Activity Report 2016

Section Partnerships and Cooperations

ALGORITHMICS, PROGRAMMING, SOFTWARE AND ARCHITECTURE

NETWORKS, SYSTEMS AND SERVICES, DISTRIBUTED COMPUTING

PERCEPTION, COGNITION AND INTERACTION

ANTIQUE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. AnaStaSec

Title: Static Analysis for Security Properties

Type: ANR générique 2014

Defi: Société de l'information et de la communication

Instrument: ANR grant

Duration: January 2015 - December 2018

Coordinator: Inria Paris-Rocquencourt (France)

Others partners: Airbus France (France), AMOSSYS (France), CEA LIST (France), Inria Rennes-Bretagne Atlantique (France), TrustInSoft (France)

Inria contact: Jérôme Feret

See also: http://www.di.ens.fr/ feret/anastasec/

Abstract: An emerging structure in our information processing-based society is the notion of trusted complex systems interacting via heterogeneous networks with an open, mostly untrusted world. This view characterises a wide variety of systems ranging from the information system of a company to the connected components of a private house, all of which have to be connected with the outside.

It is in particular the case for some aircraft-embedded computer systems, which communicate with the ground through untrusted communication media. Besides, the increasing demand for new capabilities, such as enhanced on-board connectivity, e.g. using mobile devices, together with the need for cost reduction, leads to more integrated and interconnected systems. For instance, modern aircrafts embed a large number of computer systems, from safety-critical cockpit avionics to passenger entertainment. Some systems meet both safety and security requirements. Despite thorough segregation of subsystems and networks, some shared communication resources raise the concern of possible intrusions.

Some techniques have been developed and still need to be investigated to ensure security and confidentiality properties of such systems. Moreover, most of them are model-based techniques operating only at architectural level and provide no guarantee on the actual implementations. However, most security incidents are due to attackers exploiting subtle implementation-level software vulnerabilities. Systems should therefore be analyzed at software level as well (i.e. source or executable code), in order to provide formal assurance that security properties indeed hold for real systems.

Because of the size of such systems, and considering that they are evolving entities, the only economically viable alternative is to perform automatic analyses. Such analyses of security and confidentiality properties have never been achieved on large-scale systems where security properties interact with other software properties, and even the mapping between high-level models of the systems and the large software base implementing them has never been done and represents a great challenge. The goal of this project is to develop the new concepts and technologies necessary to meet such a challenge.

The project ANASTASEC project will allow for the formal verification of security properties of software-intensive embedded systems, using automatic static analysis techniques at different levels of representation: models, source and binary codes. Among expected outcomes of the project will be a set of prototype tools, able to deal with realistic large systems and the elaboration of industrial security evaluation processes, based on static analysis.

8.1.2. REPAS

The project REPAS, Reliable and Privacy-Aware Software Systems via Bisimulation Metrics (coordination Catuscia Palamidessi, Inria Saclay), aims at investigating quantitative notions and tools for proving program correctness and protecting privacy, focusing on bisimulation metrics, the natural extension of bisimulation on quantitative systems. A key application is to develop mechanisms to protect the privacy of users when their location traces are collected. Partners: Inria (Comete, Focus), ENS Cachan, ENS Lyon, University of Bologna.

8.1.3. VerAsCo

Title: Formally-verified static analyzers and compilers

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: September 2011 - June 2016

Coordinator: Inria (France)

Others partners: Airbus France (France), IRISA (France), Inria Saclay (France)

See also: http://www.systematic-paris-region.org/fr/projets/verasco

Abstract: The usefulness of verification tools in the development and certification of critical software is limited by the amount of trust one can have in their results. A first potential issue is *unsoundness* of a verification tool: if a verification tool fails (by mistake or by design) to account for all possible executions of the program under verification, it can conclude that the program is correct while it actually misbehaves when executed. A second, more insidious, issue is *miscompilation*: verification tools generally operate at the level of source code or executable model; a bug in the compilers and code generators that produce the executable code that actually runs can lead to a wrong executable being generated from a correct program.

The project VERASCo advocates a mathematically-grounded solution to the issues of formal verifying compilers and verification tools. We set out to develop a generic static analyzer based on abstract interpretation for the C language, along with a number of advanced abstract domains and domain combination operators, and prove the soundness of this analyzer using the Coq proof assistant. Likewise, we will continue our work on the CompCert C formally-verified compiler, the first realistic C compiler that has been mechanically proved to be free of any miscompilation will be continued. Finally, the tool qualification issues that must be addressed before formally-verified tools can be used in the aircraft industry, will be investigated.

8.1.4. AstréeA

Title: Static Analysis of Embedded Asynchronous Real-Time Software

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: January 2012 - November 2016

Coordinator: Airbus France (France)

Others partners: École normale supérieure (France)

Inria contact: Antoine Miné

See also: http://www.astreea.ens.fr

Abstract: The focus of the ASTRÉEA project is on the development of static analysis by abstract interpretation to check the safety of large-scale asynchronous embedded software. During the THESEE ANR project (2006–2010), we developed a concrete and abstract models of the ARINC 653 operating system and its scheduler, and a first analyzer prototype. The gist of the ASTRÉEA project is the continuation of this effort, following the recipe that made the success of ASTRÉE: an incremental refinement of the analyzer until reaching the zero false alarm goal. The refinement concerns: the abstraction of process interactions (relational and history-sensitive abstractions), the scheduler model (supporting more synchronisation primitives and taking priorities into account), the memory model (supporting volatile variables), and the abstraction of dynamical data-structures (linked lists). Patrick Cousot is the principal investigator for this project.

8.1.5. VeriFault

This was a PEPS project for one year, coordinated by Cezara Drăgoi, on the topic of fault-tolerant distributed algorithms. These algorithms are notoriously difficult to implement correctly, due to asynchronous communication and the occurrence of faults, such as the network dropping messages or computers crashing. Although fault-tolerant algorithms are at the core of critical applications, there are no automated verification techniques that can deal with their complexity. Due to the complexity distributed systems have reached, we believe it is no longer realistic nor efficient to assume that high level specifications can be proved when development and verification are two disconnected steps in the software production process. Therefore we propose to introduce a domain specific language that has a high-level control structure which focuses on the algorithmic aspects rather than on low-level network and timer code, and makes programs amendable to automated verification.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

ASSUME, ITEA 3 project (Affordable Safe & Secure Mobility Evolution). Affordable Safe & Secure Mobility Evolution

Future mobility solutions will increasingly rely on smart components that continuously monitor the environment and assume more and more responsibility for a convenient, safe and reliable operation. Currently the single most important roadblock for this market is the ability to come up with an affordable, safe multi-core development methodology that allows industry to deliver trustworthy new functions at competitive prices. ASSUME will provide a seamless engineering methodology, which addresses this roadblock on the constructive and analytic side.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Prof. Kwangkeun Yi Visiteur from Seoul National University, was an invited visitor until Oct 2016.

8.3.1.1. Internships

- Ken Chanseau Saint-Germain, ENS Paris, until Aug 2016
- Marc Chevalier, ENS Lyon, since Sept 2016
- Anton Kulaga, Jul and Aug 2016
- Yoon Seok Ko, Inria, until Jun 2016
- David Romero Suarez, Inria, from Feb 2016 until May 2016]
- Gaelle Candel, Chimie ParisTech

AOSTE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. HOPE
Participants: Carlos Gomez Cardenas, Ameni Khecharem, Emilien Kofman, Robert de Simone.

The ANR HOPE project focused on hierarchical aspects for the high-level modeling and early estimation of power management techniques, with potential synthesis in the end if feasible. Partners were Intel, Synopsys, Magillem, UNS UMR LEAT, and ourselves.

We defined a multi-view, Model-Based design environment named MuVarch, accounting for power-level and performance of embedded hardware architectures, together with representation of abstract applications defining typical use cases fro these platforms.

Started in November 2013, the project reached its completion in February 2016, while Ameni Khecharem PhD defense took place in April 2016 [16].

8.1.1.2. GeMoC
Participants: Matias Vara Larsen, Julien Deantoni, Frédéric Mallet.

This project was admistratively handled by CNRS for our joint team, on the UMR I3S side. It ended September 2016. Partners were Inria (DiverSE EPC), ENSTA-Bretagne, IRIT, Obeo, Thales TRT and Supelec. The project focused on the executable modeling of heterogeneous systems using Models of Computation and Communication described using meta-languages. Specifically, the operational semantics of languages were equipped with precise timely constraints specified in CCSL. There were many outputs from the project but, from AOSTE perspective, we essentially developped MoCCML, an extension of CCSL with constraint automata (already integrated to TimeSquare) and BCool, a language dedicated to coordination apttern specification, which is described as part of Matias Vara-Larsen PhD thesis[19]. All the development realized in this project will end up as the first official eclipse research consortium.

8.1.1.3. FUI CLISTINE
Participants: Robert de Simone, Amin Oueslati, Emilien Kofman.

This project was started in Oct 2013, and provides PhD funding for Amine Oueslati. Partners are SynergieCAD (coordinator), Avantis, Optis, and the two EPIs Aoste and Nachos. The goal is to study the feasibility of building a low-cost, low-power "supercomputer", reusing ideas from SoC design, but this time with out-of-chip network "on-board", and out-of-the-shelf processor elements organized as an array. The network itself should be time predictable and highly parallel (far more than PCI-e for instance). We started a thorough classification of parallel program types (known as "Dwarfs" in the literature), to provide benchmarks and evaluate the platform design options.

8.1.1.4. FUI Waruna
Participants: Liliana Cucu, Adriana Gogonel, Walid Talaboulma, Dorin Maxim.

This recent project was started in September 2015. It targets the creation of a framework allowing to connect different existing methods while enriching the description with Waruna results. This framework allows timing analyses for different application domains like avionics, railways, medical, aerospace, automotive, etc.

8.1.2. Investissements d'Avenir

8.1.2.1. DEPARTS
Participants: Liliana Cucu-Grosjean, Adriana Gogonel, Walid Talaboulma.

This project is funded by the BGLE Call (*Briques Logicielles pour le Logiciel Embarqué*) of the national support programme *Investissements d'Avenir*. Formally started on October 1st, 2012 with the kick-off meeting held on April, 2013 for administrative reasons. Research will target solutions for probabilistic component-based models, and a Ph.D. thesis should start at latest on September 2015. The goal is to unify in a common framework probabilistic scheduling techniques with compositional assume/guarantee contracts that have different levels of criticality.

8.1.2.2. CLARITY
Participants: Frédéric Mallet, Julien Deantoni, Ales Mishchenko, Robert de Simone, Marie Agnès Peraldi-Frati.

This project is funded by the LEOC Call (*Logiciel Embarqué et Objets Connectés*) of the national support programme *Investissements d'Avenir*. It was started in September 2014 , and a kick-of meeting was held on October 9th. Partners are: Thales (several divisions), Airbus, Areva, Altran, All4Tec, Artal, the Eclipse Fondation, Scilab Enterprises, CESAMES, U. Rennes, and Inria. The purpose of the project is to develop and promote an open-source version of the ARCADIA Melody system design environment from Thales, renamed CAPPELLA for that purpose.
Our technical contributions to the project achievement are described in subsection 6.2 .

8.1.2.3. Capacites
Participants: Liliana Cucu-Grosjean, Dumitru Potop-Butucaru, Yves Sorel, Walid Talaboulma.

This project is funded by the LEOC Call (*Logiciel Embarqué et Objets Connectés*) of the national support programme *Investissements d'Avenir*. It has started on November 1st, 2014 with the kick-off meeting held on November, 12th 2014. The project cordinator is Kalray, and the objective of the project is to study the relevance of Kalray-style MPPA processor array for real-time computation in the avionic domain (with partners such as Airbus for instance). The post-doc of Mihail Asavoae and the PhD of Walid Talaboulma are funded on this contract.

8.2. European Initiatives

8.2.1. *Collaborations in European Programs, Except FP7 & H2020*

8.2.1.1. ASSUME
Participants: Dumitru Potop-Butucaru, Keryan Didier, Liliana Cucu.

This project is funded by the ITEA3 program. It has started on September 1st 2015. Project coordinator is Daimler. ASSUME has funded the (now completed) post-doc of Raul Gorcitz, and funds the PhD thesis of Keryan Didier.

Future mobility solutions will increasingly rely on smart components that continuously monitor the environment and assume more and more responsibility for a convenient, safe and reliable operation. Currently the single most important roadblock for this market is the ability to come up with an affordable, safe multi-core development methodology that allows industry to deliver trustworthy new functions at competitive prices. ASSUME will provide a seamless engineering methodology, which addresses this roadblock on the constructive and analytic side.

In this project, most our effort goes to work package "Synthesis of Predictable Concurrent Systems", which we lead. Main scientific results of our work in this project have beenn presented in sections 6.11 and 6.12 . In addition, we closely interacted with our industrial partners to determine their needs, and developed importer tools for their internal formalisms, including Scade v4 and internal formalisms used at Airbus (all importers were developed jointly with EPI PARKAS). This work also resulted in proposals to Airbus on the specification of certain non-functional properties (e.g. the atomic groups of operations that cannot be split during allocation and scheduling). By applying our prototype tools, we have also determined that the use case has significant potential parallelism and will achieve significant speedups through execution on the chosen target architecture (the many-core Kalray MPPA256).

8.3. International Initiatives

8.3.1. FM4CPS

Title: Formal Models and tools for Cyber-Physical Systems

International Partner (Institution - Laboratory - Researcher):

ECNU (China) - Artificial Intelligence Lab - Jifeng He

Start year: 2015

See also: https://project.inria.fr/fm4cps/

Cyber-Physical Systems (CPS) and the connected Internet of Things (IoT) are inherently heterogeneous systems, with ("cyber") computer digital parts interacting with their physical sensible environment, under user requirements for functional and temporal correctness. Thus, design of such systems as a whole requires a diversity of models, and the behavior orchestration between such models must be carefully defined and analyzed.

FM4CPS will address several facets of Formal Model-Driven Engineering for Cyber-Physical Systems and Internet of Things. The design of such large heterogeneous systems calls for hybrid modeling, and the combination of classes of models, most previously well-established in their own restricted area: Formal Models of Computations drawn from Concurrency Theory for the "cyber" discrete processors, timed extension and continuous behaviors for physical environments, requirement models and user constraints extended to non-functional aspects, new challenges for designing and analyzing large and highly dynamic communicating software entities. Orchestration and comparison of models, with their expressive power vs. their decidable aspects, shall be considered with the point of view of hybrid/heterogeneous modeling here. Main aspects are the various timing or quantitative structure extensions relying for instance on a hybrid logical clock model for the orchestration of underlying components.

The associated team aims at various level of research, from formal models, semantics, or complexity, to experimental tools development. This will start for example on one side with building a formal orchestration model for CPSs, based on an hybrid clock model that combine discrete and physical time, synchronous and asynchronous computations or communications. Another goal will be the study of expressiveness and decidability for CPS, based on dedicated sub-families of well-structured push-down systems, addressing both unbounded communication and time-sensitive models.

Beyond their own expertise in this field, the partners will build on the results of previous cooperations in the context of the Liama projects Hades and Tempo, and the associated team DAESD. The current proposal widely broadens the domain of collaboration, and with the inclusion, for the first time, of Jiao Tong University. We expect this is the first step towards the extension of LIAMA in Shanghai with the strengthening of the involvement of E.C.N.U., and the contribution of new top notch universities such as Jiaotong.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

We have signed an agreement with the University of Verona, which covers joint activities (see section 6.7 , together with the housing of interns.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Nieto Luis Agustin

Date: Sep 2015 - Feb 2016

Institution: Universidad de Buenos Aires (Argentina)

<p style="text-align:center; color:red">ARIC Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

ARC6 PHD PROGRAMME.   The PhD grant of Valentina Popescu is funded since September 2014 by Région Rhône-Alpes through the "ARC6" programme.

PALSE PROJECT.   Benoît Libert was awarded a 500keur grant (from July 2014 to November 2016) for his PALSE (Programme d'Avenir Lyon Saint-Etienne) project *Towards practical enhanced asymmetric encryption schemes*.

8.2. National Initiatives

8.2.1. ANR HPAC Project

Participants: Claude-Pierre Jeannerod, Nicolas Louvet, Clément Pernet, Nathalie Revol, Gilles Villard.

"High-performance Algebraic Computing" (HPAC) was a four year ANR project that started in January 2012 and was extended till mid-2016. The final report has been sent in July 2016. The Web page of the project is http://hpac.gforge.inria.fr/. HPAC has been headed by Jean-Guillaume Dumas (CASYS team, LJK laboratory, Grenoble); it was involving AriC as well as the Inria project-team MOAIS (LIG, Grenoble), the Inria project-team PolSys (LIP6 lab., Paris), the ARITH group (LIRMM laboratory, Montpellier), and the HPC Project company.

The overall ambition of HPAC was to provide international reference high-performance libraries for exact linear algebra and algebraic systems on multi-processor architecture and to influence parallel programming approaches for algebraic computing. The central goal has been to extend the efficiency of the LinBox and FGb libraries to new trend parallel architectures such as clusters of multi-processor systems and graphics processing units in order to tackle a broader class of problems in lattice-based cryptography and algebraic cryptanalysis. HPAC has conducted researches along three axes:

- A domain specific parallel language (DSL) adapted to high-performance algebraic computations;
- Parallel linear algebra kernels and higher-level mathematical algorithms and library modules;
- Library composition, their integration into state-of-the-art software, and innovative high-performance solutions for cryptology challenges.

8.2.2. ANR DYNA3S Project

Participants: Guillaume Hanrot, Gilles Villard.

Dyna3s is a four year ANR project that started in October 2013. The Web page of the project is https://www.irif.fr/~dyna3s. It is headed by Valérie Berthé (U. Paris 7) and involves also the University of Caen.

The aim is to study algorithms that compute the greatest common divisor (gcd) from the point of view of dynamical systems. A gcd algorithm is considered as a discrete dynamical system by focusing on integer input. We are mainly interested in the computation of the gcd of several integers. Another motivation comes from discrete geometry, a framework where the understanding of basic primitives, discrete lines and planes, relies on algorithm of the Euclidean type.

8.2.3. ANR FastRelax Project

Participants: Nicolas Brisebarre, Guillaume Hanrot, Vincent Lefèvre, Jean-Michel Muller, Bruno Salvy, Serge Torres, Silviu Filip.

FastRelax stands for "Fast and Reliable Approximation". It is a four year ANR project started in October 2014. The web page of the project is http://fastrelax.gforge.inria.fr/. It is headed by B. Salvy and involves AriC as well as members of the Marelle Team (Sophia), of the Mac group (LAAS, Toulouse), of the Specfun and Toccata Teams (Saclay), as well as of the Pequan group in UVSQ and a colleague in the Plume group of LIP.

The aim of this project is to develop computer-aided proofs of numerical values, with certified and reasonably tight error bounds, without sacrificing efficiency. Applications to zero-finding, numerical quadrature or global optimization can all benefit from using our results as building blocks. We expect our work to initiate a "fast and reliable" trend in the symbolic-numeric community. This will be achieved by developing interactions between our fields, designing and implementing prototype libraries and applying our results to concrete problems originating in optimal control theory.

8.2.4. ANR MetaLibm Project

Participants: Claude-Pierre Jeannerod, Jean-Michel Muller.

MetaLibm is a four-year project (started in October 2013) focused on the design and implementation of code generators for mathematical functions and filters. The web page of the project is http://www.metalibm.org/ANRMetaLibm/. It is headed by Florent de Dinechin (INSA Lyon and Socrate team) and, besides Socrate and AriC, also involves teams from LIRMM (Perpignan), LIP6 (Paris), CERN (Geneva), and Kalray (Grenoble). The main goals of the project are to automate the development of mathematical libraries (libm), to extend it beyond standard functions, and to make it unified with similar approaches developed in or useful for signal processing (filter design). Within AriC, we are especially interested in studying the properties of fixed-point arithmetic and floating-point arithmetic that can help develop such a framework.

8.2.5. ANR ALAMBIC Project

Participants: Benoît Libert, Fabien Laguillaumie.

ALAMBIC is a four-year project (started in October 2016) focused on the applications of cryptographic primitives with homomorphic or malleability properties. The web page of the project is https://crypto.di.ens.fr/projects:alambic:description. It is headed by Damien Vergnaud (ENS Paris and CASCADE team) and, besides AriC, also involves teams from the XLIM laboratory (Université de Limoges) and the CASCADE team (ENS Paris). The main goals of the project are: (i) Leveraging the applications of malleable cryptographic primitives in the design of advanced cryptographic protocols which require computations on encrypted data; (ii) Enabling the secure delegation of expensive computations to remote servers in the cloud by using malleable cryptographic primitives; (iii) Designing more powerful zero-knowledge proof systems based on malleable cryptography.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

LATTAC ERC GRANT. Damien Stehlé was awarded an ERC Starting Grant for his project *Euclidean lattices: algorithms and cryptography* (LattAC) in 2013 (1.4Meur for 5 years from January 2014). The LattAC project aims at studying all computational aspects of lattices, from algorithms for manipulating them to applications. The main objective is to enable the rise of lattice-based cryptography.

OPENDREAMKIT is a H2020 Infrastructure project providing substantial funding to the open source computational mathematics ecosystem. It will run for four years, starting from September 2015. Clément Pernet is a participant.

8.4. International Research Visitors

8.4.1. Visiting Scientists

- George Labahn, Professor at U. Waterloo, Ontario, Canada spent the month of April with our team.

- Elena Kirshanova, PhD student at Ruhr-U. Bochum, Germany spent one month with our team, from mid-February to mid-March.
- Jiantao Li, PhD student at East China Normal U., China spends a year with our team. He arrived in September.

8.4.2. Internships

Willy Quach

      Date: February 2016–June 2016

      Institution: ENS de Lyon

      Supervisor: Damien Stehlé

Balthazar Bauer

      Date: March 2016–August 2016

      Institution: Paris 7

      Supervisor: Benoît Libert

Qian Chen

      Date: March 2016–August 2016

      Institution: ENS Rennes

      Supervisors: Fabien Laguillaumie and Benoît Libert

Thi Xuan Vu

      Date: May 2016–July 2016

      Institution: ENS de Lyon

      Supervisors: Claude-Pierre Jeannerod and Vincent Neiger

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AROMATH Project-Team

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7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Inria SAM Action Transverse*
Participants: Paul Görlach, Evelyne Hubert.

Finding biomarkers of abnormalities of the white matter is one important problem in dMRI processing. As these biomarkers need to be independent of the orientation of the head, they are functions of the rotational invariants of the shapes that characterize the diffusion probabilities in the white matter. While the situation is well understood for second order tensors, these are not powerful enough to represent crossings in the white matter. Acquisitions made with the HARDI scheme allow for a richer description of probabilities. In particular, the project-team ATHENA has modelled them as (positive) ternary quartics (symmetric tensors of order 4). But invariants of these quartics are not well known. For a long period, only six were known, when there should be at least 12. Strategies were developed in the project-team ATHENA to compute more invariants, either algebraic [25] or polynomial [21]. The former suffered some instability issues in their evaluations, the latter did not form a minimal set. The goal of this "Transverse action" was to team up with expertise in algebraic computation and leverage the methods [23], [24], [22] [19], [7] developed in the project team AROMATH to gain more insight in this problem of rotational invariants of ternary quartics.

This action is done in collaboration with Théodore Papadopoulo (ATHENA team).

7.1.2. *CIMI thematic project*
Participant: Evelyne Hubert.

Labex CIMI Toulouse supports the project *Joint Implicit and Parametric Representation based on Skeleton* where the PI are Géraldine Morin (IRIT, Vortex team) and Evelyne Hubert. This project aims at developing a mathematical model and software for surfaces, based on a joint parametric and implicit representation, with a skeleton.

7.2. European Initiatives

7.2.1. *FP7 & H2020 Projects*

Program: Marie Skłodowska-Curie ITN

Project acronym: ARCADES

Project title: Algebraic Representations in Computer-Aided Design for complEx Shapes

Duration: January 2016 - December 2019

Coordinator: I.Z. Emiris (NKUA, Athens, Greece, and ATHENA Research Innovation Center)

Scientist-in-charge at Inria: L. Busé

Other partners: U. Barcelona (Spain), Inria Sophia-Antipolis (France), J. Kepler University, Linz (Austria), SINTEF Institute, Oslo (Norway), U. Strathclyde, Glascow (UK), Technische U. Wien (Austria), Evolute GmBH, Vienna (Austria).

Webpage: http://arcades-network.eu/

Abstract: ARCADES aims at disrupting the traditional paradigm in Computer-Aided Design (CAD) by exploiting cutting-edge research in mathematics and algorithm design. Geometry is now a critical tool in a large number of key applications; somewhat surprisingly, however, several approaches of the CAD industry are outdated, and 3D geometry processing is becoming increasingly the weak link. This is alarming in sectors where CAD faces new challenges arising from fast point acquisition, big data, and mobile computing, but also in robotics, simulation, animation, fabrication and manufacturing, where CAD strives to address crucial societal and market needs. The challenge taken up by ARCADES is to invert the trend of CAD industry lagging behind mathematical breakthroughs and to build the next generation of CAD software based on strong foundations from algebraic geometry, differential geometry, scientific computing, and algorithm design. Our game-changing methods lead to real-time modelers for architectural geometry and visualisation, to isogeometric and design-through-analysis software for shape optimisation, and marine design & hydrodynamics, and to tools for motion design, robot kinematics, path planning, and control of machining tools.

7.3. International Initiatives

7.3.1. Participation in Other International Programs

7.3.1.1. PICS project
Participant: Laurent Busé.

We participate to a bilateral collaboration between France and Spain which is supported as a PICS from CNRS. This project, titled *Diophantine Geometry and Computer Algebra*, aims at exploring interactions between diophantine geometry and computer algebra by stimulating collaborations between experts in both domains. The research program focuses on five particular topics : toric varieties and height, equidistribution, Diophantine geometry and complexity, factorization of multivariate polynomials by means of toric geometry and study of singularities of toric parameterizations.

The Spanish partner is the University of Barcelona, with participants J. Burgos, C. D'Andrea, Martin Sombra, and the French partners are the university of Caen, with participants F. Amoroso and M. Weimann, the University of Paris 6, with participants M. Chardin and P. Philippon and the Inria project-team AROMATH, with participant L. Busé.

7.3.1.2. SYRAM project
Participants: Laurent Busé, Bernard Mourrain, André Galligo.

Title: Geometry of SYzygies of RAtional Maps with applications to geometric modeling (SYRAM)

We coordinate a research project which is funded by the regional program Math-AmSud for two years : 2015-2016. This project is composed by research teams from Argentina, Universidad de Buenos Aires (Nicolás Botbol, Alicia Dickenstein), Brazil, Universidade Federal de Rio de Janeiro, de Pernambuco e de Sergipe (Sayed Hamid Hassanzadeh, Aron Simis) and France, Institut de Mathématiques de Jussieu (Marc Chardin) and the Inria project-team AROMATH.

The study of rational maps is of theoretical interest in algebraic geometry and commutative algebra, and of practical importance in geometric modeling. This research proposal focuses on rational maps in low dimension, typically parameterizations of curves and surfaces embedded in the projective space of dimension three, but also dominant rational maps in dimension two and three. The two main objectives amount to unravel geometric properties of these rational maps from the syzygies of their projective coordinates. The first one aims at extending and generalizing the determination of the closed image of a rational map, as well as its geometric features, whereas the second one will focus on the study of dominant rational maps, in particular on the characterization of those that are generically one-to-one.

7.4. International Research Visitors

7.4.1. *Visits of International Scientists*

Cordian Riener (University of Konstanz, Germany) visited from September 4-9th, 2016 to collaborate on symmetry, orthogonal polynomials and cubature with Evelyne Hubert and Bernard Mourrain.

Lan Nguyen (University of Vietnam at Hanoï) visited to collaborate on implicitization of rational maps with Laurent Busé. His visits received the financial support of LIAFV (International Laboratory for France-Vietnam collaborations in mathematics).

Aron Simis (University of Pernambuco, Brazil) visited to collaborate on syzygies of rational maps with Laurent Busé.

Nicolas Botbol (Universidad de Buenos Aires, Argentina) visited to collaborate on distance function to rational curves and surfaces with Laurent Busé.

7.4.1.1. *Internships*

Paul Görlach (University of Bonn) came to work on the *CRISAM - Transverse action* between the project teams AROMATH and ATHENA (August-December).

Akshit Goyal and Deepak Bhatt (IIT Dehli) worked during their internship on "Meshing Singular Isosurfaces" and "Isosurface of the distance function" (May-July).

Antoine Deharveng, student at the engineer school of the University of Nice Sophia Antipolis, came since June 15 to work on the extraction of geometric primitives in a 3D point cloud under the supervision of Laurent Busé.

7.4.2. *Visits to International Teams*

7.4.2.1. *Sabbatical programme*

Evelyne Hubert was in Ontario from September 1st 2015 to February 29th 2016, with the sabbatical programme of Inria DPEI. For the period of January and February 2016 she was hosted and supported by University of Waterloo, visiting the Symbolic Computation Lab, and more particularly Pr. George Labahn.

Bernard Mourrain was invited at Univ. of Texas, Austin, for a collaboration with Pr. Chandajit Bajaj (7th-19th May).

CAIRN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Images & Réseaux Competitivity Cluster - Embrace (2014-2016)*

Participants: Raphaël Bardoux, Arnaud Carer, Olivier Sentieys.

Embrace (Embedded Radio Accelerator) is a project which involves CAIRN and two Small Medium Enterprises (SMEs): Digidia and PrimeGPS. Embrace aims at developing a software radio platform to enable the digital demodulation of HF signals. Both SMEs will use this platform as the first step to implement new products. These products will be dedicated to two different applications (Global Navigation Satellite System and Navigation Safety) at the heart of the markets of the SMEs. CAIRN goal is the technological transfer of the methods proposed by the team that enable the rapid prototyping of digital radios.

8.2. National Initiatives

8.2.1. *ANR Blanc - PAVOIS (2012–2016)*

Participants: Arnaud Tisserand, Emmanuel Casseau, Jérémie Métairie, Karim Bigou, Pierre Guilloux.

PAVOIS is a project on Arithmetic Protections Against Physical Attacks for Elliptic Curve based Cryptography that will provide novel implementations of curve based cryptographic algorithms on custom hardware platforms. A specific focus is placed on trade-offs between efficiency and robustness against physical attacks. It involves IRISA-CAIRN (Lannion) and LIRMM (Perpignan and Montpellier). Theoretical aspects include an investigation of how special number representations can be used to speed-up cryptographic algorithms, and protect cryptographic devices from physical attacks. On the practical side, we design innovative cryptographic hardware architectures of a specific processor based on the theoretical advancements described above to implement curve based protocols. For more details see http://pavois.irisa.fr.

8.2.2. *ANR Ingénérie Numérique et Sécurité - ARDyT (2011-2016)*

Participants: Arnaud Tisserand, Pierre Guilloux.

ARDyT is a project on a Reliable and Reconfigurable Dynamic Architecture. It involves IRISA-CAIRN (Lannion), Lab-STICC (Lorient), LIEN (Nancy) and ATMEL. The purpose of the ARDyT project is to provide a complete environment for the design of a fault tolerant and self-adaptable platform. Then, a platform architecture, its programming environment and management methodologies for diagnosis, testability and reliability have to be defined and implemented. The considered techniques are exempt from the use of hardened components for terrestrial and aeronautics applications for the design of low-cost solutions. For more details see http://ardyt.irisa.fr.

8.2.3. *Labex CominLabs - BoWI (2012-2016)*

Participants: Olivier Sentieys, Arnaud Carer.

The BoWi project (Body Wold Interactions) project aims at designing an accurate gesture and body movement estimation using very-small and low-power wearable sensor nodes, to propose pioneer interfaces for an emerging interacting world based on smart environments (house, media, information and entertainment systems...). Relying on Wireless Body Areas Sensor Networks, we propose an accurate Gesture and Body Movement estimation with extremely severe constraints in terms of footprint and energy consumption. The BoWI geolocation approach will combine radio communication distance measurement and inertial sensors and will also strongly benefit from cooperative techniques based on multiple observations and distributed computation. Different types of applications, such as health care, activity monitoring and environment control, are considered and prototyped. BoWI involves CAIRN, IRISA Granit (Lannion), IETR (Rennes), and Lab-STICC (Brest, Lorient, Vannes). For more details see http://www.bowi.cominlabs.ueb.eu.

8.2.4. *Labex CominLabs - 3DCORE (2014-2018)*

Participants: Olivier Sentieys, Daniel Chillet, Cédric Killian, Jiating Luo, Van Dung Pham, Ashraf El-Antably.

3DCORE (3D Many-Core Architectures based on Optical Network on Chip) is a project investigating new solutions based on silicon photonics to enhance by 2 to 3 magnitude orders energy efficiency and data rate of on-chip interconnect in the context of a many-core architecture. Moreover, 3DCore will take advantage of 3D technologies to design a specific optical layer suitable for a flexible and energy efficient high-speed optical network on chip (ONoC). 3DCORE involves CAIRN, FOTON (Rennes, Lannion) and Institut des Nanotechnologies de Lyon. For more details see http://www.3d-opt-many-cores.cominlabs.ueb.eu.

8.2.5. *Labex CominLabs - RELIASIC (2014-2018)*

Participants: Emmanuel Casseau, Arnaud Tisserand.

RELIASIC (Reliable Asic) will address the issue of fault-tolerant computation with a bottom-up approach, starting from an existing application as a use case (a GPS receiver) and adding some redundant mechanisms to allow the GPS receiver to be tolerant to transient errors due to low voltage supply. RELIASIC involves CAIRN, Lab-STICC (Lorient) and IETR (Rennes). For more details see http://www.reliasic.cominlabs.ueb.eu In this project, CAIRN is in charge of the analysis and design of arithmetic operators for fault tolerance. We focus on the hardware implementations of conventional arithmetic operators such as adders, multipliers and MACs but also higher level operators like butterfly computation operator for FFT algorithm.

8.2.6. *Labex CominLabs & Lebesgue - H-A-H (2014-2017)*

Participants: Arnaud Tisserand, Karim Bigou, Gabriel Gallin, Audrey Lucas.

H-A-H for *Hardware and Arithmetic for Hyperelliptic Curves Cryptography* is a project on advanced arithmetic representation and algorithms for hyper-elliptic curve cryptography. It will provide novel implementations of HECC based cryptographic algorithms on custom hardware platforms. H-A-H involves CAIRN (Lannion) and IRMAR (Rennes). For more details see http://h-a-h.inria.fr/.

8.3. European Initiatives

8.3.1. *H2020 ARGO*

Participants: Steven Derrien, Olivier Sentieys, Imen Fassi, Ali Hassan El-Moussawi.

> Program: H2020-ICT-04-2015
> Project acronym: ARGO
> Project title: WCET-Aware Parallelization of Model-Based Applications for Heterogeneous Parallel Systems
> Duration: Feb. 2016 - Feb. 2019
> Coordinator: KIT
> Other partners: KIT (DE), UR1/Inria/CAIRN (FR), Recore Systems (NL), TEI-WG (GR), Scilab Ent. (FR), Absint (DE), DLR (DE), Fraunhofer (DE)

Increasing performance and reducing cost, while maintaining safety levels and programmability are the key demands for embedded and cyber-physical systems, e.g. aerospace, automation, and automotive. For many applications, the necessary performance with low energy consumption can only be provided by customized computing platforms based on heterogeneous many-core architectures. However, their parallel programming with time-critical embedded applications suffers from a complex toolchain and programming process. ARGO will address this challenge with a holistic approach for programming heterogeneous multi- and many-core architectures using automatic parallelization of model-based real-time applications. ARGO will enhance WCET-aware automatic parallelization by a cross-layer programming approach combining automatic tool-based and user-guided parallelization to reduce the need for expertise in programming parallel heterogeneous architectures. The ARGO approach will be assessed and demonstrated by prototyping comprehensive time-critical applications from both aerospace and industrial automation domains on customized heterogeneous many-core platforms.

8.3.2. ANR International ARTEFaCT

Participants: Olivier Sentieys, Benjamin Barrois, Tara Petric, Tomofumi Yuki.

Program: ANR International France-Switzerland

Project acronym: ARTEFaCT

Project title: AppRoximaTivE Flexible Circuits and Computing for IoT

Duration: Feb. 2016 - Dec. 2019

Coordinator: CEA

Other partners: CEA-LETI (FR), CAIRN (FR), EPFL (SW)

The ARTEFaCT project aims to build on the preliminary results on inexact and exact near-threshold and sub-threshold circuit design to achieve major energy consumption reductions by enabling adaptive accuracy control of applications. ARTEFaCT proposes to address, in a consistent fashion, the entire design stack, from physical hardware design, up to software application analysis, compiler optimizations, and dynamic energy management. We do believe that combining sub-near-threshold with inexact circuits on the hardware side and, in addition, extending this with intelligent and adaptive power management on the software side will produce outstanding results in terms of energy reduction, i.e., at least one order of magnitude, in IoT applications. The project will contribute along three research directions: (1) approximate, ultra low-power circuit design, (2) modeling and analysis of variable levels of computation precision in applications, and (3) accuracy-energy trade- offs in software.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. HARDIESSE

Title: Heterogeneous Accelerators for Reconfigurable DynamIc, Energy efficient, Secure SystEms

International Partner (Institution - Laboratory - Researcher):

University of Massachusetts at Ahmerst (United States) - Reconfigurable Computing Group - Russel Tessier

Start year: 2014

See also: https://team.inria.fr/cairn/hardiesse/

Rapid evolutions of applications and standards require frequent in-the-field system modifications and thus strengthens the need for adaptive devices. This need for a strong flexibility, combined with technology evolution (and the so-called power wall) has motivated the surge towards the use of multiple processor cores on a single chip (MPSoC). While it is now clear that we have entered the multi-core era, it is however indisputable that, especially for energy-efficient embedded systems, these architectures will have to be heterogeneous, by combining processor cores and specialized accelerators. We foresee a need for systems able to continuously adapt themselves to changing environments where software updates alone will not be enough for tackling energy management and error tolerance challenges. We believe that a dynamic and transparent adaptation of the hardware structure is the key to success. Security will also be an important challenge for embedded devices. Protections against physical attacks will have to be integrated in all secured components. In this Associated Team, we study new reconfigurable structures for such hardware accelerators with specific focus on: energy efficiency, runtime dynamic reconfiguration, security, and verification.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

8.4.2.1.1. LRS

Title: Loop unRolling Stones: compiling in the polyhedral model

International Partner (Institution - Laboratory - Researcher):

Colorado State University (United States) - Department of Computer Science - Prof. Sanjay Rajopadhye

8.4.2.1.2. HARAMCOP

Title: Hardware accelerators modeling using constraint-based programming

International Partner (Institution - Laboratory - Researcher):

Lund University (Sweden) - Department of Computer Science - Prof. Krzysztof Kuchcinski

8.4.2.1.3. SPINACH

Title: Secure and low-Power sensor Networks Circuits for Healthcare embedded applications

International Partner (Institution - Laboratory - Researcher):

University College Cork (Ireland) - Department of Electrical and Electronic Engineering - Prof. Liam Marnane and Prof. Emanuel Popovici

Arithmetic operators for cryptography, side channel attacks for security evaluation, energy-harvesting sensor networks, and sensor networks for health monitoring.

8.4.2.2. Informal International Partners

Imec (Belgium), Fault-tolerant computing architectures.

Ecole Polytechnique Fédérale de Lausanne - EPFL (Switzerland), Optimization of embedded systems using fixed-point arithmetic, approximate computing.

Technical University of Madrid - UPM (Spain), Optimization of embedded systems using fixed-point arithmetic.

LSSI laboratory, Québec University in Trois-Rivières (Canada), Design of architectures for digital filters and mobile communications.

Department of Electrical and Computer Engineering, University of Patras (Greece), Wireless Sensor Networks, Worst-Case Execution Time, priority scheduling, loop transformations for memory optimizations.

Karlsruhe Institute of Technology - KIT (Germany), Loop parallelization and compilation techniques for embedded multicores.

Ruhr - University of Bochum - RUB (Germany), Reconfigurable architectures.

University of Science and Technology of Hanoi (Vietnam), Participation of several CAIRN's members in the Master ICT / Embedded Systems.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Prof. Maciej Cieselski, University of Massachusetts, Amherst, US, for three weeks in July. This visit was partly funded by HARDIESSE Inria Associate Team.

Prof. Daniel Massicotte, Université du Québec à Trois-Rivières, CA, for three weeks in December. This visit was funded by ISTIC.

Maroua Gam, LabTim (Technologie Imagerie Médicale), Monastir, Tunisia, for one month in March.

8.5.2. Visits to International Teams

Angeliki Kritikakou visited University of Patras, Greece, for 1 week in November. This visit was funded by U. Rennes 1.

Patrice Quinton visited University of Massachusetts, Amherst, US, for 1 week in December. This visit was funded by HARDIESSE Inria Associate Team.

Tomofumi Yuki visited University of Arizona, US, in June.

8.5.2.1. Sabbatical programme

Casseau Emmanuel

Date: Aug 2016 - Jul 2017

Institution: University of Auckland (New Zealand), Parallel and Reconfigurable Research Lab. of the Electrical and Computer Engineering department.

The goal of the project is to propose dynamic mapping and scheduling algorithms dedicated to unreliable heterogeneous platforms, enabling self-adaptive and resource-aware computing.

<p style="text-align:center; color:red;">**CAMUS Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

Philippe Clauss, Alain Ketterlin, Cédric Bastoul and Vincent Loechner are involved in the Inria Project Lab entitled "Large scale multicore virtualization for performance scaling and portability" and regrouping several french researchers in compilers, parallel computing and program optimization [0]. The project started officially in January 2013. In this context and since January 2013, Philippe Clauss is co-advising with Erven Rohou of the Inria team PACAP, Nabil Hallou's PhD thesis focusing on dynamic optimization of binary code.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

The CAMUS team maintains regular contacts with the following entities:

- Reservoir Labs, New York, NY, USA
- University of Batna, Algeria
- Ohio State University, Colombus, USA
- Louisiana State University, Baton Rouge, USA
- Colorado State University, Fort Collins, USA
- Indian Institute of Science (IIIS) Bangalore, India

9.3. International Research Visitors

9.3.1. Visits of International Scientists

9.3.1.1. Researchers

Rachid Seghir

Date: April 30 - May 14

Institution: University of Batna, Algeria

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[0] https://team.inria.fr/multicore

CARAMBA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PEPS JCJC INS2I SPICE

The SPICE proposal ("Systèmes Polynomiaux et calcul d'Indice sur les Courbes Elliptiques : indicateurs de complexité en petite caractéristique") has been accepted in the PEPS JCJC INS2I program in 2016. It involves Pierre-Jean Spaenlehauer (CARAMBA) and Vanessa Vitse (Université Joseph Fourier). This project is coordinated by Vanessa Vitse.

<p style="text-align:center">**CARTE Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

We participate in a PEPS project "Jeux quantiques sans probabilite´s". The partners are Mehdi Mhalla (CR CNRS, LIG, coordinator), Pablo Arrighi (Prof. Aix-Marseille), Paul Dorbec (MdC, U. Bordeaux), Frédéric Magniez (DR CNRS, IRIF), Simon Perdrix (CR CNRS, CARTE).

7.1.1. ANR

- The team is a funding partner in ANR Elica (2014-2019), "Elargir les idées logistiques pour l'analyse de complexité". The CARTE team is well-known for its expertise in implicit computational complexity.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

Mathieu Hoyrup participates in the Marie-Curie RISE project *Computing with Infinite Data* coordinated by Dieter Spreen (Univ. Siegen) that has been accepted and will start in April 2017.

7.3. International Initiatives

7.3.1. Participation in Other International Programs

- An Hubert Curien Partnership (PHC) PHC Imhotep from the French Ministry of Foreign Affairs and with the support of the French Ministry of National Education and Ministry of Higher Education and Research holds between members of EPC CARTE and Alexandria E-Just University.

- Foundations of Quantum Computation: Syntax and Semantics (FoQCoSS), Regional Program STIC-AmSud. This 2-year project has been accepted in late 2015. The Argentinian-Brazilian-French consortium consists of: Pablo ARRIGHI (Université Aix-Marseille, France), Alejandro DIAZ-CARO (Universidad Nacional de Quilmes, Argentina), Gilles DOWEK (Inria, France), Juliana KAIZER VIZZOTTO (Universidade Federal de Santa Maria, Brazil), Simon PERDRIX (CNRS/CARTE, France) and Benoît VALIRON (CentraleSupélec – LRI, France). The ultimate goal of this project is to study the foundations of quantum programming languages and related formalisms. With this goal in mind, we will need to study topics such as parallelism, probabilistic systems, isomorphisms, etc., which constitute subjects of study by themselves. The interest goes beyond having a working programming language for quantum computing; we are interested, on one hand, in its individual characteristics and its consequences for classical systems, and, on the other hand, in its implications for the foundations of quantum physics.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Walid Gomaa, associate professor at Alexandria E-Just University, was invited during two months (March and May) in the team in the PHC Imhotep.

7.4.1.1. Internships

Arinta Auza (ENS Cachan / Indonesie)

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

Nazim Fatès was invited for a short stay at the Technische Universtät Dresden, in the Centre for Information Services and High Performance Computing (ZIH), in the team of Andreas Deutsch, head of Department for Innovative Methods of Computing. He gave a talk at the monthly ZIH colloquium.

Simon Perdrix spent one month at the Simons Institute for Theoretical Computer Science at Berkeley, University of California, as an invited researcher during the semester of Logic and Computation (mid-November to Mid-December 2016)

CASCADE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives with Industrials

7.1.1. SIMPATIC

Title: SIM and PAiring Theory for Information and Communications security

Program: ANR INS

Duration: February 2013 – July 2016

Coordinator: Orange Labs

Partners:

Orange Labs

ENS

INVIA

Oberthur Technologies

STMicroelectronics

Université Bordeaux 1

Université de Caen Basse-Normandie

Université de Paris VIII

Local coordinator: David Pointcheval

We aim at providing the most possible efficient and secure hardware/software implementation of a bilinear pairing in a SIM card.

7.1.2. CryptoComp

Program: FUI

Duration: October 2014 – November 2018

Coordinator: CryptoExperts

Partners:

CEA

CNRS

Kalray

Inria

Dictao

Université de Limoges

VIACESS

Bertin technologies

GEMALTO

Local coordinator: David Pointcheval

We aim at studying delegation of computations to the cloud, in a secure way.

7.2. National Collaborations within Academics

7.2.1. ROMAnTIC

Title: Randomness in Mathematical Cryptography

Program: ANR JCJC

Duration: October 2012 – September 2016

PI: Damien Vergnaud

Partners: ENS Lyon, Université de Limoges

    ANSSI

    Univ. Paris 7

    Univ. Limoges

The goal of this project is to get a better understanding of the interplay between randomness and cryptography and to study the security of various cryptographic protocols at different levels (information-theoretic and computational security, number-theoretic assumptions, design and provable security of new and existing constructions).

7.2.2. EnBiD

Title: Encryption for Big Data

Program: ANR JCJC

Duration: October 2014 – September 2018

PI: Hoeteck Wee

Partners:

    Univ. Paris 2

    Univ. Limoges

The main objective of this project is to study techniques for efficient and expressive functional encryption schemes. Functional encryption is a novel paradigm for public-key encryption that enables both fine-grained access control and selective computation on encrypted data, as is necessary to protect big, complex data in the cloud.

7.2.3. EfTrEC

Title: Efficient Transferable E-Cash

Program: ANR JCJC

Duration: October 2016 – September 2020

PI: Georg Fuchsbauer

Partners:

    Univ. Paris 2

This project deals with e-cash systems which let users transfer electronic coins between them offline. The main objectives of this project are:

- establish a clean formal model for the primitive;
- construct schemes which are practically efficient;
- develop schemes that are even resistant to attacks on quantum computers.

7.2.4. ALAMBIC

Title: AppLicAtions of MalleaBIlity in Cryptography

Program: ANR PRC

Duration: October 2016 – September 2020

PI: Damien Vergnaud

Partners:

ENS Lyon

Univ. Limoges

The main objectives of the proposal are the following:

- Define theoretical models for "malleable" cryptographic primitives that capture strong practical attacks (in particular, in the settings of secure computation outsourcing, server-aided cryptography, cloud computing and cryptographic proof systems);

- Analyze the security and efficiency of primitives and constructions that rely on malleability;

- Conceive novel cryptographic primitives and constructions (for secure computation outsourcing, server-aided cryptography, multi-party computation, homomorphic encryption and their applications);

- Implement these new constructions in order to validate their efficiency and effective security.

7.3. European Initiatives

7.3.1. CryptoAction

Title: Cryptography for Secure Digital Interaction

Program: H2020 ICT COST

Duration: April 2014 – April 2018

Local coordinator: Michel Abdalla

The aim of this COST CryptoAction is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments.

7.3.2. CryptoCloud

Title: Cryptography for the Cloud

Program: FP7 ERC Advanced Grant

Duration: June 2014 – May 2019

PI: David Pointcheval

The goal of the CryptoCloud project is to develop new interactive tools to provide privacy to the Cloud.

7.3.3. SAFEcrypto

Title: Secure Architectures of Future Emerging Cryptography

Program: H2020

Duration: January 2015 - January 2019

Coordinator: The Queen's University of Belfast

Partners:

Inria/ENS (France)

Emc Information Systems International (Ireland)

Hw Communications (United Kingdom)

The Queen's University of Belfast (United Kingdom)

Ruhr-Universitaet Bochum (Germany)

Thales Uk (United Kingdom)

Universita della Svizzera italiana (Switzerland)

IBM Research Zurich (Switzerland)

Local coordinator: Michel Abdalla

SAFEcrypto will provide a new generation of practical, robust and physically secure post quantum cryptographic solutions that ensure long-term security for future ICT systems, services and applications. Novel public-key cryptographic schemes (digital signatures, authentication, public-key encryption, identity-based encryption) will be developed using lattice problems as the source of computational hardness. The project will involve algorithmic and design optimisations, and implementations of the lattice-based cryptographic schemes addressing the cost, energy consumption, performance and physical robustness needs of resource-constrained applications, such as mobile, battery-operated devices, and of real-time applications such as network security, satellite communications and cloud. Currently a significant threat to cryptographic applications is that the devices on which they are implemented on leak information, which can be used to mount attacks to recover secret information. In SAFEcrypto the first analysis and development of physical-attack resistant methodologies for lattice-based cryptographic implementations will be undertaken. Effective models for the management, storage and distribution of the keys utilised in the proposed schemes (key sizes may be in the order of kilobytes or megabytes) will also be provided. This project will deliver proof-of-concept demonstrators of the novel lattice-based public-key cryptographic schemes for three practical real-word case studies with real-time performance and low power consumption requirements. In comparison to current state-of-the-art implementations of conventional public-key cryptosystems (RSA and Elliptic Curve Cryptography (ECC)), SAFEcrypto's objective is to achieve a range of lattice-based architectures that provide comparable area costs, a 10-fold speed-up in throughput for real-time application scenarios, and a 5-fold reduction in energy consumption for low-power and embedded and mobile applications.

7.3.4. ECRYPT-NET

Title: Advanced Cryptographic Technologies for the Internet of Things and the Cloud

Program: H2020 ITN

Duration: March 2015 – February 2019

Coordinator: KU Leuven (Belgium)

Partners:

KU Leuven (Belgium)

École Normale Supérieure (France)

Ruhr-Universität Bochum (Germany)

Royal Holloway, University of London (UK)

University of Bristol (UK)

CryptoExperts (France)

NXP Semiconductors (Belgium)

Technische Universiteit Eindhoven (the Netherlands)

Local coordinator: Michel Abdalla

ECRYPT-NET is a research network of six universities and two companies, as well as 7 associated companies, that intends to develop advanced cryptographic techniques for the Internet of Things and the Cloud and to create efficient and secure implementations of those techniques on a broad range of platforms.

7.3.5. aSCEND

Title: Secure Computation on Encrypted Data

Program: H2020 ERC Starting Grant

Duration: June 2015 – May 2020

PI: Hoeteck Wee

The goals of the aSCEND project are (i) to design pairing and lattice-based functional encryption that are more efficient and ultimately viable in practice; and (ii) to obtain a richer understanding of expressive functional encryption schemes and to push the boundaries from encrypting data to encrypting software.

7.4. International Research Visitors

- Sanjam Garg (UC Berkeley)
- Yuval Ishai (UCLA/Technion)
- Gregory Neven (IBM Zurich)
- Ryo Nishimaki (NTT)
- Claudio Orlandi (Aarhus)
- Rafael Pass (Cornell)
- Leonid Reyzin (Boston University)
- Alessandra Scafuro (postdoc, BU/NEU)
- Victor Shoup (NY University)
- Vinod Vaikuntanathan (MIT)
- Daniel Wichs (Northeastern University)

<p align="center" style="color:red">CELTIQUE Project-Team</p>

5. Partnerships and Cooperations

5.1. Regional Initiatives

5.1.1. *Labex COMIN Labs Seccloud project*

Participants: Frédéric Besson, Thomas Jensen, Alan Schmitt, Thomas Genet, Martin Bodin, Gurvan Cabon.

The SecCloud project, started in 2012, will provide a comprehensive language-based approach to the definition, analysis and implementation of secure applications developed using Javascript and similar languages. Our high level objectives is to enhance the security of devices (PCs, smartphones, ect.) on which Javascript applications can be downloaded, hence on client-side security in the context of the Cloud. We will achieve this by focusing on three related issues: declarative security properties and policies for client-side applications, static and dynamic analysis of web scripting programming languages, and multi-level information flow monitoring.

This is a joint project with Supelec Rennes and Ecole des Mines de Nantes.

5.2. National Initiatives

5.2.1. *The ANR VERASCO project*

Participants: Sandrine Blazy, Delphine Demange, David Pichardie.

Static program analysis, Certified static analysis

The VERASCO project (2012–06/2016) is funded by the call ISN 2011, a program of the Agence Nationale de la Recherche. It investigates the formal verification of static analyzers and of compilers, two families of tools that play a crucial role in the development and validation of critical embedded software. It is a joint project with the Inria teams ABSTRACTION, GALLIUM, The VERIMAG laboratory and the Airbus company.

5.2.2. *The ANR AnaStaSec project*

Participants: Frédéric Besson, Sandrine Blazy, Thomas Jensen, Alexandre Dang, Julien Lepiller.

Static program analysis, Security, Secure compilation

The AnaStaSec project (2015–2018) aims at ensuring security properties of embedded critical systems using static analysis and security enhancing compiler techniques. The case studies are airborne embedded software with ground communication capabilities. The Celtique project focuses on software fault isolation which is a compiler technology to ensure by construction a strong segregation of tasks.

This is a joint project with the Inria teams ANTIQUE and PROSECCO, CEA-LIST, TrustInSoft, AMOSSYS and Airbus Group.

5.2.3. *The ANR Binsec project*

Participants: Frédéric Besson, Sandrine Blazy, Pierre Wilke, Julien Lepiller.

Binary code, Static program analysis

The Binsec project (2013–2017) is funded by the call ISN 2012, a program of the Agence Nationale de la Recherche. The goal of the BINSEC project is to develop static analysis techniques and tools for performing automatic security analyses of binary code. We target two main applicative domains: vulnerability analysis and virus detection.

Binsec is a joint project with the Inria CARTE team, CEA LIS, VERIMAG and EADS IW.

5.2.4. *The ANR MALTHY project*

Participant: David Cachera.

The MALTHY project, funded by ANR in the program INS 2013, aims at advancing the state-of-the-art in real-time and hybrid model checking by applying advanced methods and tools from linear algebra and algebraic geometry. MALTHY is coordinated by VERIMAG, involving CEA-LIST, Inria Rennes (Tamis and Celtique), Inria Saclay (MAXPLUS) and VISEO/Object Direct.

5.2.5. *The ANR AJACS project*

Participants: Martin Bodin, Gurvan Cabon, Thomas Jensen, Alan Schmitt.

The goal of the AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts. To this end, we propose to define a mechanized semantics of the full JavaScript language, the most widely used language for the Web. We then propose to develop and prove correct analyses for JavaScript programs, in particular information flow analyses that guarantee no secret information is leaked to malicious parties. The definition of sub-languages of JavaScript, with certified compilation techniques targeting them, will allow us to derive more precise analyses. Finally, we propose to design and certify security and privacy enforcement mechanisms for web applications, including the APIs used to program real-world applications.

The project partners include the following Inria teams: Celtique, Indes, Prosecco, and Toccata; it also involves researchers from Imperial College as external collaborators. The project runs from December 2014 to June 2018.

5.2.6. *The ANR DISCOVER project*

Participants: Sandrine Blazy, Delphine Demange, Thomas Jensen, David Pichardie, Yon Fernandez de Retana.

The DISCOVER project project aims at leveraging recent foundational work on formal verification and proof assistants to design, implement and verify compilation techniques used for high-level concurrent and managed programming languages. The ultimate goal of DISCOVER is to devise new formalisms and proof techniques able to scale to the mechanized correctness proof of a compiler involving a rich class of optimizations, leading to efficient and scalable applications, written in higher-level languages than those currently handled by cutting-edge verified compilers.

In the light of recent work in optimizations techniques used in production compilers of high-level languages, control-flow-graph based intermediate representations seems too rigid. Indeed, the analyses and optimizations in these compilers work on more abstract representations, where programs are represented with data and control dependencies. The most representative representation is the sea-of-nodes form, used in the Java Hotspot Server Compiler, and which is the rationale behind the highly relaxed definition of the Java memory model. DISCOVER proposes to tackle the problem of verified compilation for shared-memory concurrency with a resolute language-based approach, and to investigate the formalization of adequate program intermediate representations and associated correctness proof techniques.

The project runs from October 2014 to September 2018.

5.3. European Initiatives

5.3.1. *Collaborations in European Programs, Except FP7 & H2020*

> Program:CA COST Action CA15123
>
> Project acronym: EUTYPES
>
> Project title: European research network on types for programming and verification
>
> Duration: 03/2016 to 03/2020
>
> Coordinator: Herman Geuvers (Radboud University Nijmegen, The Netherlands)

Other partners: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Macedonia, Germany, Hungary, Israel, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, United Kingdom

Abstract: Types are pervasive in programming and information technology. A type defines a formal interface between software components, allowing the automatic verification of their connections, and greatly enhancing the robustness and reliability of computations and communications. In rich dependent type theories, the full functional specification of a program can be expressed as a type. Type systems have rapidly evolved over the past years, becoming more sophisticated, capturing new aspects of the behaviour of programs and the dynamics of their execution.

This COST Action will give a strong impetus to research on type theory and its many applications in computer science, by promoting (1) the synergy between theoretical computer scientists, logicians and mathematicians to develop new foundations for type theory, for example as based on the recent development of "homotopy type theory", (2) the joint development of type theoretic tools as proof assistants and integrated programming environments, (3) the study of dependent types for programming and its deployment in software development, (4) the study of dependent types for verification and its deployment in software analysis and verification. The action will also tie together these different areas and promote cross-fertilisation.

5.4. International Initiatives

5.4.1. Inria Associate Teams Not Involved in an Inria International Labs

5.4.1.1. JCERT

Title: Verified Compilation of Concurrent Managed Languages

International Partner (Institution - Laboratory - Researcher):

Purdue University (United States) - School of Electrical and Computer Engineering (ECE) - Jan Vitek

Start year: 2014

See also: http://www.irisa.fr/celtique/ea/jcert/

Safety-critical applications demand rigorous, unambiguous guarantees on program correctness. While a combination of testing and manual inspection is typically used for this purpose, bugs latent in other components of the software stack, especially the compiler and the runtime system, can invalidate these hard-won guarantees. To address such concerns, additional laborious techniques such as manual code reviews of generated assembly code are required by certification agencies. Significant restrictions are imposed on compiler optimizations that can be performed, and the scope of runtime and operating system services that can be utilized. To alleviate this burden, the JCert project is implementing a verified compiler and runtime for managed concurrent languages like Java or C#.

5.4.2. Inria International Partners

5.4.2.1. WEBCERT

Title: Verified Trustworthy web Applications

International Partner (Institution - Laboratory - Researcher):

Imperial College (United Kingdom) - Department of Computing - Philippa Gardner

Duration: 2015 - 2019

Start year: 2015

See also: JSCert web page

The goal of the WebCert partnership is to extend the development of the JSCert formal semantics of JavaScript in the following domains: further mechanized specification, human-readable formal specification, program logic, verification tools, and the formalization of Defensive JavaScript.

5.4.2.2. Informal International Partners

Alan Schmitt is part of a Polonium Hubert Curien Partnership (PHC) with the University of Wrocław. This partnership is led by Sergueï Lenglet, from Loria, Nancy (currently visiting member of the Celtique project).

5.5. International Research Visitors

5.5.1. Visits of International Scientists

5.5.1.1. Internships

Thomas Wood

Date: Oct 2016 - Dec 2016

Institution: Imperial College (United Kingdom)

Ahmad Salim Al-Sibahi

Date: Sep 2016 - Jan 2017

Institution: IT University of Copenhagen (Denmark)

<p style="text-align:center;color:red;font-weight:bold;">COMETE Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Projects funded by Digiteo-DigiCosme

9.1.1.1. OPTIMEC

Project title: Optimal Mechanisms for Privacy Protection

Duration: September 2016 - August 2019

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

Other PI's: Serge Haddadm ENS Cachan.

Abstract: In this project we plan to investigate classes of utility and privacy measures, and to devise methods to obtain optimal mechanisms with respect to the trade-off between utility and privacy. In order to represent the probabilistic knowledge of the adversary and of the user, and the fact that mechanisms themselves can be randomized, we will consider a probabilistic setting. We will focus, in particular, on measures that are expressible as linear functions of the probabilities.

9.1.1.2. D-SPACES

Project title: D-spaces : Distributed Spaces in Concurrent Epistemic Systems

Duration: Nov 2013 - Oct 2016

Coordinator: Frank Valencia, CNRS-LIX and Inria Saclay, EPI Comète

Other PI's: Stefan Haar ENS Cachan.

Abstract: In this project we developed an innovative and expressive computational model for these systems that coherently combines techniques for the analysis of concurrent systems such as process calculi with epistemic and spatial formalisms.

9.2. National Initiatives

9.2.1. Large-scale initiatives

Project acronym: CAPPRIS

Project title: Collaborative Action on the Protection of Privacy Rights in the Information Society

Duration: September 2013 - December 2016

URL: https://cappris.inria.fr/

Coordinator: Daniel Le Metayer, Inria Grenoble

Other partner institutions: The project involves four Inria research centers (Saclay, Saphia-Antipolis, Rennes and Grenoble), CNRS-LAAS, Eurecom and the university of Namur. Besides computer scientists, the consortium also includes experts in sociology and in law, thus covering the complementary areas of expertise required to reach the objectives.

Abstract: The goal of this project is to study the challenges related to privacy in the modern information society, trying to consider not only the technical, but also the social and legal ones, and to develop methods to enhance the privacy protection.

9.3. International Initiatives

9.3.1. Inria-MSR joint lab

9.3.1.1. Privacy-Friendly Services and Apps

Title: Privacy-Friendly Services and Applications

Inria principal investigator: Catuscia Palamidessi

International Partners:

> Cedric Fournet, Microsoft Research Lab, Cambridge, UK
>
> Andy Gordon, Microsoft Research Lab, Cambridge, UK

Duration: 2014 - 2016

URL: http://www.msr-inria.fr/projects/privacy-friendly-services-and-apps/

Abstract: This is a project sponsored by Microsoft Research Lab, on methods to preserve privacy in web services and location-based services.

9.3.2. Inria Associate Teams

9.3.2.1. LOGIS

Title: Logical and Formal Methods for Information Security

Inria principal investigator: Konstantinos Chatzikokolakis

International Partners:

> Mitsuhiro Okada, Keio University (Japan)
>
> Yusuke Kawamoto, AIST (Japan)
>
> Tachio Terauchi, JAIST (Japan)
>
> Masami Hagiya, University of Tokyo (Japan)

Start year: 2016

URL: http://www.lix.polytechnique.fr/~kostas/projects/logis/

Abstract: The project aims at integrating the logical / formal approaches to verify security protocols with (A) complexity theory and (B) information theory. The first direction aims at establishing the foundations of logical verification for security in the computational sense, with the ultimate goal of automatically finding attacks that probabilistic polynomial-time adversaries can carry out on protocols. The second direction aims at developing frameworks and techniques for evaluating and reducing information leakage caused by adaptive attackers.

9.3.3. Inria International Partners

9.3.3.1. Informal International Partners

> Geoffrey Smith, Florida International University (United States)
>
> Carroll Morgan, NICTA (Australia)
>
> Annabelle McIver, Maquarie University (Australia)
>
> Moreno Falaschi, Professor, University of Siena, Italy
>
> Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil
>
> Camilo Rueda, Professor, Universidad Javeriana Cali, Colombia

9.3.4. Participation in Other International Programs

9.3.4.1. REPAS

Program: ANR Blanc

Project title: Reliable and Privacy-Aware Software Systems via Bisimulation Metrics

Duration: October 2016 - September 2021

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

Other PI's and partner institutions: Ugo del Lago, Inria Sophia Antipolis (EPI Focus) and University of Bologna (Italy). Vincent Danos, ENS Paris. Filippo Bonchi, ENS Lyon.

Abstract: In this project, we aim at investigating quantitative notions and tools for proving program correctness and protecting privacy. In particular, we will focus on bisimulation metrics, which are the natural extension of bisimulation on quantitative systems. As a key application, we will develop a mechanism to protect the privacy of users when their location traces are collected.

9.3.4.2. PACE

Program: ANR Blanc International

Project title: Beyond plain Processes: Analysis techniques, Coinduction and Expressiveness

Duration: January 2013 - December 2016

URL: http://perso.ens-lyon.fr/daniel.hirschkoff/pace/

Coordinator: Daniel Hirschkoff, Ecole Normale Supérieure de Lyon

Other PI's and partner institutions: Catuscia Palamidessi, Inria Saclay, Frank Valencia, CNRS-LIX and Inria Saclay (France). Davide Sangiorgi, University of Bologna (Italy). Yuxi Fu, Shanghai Jiao Tong University (China).

Abstract: This project objective is to enrich and adapt these methods, techniques, and tools to much broader forms of interactive models, well beyond the realm of "traditional" processes.

9.3.4.3. LOCALI

Program: ANR Blanc International

Project title: Logical Approach to Novel Computational Paradigms

Duration: January 2012 - December 2016

URL: http://www.agence-nationale-recherche.fr/?Project=ANR-11-IS02-0002

Coordinator: Gilles Dowek, Inria Rocquencourt

Other PI's and partner institutions: Catuscia Palamidessi, Inria Saclay. Thomas Erhard, Paris VII. Ying Jiang , Chinese Academy of Science in Beijin (China).

Abstract: This project aims at exploring the interplays between logic and sequential/distributed computation in formalisms like the lambda calculus and the π calculus. Going back to the fundamentals of the definitions of these calculi, the project plans to design new programming languages and proof systems via a logical approach.

9.3.4.4. MUSICAL

Program: CNPq Science Without Borders.

Project title: Music and Spatial Interaction with Constraints, Algebra and Logic: Foundations and Applications.

Duration: Oct 2014 - Oct 2016

URL: http://cic.puj.edu.co/~caolarte/musical/Musical/Welcome.html

Coordinator: Elaine Pimentel, Universidade Federal do Rio Grande do Norte (Brazil),

Other PI's and partner institutions: Camilo Rueda, PUJ Cali (Colombia). Carlos Olarte, Universidade Federal do Rio Grande do Norte (Brazil). Frank Valencia, CNRS-LIX and Inria Saclay (France). Gerard Assayag, IRCAM (France).

Abstract: This multi-disciplinary project aims to develop and integrate tools from logic and concurrency theory for the design and analysis of reactive systems and to their application to musical processes and multimedia systems.

9.3.4.5. CLASSIC

Program: Colciencias - Conv. 712.

Project title: Concurrency, Logic and Algebra for Social and Spatial Interactive Computation.

Duration: Oct 2016 - Oct 2019

URL: http://goo.gl/Gv6Lij

Coordinator: Camilo Rueda PUJ Cali (Colombia).

Other PI's and partner institutions: Carlos Olarte, Universidade Federal do Rio Grande do Norte (Brazil). Frank Valencia, CNRS-LIX and Inria Saclay (France).

Abstract:This project will advance the state of the art of domains such as mathematical logic, order theory and concurrency for reasoning about spatial and epistemic behaviour in multi-agent systems..

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil, Dec 2016

Annabelle McIver, Associate Professor, Macquarie University, Australia, Dec 2016

Carroll Morgan, Professor, University of New South Wales and NICTA, Australia, Dec 2016

Geoffrey Smith, Professor, Florida International University, USA, Dec 2016

Camilo Rueda, Professor, PUJ Cali, Colombia, May 2016 and Nov 2016.

Camilo Rocha, Professor, PUJ Cali, Colombia, Oct 2016.

9.4.2. Visits to International Teams

Catuscia Palamidessi visited the Computer Security team of Roberto Focardi at the University of Venice, Italy, from 4 April to 30 April, 2016.

<div align="center">

COMPSYS Team

</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

Compsys followed or participated to the activities of LyonCalcul (http://lyoncalcul.univ-lyon1.fr/), a network to federate activities on high-performance computing in Lyon. In this context, and with the support of the Labex MILYON (http://milyon.universite-lyon.fr/), Compsys had organized in 2013 a thematic quarter on compilation (http://labexcompilation.ens-lyon.fr). A second thematic quarter on high performance computing (HPC) was organized in 2016, initiated by Violaine Louvet (Institute Camille Jordan), with the participation of the LIP teams Aric, Avalon, Compsys, and Roma. Among other events, it included a CNRS inter-disciplinary spring school (https://mathsinfohpc.sciencesconf.org) co-organized by Compsys, connecting mathematics (HPC numerical analysis) and computer science (polyhedral optimizations for HPC) that can be seen as a follow-up of the first polyhedral school organized by Compsys in 2013. See details in Section 10.1 .

Alain Darte, Alexandre Isoard, and Tomofumi Yuki had also some exchanges with Violaine Louvet and Thierry Dumont on tiling code optimizations, advising (in an informal way) some of their students during their internships, for implementations on multicore machines and GPUs.

9.2. National Initiatives

9.2.1. French Compiler Community

In 2010, Laure Gonnord and Fabrice Rastello created the french community of compilation, which had no organized venue in the past. All groups with activities related to compilation were contacted and the first "compilation day" was organized in Lyon. This effort has been quickly a success: the community (http://compilfr.ens-lyon.fr/) is now well identified and 3-days workshops now occur at least once a year (the 11th event has been organized in Sep. 2016). The community is animated by Laure Gonnord and Fabrice Rastello since 2010, and now also by Florian Brandner (ex-Compsys too). Alain Darte and Tomofumi Yuki participated to the 11th edition.

Recognized as a sub-group of the CNRS GDR GPL (Software Engineering and Programming), the community is also in charge, since 2014, of organizing one day of the research school "Ecole des jeunes chercheurs en Algorithmique et Programmation" (EJCP). Tomofumi Yuki, in this context, gave a half-day lecture at the 2016 edition (http://ejcp2016.univ-lille1.fr/), following his 2015 course.

9.2.2. Collaboration with Parkas group, in Paris

Alain Darte and Paul Feautrier have regular meetings with Albert Cohen, from the Parkas team at ENS Paris. The current discussions are mostly related to the analysis and compilation of the OpenStream language developed by Parkas, a research topic that started though the ManycoreLabs project (see previous reports). The results of Sections 7.2 and 7.1 are related to this collaboration. Now that Compsys has been stopped, Paul Feautrier is affiliated to Parkas, in addition to his emeritus position at ENS-Lyon.

9.2.3. Collaboration with Cairn group, in Rennes

Tomofumi Yuki continues to work with the Cairn group through regular meetings and occasional visits. The topic of the collaboration is in applying compiler techniques for hardware design using high-level synthesis. Section 7.5 presents the results through this collaboration.

9.2.4. Collaboration with Camus group, in Strasbourg

Paul Feautrier and Tomofumi Yuki have an ongoing cooperation with Alain Ketterlin and Eric Violard (Camus group, Strasbourg). The main result has been the determination of the *happens before* relation of clocked X10, a prerequisite for the detection of races in clocked programs. The resulting formula has been proved correct using the Coq proof assistant. Publishing formal proofs is known to be difficult, but we will give it a try soon.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

After the participation to a (rejected) H2020 proposal in 2015, Compsys did not try any effort in this direction as the team was going to be stopped.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Same situation.

9.3.3. Collaborations with Major European Organizations

Compsys members participate to the European Network of Excellence on High Performance and Embedded Architecture and Compilation (HiPEAC, http://www.hipeac.net/), either as members or affiliate members. The International Workshop on Polyhedral Compilation Techniques (IMPACT, see Section 9.4.2), co-created by Christophe Alias in 2011, is now an annual event of the HIPEAC conference, as an official workshop. The 5th edition, IMPACT'15, was co-chaired by Alain Darte (see http://impact.gforge.inria.fr/impact2015/), while the 6h edition, IMPACT'16, was co-chaired by Tomofumi Yuki (see http://impact.gforge.inria.fr/impact2016/).

9.4. International Initiatives

9.4.1. Collaboration with Colorado State University

Compsys had always kept strong connections with Colorado State University (CSU):

- In July 2016, Guillaume Iooss defended his joint ENS-Lyon/CSU PhD thesis [16]. He was co-advised by both Sanjay Rajopadhye (CSU) and Christophe Alias (with supplementary support by Alain Darte for administrative reason, as he has no HDR yet).
- Tomofumi Yuki, who did his PhD with Sanjay Rajopadhye, then a post-doc in the Cairn team in Rennes, continued his collaboration with these two groups, as the results described in Section 7.5 illustrate. He also participates regularly, over the net, to the reading group "Melange" of S. Rajodapdhye's group, with CSU students. Due to the stop of Compsys, Tomofumi Yuki has now returned to the Cairn team.
- Waruna Ranasinghe, a PhD student from S. Rajopadhye's team, visited Compsys, to work with Tomofumi Yuki, for 2 months (see Section 9.5).

9.4.2. Polyhedral Community

In 2011, as part of the organization of the workshops at CGO'11, Christophe Alias (with Cédric Bastoul) organized IMPACT'11 (international workshop on polyhedral compilation techniques, http://impact2011.inrialpes.fr/). This workshop in Chamonix was the very first international event on this topic, although it was introduced by Paul Feautrier in the late 80s. Alain Darte gave the introductory keynote talk. After this successful edition (more than 60 people), IMPACT continued as a satellite workshop of the HIPEAC conference, in Paris (2012), Berlin (2013), Vienna (2014). Alain Darte was program co-chair and co-organizer of the 2015 edition in Amsterdam, and Tomofumi Yuki of the 2016 edition in Prague.

The creation of IMPACT, now the annual event of the polyhedral community, helped to identify this community and to make it more visible. This effort was complemented by the organization by Alain Darte of the first school on polyhedral code analysis and optimizations (http://labexcompilation.ens-lyon.fr/polyhedral-school/). A second polyhedral school (https://mathsinfohpc.sciencesconf.org), more open, because involving themes and researchers from numerical analysis (users of HPC), was organized in 2016 by Alain Darte (for the compiler side) and Violaine Louvet (for the HPC side). See details in Section 10.1 .

Alain Darte also manages two new mailing lists for news (polyhedral-news@listes.ens-lyon.fr) and discussions (polyhedral-discuss@listes.ens-lyon.fr) on polyhedral code analysis and optimizations. Tomofumi Yuki is involved in the development of PolyBench (http://sourceforge.net/projects/polybench), a suite of kernels used for illustrating polyhedral optimizations. He is also developing PolyApps, a set of larger applications to evaluate the gap between kernels and "real" applications, see more details in Section 7.7 .

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Visiting PhD students

- Emna Hammami (Tunis University, with Yosr Slama) visited Compsys from April to June 2016 to refine her PhD topic with Compsys members. She also participated to the spring school on numerical simulation and polyhedral compilation.

- Waruna Ranasinghe (Colorado State University, with Sanjay Rajopadhye) visited Compsys from end of June to mid August 2016 to work with Tomofumi Yuki on extending cache oblivious techniques to polyhedral programs.

9.5.1.2. Internships

- Julien Versaci, M2 student from Lyon 1 University, from both physics and computer science departments, worked from April to June 2016 in Compsys, to work on the parallelization of a model of quantum physics. Julien was co-supervised by Jean-Philippe Guillet (physicist) and Tomofumi Yuki, the second part of his internship (until mid August) being done affiliated to Annecy physics laboratory (LAPTH). Julien also participated to the spring school on numerical simulation and polyhedral compilation.

9.5.2. Visits to International Teams

No long (more than one month) stay abroad in 2016.

CONVECS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ARC6 Programme
Participants: Lina Marsso, Radu Mateescu, Wendelin Serwe.

ARC6 is an academic research community funded by the Auvergne Rhône-Alpes region, whose objective is to foster the scientific collaborations between different academic institutions of the region working in the domain of information and communication technologies. ARC6 organizes various scientific animations (conferences, working groups, summer schools, etc.) and issues a yearly call for PhD and post-doctorate research project proposals.

Lina Marsso is supported by an ARC6 grant (from October 2016 to October 2019) on formal methods for testing networks of programmable logic controllers, under the supervision of Radu Mateescu and Wendelin Serwe (CONVECS), Ioannis Parissis and Christophe Deleuze (LCIS, Valence).

8.2. National Initiatives

8.2.1. FSN (Fonds national pour la Société Numérique)

8.2.1.1. Connexion
Participants: Hubert Garavel [correspondent], Frédéric Lang.

Connexion [0] (*COntrôle commande Nucléaire Numérique pour l'EXport et la rénovatION*) is a project funded by the FSN, within the second call for projects "*Investissements d'Avenir — Briques génériques du logiciel embarqué*". The project, led by EDF and supported by the *Pôles de compétitivité* Minalogic, Systematic, and *Pôle Nucléaire Bourgogne*, involves many industrial and academic partners, namely All4Tech, Alstom Power, ArevA, Atos Worldgrid, CEA-LIST, CNRS/CRAN, Corys Tess, ENS Cachan, Esterel Technologies, Inria, LIG, Predict, and Rolls-Royce. Connexion aims at proposing and validating an innovative architecture dedicated to the design and implementation of control systems for new nuclear power plants in France and abroad.

Connexion started in April 2012 for four years, and was extended for 6 months until September 2016. In this project, CONVECS assisted another LIG team, IIHM, in specifying human-machine interfaces formally using the LNT language and in verifying them using CADP.

8.2.2. Competitivity Clusters

8.2.2.1. Bluesky for I-Automation
Participants: Hugues Evrard, Hubert Garavel, Fatma Jebali, Jingyan Jourdan-Lu, Frédéric Lang, Eric Léo, Radu Mateescu [correspondent].

Bluesky for I-Automation is a project funded by the FUI (*Fonds Unique Interministériel*) within the *Pôle de Compétitivité* Minalogic. The project, led by Crouzet Automatismes (Valence), involves the SMEs (*Small and Medium Enterprises*) Motwin and VerticalM2M, the LCIS laboratory of Grenoble INP, and CONVECS. Bluesky aims at bringing closer the design of automation applications and the Internet of things by providing an integrated solution consisting of hardware, software, and services enabling a distributed, Internet-based design and development of automation systems. The automation systems targeted by the project are networks of programmable logic controllers, which belong to the class of GALS (*Globally Asynchronous, Locally Synchronous*) systems.

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[0]http://www.cluster-connexion.fr

Bluesky started in September 2012 for three years and was extended for nine months until June 2016. The main contributions of CONVECS to Bluesky (see § 6.1.6) are the definition of GRL, the formal pivot language for describing the asynchronous behavior of logic controller networks, and the automated verification of the behavior using compositional model checking and equivalence checking techniques.

8.2.3. *Other National Collaborations*

We had sustained scientific relations with the following researchers:

- Pierre Boullier (Inria, team ALPAGE),
- Pierre-Etienne Moreau (LORIA, team PAREO),
- Fabrice Kordon and Lom Messan Hillah (LIP6, Paris),
- Noël De Palma and Fabienne Boyer (LIG, Grenoble),
- Xavier Etchevers (Orange Labs, Meylan),
- Christophe Deleuze and Ioannis Parissis (LCIS, Valence),
- Pascal Poizat (LIP6, Paris),
- Lina Ye (LRI, Paris).

8.3. European Initiatives

8.3.1. *FP7 & H2020 Projects*

8.3.1.1. SENSATION

Participants: Hubert Garavel [correspondent], Radu Mateescu, Wendelin Serwe.

SENSATION [0] (*Self ENergy-Supporting Autonomous computaTION*) is a European project no. 318490 funded by the FP7-ICT-11-8 programme. It gathers 9 participants: Inria (ESTASYS and CONVECS project-teams), Aalborg University (Denmark), RWTH Aachen and Saarland University (Germany), University of Twente (The Netherlands), GomSpace (Denmark), and Recore Systems (The Netherlands). The main goal of SENSATION is to increase the scale of systems that are self-supporting by balancing energy harvesting and consumption up to the level of complete products. In order to build such Energy Centric Systems, embedded system designers face the quest for optimal performance within acceptable reliability and tight energy bounds. Programming systems that reconfigure themselves in view of changing tasks, resources, errors, and available energy is a demanding challenge.

SENSATION started on October 1st, 2012 for three years, and has been extended for five months until February 29, 2016. CONVECS contributed to the project regarding the extension of formal languages with quantitative aspects (see § 6.3.1), studying common semantic models for quantitative analysis, and applying formal modeling and analysis to the case studies provided by the industrial partners.

8.3.2. *Collaborations with Major European Organizations*

The CONVECS project-team is member of the FMICS (*Formal Methods for Industrial Critical Systems*) working group of ERCIM [0]. H. Garavel and R. Mateescu are members of the FMICS board, H. Garavel being in charge of dissemination actions.

8.4. International Initiatives

H. Garavel is a member of IFIP (*International Federation for Information Processing*) Technical Committee 1 (*Foundations of Computer Science*) Working Group 1.8 on Concurrency Theory chaired successively by Luca Aceto and Jos Baeten.

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[0] http://sensation-project.eu/
[0] http://fmics.inria.fr

At Saarland University (Germany), H. Garavel is a guest scientist of the DEPEND research group headed by Holger Hermanns, who received an ERC Advanced Grant ("POWVER") in 2016.

In 2016, we had scientific relations with several universities and companies abroad, including:

- SRI International, California, USA (Steven Eker),
- Technical University of Eindhoven, The Netherlands (Jan Friso Groote),
- University of Málaga, Spain (Francisco Durán and Carlos Canal),
- Aalto University, Finland (Hernan Ponce de Leon),
- Technical University of Graz, Austria (Franz Wotawa),
- University of Zaragoza, Spain (José Ignacio Requeno),
- University of Utah, USA (Chris Myers and Zhen Zhang),
- DiffBlue, Oxford, UK (Matthias Güdemann).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Hernan Ponce de Leon (Aalto University, Finland) visited us from February 15 to February 19, 2016.

CORSE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. HEAVEN Persyval Project

- Title: HEterogenous Architectures: Versatile Exploitation and programiNg

- HEAVEN leaders: François Broquedis, Olivier Muller[TIMA lab]

- CORSE participants: François Broquedis, Frédéric Desprez, Georgios Christodoulis

- Computer architectures are getting more and more complex, exposing massive parallelism, hierarchically-organized memories and heterogeneous processing units. Such architectures are extremely difficult to program as they most of the time make application programmers choose between portability and performance.

  While standard programming environments like OpenMP are currently evolving to support the execution of applications on different kinds of processing units, such approaches suffer from two main issues. First, to exploit heterogeneous processing units from the application level, programmers need to explicitly deal with hardware-specific low-level mechanisms, such as the memory transfers between the host memory and private memories of a co-processor for example. Second, as the evolution of programming environments towards heterogeneous programming mainly focuses on CPU/GPU platforms, some hardware accelerators are still difficult to exploit from a general-purpose parallel application.

  FPGA is one of them. Unlike CPUs and GPUs, this hardware accelerator can be configured to fit the application needs. It contains arrays of programmable logic blocks that can be wired together to build a circuit specialized for the targeted application. For example, FPGAs can be configured to accelerate portions of code that are known to perform badly on CPUs or GPUs. The energy efficiency of FPGAs is also one of the main assets of this kind of accelerators compared to GPUs, which encourages the scientific community to consider FPGAs as one of the building blocks of large scale low-power heterogeneous multicore platforms.

  However, only a fraction of the community considers programming FPGAs for now, as configurations must be designed using low-level description languages such as VHDL that application programmers are not experienced with.

  The main objective of this project is to improve the accessibility of heterogeneous architectures containing FPGA accelerators to parallel application programmers. The proposed project focuses on three main aspects:
  - Portability: we don't want application programmers to redesign their applications completely to benefit from FPGA devices. This means extending standard parallel programming environments like OpenMP to support FPGA. Improving application portability also means leveraging most of the hardware-specific low-level mechanisms at the runtime system level ;
  - Performance: we want our solution to be flexible enough to get the most out of any heterogeneous platforms containing FPGA devices depending on specific performance needs, like computation throughput or energy consumption for example ;
  - Experiments: Experimenting with FPGA accelerators on real-life scientific applications is also a key element of our project proposal. In particular, the solutions developed in this project will allow comparisons between architectures on real-life applications from different domains like signal processing and computational finance.

Efficient programming and exploitation of heterogeneous architectures implies the development of methods and tools for system design, embedded or not. The HEAVEN project proposal fits in the PCS research action of the PERSYVAL-lab. The PhD of Georgios Christodoulis is funded by this project.

8.1.2. HPES Persyval Project

- Title: High Performance Embedded Systems

- HPES leader: Henri-Pierre Charles [CEA List, CRI PILSI]

- HPES participants: Suzane Lesecq [CEA Leti], Laurent Fesquet [TIMA Lab], Stéphane Mancini [TIMA Lab], Eric Ruten [Inria/CtrlA], Nicolas Marchand [Gipsa Lab], Bogdan Robu [Gipsa Lab]

- CORSE participants: Naweiluo Zhou [PhD Persyval], Fabrice Rastello, Jean-François Méhaut

- The computing area has been recently deeply modified by the emergence of the so-called multicore processor. Within the same chip, several computing units are implemented. This architectural concept allows meeting the performance requirements under stringent energy consumption constraints. Multicores are used for laptops, Graphical Processor Units (GPU), High Performance Computing (HPC) platforms, but also for embedded systems su ch as mobile phones. Moreover, low-power high performance multicores developed for embedded systems will be soon used in data centers for HPC. This raises new scientific challenges to architecture, systems and application designers that have face massively parallel computing platforms.

  The number of cores on a chip is increasing quickly. At the same time, the memory bandwidth is increasing too slowly to ensure the performance such multicore platforms should attain. This phenomenon is known as "Memory Wall" and at the moment no efficient solution to exceed this limitation exists. With the increase in the number of cores, cache coherency is becoming as well a tremendous challenge.

  Power consumption is also a huge challenge as it imposes strong constraints on the computing platform, whatever the application domain. The first machine ranked in the Green500 has an energy performance ratio of 2 Gflops per watt. This ratio has to be improved by 30 when exascale computing is considered. The multi-core processor might help to improve this ratio; however, the software stack should as well evolve to boost this improvement.

8.1.3. AGIR DEREVES

- Title: DEcentralised Runtime Verification and Enforcement of distributed and cyber-physical Systems

- DEREVES leader: Ylies Falcone

- CORSE participants: Ylies Falcone, Antoine El-Hokayem, Raphaël Jakse

- DEREVES aims at advancing the theory of decentralised runtime verification and enforce- ment for distributed systems, with the objective of proposing realistic monitoring and monitor-synthesis algorithms for expressive specifications that can be used for the efficient monitoring of multi-threaded, dis- tributed and cyber-physical systems. The project shall help transferring runtime verification and enforcement to a wider audience of programmers of distributed systems by providing them techniques and tools to help them guaranteeing the correctness of their systems.

8.2. National Initiatives

8.2.1. IPL C2S@Exa

- Title: Computer and Computational Sciences at Exascale

- C2S@Exa leader: Stéphane Lanteri

- CORSE participants: François Broquedis, Frédéric Desprez, Jean-François Méhaut, Brice Videau, Philippe Virouleau, Nora Hagmeyer

- The C2S@Exa Inria large-scale initiative is concerned with the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of the C2S@Exa Inria large-scale initiative is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.2.2. PIA ELCI

- Title: Environnement logiciel pour le calcul intensif
- ELCI leader: Corinne Marchand (BULL SAS)
- CORSE participants: François Broquedis, Philippe Virouleau
- Duration: from Sept. 2014 to Sept. 2017
- The ELCI project main goal is to develop a highly-scalable new software stack to tackle high-end supercomputers, from numerical solvers to programming environments and runtime systems. In particular, the CORSE team is studying the scalability of OpenMP runtime systems on large scale shared memory machines through the PhD of Philippe Virouleau, co-advised by researchers from the CORSE and AVALON Inria teams. This work intends to propose new approaches based on a compiler/runtime cooperation to improve the execution of scientific task-based programs on NUMA platforms. The PhD of Philippe Virouleau is funded by this project.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Mont-Blanc2

Title: Mont-Blanc (European scalable and power efficient HPC platform based on low-power embedded technology)

Program FP7

Duration: 01/10/2013 - 31/01/2017

Coordinator: Barcelona Supercomputing Center (BSC)

Mont-Blanc consortium: BSC, Bull, Arm, Juelich, LRZ, USTUTT, Cineca, CNRS, Inria, CEA Leti, Univ. Bristol, Allinea

CORSE contact: Jean-François Méhaut

CORSE participants: Brice Videau, Kevin Pouget

The Mont-Blanc project aims to develop a European Exascale approach leveraging on commodity power-efficient embedded technologies. The project has developed a HPC system software stack on ARM, and is deployed the first integrated ARM-based HPC prototype by 2014, and is also working on a set of 11 scientific applications to be ported and tuned to the prototype system.

The rapid progress of Mont-Blanc towards defining a scalable power efficient Exascale platform has revealed a number of challenges and opportunities to broaden the scope of investigations and developments. Particularly, the growing interest of the HPC community in accessing the Mont-Blanc platform calls for increased efforts to setup a production-ready environment. The Mont-Blanc 2 proposal has 4 objectives:

1. To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support

2. To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system

3. To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips)

4. To provide continued support for the Mont-Blanc consortium, namely operations of the original Mont-Blanc prototype, the new developer kit clusters and hands-on support for our application developers

Mont-Blanc 2 contributes to the development of extreme scale energy-efficient platforms, with potential for Exascale computing, addressing the challenges of massive parallelism, heterogeneous computing, and resiliency. Mont-Blanc 2 has great potential to create new market opportunities for successful EU technology, by placing embedded architectures in servers and HPC.

8.3.1.2. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

> Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)
>
> Commissariat A L Energie Atomique et Aux Energies Alternatives (France)
>
> Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)
>
> Consiglio Nazionale Delle Ricerche (Italy)
>
> The Cyprus Institute (Cyprus)
>
> Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)
>
> Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)
>
> Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)
>
> Forschungszentrum Julich (Germany)
>
> Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany)
>
> University of Bath (United Kingdom)
>
> Universite Libre de Bruxelles (Belgium)
>
> Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

The aim of the present proposal is to establish an Energy Oriented Centre of Excellence for computing applications, (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

8.3.1.3. HPC4E

Title: HPC for Energy (HPC4E)

Programm: H2020

Duration: December 2015 - November 2017

Program FP7

Coordinator: Barcelona Supercomputing Center

Partners:

> Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)
>
> Iberdrola Renovables Energia (Spain)
>
> Repsol (Spain)
>
> Total S.A. (France)
>
> Lancaster University (United Kingdom)

Inria contact: Stephane Lanteri

CORSE particpants: Jean-François Méhaut, Frédéric Desprez, Emmanuelle Saillard (Post-Doct since Dec 2016)

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO_2 emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use

in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

8.3.2. *Collaborations in European Programs, Except FP7 & H2020*

Program: COST

Project acronym: ArVI

Project title: Runtime Verification beyond Monitoring

Duration: December 2014 - May 2017

Coordinator: Martin Leucker, University of Lubeck

Abstract: Runtime verification (RV) is a computing analysis paradigm based on observing a system at runtime to check its expected behavior. RV has emerged in recent years as a practical application of formal verification, and a less ad-hoc approach to conventional testing by building monitors from formal specifications.

There is a great potential applicability of RV beyond software reliability, if one allows monitors to interact back with the observed system, and generalizes to new domains beyond computers programs (like hardware, devices, cloud computing and even human centric systems). Given the European leadership in computer based industries, novel applications of RV to these areas can have an enormous impact in terms of the new class of designs enabled and their reliability and cost effectiveness.

This Action aims to build expertise by putting together active researchers in different aspects of runtime verification, and meeting with experts from potential application disciplines. The main goal is to overcome the fragmentation of RV research by (1) the design of common input formats for tool cooperation and comparison; (2) the evaluation of different tools, building a growing sets benchmarks and running tool competitions; and (3) by designing a road-map and grand challenges extracted from application domains.

8.4. International Initiatives

8.4.1. *Inria International Labs*

- JLESC (Joint Laboratory on Exascale Computing)
  The CORSE team is involved in the JLESC with collaborations with UIUC (Sanjay Kalé) and BSC (Mont-Blanc projects). Kevin Pouget, Brice Videau and Jean-François Méhaut attended to the two JLESC workshops (Barcelona and Bonn) in 2015.
  - **Energy Efficiency and Load Balancing**
  - The power consumption of High Performance Computing (HPC) systems is an increasing concern as large-scale systems grow in size and, consequently, consume more energy. In response to this challenge, we propose new energy-aware load balancers that aim at reducing the energy consumption of parallel platforms running imbalanced scientific applications without degrading their performance. Our research explores dynamic load balancing, low power manycore platforms and DVFS techniques in order to reduce power consumption.

– We propose the improvement of the performance and scalability of parallel seismic wave models through dynamic load balancing. These models suffer from load imbalance for two reasons. First, they add a specific numerical condition at the borders of the domain, in order to absorb the outgoing energy. The decomposition of the domain into a grid of subdomains, which are distributed among tasks, creates load differences between the tasks that simulate the borders and those responsible for the central subdomains. Second, the propagation of waves in the simulated area changes the workload on the subdomains on different time-steps. Therefore causing dynamic load imbalance. In order to evaluate the use of dynamic load balancing, we ported a seismic wave simulator to Adaptive MPI, to benefit from its load balancing framework. Our experimental results show that dynamic load balancers can adapt to load variations during the application's execution and improve performance by 36%.

– we also focus on reducing the energy consumption of imbalanced applications through a combination of load balancing and Dynamic Voltage and Frequency Scaling (DVFS). Our strategy employs an Energy Daemon Tool to gather power information and a load balancing module that benefits from the load balancing framework available in the CHARM++ runtime system. We propose two variants of our energy-aware load balancer (ENER-GYLB) to save energy on imbalanced workloads without considerably impacting the overall system performance. The first one, called Fine- Grained EnergyLB (FG-ENERGYLB), is suitable for plat- forms composed of few tens of cores that allow per-core DVFS. The second one, called Coarse-Grained EnergyLB (CG-ENERGLB) is suitable for current HPC platforms composed of several multi-core processors that feature per-chip DVFS.

8.4.2. Inria Associate Teams Not Involved in an Inria International Labs

8.4.2.1. IOComplexity

Title: Automatic characterization of data movement complexity

International Partner (Institution - Laboratory - Researcher):

Ohio State University (United States) - P. Sadayappan

Start year: 2015

See also: https://team.inria.fr/corse/iocomplexity/

The goal of this project is to develop new techniques and tools for the automatic characterization of the data movement complexity of an application. The expected contributions are both theoretical and practical, with the ambition of providing a fully automated approach to I/O complexity characterization, in starking contrast with all known previous work that are stricly limited to pen-and-paper analysis.

I/O complexity becomes a critical factor due in large part to the increasing dominance of data movement over computation in energy consumption for current and emerging architectures. This project aims at enabling: 1. the selection of algorithms according to this new criteria (as opposed to the criteria on arithmetic complexity that has been used up to now); 2. the design of specific architectures in terms of cache size, memory bandwidth, GFlops etc. based on application-specific bounds on memory traffic; 3. higher quality feedback to the user, the compiler, or the run-time system about data traffic, a major performance and energy factor.

8.4.2.2. PROSPIEL

- Title: Profiling and specialization for locality
- International Partner (Institution - Laboratory - Researcher):

  Universidade Federal de Minas Gerais (Brazil) - Computer Science Department - Fernando Magno Quintão Pereira
- Start year: 2015

- See also: https://team.inria.fr/alf/prospiel/
- The PROSPIEL project aims at optimizing parallel applications for high performance on new throughput-oriented architectures: GPUs and many-core processors. Traditionally, code optimization is driven by a program analysis performed either statically at compile-time, or dynamically at run-time. Static program analysis is fully reliable but often over-conservative. Dynamic analysis provides more accurate data, but faces strong execution time constraints and does not provide any guarantee. By combining profiling-guided specialization of parallel programs with runtime checks for correctness, PROSPIEL seeks to capture the advantages of both static analysis and dynamic analysis. The project relies on the polytope model, a mathematical representation for parallel loops, as a theoretical foundation. It focuses on analyzing and optimizing performance aspects that become increasingly critical on modern parallel computer architectures: locality and regularity.

8.4.2.3. Exase

Title: Exascale Computing Scheduling Energy

See also: https://team.inria.fr/exase/

Inria leader: Jean-Marc Vincent (Mescal)

Inria teams: Mescal, Moais, CORSE

CORSE participants: Jean-François Méhaut, François Broquedis, Frédéric Desprez

International Partner (Institution - Laboratory - Researcher):

Federal University of Rio Grande do Soul (UFRGS, Porto Alegre, Brazil) - Informatics Faculty - L. Schnoor, N. Maillard, P. Navaux

Pontifical University Minas (PUC Minas, Belo Horizonte, Brazil) - Computer Science faculty, Henrique Freitas

University of Sao Paulo (USP, Sao Paulo, Brazil), IME faculty, Alfredo Goldman

Start year: 2014

The main scientific goal of Exase for the three years is the development of state-of- the-art energy-aware scheduling algorithms for exascale systems. As previously stated, issues on energy are fundamental for next generation parallel platforms and all scheduling decisions must be aware of that. Another goal is the development of trace analysis techniques for the behavior analysis of schedulers and the applications running on exascale machines. We list below specific objectives for each development axis presented in the previous section. analysis.

- Fundamentals for the scaling of schedulers
- Design of schedulers for large-scale infrastructures
- Tools for the analysys of large scale schedulers

8.4.3. Participation in Other International Programs

- LICIA (LIG, UFRGS Brazil)
- EnergySFE (STIC Amsud)
  - Leader: University Federal of Santa Catarina (UFSC): Màrcio Castro
  - Partners: UFSC (Florianopolis, Brazil), UFRGS (Porto Alegre, Brazil), ESPE (Ecuador), CNRS (LIG/CORSE, TIMA, LSPSC)
  - Duration: January 2016 - December 2017
  - CORSE participants: Jean-François Méhaut, François Broquedis, Frédéric Desprez
  - The main goal of the EnergySFE research project is to propose fast and scalable energy-aware scheduling and fault tolerance techniques and algorithms for large-scale highly parallel architectures. To achieve this goal, it will be crucial to answer the following research questions:

    *   How to schedule tasks and threads that compete for resources with different constraints while considering the complex hierarchical organization of future Exascale supercomputers?

    *   How to tolerate faults without incurring in too much overhead in future Exascale supercomputers?

    *   How scheduling and fault tolerance approaches can be adapted to be energy-aware?

The first EnergySFE workshop was organized by the CORSE team a the Inria Minatec building in September 2016.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Louis-Noël Pouchet (OSU), visited CORSE two times one month
- Julien Langou (UCDenver) is visiting professor since September 2016
- Mohamad Jaber (AUB) visited CORSE two weeks in January 2016
- Sylvain Hallé (U of Québec) visited CORSE one week in August 2016
- Christian Colombo (U of Malta) visited CORSE two weeks in March 2016
- Henrique Freitas (PUC Minas) visited CORSE one year since July 2015 until July 2016

<p style="text-align:center; color:red; font-weight:bold;">DATASHAPE Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR TOPDATA

Participants: Jean-Daniel Boissonnat, Frédéric Chazal, David Cohen-Steiner, Mariette Yvinec, Steve Oudot, Marc Glisse.

- Acronym : TopData.

- Type : ANR blanc.

- Title : Topological Data Analysis: Statistical Methods and Inference.

- Coordinator : Frédéric Chazal (DATASHAPE).

- Duration : 4 years starting October 2013.

- Others Partners: Département de Mathématiques (Université Paris Sud), Institut de Mathématiques (Université de Bourgogne), LPMA (Université Paris Diderot), LSTA (Université Pierre et Marie Curie).

- Abstract: TopData aims at designing new mathematical frameworks, models and algorithmic tools to infer and analyze the topological and geometric structure of data in different statistical settings. Its goal is to set up the mathematical and algorithmic foundations of Statistical Topological and Geometric Data Analysis and to provide robust and efficient tools to explore, infer and exploit the underlying geometric structure of various data.

Our conviction, at the root of this project, is that there is a real need to combine statistical and topological/geometric approaches in a common framework, in order to face the challenges raised by the inference and the study of topological and geometric properties of the wide variety of larger and larger available data. We are also convinced that these challenges need to be addressed both from the mathematical side and the algorithmic and application sides. Our project brings together in a unique way experts in Statistics, Geometric Inference and Computational Topology and Geometry. Our common objective is to design new theoretical frameworks and algorithmic tools and thus to contribute to the emergence of a new field at the crossroads of these domains. Beyond the purely scientific aspects we hope this project will help to give birth to an active interdisciplinary community. With these goals in mind we intend to promote, disseminate and make our tools available and useful for a broad audience, including people from other fields.

- See also: http://geometrica.saclay.inria.fr/collaborations/TopData/Home.html

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. ERC GUDHI

Title: Algorithmic Foundations of Geometry Understanding in Higher Dimensions.

Program: FP7.

Type: ERC.

Duration: February 2014 - January 2019.

Coordinator: Inria.

PI: Jean-Daniel Boissonnat.

The central goal of this proposal is to settle the algorithmic foundations of geometry understanding in dimensions higher than 3. We coin the term geometry understanding to encompass a collection of tasks including the computer representation and the approximation of geometric structures, and the inference of geometric or topological properties of sampled shapes. The need to understand geometric structures is ubiquitous in science and has become an essential part of scientific computing and data analysis. Geometry understanding is by no means limited to three dimensions. Many applications in physics, biology, and engineering require a keen understanding of the geometry of a variety of higher dimensional spaces to capture concise information from the underlying often highly nonlinear structure of data. Our approach is complementary to manifold learning techniques and aims at developing an effective theory for geometric and topological data analysis. To reach these objectives, the guiding principle will be to foster a symbiotic relationship between theory and practice, and to address fundamental research issues along three parallel advancing fronts. We will simultaneously develop mathematical approaches providing theoretical guarantees, effective algorithms that are amenable to theoretical analysis and rigorous experimental validation, and perennial software development. We will undertake the development of a high-quality open source software platform to implement the most important geometric data structures and algorithms at the heart of geometry understanding in higher dimensions. The platform will be a unique vehicle towards researchers from other fields and will serve as a basis for groundbreaking advances in scientific computing and data analysis.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. CATS

Title: Computations And Topological Statistics

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Department of Statistics - Larry Wasserman

Start year: 2015

See also: http://geometrica.saclay.inria.fr/collaborations/CATS/CATS.html

Topological Data Analysis (TDA) is an emergent field attracting interest from various communities, that has recently known academic and industrial successes. Its aim is to identify and infer geometric and topological features of data to develop new methods and tools for data exploration and data analysis. TDA results mostly rely on deterministic assumptions which are not satisfactory from a statistical viewpoint and which lead to a heuristic use of TDA tools in practice. Bringing together the strong expertise of two groups in Statistics (L. Wasserman's group at CMU) and Computational Topology and Geometry (Inria Geometrica), the main objective of CATS is to set-up the mathematical foundations of Statistical TDA to design new TDA methods and to develop efficient and easy-to-use software tools for TDA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Ramsay Dyer (April and November 2016)

Arijit Ghosh, Indian Statistical Institute, Kolkata (April and November 2016)

Jose Carlos Gomez Larranaga, CIMAT, Guanajuato, Mexico (September 2016)

Kim Jisu, CMU, Pittsburgh, USA (May and December 2016).

Antony Bak, Palantir company, USA (October 2016)

9.4.1.1. Internships

Uday Kusupati, Indian Institute of Technology, Bombay (May-July 2016)

Sandip Banerjee (bourse Charpak), Indian Statistical Institute, Kolkata (March-August 2016)

Sameer Desai, Indian Statistical Institute, Kolkata (October-December 2016)

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Steve Oudot and Jérémy Cochoy spent 3 months (Sept.-Nov.) at the Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University. They were invited there for the semester program entitled *Topology in Motion* (see https://icerm.brown.edu/programs/sp-f16/).

DEDUCTEAM Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Locali

We are coordinators of the ANR-NFSC contract Locali with the Chinese Academy of Sciences.

7.1.2. ANR BWare

We are members of the ANR BWare, which started on September 2012 (David Delahaye is the national leader of this project). The aim of this project is to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method. The methodology used in this project consists in building a generic platform of verification relying on different theorem provers, such as first-order provers and SMT solvers. We are in particular involved in the introduction of Deduction modulo in the first-order theorem provers of the project, i.e. Zenon and iProver, as well as in the backend for these provers with the use of Dedukti.

7.1.3. ANR Tarmac

We are members of the ANR Tarmac on models of computation, coordinated by Pierre Valarcher.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: CA COST Action CA15123

Project acronym: EUTYPES

Project title: European research network on types for programming and verification

Duration: 21/03/16 - 20/03/20

Coordinator: Herman Geuvers

7.3. International Initiatives

7.3.1. Participation in Other International Programs

Login

Title: Logic and Information

International Partner (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (Argentina) - Ricardo Oscar Rodrigues

Duration: 2015 - 2016

This project aims to propose an improvement on a long-term already existing collaboration between Inria, the brazilians and the argentin named team. We already have a CAPES-COFECUB cooperation (n. 690/10, namely "Teorias lógicas contemporâneas e a filosofia da linguagem: questões epistemológicas e semânticas") that leaded to many students interchange and technical visits of Professors, including the organisation of some workshops (the last one was the 2nd Workshop on Logic and Semantics, at UERJ, Ilha Grande-RJ, Brazil. Prof. Gilles Dowek is also a Co-Advisor with Prof. Edward Hermann Haeusler of a brazilian Ph.D. Candidate in this project (and a former one also in this project, these two candidates finalised recently a sandwich doctorate - similar to stage doctorale - at Inria). Prof. Gilles Dowek also collaborates with other members of this team and is supervising a post-doc project of another member. Since 2011 members of the team presents.

FoQCoSS

Title: Foundations of Quantum Computation: Syntax and Semantics

International Partners (Institution - Laboratory - Researcher):

Universidad Nacional de Quilmes (Argentina) - Alejandro Diaz-Caro

CNRS (France) - Simon Perdrix

Duration: 2016 - 2017

The design of quantum programming languages involves the study of many characteristics of languages which can be seen as special cases of classical systems: parallelism, probabilistic systems, non-deterministic systems, type isomorphisms, etc. This project proposes to study some of these characteristics, which are involved in quantum programming languages, but also have a more immediate utility in the study of nowadays systems. In addition, from a more foundational point of view, we are interested in the implications of computer science principles for quantum physics. For example, the consequences of the Church-Turing thesis for Bell-like experiments: if some of the parties in a Bell-like experiment use a computer to decide which measurements to make, then the computational resources of an eavesdropper have to be limited in order to have a proper observation of non-locality. The final aim is to open a new direction in the search for a framework unifying computer science and quantum physics.

7.4. International Research Visitors

7.4.1. Internships

- Clément Chouteau, from May 2016 to July 2016
- David Pham (Univ. Évry) from June 2016 to July 2016

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

F. Gilbert spent one month in the formal methods team at NASA Langley Research Center, to work with Cesar Munoz on the use of automated theorem provers to verify PVS proofs.

<p align="center" style="color:red">DICE Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. IXXI

The Dice team is hosted in the Rhoˆne-Alpes Institute for Complex Systems, IXXI, located in Ecole Normale Supe´rieure de Lyon. IXXI is promoting trans-disciplinary research, in particular with social sciences, thus facilitating the establishment of connections with researchers in fields such as economics, history, law, etc.

8.1.2. ARC 6 "Innovative Services for Social Networks"

DICE is involved in a regional project of the Rhoˆne-Alpes region, ARC6 "Innovative Services for Social Networks", with Telecom Saint Etienne.

8.2. National Initiatives

8.2.1. ANR

DICE is involved in an ANR project, which started at the end of 2013

- C3PO, on Collaborative Creation of Contents and Publishing using Opportunistic networks, with LT2C Telecom Saint-Etienne, INSA LYON, IRISA, ChronoCourse, et Ecole des Mines de Nantes.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

DICE is involved in the CSA project "Big data roadmap and cross-disciplinarY community for addressing socieTal Externalities (BYTE)", Objective ICT-2013.4.2 Scalable data analytics (c) Societal externalities of Big Data roadmap.

8.4. International Initiatives

8.4.1. Inria International Labs

Dice is involved in IPL CityLab@Inria which studies ICT solutions for smart cities. Dice takes part in the Platforms and City Governance theme. Dice focuses on analysing and forecasting the role of intermediation platforms in the governance.

DREAMPAL Project-Team

7. Partnerships and Cooperations

7.1. International Initiatives

7.1.1. Inria International Partners

7.1.1.1. Informal International Partners

In 2016 we have continued our strong and long-term collaboration with Prof. Dorel Lucanu's group Univ. Iasi as witnessed by the co-authored publications (3 journals and 1 conference). Vlad Rusu serves as "external advisor for PhD students" in Prof. Lucanu's group. In 2016 we have also had notable interactions with Prof. José Meseguer (Univ. Illinois at Urbana Champaign, USA), which consisted in sharing ideas and mutual reading and commenting advanced drafts prior to submission in journals/conferences.

GALLIUM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR projects

9.1.1.1. BWare
Participants: Damien Doligez, Fabrice Le Fessant.

The "BWare" project (2012–2016) is coordinated by David Delahaye at Conservatoire National des Arts et Métiers and funded by the *Ingénierie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. BWare is an industrial research project that aims to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method and requiring high guarantees of confidence.

9.1.1.2. Verasco
Participants: Jacques-Henri Jourdan, Xavier Leroy.

The "Verasco" project (2012–2016) is coordinated by Xavier Leroy and funded by the *Ingéniérie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. The objective of this 4.5-year project is to develop and formally verify a static analyzer based on abstract interpretation, and interface it with the CompCert C verified compiler.

9.1.1.3. Vocal
Participants: Xavier Leroy, François Pottier.

The "Vocal" project (2015–2020) aims at developing the first mechanically verified library of efficient general-purpose data structures and algorithms. It is funded by *Agence Nationale de la Recherche* under its "appel à projets générique 2015".

The library will be made available to all OCaml programmers and will be of particular interest to implementors of safety-critical OCaml programs, such as Coq, Astrée, Frama-C, CompCert, Alt-Ergo, as well as new projects. By offering verified program components, our work will provide the essential building blocks that are needed to significantly decrease the cost of developing new formally verified programs.

9.1.2. FSN projects

9.1.2.1. ADN4SE
Participants: Damien Doligez, Martin Riener.

The "ADN4SE" project (2012–2016) is coordinated by the Sherpa Engineering company and funded by the *Briques Génériques du Logiciel Embarqué* programme of *Fonds national pour la Société Numérique*. The aim of this project is to develop a process and a set of tools to support the rapid development of embedded software with strong safety constraints. Gallium is involved in this project to provide tools and help for the formal verification in TLA+ of some important aspects of the PharOS real-time kernel, on which the whole project is based.

9.1.3. FUI Projects

9.1.3.1. Secur-OCaml
Participants: Damien Doligez, Fabrice Le Fessant.

The "Secur-OCaml" project (2015–2018) is coordinated by the OCamlPro company, with a consortium focusing on the use of OCaml in security-critical contexts, while OCaml is currently mostly used in safety-critical contexts. Gallium is invoved in this project to integrate security features in the OCaml language, to build a new independant interpreter for the language, and to update the recommendations for developers issued by the former LaFoSec project of ANSSI.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. Deepsea
Participants: Umut Acar, Vitalii Aksenov, Arthur Charguéraud, Michael Rainey, Filip Sieczkowski.

The Deepsea project (2013–2018) is coordinated by Umut Acar and funded by FP7 as an ERC Starting Grant. Its objective is to develop abstractions, algorithms and languages for parallelism and dynamic parallelism, with applications to problems on large data sets.

9.2.2. ITEA3 Projects

9.2.2.1. Assume
Participants: Xavier Leroy, Luc Maranget.

ASSUME (2015–2018) is an ITEA3 project involving France, Germany, Netherlands, Turkey and Sweden. The French participants are coordinated by Jean Souyris (Airbus) and include Airbus, Kalray, Sagem, ENS Paris, and Inria Paris. The goal of the project is to investigate the usability of multicore and manycore processors for critical embedded systems. Our involvement in this project focuses on the formalisation and verification of memory models and of automatic code generators from reactive languages.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- Princeton University: interactions between the CompCert verified C compiler and the Verified Software Toolchain developed at Princeton.
- Cambridge University and Microsoft Research Cambridge: formal modeling and testing of weak memory models.

<div align="center">**GRACE Project-Team**</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. PEPS Aije-bitcoin

Within the group PAIP (Pour une Approche Interdisciplinaire de la Privacy), D. Augot presented the cryptographic and peer-to-peer principles at the heart of the Bitcoin protocol (electronic signature, hash functions, and so on). Most of the information is publicly available: the history of all transactions, evolution of the source code, developers' mailing lists, and the Bitcoin exchange rate. It was recognized by the economists in our group that such an amount of data is very rare for an economic phenomenon, and it was decided to start research on the history of Bitcoin, to study the interplay between the development of protocol and the development of the economical phenomenon.

The project **Aije-Bitcoin** (analyse informatique, juridique et economique de Bitcoin) was accepted as interdisciplinary research for a PEPS (Projet exploratoire Premier Soutien) cofunded by the CNRS and Universite de Paris-Saclay. This one-year preliminary program will enable the group to master the understanding of Bitcoin from various angles, allowing more advanced research in the following years.

One M2 intern, E. Palazzollo, was intern in Sceaux, with aim to qualify the nature of bitcoin, as an asset, curency, etc.

This project ended in March 2016

9.1.2. IDEALCODES

Idealcodes is a two-year Digiteo research project, started in October 2014. The partners involved are the École Polytechnique (X) and the Université de Versailles–Saint-Quentin-en-Yvelines (Luca de Feo, UVSQ). After hiring J. Nielsen the first year, we have hired V. Ducet for the second year, both working at the boundary between coding theory, cryptography, and computer algebra

Idealcodes spans the three research areas of algebraic coding theory, cryptography, and computer algebra, by investigating the problem of lattice reduction (and root-finding). In algebraic coding theory this is found in Guruswami and Sudan's list decoding of algebraic geometry codes and Reed–Solomon codes. In cryptography, it is found in Coppersmith's method for finding small roots of integer equations. These topics were unified and generalised by H. Cohn and N. Heninger [25], by considering algebraic geometry codes and number field codes under the deep analogy between polynomials and integers. Sophisticated results in coding theory could be then carried over to cryptanalysis, and vice-versa. The generalized view raises problems of computing efficiently, which is one of the main research topics of Idealcodes.

The last year of the one-year project aims to find matrices with good diffusion properties over small finite fields. The principle is to find non-maximal matrices, but with better coefficients and implementation properties. The relevant cryptographic properties to be studied correspond to the weight distribution of the associated code. Since we use Algebraic-Geometry codes, much more powerful techniques can be used for computing these weight distribution, using and improving Duursma's ideas [28].

9.1.3. IRT System-X

D. Augot is co-advising a PhD candidate, H.-M. Bisserier, on "les relations contractuelles de droit privé à l'épreuve de la technologie des blockchains", i.e. on (French) law and so-called "smart contracts". D. Augot will mainly help H.-M. Bisserier to clarify the essential computer science topics and issues relevant to the most important blockchains (bitcoin, ethereum). Then H.-M. Bisserier will be advised by C. Zolynksi for remaining two years, fixing research directions.

9.2. National Initiatives

9.2.1. ANR

MANTA (accepted July 2015, starting March 2016): "Curves, surfaces, codes and cryptography". This project deals with applications of coding theory error correcting codes to in cryptography, multi-party computation, and complexity theory, using advanced topics in algebraic geometry and number theory. The kickoff was a one week-retreat in Dordogne (20 participants), and we had another four day meeting in Saclay in November 17. See http://anr-manta.inria.fr/.

9.2.2. DGA

Cybersecurity. Inria and DGA contracted for three PhD topics at the national level, one of them involving Grace. Grace started a new PhD, and hired P. Karpman. The topic of this PhD is complementary to the above DIFMAT-3: while DIFMAT-3 provides fundamental methods for dealing with AG codes, in application for diffusion layers in block ciphers, the topic here is to make concrete propositions of block ciphers using these matrices. P. Karpman is coadvised by T. Peyrin (Nanyang Technological University, Singapore), by P.-A. Fouque (Université de Rennes), and D. Augot.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. PQCRYPTO

Title: Post-quantum cryptography for long-term security

Programm: H2020

Duration: March 2015 - March 2018

Coordinator: TECHNISCHE UNIVERSITEIT EINDHOVEN

Partners:

Academia Sinica (Taiwan)

Bundesdruckerei (Germany)

Danmarks Tekniske Universitet (Denmark)

Katholieke Universiteit Leuven (Belgium)

Nxp Semiconductors Belgium Nv (Belgium)

Ruhr-Universitaet Bochum (Germany)

Stichting Katholieke Universiteit (Netherlands)

Coding Theory and Cryptology group, Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Darmstadt (Germany)

University of Haifa (Israel)

Inria contact: Nicolas Sendrier

Online security depends on a very few underlying cryptographic algorithms. Public-key algorithms are particularly crucial since they provide digital signatures and establish secure communication. Essentially all applications today are based on RSA or on the discrete-logarithm problem in finite fields or on elliptic curves. Cryptographers optimize parameter choices and implementation details for these systems and build protocols on top of these systems; cryptanalysts fine-tune attacks and establish exact security levels for these systems.

It might seem that having three systems offers enough variation, but these systems are all broken as soon as large quantum computers are built. The EU and governments around the world are investing heavily in building quantum computers; society needs to be prepared for the consequences, including cryptanalytic attacks accelerated by these computers. Long-term confidential documents

such as patient health-care records and state secrets have to guarantee security for many years, but information encrypted today using RSA or elliptic curves and stored until quantum computers are available will then be as easy to decipher.

PQCRYPTO will allow users to switch to post-quantum cryptography: cryptographic systems that are not merely secure for today but that will also remain secure long-term against attacks by quantum computers. PQCRYPTO will design a portfolio of high-security post-quantum public-key systems, and will improve the speed of these systems, with reference implementations.

Our team is engaged in WP3.3 "advanced applications for the cloud". We envision to focus essentially on secure multiparty computation, essentially the information theoretically secure constructions, who are naturally secure against a quantum computer invoked on classical queries. We will study whether these protocols still resist quantum queries. This work sub package started March 2015, and is dealt with by D. Augot.

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HYCOMES Project-Team

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8. Partnerships and Cooperations

8.1. Regional Initiatives

- Ayman Aljarbouh's PhD is partially funded by an ARED grant of the Brittany Regional Council. His doctoral work took place in the context of the Modrio (completed in 2016) and Sys2Soft (completed in 2015) projects on hybrid systems modeling. Ayman Aljarbouh is working on accelerated simulation techniques for hybrid systems. In particular, he is focusing on the regularisation, at runtime, of chattering behaviour and the approximation of Zeno behaviour.

- Benoît Caillaud and Aurélien Lamercerie are participating to the S3PM and SUNSET projects of the CominLabs excellence laboratory [0]. This project focuses on the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution [31]. The objective is to develop an enabling technology for procedural knowledge based computer assistance of surgery. In this project, we demonstrate its potential added value in nurse and surgeon training [9], [5].

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: ITEA2

Project acronym: Modrio

Project title: Model Driven Physical Systems Operation

Duration: September 2012 – May 2016

Coordinator: EDF (France)

Other partners: ABB (Sweden), Ampère Laboratory / CNRS (France), Bielefeld University (Germany), Dassault Systèmes (Sweden), Dassault Aviation (France), DLR (Germany), DPS (France), EADS (France), Equa Simulation (Sweden), IFP (France), ITI (Germany), Ilmenau University (Germany), Katholic University of Leuven (Belgium), Knorr-Bremse (Germany), LMS (France and Belgium), Linköping University (Sweden), MathCore (Sweden), Modelon (Sweden), Pöry (Finland), Qtronic (Germany), SICS (Sweden), Scania (Sweden), Semantum (Finland), Sherpa Engineering (France), Siemens (Germany and Sweden), Simpack (Germany), SKF (Sweden), Supmeca (France), Triphase (Belgium), University of Calabria (Italy), VTT (Finland), Vattenfall (Sweden), Wapice (Finland).

Abstract: Modelling and simulation are efficient and widely used tools for system design. But they are seldom used for systems operation. However, most functionalities for system design are beneficial for system operation, provided that they are enhanced to deal with real operating situations. Through open standards the benefits of sharing compatible information and data become obvious: improved cooperation between the design and the operation communities, easier adaptation of operation procedures wrt. design evolutions. Open standards also foster general purpose technology. The objective of the ITEA 2 MODRIO project is to extend modelling and simulation tools based on open standards from system design to system operation.

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[0] http://www.s3pm.cominlabs.ueb.eu/

<p style="text-align:center; color:red;">**LFANT Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Simpatic – SIM and PAiring Theory for Information and Communications security
Participants: Guilhem Castagnos, Damien Robert.

http://simpatic.orange-labs.fr

The SIMPATIC project is an industrial research project, formed by academic research teams and industrial partners: Orange Labs, École Normale Supérieure, INVIA, Oberthur Technologies, ST-Ericsson France, Université de Bordeaux 1, Université de Caen Basse-Normandie, Université de Paris 8.

The aim of the SIMPATIC project is to provide the most efficient and secure hardware/software implementation of a bilinear pairing in a SIM card. This implementation will then be used to improve and develop new cryptographic algorithms and protocols in the context of mobile phones and SIM cards. The project will more precisely focus on e-ticketing and e-cash, on cloud storage and on the security of contactless and of remote payment systems.

D. Robert is a participant in the Task 2 whose role is to give state of the art algorithms for pairing computations, adapted to the specific hardware requirements of the Simpatic Project.

G. Castagnos is a participant in the Task 4 whose role is to design new cryptographic primitives adapted to the specific applications of the Simpatic Project.

The SIMPATIC project has ended in August 2016. The project has shown that pairings can now efficiently be integrated into smart cards publicly deployed, by obtaining performances that outperform the state of the art. Cryptographic tools designed by the project are moreover capable of combining complex functionalities and efficiency in many areas such as digital signatures, minimization of personal data in contactless services, pay TV, or protecting data stored in an untrusted cloud.

7.1.2. ANR Alambic – AppLicAtions of MalleaBIlity in Cryptography
Participant: Guilhem Castagnos.

https://crypto.di.ens.fr/projects:alambic:main

The ALAMBIC project is a research project formed by members of the Inria Project-Team CASCADE of ENS Paris, members of the AriC Inria project-team of ENS Lyon, and members of the CRYPTIS of the university of Limoges. G. Castagnos is an external member of the team of Lyon for this project.

Non-malleability is a security notion for public key cryptographic encryption schemes that ensures that it is infeasible for an adversary to modify ciphertexts into other ciphertexts of messages which are related to the decryption of the first ones. On the other hand, it has been realized that, in specific settings, malleability in cryptographic protocols can actually be a very useful feature. For example, the notion of homomorphic encryption allows specific types of computations to be carried out on ciphertexts and generate an encrypted result which, when decrypted, matches the result of operations performed on the plaintexts. The homomorphic property can be used to create secure voting systems, collision-resistant hash functions, private information retrieval schemes, and for fully homomorphic encryption enables widespread use of cloud computing by ensuring the confidentiality of processed data.

The aim of the ALAMBIC project to investigate further theoretical and practical applications of malleability in cryptography. More precisely, this project focuses on three different aspects: secure computation outsourcing and server-aided cryptography, homomorphic encryption and applications and << paradoxical >> applications of malleability.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. ANTICS

Title: Algorithmic Number Theory in Computer Science

Program: FP7

Duration: January 2012 - December 2016

Coordinator: Inria

Inria contact: Andreas Enge

'During the past twenty years, we have witnessed profound technological changes, summarised under the terms of digital revolution or entering the information age. It is evident that these technological changes will have a deep societal impact, and questions of privacy and security are primordial to ensure the survival of a free and open society. Cryptology is a main building block of any security solution, and at the heart of projects such as electronic identity and health cards, access control, digital content distribution or electronic voting, to mention only a few important applications. During the past decades, public-key cryptology has established itself as a research topic in computer science; tools of theoretical computer science are employed to "prove" the security of cryptographic primitives such as encryption or digital signatures and of more complex protocols. It is often forgotten, however, that all practically relevant public-key cryptosystems are rooted in pure mathematics, in particular, number theory and arithmetic geometry. In fact, the socalled security "proofs" are all conditional to the algorithmic untractability of certain number theoretic problems, such as factorisation of large integers or discrete logarithms in algebraic curves. Unfortunately, there is a large cultural gap between computer scientists using a black-box security reduction to a supposedly hard problem in algorithmic number theory and number theorists, who are often interested in solving small and easy instances of the same problem. The theoretical grounds on which current algorithmic number theory operates are actually rather shaky, and cryptologists are generally unaware of this fact. The central goal of ANTICS is to rebuild algorithmic number theory on the firm grounds of theoretical computer science.'

Title: OpenDreamKit

Program: H2020

Duration: January 2016 - December 2020

Inria contact: Karim Belabas

Description http://cordis.europa.eu/project/rcn/198334_en.html, http://opendreamkit.org

7.3. International Initiatives

7.3.1. Inria International Labs

7.3.1.1. International Laboratory for Research in Computer Science and Applied Mathematics

MACISA

Title: Mathematics Applied to Cryptology and Information Security in Africa

International Partner (Institution - Laboratory - Researcher):

Université des Sciences et Techniques de Masuku (Gabon) - Faculté des Sciences - Dpt de Mathématiques et Informatique - Tony Ezome

Duration: 2012 - 2016

The projects aims at understanding the role played by algebraic maps in public key cryptography. Since this is a very broad topic, we will focus on objects of dimension zero (finite sets and rings) and one (algebraic curves, their differentials and jacobians). The proposed project-team consists of African and French researchers working in mathematical and statistical aspects of public-key cryptology. The French researchers work in the Inria project-team LFANT in Bordeaux, and the IRMAR (Institut de Recherche en Mathématiques et Applications de Rennes) in Rennes. The African researchers already cooperate in the project PRMAIS (Pole of Research in Mathematics and their Applications in Information Security in Sub-Saharan Africa) supported by the Simons' foundation.

The project is managed by a team of five permanent researchers: G. Nkiet, J.-M. Couveignes, T. Ezome, D. Robert and A. Enge. Since Sep. 2014 the coordinator is T. Ezome and the vice-coordinator is D. Robert. The managing team organises the cooperation, schedules meetings, prepares reports, controls expenses, reports to the LIRIMA managing team and administrative staff.

A non-exhaustive list of activities organised or sponsored by Macisa includes

- The Summer school (EMA) in Bamenda with the International Center for Pure and Applied Mathematics (ICPAM/CIMPA), June 2016;
- The visit of Abdoulaye Maiga in Bordeaux to work with D. Robert on canonical lifts of genus 2 curves.

2016 was the last year of Macisa. A new project FAST "(Harder Better) FAster STronger cryptography" has been proposed as an associated team between LFANT and the PREMA (Pole of Research in Mathematics and Applications in Africa) Simon's foundation project.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

The team is used to collaborate with Leiden University through the ALGANT program for PhD joint supervision.

Eduardo Friedman (U. of Chile), long term collaborator of K. Belabas and H. Cohen is a regular visitor in Bordeaux (about 1 month every year).

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Researchers visiting the team to give a talk to the team seminar include Enea Milio (Inria Nancy Grand Est), Gregor Seiler (ETH Zurich), Aurélien Focqué (Industry) and Razvan Barbulescu (University Paris 6). Researchers visting the team for collaboration include Bernadette Perrin-Riou (Paris-Sud).

7.4.2. Visits to International Teams

F. Johansson visited during 1 week the PolSys team at LIP6, Pierre et Marie Curie University.

F. Johansson visited during 1 week (two times) with the Computer Algebra group, TU Kaiserslautern.

<p align="center" style="color:red">MARELLE Project-Team</p>

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

We are currently members of two projects funded by the French national agency for research funding.

- BRUTUS "Chiffrements authentifiés et résistants aux attaques par canaux auxiliaires", started on October 1st, 2014, for 60 months, with a grant of 41 kEuros for Marelle. Other partners are Université de Rennes 1, CNRS, secrétariat Général de la défense et de la sécurité nationale, and Université des Sciences et Technologies de Lille 1. The corresponding researcher for this contract is Benjamin Grégoire.

- FastRelax, "Fast and Reliable Approximations", started on October 1st, 2014, for 60 months, with a grant of 75 kEuros for Marelle. Other partners are Inria Grenoble (ARIC project-team), LAAS-CNRS (Toulouse), Inria Saclay (Toccata and Specfun project-teams), and LIP6-CNRS (Paris). The corresponding researcher for this contract is Laurence Rideau.

6.2. International Initiatives

6.2.1. Inria International Partners

6.2.1.1. Informal International Partners

We work with the team of Adam Chlipala at MIT, in particular the engineer Paul Steckler, with whom we have regular meetings concerning the optimization of parts of the Coq system with respect to use cases provided by the MIT team, and the design of user-interface tools. This engineer had a visit of 6 weeks in France in April, three weeks in the pi.r2 team (mostly hosted by Matthieu Sozeau) and three weeks in the Marelle team, mostly hosted by Enrico Tassi and Maxime Dénès. The collaboration continues since that visit with a weekly phone conference.

6.3. International Research Visitors

6.3.1. Visits of International Scientists

We had visits by Gilles Barthe (IMDEA, Madrid, Spain) for 2 weeks, Benedikt Schmidt (IMDEA), for 2 weeks, François-Xavier Standaert (Université Catholique de Louvain, Crypto Group, Belgium), for 1 week, Sebastian Faust (Ruhr-University Bochum, Germany) for 1 week, François Dupressoir (IMDEA) for 1 week, Pierre-Yves Strub (IMDEA), for 1 week, and Peter Schwabe (Radboud University, Nijmegen, the Netherlands) for 3 days.

6.3.2. Visits to International Teams

Benjamin Grégoire visited IMDEA (Madrid, Spain) for two one-week trips.

Yves Bertot, Maxime Dénès, and Enrico Tassi visited Princeton University in June for the kick-off meeting of the *Expedition in Computing* entitled "the science of deep specification" funded by the NSF foundation.

Enrico Tassi visited the team of Jesper Bengtson at the IT-University of Copenhagen, Denmark.

Anders Mörtberg visited the team of Thierry Coquand at Chalmers and University of Göteborg in Sweden.

<div align="center">

MEXICO Project-Team

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8. Partnerships and Cooperations

8.1. National Initiatives

We will be participating in the ANR Project ALGORECELL that starts in 2017.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Serge Haddad is participating in the ERC EQualIS, 'Enhancing the Quality of Interacting Systems', directed by Patricia Bouyer.

8.3. International Initiatives

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. LifeForm

Title: Life Sciences need formal Methods !

International Partner (Institution - Laboratory - Researcher):

Newcastle University (United Kingdom) - School of Computing Science - Victor Khomenko

Start year: 2016

See also: http://projects.lsv.ens-cachan.fr/LifeForm/

This project extends an existing cooperation between the MEXICO team and Newcastle University on partial-order based formal methods for concurrent systems. We enlarge the partnership to bioinformatics and synthetic biology. The proposal addresses addresses challenges concerning formal specification, verification, monitoring and control of synthetic biological systems, with use cases conducted in the Center for Synthetic Biology and the Bioeconomy (CSBB) in Newcastle. A main challenge is to create a solid modelling framework based on Petri-net type models that allow for causality analysis and rapid state space exploration for verification, monitoring and control purposes; a potential extension to be investigated concerns the study of attractors and cell reprogramming in Systems Biology.

8.3.2. Participation in Other International Programs

UMI with CMI, India, starting in 2017; currently LIA INFORMEL, see below.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Visits by Victor Khomenko and Maciej Koutny within the LifeForm associated team

8.4.2. Internships

- **Juraj Kolcˇák** from Masaryk University, Brno, Czech Republic, on *Efficient Analysis of Boolean Networks under Parameter Uncertainty*, Spring/summer of 2016 (Master's thesis research); director: Stefan Haar
- **Clara Scherbaum** from Aachen University, Germany, on *Computing Cut Sets for Petri Nets*, Spring 2016, LSV (ENS Cachan),
- **Hugues Mandon**: Algorithms for cellular reprogramming.

8.4.3. Visits to International Teams

8.4.3.1. Research Stays Abroad

Paul Gastin is visiting IIT Bombay and Chennay Mathematical Institute, India, from October 10, 2016 to March 10, 2017.

<p style="text-align:center; color:red">MUTANT Project-Team</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Mutant was the PI of the ANR INEDIT project, ended in october 2015. The INEDIT project aims to provide a scientific view of the interoperability between common tools for music and audio productions, in order to open new creative dimensions coupling *authoring of time* and *authoring of interaction*.

Mutant participates also actively in the Efficace ANR Project. This project explores the relations between computation, time and interactions in computer-aided music composition, using OpenMusic and other technologies developed at IRCAM and at CNMAT (UC Berkeley).

The MuTant team is also an active member of the ANR CHRONOS Network by Gérard Berry, Collège de France).

7.2. European Initiatives

7.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: PHC Amadeus (France-Austria)

Project acronym: LETITBE

Project title: Logical Execution Time for Interactive And Composition Assistance Music Systems

Duration: 01/2015 - 01/2017

Coordinator: Florent Jacquemard, Christoph Kirsch

Other partners: Department of Computer Sciences University of Salzburg, Austria

Abstract: The objective of the LETITBE project is to contribute to the development of computer music systems supporting advanced temporal structure in music and advanced dynamics in interactivity. For this purpose we are proposing to re-design and re-engineer computer music systems (from IRCAM at Paris) using advanced notions of time and their software counterparts developed for safety-critical embedded systems (from University of Salzburg). In particular, we are applying the so-called logical execution time paradigm as well as its accompanying time safety analysis, real-time code generation, and portable code execution to computer music systems. Timing in music is obviously very important. Advanced treatment of time in safety-critical embedded systems has helped address extremely challenging problems such as predictability and portability of real-time code. We believe similar progress can be made in computer music systems potentially enabling new application areas. The objective of the project is ideally suited for a collaboration of partners with complementary expertise in computer music and real-time systems.

This year, Pierre Donat-Bouillud has spent 5 months in the University of Salzburg and one month in the University of California Berkeley, in the context of the LETITBE project, before starting his PhD in Mutant. Several other student exchanges and scientists visits between Salzburg and Paris have been funded this year by the LETITBE projetc

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

- We are collaborating with Slawek Staworko (LINKS and Algomus, Lille – on leave at U. Edinburgh in 2016), and the Algomus group at Lille, in the context of our projects on rhythm transcription described at Sections 5.2 and 6.2 . This collaboration led this year to the following publications: [23], [22].

- We are pursuing a long term collaboration with Masahiko Sakai (U. Nagoya) on term rewriting techniques and applications (in particular applications related to rhythm notation) [19], [27].

- MuTant team collaborates with *Bucharest Polytechnic University*, in the framework of Grig Burloiu's PhD Thesis on *AscoGraph* UIX design which has resulted in a the new design of AscoGraph (see 5.4) and publications [13], [32], [33].

- MuTant team collaborated with researchers at National Institute of Informatics of Tokyo on real-time Symbolic Alignment of music data [56].

<p align="center" style="color:red">PACAP Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. *Capacités: Projet "Investissement d'Avenir", 1/11/14 to 31/01/2018*

Participants: Damien Hardy, Isabelle Puaut, Viet Anh Nguyen, Sébastien Martinez.

The project objective is to develop a hardware and software platform based on manycore architectures, and to demonstrate the relevance of these manycore architectures (and more specifically the Kalray manycore) for several industrial applications. The Kalray MPPA manycore architecture is currently the only one able to meet the needs of embedded systems simultaneously requiring high performance, lower power consumption, and the ability to meet the requirements of critical systems (low latency I/O, deterministic processing times, and dependability). The project partners are Kalray (lead), Airbus, Open-Wide, Safran Sagem, IS2T, Real Time at Work, Dassault Aviation, Eurocopter, MBDA, ProbaYes, IRIT, Onera, Verimag, Inria, Irisa, Tima and Armines.

9.1.2. *Multicore: Inria Project Lab, 2013-2016*

Participants: Erven Rohou, Nabil Hallou.

Multicore is an Inria Project Lab (IPL, formerly *Action d'Envergure*) started in 2013. It is entitled "Large scale multicore virtualization for performance scaling and portability". Partner project-teams include: PACAP, ALGORILLE, CAMUS, REGAL, RUNTIME, as well as DALI. This project aims to build collaborative virtualization mechanisms that achieve essential tasks related to parallel execution and data management. We want to unify the analysis and transformation processes of programs and accompanying data into one unique virtual machine.

9.1.3. *ANR Continuum 2015–2019*

Participants: Erven Rohou, Rabab Bouziane.

The CONTINUUM project aims to address the energy-efficiency challenge in future computing systems by investigating a design continuum for compute nodes, which seamlessly goes from software to technology levels via hardware architecture. Power saving opportunities exist at each of these levels, but the real measurable gains will come from the synergistic focus on all these levels as considered in this project. Then, a cross-disciplinary collaboration is promoted between computer science and microelectronics, to achieve two main breakthroughs: i) combination of state-of-the-art heterogeneous adaptive embedded multicore architectures with emerging communication and memory technologies and, ii) power-aware dynamic compilation techniques that suitably match such a platform.

Continuum started on Oct 1st 2015. Partners are LIRMM and Cortus SAS.

9.1.4. *ANR CHIST-ERA SECODE 2016-2018*

Participants: Nicolas Kiss, Damien Hardy, Erven Rohou.

In this project, we specify and design error correction codes suitable for an efficient protection of sensitive information in the context of Internet of Things (IoT) and connected objects. Such codes mitigate passive attacks, like memory disclosure, and active attacks, like stack smashing. The innovation of this project is to leverage these codes for protecting against both cyber and physical attacks. The main advantage is a full coverage of attacks of the connected embedded systems, which is considered as a smart connected device and also a physical device. The outcome of the project is first a method to generate and execute cyber-resilient software, and second to protect data and its manipulation from physical threats like side-channel attacks. Theses results are demonstrated by using a smart sensor application with hardened embedded firmware and tamper-proof hardware platform.

Partners are Télécom Paris Tech, Université Paris 8, University of Sabancı(Turkey), and Université Catholique de Louvain (Belgium).

9.1.5. *ANR W-SEPT 2012-2016*

Participants: Isabelle Puaut, Erven Rohou.

Critical embedded systems are generally composed of repetitive tasks that must meet drastic timing constraints, such as termination deadlines. Providing an upper bound of the worst-case execution time (WCET) of such tasks at design time is thus necessary to prove the correctness of the system. Static WCET estimation methods, although safe, may produce largely over-estimated values. The objective of the project is to produce tighter WCET estimates by discovering and transforming flow information at all levels of the software design process, from high level-design models (e.g. Scade, Simulink) down to binary code. The ANR W-SEPT project partners are Verimag Grenoble, IRIT Toulouse, Inria Rennes. A case study is provided by Continental Toulouse.

9.1.6. *PEPS INS2I gDGA*

Participant: Sylvain Collange.

This interdisciplinary project aims at extending the definition and the range of applicability of distance geometry, with a particular attention to its discretization. As it is already possible to remark from recent publications in the scientific literature, the distance geometry can nowadays be seen as a classical problem in operational research, with a wide range of potential applications. Among the possible extensions, this project will mainly focus on dynamical problems, motivated by a certain number of novel applications that we have identified. These include interaction motion adaptation, the simulation of crowd behaviors, and the conception of recommender systems that are able to satisfy modern privacy regulations. The classical application of the distance geometry arising in the biological field will also be considered in this project. The necessity of a strong computational power for the mentioned applications motivates the need of implementing our algorithms in environments capable of exploiting the resources in GPU cards.

Partners are: Inria, Unviersité de Rennes 2, INSA Rennes, Université d'Avignon, CNRS.

9.2. European Initiatives

9.2.1. *FP7 & H2020 Projects*

9.2.1.1. ANTAREX

Participants: Erven Rohou, Imane Lasri.

Title: Auto-Tuning and Adaptivity appRoach for Energy efficient exascale HPC Systems

Programm: H2020

Duration: September 2015 - September 2018

Coordinator: Politecnico di Milano, Italy (POLIMI)

Partners:

Consorzio Interuniversitario Cineca (Italy)

Dompé Farmaceutici Spa (Italy)

Eidgenoessische Technische Hochschule Zürich (Switzerland)

Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)

Politecnico di Milano (Italy)

Sygic As (Slovakia)

Universidade do Porto (Portugal)

Inria contact: Erven Rohou

Energy-efficient heterogeneous supercomputing architectures need to be coupled with a radically new software stack capable of exploiting the benefits offered by the heterogeneity at all the different levels (supercomputer, job, node) to meet the scalability and energy efficiency required by Exascale supercomputers. ANTAREX will solve these challenging problems by proposing a disruptive holistic approach spanning all the decision layers composing the supercomputer software stack and exploiting effectively the full system capabilities (including heterogeneity and energy management). The main goal of the ANTAREX project is to provide a breakthrough approach to express application self-adaptivity at design-time and to runtime manage and autotune applications for green and heterogenous High Performance Computing (HPC) systems up to the Exascale level.

9.2.1.2. Eurolab-4-HPC

Participant: André Seznec.

Title: EuroLab-4-HPC: Foundations of a European Research Center of Excellence in High Performance Computing Systems

Programm: H2020

Duration: September 2015 - September 2017

Coordinator: CHALMERS TEKNISKA HOEGSKOLA AB

Partners:

> Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)
>
> Chalmers Tekniska Hoegskola (Sweden)
>
> École Polytechnique Federale de Lausanne (Switzerland)
>
> Foundation for Research and Technology Hellas (Greece)
>
> Universität Stuttgart (Germany)
>
> Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)
>
> Technion - Israel Institute of Technology (Israel)
>
> Universitaet Augsburg (Germany)
>
> The University of Edinburgh (United Kingdom)
>
> Universiteit Gent (Belgium)
>
> The University of Manchester (United Kingdom)

Inria contact: Albert Cohen (Inria Paris)

Europe has built momentum in becoming a leader in large parts of the HPC ecosystem. It has brought together technical and business stakeholders from application developers via system software to exascale systems. Despite such gains, excellence in high performance computing systems is often fragmented and opportunities for synergy missed. To compete internationally, Europe must bring together the best research groups to tackle the longterm challenges for HPC. These typically cut across layers, e.g., performance, energy efficiency and dependability, so excellence in research must target all the layers in the system stack. The EuroLab-4-HPC project's bold overall goal is to build connected and sustainable leadership in high-performance computing systems by bringing together the different and leading performance oriented communities in Europe, working across all layers of the system stack and, at the same time, fueling new industries in HPC.

9.2.1.3. DAL

Participants: Pierre Michaud, Sylvain Collange, Erven Rohou, André Seznec, Arthur Perais, Sajith Kalathingal, Andrea Mondelli, Aswinkumar Sridharan.

Title: DAL: Defying Amdahl's Law

Program: FP7

Type: ERC

Duration: April 2011 - March 2016

Coordinator: Inria

Inria contact: André Seznec

Multicore processors have now become mainstream for both general-purpose and embedded computing. Instead of working on improving the architecture of the next generation multicore, with the DAL project, we deliberately anticipate the next few generations of multicores. While multicores featuring 1000's of cores might become feasible around 2020, there are strong indications that sequential programming style will continue to be dominant. Even future mainstream parallel applications will exhibit large sequential sections. Amdahl's law indicates that high performance on these sequential sections is needed to enable overall high performance on the whole application. On many (most) applications, the effective performance of future computer systems using a 1000-core processor chip will significantly depend on their performance on both sequential code sections and single thread. We envision that, around 2020, the processor chips will feature a few complex cores and many (may be 1000's) simpler, more silicon and power effective cores. In the DAL research project, we will explore the microarchitecture techniques that will be needed to enable high performance on such heterogeneous processor chips. Very high performance will be required on both sequential sections -legacy sequential codes, sequential sections of parallel applications- and critical threads on parallel applications -e.g. the main thread controlling the application. Our research will focus on enhancing single process performance. On the microarchitecture side, we will explore both a radically new approach, the sequential accelerator, and more conventional processor architectures. We will also study how to exploit heterogeneous multicore architectures to enhance sequential thread performance.

9.2.1.4. ARGO

Participants: Isabelle Puaut, Damien Hardy.

Title: Argo: WCET-Aware Parallelization of Model-Based Applications for Heterogeneous Parallel Systems

Program: H2020

Type: RIA

Duration: Jan 2016 - Dec 2018

Coordinator: Karlsruher Institut fuer Technologie (KIT)

Université Rennes I contact: Steven Derrien

Partners:

Karlsruher Institut fuer Technologie (KIT)

SCILAB enterprises SAS

Recore Systems BV

Université de Rennes 1

Technologiko Ekpaideftiko Idryma (TEI) Dytikis Elladas

Absint GmbH

Deutsches Zentrum fuer Luft - und Raumfahrt EV

Fraunhofer

Increasing performance and reducing costs, while maintaining safety levels and programmability are the key demands for embedded and cyber-physical systems in European domains, e.g. aerospace, automation, and automotive. For many applications, the necessary performance with low energy consumption can only be provided by customized computing platforms based on heterogeneous many-core architectures. However, their parallel programming with time-critical embedded applications suffers from a complex toolchain and programming process. Argo (WCET-Aware PaRallelization of Model-Based Applications for HeteroGeneOus Parallel Systems) will address this challenge with a holistic approach for programming heterogeneous multi- and many-core architectures using automatic parallelization of model-based real-time applications. Argo will enhance WCET-aware automatic parallelization by a crosslayer programming approach combining automatic tool-based and user-guided parallelization to reduce the need for expertise in programming parallel heterogeneous architectures. The Argo approach will be assessed and demonstrated by prototyping comprehensive time-critical applications from both aerospace and industrial automation domains on customized heterogeneous many-core platforms.

Argo also involves Steven Derrien, Angeliki Kritikakou, and Imen Fassi from the CAIRN team.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

9.2.2.1. COST Action TACLe - Timing Analysis on Code-Level 10-2012/09-2016
Participants: Damien Hardy, Isabelle Puaut, Benjamin Rouxel.

Embedded systems increasingly permeate our daily lives. Many of those systems are business- or safety-critical, with strict timing requirements. Code-level timing analysis (used to analyze software running on some given hardware w.r.t. its timing properties) is an indispensable technique for ascertaining whether or not these requirements are met. However, recent developments in hardware, especially multi-core processors, and in software organization render analysis increasingly more difficult, thus challenging the evolution of timing analysis techniques.

New principles for building "timing-composable" embedded systems are needed in order to make timing analysis tractable in the future. This requires improved contacts within the timing analysis community, as well as with related communities dealing with other forms of analysis such as model-checking and type-inference, and with computer architectures and compilers. The goal of this COST Action is to gather these forces in order to develop industrial-strength code-level timing analysis techniques for future-generation embedded systems, through several working groups:

- WG1 Timing models for multi-cores and timing composability
- WG2 Tooling aspects
- WG3 Early-stage timing analysis
- WG4 Resources other than time

Isabelle Puaut is in the management committee of the COST Action TACLe - Timing Analysis on Code-Level (http://www.tacle.eu). She is responsible of Short Term Scientific Missions (STSM) within TACLe.

9.2.3. Collaborations with Major European Organizations

9.2.3.1. HiPEAC4 NoE
Participants: Pierre Michaud, Erven Rohou, André Seznec.

P. Michaud, A. Seznec and E. Rohou are members of the European Network of Excellence HiPEAC4.

HiPEAC4 addresses the design and implementation of high-performance commodity computing devices in the 10+ year horizon, covering both the processor design, the optimizing compiler infrastructure, and the evaluation of upcoming applications made possible by the increased computing power of future devices.

9.3. International Initiatives

9.3.1. PHC IMHOTEP

Participant: Erven Rohou.

> Title: Thoth – An Automatic Dynamic Binary Parallelisation System
>
> International Partner (Institution - Laboratory - Researcher):
>
> > Egypt-Japan University of Science and Technology - Prof. Ahmed ElMahdy.
>
> Dates: 2016–2017

With the current global trend towards utilizing cloud computing and smart devices, executing the same application across becomes a necessity. Moreover, parallelism is now abundant with various forms that include thread- and data-parallel execution models. Such diversity in ISA and explicit parallelism makes software development cost prohibitive, especially for natively optimized binaries. This project leverages dynamic binary translation technology to provide for exploiting the underlying parallel resources without the need of having the source code of the application. In particular the project integrates low overhead dynamic profiling, novel OSR parallel de-optimization and a retargetable parallelization modules to allow for dynamic parallelization of binaries.

9.3.2. Inria Associate Teams Not Involved in an Inria International Labs

9.3.2.1. PROSPIEL

Participant: Sylvain Collange.

> Title: Profiling and specialization for locality
>
> International Partner (Institution - Laboratory - Researcher):
>
> > Universidade Federal de Minas Gerais (Brazil) - DCC - Fernando Magno Quintão Pereira
>
> Start year: 2015
>
> See also: https://team.inria.fr/pacap/prospiel/
>
> The PROSPIEL project aims at optimizing parallel applications for high performance on new throughput-oriented architectures: GPUs and many-core processors. Traditionally, code optimization is driven by a program analysis performed either statically at compile-time, or dynamically at run-time. Static program analysis is fully reliable but often over-conservative. Dynamic analysis provides more accurate data, but faces strong execution time constraints and does not provide any guarantee. By combining profiling-guided specialization of parallel programs with runtime checks for correctness, PROSPIEL seeks to capture the advantages of both static analysis and dynamic analysis. The project relies on the polytope model, a mathematical representation for parallel loops, as a theoretical foundation. It focuses on analyzing and optimizing performance aspects that become increasingly critical on modern parallel computer architectures: locality and regularity.

9.3.3. Inria International Partners

9.3.3.1. Informal International Partners

The PACAP project-team has informal collaborations (visits, common publications) with University of Wisconsin at Madison (Pr Wood), University of Toronto (Pr Moshovos), University of Ghent (Dr Eyerman), University of Uppsala (Pr Hagersten), University of Cyprus (Pr Sazeides), the Egyptian-Japanese University of Science and Technology (Pr Ahmed El-Mahdy), Intel Haifa (Dr Zaks, Eng Nuzman), Barcelona Supercomputing Center (Dr Cazorla, Dr Abella), ISEP Porto (Dr Nelissen, Dr Nélis).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

Rubens Emilio Alves Moreira, student at Universidade Federal de Minas Gerais, visited from Feb 2016 to May 2016 within the context of the PROSPIEL associated team.

Stefano Cherubin, PhD student at Politecnico di Milano for one month in Oct 2016, within the context of the ANTAREX H2020 project.

Anita Tino, PhD student at Ryerson University, visited from Oct 2016 within the context of a MITACS grant.

<p style="text-align: center; color: red;">**PARKAS Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

ANR WMC project (program "jeunes chercheuses, jeunes chercheurs"), 2012–2016, 200 Keuros. F. Zappa Nardelli is the main investigator.

ANR Boole project (program "action blanche"), 2009-2014.

ANR CAFEIN, 2013-2015. Marc Pouzet.

8.1.2. Investissements d'avenir

Sys2Soft contract (Briques Génériques du Logiciel Embarqué). Partenaire principal: Dassault-Systèmes, etc. Inria contacts are Benoit Caillaud (HYCOMES, Rennes) and Marc Pouzet (PARKAS, Paris).

ManycoreLabs contract (Briques Génériques du Logiciel Embarqué). Partenaire principal: Kalray. Inria contacts are Albert Cohen (PARKAS, Paris), Alain Darte (COMPSYS, Lyon), Fabrice Rastello (CORSE, Grenoble).

8.1.3. Others

Marc Pouzet is scientific advisor for the Esterel-Technologies/ANSYS company.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. Eurolab-4-HPC

Title: EuroLab-4-HPC: Foundations of a European Research Center of Excellence in High Performance Computing Systems

Programm: H2020

Duration: September 2015 - September 2017

Coordinator: CHALMERS TEKNISKA HOEGSKOLA AB

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Chalmers Tekniska Hoegskola (Sweden)

Ecole Polytechnique Federale de Lausanne (Switzerland)

Eidgenoessische Technische Hochschule Zuerich (Switzerland)

Foundation for Research and Technology Hellas (Greece)

Universitaet Stuttgart (Germany)

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Technion - Israel Institute of Technology (Israel)

Universitaet Augsburg (Germany)

The University of Edinburgh (United Kingdom)

Universiteit Gent (Belgium)

The University of Manchester (United Kingdom)

Inria contact: Albert Cohen

Europe has built momentum in becoming a leader in large parts of the HPC ecosystem. It has brought together technical and business stakeholders from application developers via system software to exascale systems. Despite such gains, excellence in high performance computing systems is often fragmented and opportunities for synergy missed. To compete internationally, Europe must bring together the best research groups to tackle the longterm challenges for HPC. These typically cut across layers, e.g., performance, energy efficiency and dependability, so excellence in research must target all the layers in the system stack. The EuroLab-4-HPC project's bold overall goal is to build connected and sustainable leadership in high-performance computing systems by bringing together the different and leading performance orientated communities in Europe, working across all layers of the system stack and, at the same time, fuelling new industries in HPC.

8.2.1.2. TETRACOM

Title: Technology Transfer in Computing Systems

Programm: FP7

Duration: September 2013 - August 2016

Coordinator: RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN

Partners:

Imperial College of Science, Technology and Medicine (United Kingdom)

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Technische Universiteit Delft (Netherlands)

Tty-Saatio (Finland)

Universita di Pisa (Italy)

Inria contact: Albert Cohen

The mission of the TETRACOM Coordination Action is to boost European academia-to-industry technology transfer (TT) in all domains of Computing Systems. While many other European and national initiatives focus on training of entrepreneurs and support for start-up companies, the key differentiator of TETRACOM is a novel instrument called Technology Transfer Project (TTP). TTPs help to lower the barrier for researchers to make the first steps towards commercialisation of their research results. TTPs are designed to provide incentives for TT at small to medium scale via partial funding of dedicated, well-defined, and short term academia-industry collaborations that bring concrete R&D results into industrial use. This will be implemented via competitive Expressions-of-Interest (EoI) calls for TTPs, whose coordination, prioritization, evaluation, and management are the major actions of TETRACOM. It is expected to fund up to 50 TTPs. The TTP activities will be complemented by Technology Transfer Infrastructures (TTIs) that provide training, service, and dissemination actions. These are designed to encourage a larger fraction of the R&D community to engage in TTPs, possibly even for the first time. Altogether, TETRACOM is conceived as the major pilot project of its kind in the area of Computing Systems, acting as a TT catalyst for the mutual benefit of academia and industry. The projects primary success metrics are the number and value of coordinated TTPs as well as the amount of newly introduced European TT actors. It is expected to acquire around more than 20 new contractors over the project duration. TETRACOM complements and actually precedes the use of existing financial instruments such as venture capital or business angels based funding.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

Program: ITEA 3

Project acronym: ASSUME

Project title: Affordable Safe & Secure Mobility Evolution

Duration: Sep 2015–Aug 2018

Coordinator: Udo Gleich

Other partners: AbsInt Angewandte Informatik GmbH, Airbus, Arcelik, Articus Systems AB, BTC Embedded Systems AG, Berner & Mattner Systemtechnik GmbH, Daimler AG, Eindhoven University of Technology, Ericsson, ANSYS, FindOut Technologies AB,

Ford Otosan, Forschungszentrum Informatik (FZI), Havelsan, KTH (Royal Institute of Technology), Kalray SA, Karlsruhe Institute of Technology (KIT), Kiel University, Koc University, KoçSistem, Model Engineering Solutions GmbH, Mälardalen University, NXP Semiconductors, OFFIS, Recore Systems BV, Robert Bosch GmbH, Safran Aircraft Engines SAS, Safran Electronics & Defense, Scania, TNO, Thales, UNIT Information Technologies R&D Ltd., University Pierre et Marie Curie, University of Technology in Munich, University of Twente, VDL Bus & Coach bv, Verum Software Tools BV, École normale supérieure.

Abstract: Future mobility solutions will increasingly rely on smart components that continuously monitor the environment and assume more and more responsibility for a convenient, safe and reliable operation. Currently the single most important roadblock for this market is the ability to come up with an affordable, safe multi-core development methodology that allows industry to deliver trustworthy new functions at competitive prices. ASSUME will provide a seamless engineering methodology, which addresses this roadblock on the constructive and analytic side.

8.2.3. Collaborations with Major European Organizations

Albert Cohen is an external member of the ARTEMIS-IA Working Group. Collaborating on the writing of the association's Strategic Research Agenda (SRA), and the ECSEL JU Multi-Annual Research and Innovation Agenda (MASRIA).

https://artemis-ia.eu

8.3. International Initiatives

8.3.1. POLYFLOW

Title: Polyhedral Compilation for Data-Flow Programming Languages

International Partner (Institution - Laboratory - Researcher):

    IISc Bangalore (India) - Department of Computer Science and Automation (CSA) - Uday Kumar Reddy Bondhugula

Start year: 2016

See also: http://polyflow.gforge.inria.fr

The objective of the associate team is to foster collaborations on fundamental and applied research. It also supports training sessions, exchange of undergraduate and master students, and highlighting opportunities in the partners' research, education and economic environments.

Polyhedral techniques for program transformation are now used in several proprietary and open source compilers. However, most of the research on polyhedral compilation has focused on imperative languages, where computation is specified in terms of computational statements within nested loops and control structures. Graphical data-flow languages, where there is no notion of statements or a schedule specifying their relative execution order, have so far not been studied using a powerful transformation or optimization approach. These languages are extremely popular in the system analysis, modeling and design of embedded reactive control applications. They also underline the construction of domain-specific languages and compiler intermediate representations. The execution semantics of data-flow languages impose a different set of challenges for compilation and optimization. We are studying techniques enabling the extraction of a polyhedral representation from data-flow programs, to transform them with the goal of generating memory-efficient and high-performance code for modern architectures.

The research conducted in PolyFlow covers both fundamental and applied aspects. The partners also emphasize the development of solid research tools. The associate team will facilitate their dissemination as free software and their exploitation through industrial collaborations.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Pr. Peter Sewell, Computer Laboratory, University of Cambridge, UK. Regular visits and scientific collaboration.

Pr. Jan Vitek, College of Computer & Information Science Northeastern University, USA. Regular visits and scientific collaboration.

Prof. Uday Bondhugula, CSA department, Indian Institute of Science, India. See POLYFLOW associate team for details.

Prof. Ramakrishna Updadrasta, IIT Hyderabad, India, collaboration visits including internships.

Prof. P. Sadayappan, CS department, Ohio State University, USA. Joint publications, frequent visits, occasionally for several weeks.

Prof. M. Sheeran, Computer Science and Engineering Department, Chalmers University of Technology, Sweden. Regular visits. Continuing exchanges on languages and compilation for synchronous and hybrid systems.

Prof. C. Tinelli, CS department, University of IOWA, USA. Regular visits. Continuing exchanges on the verification of synchronous languages and programs.

Prof. R. von Hanxleden, Director at the Department of Computer Science, Head of the Real-Time and Embedded Systems Group, Kiel University, Germany. Regular visits and scientific collaboration.

Prof. M. Mendler, Head of the Informatics Theory Group, Bamberg University, Germany. Regular visits and scientific collaboration.

Dr. Sven Verdoolaege, CS department, K. U. Leuven, Belgium. Joint steering of the Polly Labs initiative and contractual cooperation in this context.

Dr. Tobias Grosser in the group of Prof. Torsten Hoeffler, ETH Zürich. Joint steering of the Polly Labs initiative. See Polly Labs for details.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Prasanth Chatarasi, PhD student from Rice University.

Keyur Joshi, undergraduate student from IIT Hyderabad.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Guillaume Baudart spent three months working at the IBM Thomas J. Watson Research Centre.

PARSIFAL Project-Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. Proofcert

Title: ProofCert: Broad Spectrum Proof Certificates

Programm: FP7

Type: ERC

Duration: January 2012 - December 2016

Coordinator: Inria

Inria contact: Dale Miller

There is little hope that the world will know secure software if we cannot make greater strides in the practice of formal methods: hardware and software devices with errors are routinely turned against their users. The ProofCert proposal aims at building a foundation that will allow a broad spectrum of formal methods—ranging from automatic model checkers to interactive theorem provers—to work together to establish formal properties of computer systems. This project starts with a wonderful gift to us from decades of work by logicians and proof theorist: their efforts on logic and proof has given us a universally accepted means of communicating proofs between people and computer systems. Logic can be used to state desirable security and correctness properties of software and hardware systems and proofs are uncontroversial evidence that statements are, in fact, true. The current state-of-the-art of formal methods used in academics and industry shows, however, that the notion of logic and proof is severely fractured: there is little or no communication between any two such systems. Thus any efforts on computer system correctness is needlessly repeated many time in the many different systems: sometimes this work is even redone when a given prover is upgraded. In ProofCert, we will build on the bedrock of decades of research into logic and proof theory the notion of proof certificates. Such certificates will allow for a complete reshaping of the way that formal methods are employed. Given the infrastructure and tools envisioned in this proposal, the world of formal methods will become as dynamic and responsive as the world of computer viruses and hackers has become.

8.1.2. Collaborations in European Programs, Except FP7 & H2020

8.1.2.1. FISP: ANR blanc International

Participants: Kaustuv Chaudhuri, François Lamarche, Sonia Marin, Dale Miller, Lutz Straßburger.

Title: The Fine Structure of Formal Proof Systems and their Computational Interpretations

Duration: 01/01/2016 – 31/12/2018

Partners:

   University Paris VII, PPS (PI: Michel Parigot)

   Inria Saclay–IdF, EPI Parsifal (PI: Lutz Straßburger)

   University of Innsbruck, Computational Logic Group (PI: Georg Moser)

   Vienna University of Technology, Theory and Logic Group (PI: Matthias Baaz)

Total funding by the ANR: 316 805 EUR

The FISP project is part of a long-term, ambitious project whose objective is to apply the powerful and promising techniques from structural proof theory to central problems in computer science for which they have not been used before, especially the understanding of the computational content of proofs, the extraction of programs from proofs and the logical control of refined computational operations. So far, the work done in the area of computational interpretations of logical systems is mainly based on the seminal work of Gentzen, who in the mid-thirties introduced the sequent calculus and natural deduction, along with the cut-elimination procedure. But that approach shows its limits when it comes to computational interpretations of classical logic or the modelling of parallel computing. The aim of our project, based on the complementary skills of the teams, is to overcome these limits. For instance, deep inference provides new properties, namely full symmetry and atomicity, which were not available until recently and opened new possibilities at the computing level, in the era of parallel and distributed computing.

8.1.2.2. COCA HOLA: ANR JCJC Project
Participant: Beniamino Accattoli.

> *Title*: COst model for Complexity Analyses of Higher-Order programming LAnguages.
>
> *Collaborators*: Ugo Dal Lago (University of Bologna & Inria), Delia Kesner (Paris Diderot University), Damiano Mazza (CNRS & Paris 13 University), Claudio Sacerdoti Coen (University of Bologna).
>
> *Duration*: 01/10/2016 – 31/09/2019
>
> *Total funding by the ANR*: 155 280 EUR

The COCA HOLA project aims at developing complexity analyses of higher-order computations, i.e. that approach to computation where the inputs and outputs of a program are not simply numbers, strings, or compound data-types, but programs themselves. The focus is not on analysing fixed programs, but whole programming languages. The aim is the identification of adequate units of measurement for time and space, i.e. what are called reasonable cost models. The problem is non-trivial because the evaluation of higher-order languages is defined abstractly, via high-level operations, leaving the implementation unspecified. Concretely, the project will analyse different implementation schemes, measuring precisely their computational complexity with respect to the number of high-level operations, and eventually develop more efficient new ones. The goal is to obtain a complexity-aware theory of implementations of higher-order languages with both theoretical and practical downfalls.

The projects stems from recent advances on the theory of time cost models for the lambda-calculus, the computational model behind the higher-order approach, obtained by the principal investigator and his collaborators (who are included in the project).

COCA HOLA will span over three years and is organised around three work packages, essentially:

1. extending the current results to encompass realistic languages;
2. explore the gap between positive and negative results in the literature;
3. use ideas from linear logic to explore space cost models, about which almost nothing is known.

8.2. International Initiatives

8.2.1. Participation in Other International Programs

8.2.1.1. PHC Amadeus: Analytic Calculi for Modal Logics
Participants: Kaustuv Chaudhuri, Sonia Marin, Giselle Reis, Lutz Straßburger.

> Title: Analytic Calculi for Modal Logics
>
> Duration: 01/01/2016 – 31/12/2017
>
> Austrian Partner: TU Wien, Institute for Computer Science (Department III)

Modal logics are obtained from propositional logics by adding modalities $\Box$ and $\diamond$, meaning necessity and possibility. Originally studied by philosophers in order to reason about knowledge and belief, modal logics have nowadays many applications in computer science. Well known examples are epistemic logics, which allow to formally reason about the knowledge of independently acting and interacting agents, temporal logics, which allow to reason about temporal properties of processes, and authentication logics, which are used to formally reason about authentication protocols.

The purpose of this project is to develop a proof theory for variants of modal logic that have applications in modern computer science but that have been neglected by traditional proof theory so far.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Professor Chuck Liang (from Hofstra University, NY, USA) visited the team from 5 June to 25 June 2016 in order to continue his collaborations with team members on basic questions of proof theory. In particular, he worked with Miller on identifying possible means to allow classical and intuitionistic logic to be mixed in a common proof system. Miller is exploring how the resulting ideas might be able to reorganize the notion of kernel logic used within the ProofCert project.

8.3.1.1. Internships

Ameni Chtourou was an intern funded by ProofCert during May, June, and July 2016. She was advised by Accattoli and worked with using the Abella theorem prover to formalize connections various connections between λ-term evaluation and abstract machine models.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

Stéphane Graham-Lengrand spent 8 months, from January 2016 to August 2016, at SRI International, Computer Science Lab. This visit developed a collaboration with N. Shankar, MP Bonacina, D. Jovanovic, and Martin Schaeff on new algorithms and new architectures for automated and interactive theorem proving, as well as on new programme verification techniques.

<p style="text-align:center">**PESTO Project-Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. CNRS

- CNRS PEPS JCJC INS2I 2016 project VESPA *Verifying Equivalence Security in Protocols: Tools and Algorithms*, duration: 1 year, leader: Jannik Dreier, participant: Vincent Cheval.

  Privacy-related notions such as unlinkability and anonymity are usually expressed as equivalence properties, which are notoriously difficult to prove. Due to the complexity of the protocols and the properties, tool support is a must, yet currently rather limited. Notably, there is currently no tool that can verify unlinkability of the electronic passport for an unbounded number of sessions, or anonymity in certain classic electronic cash protocols. The goal of this project is to enable the proofs for these and similar protocols using two complementary approaches: (1) by significantly advancing the state of the art of the algorithms used inside the tools to improve handling of branching and cryptographic primitives, and (2) by providing new reduction results that simplify the tools' inputs.

- CNRS PEPS INS2I 2016 project ASSI *Analyse de Sécurité de Systèmes Industriels*, duration: 1 year, leader: Pascal Lafourcade (Université Clermont-Ferrand), participant PESTO: Jannik Dreier, other participants: Marie-Laure Potet, Maxime Puys (University Grenoble-Alpes).

  The goal of the project is to develop an approach to verify protocols used in industrial control (SCADA) systems using tools such as *TAMARIN* or ProVerif. These protocols have specific security requirements such as flow integrity, going beyond the classical authentication and secrecy properties. The project also aims at analyzing different intruder models matching the particularities of industrial systems, and to develop specific modeling and verification techniques.

9.1.2. ANR

- ANR SEQUOIA *Security properties, process equivalences and automated verification*, duration: 4 years, since October 2014, leader: Steve Kremer. Most protocol analysis tools are restricted to analyzing reachability properties while many security properties need to be expressed in terms of some process equivalence. The increasing use of observational equivalence as a modeling tool shows the need for new tools and techniques that are able to analyze such equivalence properties. The aims of this project are *(i)* to investigate which process equivalences – among the plethora of existing ones – are appropriate for a given security property, system assumptions and attacker capabilities; *(ii)* to advance the state-of-the-art of automated verification for process equivalences, allowing for instance support for more cryptographic primitives, relevant for case studies; *(iii)* to study protocols that use low-entropy secrets expressed using process equivalences; *(iv)* to apply these results to case studies from electronic voting.

9.1.3. Fondation MAIF

Project *Protection de l'information personnelle sur les réseaux sociaux*, duration: 3 years, started in October 2014. The goal of the project is to lay the foundation for a risk verification environment on privacy in social networks. Given social relations, this environment will rely on the study of metrics to characterize the security level for a user. Next, by combining symbolic and statistical techniques, an objective is to synthesize a model of risk behavior as a rule base. Finally, a verifier à la model-checking will be developed to assess the security level of user. Partners are Pesto (leader), Orpailleur and Fondation Maif.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- ProSecure (2011-2016) [0]— ERC Starting Grant Project on Provably secure systems: foundations, design, and modularity. The long-term aim of the project is to develop provably secure systems such as security protocols. The goal is to propose foundations for a careful analysis and design of large classes of up-to-date protocols. To achieve this goal, the project is structured in three main tasks. First, we develop general verification techniques for new classes of protocols that are of primary interest in nowadays life like e-voting protocols, routing protocols or security APIs. Second, we consider the cryptographic part of the primitives that are used in such protocols (encryption, signatures, ...), obtaining higher security guarantees. Third, we propose modular results both for the analysis and design of protocols. Véronique Cortier is the leader of the project.
- SPOOC (2015–2020) [0]— ERC Consolidator Grant on Automated Security Proofs of Cryptographic Protocols: Privacy, Untrusted Platforms and Applications to E-voting Protocols.

  The goals of the Spooc project are to develop solid foundations and practical tools to analyze and formally prove security properties that ensure the privacy of users as well as techniques for executing protocols on untrusted platforms. We will
    - develop foundations and practical tools for specifying and formally verifying new security properties, in particular privacy properties;
    - develop techniques for the design and automated analysis of protocols that have to be executed on untrusted platforms;
    - apply these methods in particular to novel e-voting protocols, which aim at guaranteeing strong security guarantees without need to trust the voter client software.

  Steve Kremer is the leader of the project.

9.3. International Initiatives

9.3.1. Inria International Partners

- Collaboration with David Basin, Ralf Sasse and Lara Schmid (ETH Zurich), Cas Cremers (University of Oxford), and Sasa Radomirovic (University of Dundee) on the improvement of the *TAMARIN* prover and the elaboration of a user manual.
- Collaboration with Bogdan Warinschi (Bristol University) on defining game-based privacy for e-voting protocols and isolated execution environments.
- Collaboration with Myrto Arapinis (University of Edinburgh) on simplification results for the formal analysis of e-voting protocols.
- Collaboration with Matteo Maffei (CISPA, Germany) on type systems for e-voting systems.
- Collaboration with Michael Backes and Robert Künnemann (CISPA, Germany) on automated verification of security protocols.
- Collaboration with Paliath Narendran's group (SUNY Albany) on automated deduction.
- Collaboration with Hanifa Boucheneb's group (Ecole Polytechnique de Montréal) on model-checking of collaborative systems.
- Collaboration with John Mullins's group (Ecole Polytechnique de Montréal) on information hiding.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Carlos Castro (UTSM Valparaíso, Chile), July 2015 - June 2016, partly funded as Inria invited researcher
- David Galindo (University of Bimingham), April 2016
- Bogdan Warinschi (University of Bristol), November 2016

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[0]http://prosecure.loria.fr
[0]https://members.loria.fr/SKremer/files/spooc/index.html

<p style="text-align:center;color:red;font-weight:bold;">PI.R2 Project-Team</p>

6. Partnerships and Cooperations

6.1. National Initiatives

Alexis Saurin (coordinator) and Yann Régis-Gianas are members of the four-year RAPIDO ANR project, started in January 2015. RAPIDO aims at investigating the use of proof-theoretical methods to reason and program on infinite data objects. The goal of the project is to develop logical systems capturing infinite proofs (proof systems with least and greatest fixed points as well as infinitary proof systems), to design and to study programming languages for manipulating infinite data such as streams both from a syntactical and semantical point of view. Moreover, the ambition of the project is to apply the fundamental results obtained from the proof-theoretical investigations (i) to the development of software tools dedicated to the reasoning about programs computing on infinite data, *e.g.* stream programs (more generally coinductive programs), and (ii) to the study of properties of automata on infinite words and trees from a proof-theoretical perspective with an eye towards model-checking problems. Other permanent members of the project are Christine Tasson from IRIF (PPS team), David Baelde from LSV, ENS-Cachan, and Pierre Clairambault, Damien Pous and Colin Riba from LIP, ENS-Lyon.

Pierre-Louis Curien (coordinator), Yves Guiraud (local coordinator), Philippe Malbos and Samuel Mimram have been members of the three-year Focal project of the IDEX Sorbonne Paris Cité (July 2013 to June 2016). This project, giving the support for the PhD grant of Cyrille Chenavier, concerns the interactions between higher-dimensional rewriting and combinatorial algebra. This project is joint with mathematicians form LAGA (Univ. Paris 13).

Pierre-Louis Curien (coordinator), Yves Guiraud (local coordinator), Philippe Malbos and Samuel Mimram are members of the four-year Cathre ANR project, started in January 2014. This project, giving the support for the PhD grant of Maxime Lucas, investigates the general theory of higher-dimensional rewriting, the development of a general-purpose library for higher-dimensional rewriting, and applications in the fields of combinatorial linear algebra, combinatorial group theory and theoretical computer science. This project is joint with mathematicians and computer scientists from LAGA (Univ. Paris 13), LIX (École Polytechnique), ICJ (Univ. Lyon 1 and Univ. Saint-Étienne), I2M (Univ. Aix-Marseille) and IMT (Univ. Toulouse 3).

Pierre-Louis Curien, Yves Guiraud, Hugo Herbelin, Philippe Malbos, Samuel Mimram and Alexis Saurin are members of the GDR Informatique Mathématique, in the Géocal (Geometry of computation) and LAC (Logic, algebra and computation) working groups.

Pierre-Louis Curien, Yves Guiraud (local coordinator), Philippe Malbos, Samuel Mimram and Matthieu Sozeau are members of the GDR Topologie Algébrique, federating French researchers working on classical topics of algebraic topology and homological algebra, such as homotopy theory, group homology, K-theory, deformation theory, and on more recent interactions of topology with other themes, such as higher categories and theoretical computer science.

Hugo Herbelin was the coordinator of the PPS site for the ANR Récré (January 2012 to mid 2016). Récré is about realisability and rewriting, with applications to proving with side-effects and concurrency.

Yann Régis-Gianas collaborates with Mitsubishi Rennes on the topic of differential semantics. This collaboration led to the CIFRE grant for the PhD of Thibaut Girka.

Yann Régis-Gianas is a member of the ANR COLIS dedicated to the verification of Linux Distribution installation scripts. This project is joint with members of VALS (Univ Paris Sud) and LIFL (Univ Lille).

Matthieu Sozeau is a member of the CoqHoTT project led by Nicolas Tabareau (Ascola team, École des Mines de Nantes), funded by an ERC Starting Grant. The PhD grant of Gabriel Lewertowski was funded by the CoqHoTT ERC.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

Hugo Herbelin is a deputy representative of France in the COST action EUTYPES.

6.3. International Initiatives

6.3.1. Inria Associate Teams Not Involved in an Inria International Labs

Pierre-Louis Curien participates to the Associated Team CRECOGI (Concurrent, Resourceful and Effectful Computation, by Geometry of Interaction) between the project-team Focus (Bologna) and the University of Tokyo (principal investigators Ugo dal Lago and Ichiro Hasuo, started in 2015).

6.3.2. Inria International Partners

6.3.2.1. Informal International Partners

The project-team has collaborations with University of Aarhus (Denmark), University of Oregon, University of Tokyo, University of Sovi Sad and the Institute of Mathematics of the Serbian Academy of Sciences, University of Nottingham, Institute of Advanced Study, MIT, University of Cambridge, and Universidad Nacional de Córdoba.

6.3.3. Participation in Other International Programs

Pierre-Louis Curien participates to the ANR International French-Chinese project LOCALI (Logical Approach to Novel Computational Paradigms), coordinated by Gilles Dowek (Deducteam).

6.4. International Research Visitors

6.4.1. Visits of International Scientists

Paolo Giarrusso (Univ. of Marburg) visited Yann Régis-Gianas in February 2016.

Lourdes del Carmen Gonzalez Huesca (Univ. of Mexico) visited Yann Régis-Gianas in December 2016.

6.4.2. Visits to International Teams

6.4.2.1. Research Stays Abroad

Pierre-Louis Curien visited the Category Theory group at Macquarie University in June-July 2016 (collaborative work on the combinatorial structure of type dependency).

As a part of his joint PhD, Étienne Miquey worked most of the year in Montevideo within the Logic group of the Universidad de la República of Uruguay.

POLSYS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- **ANR Grant HPAC: High Performance Algebraic Computing (2012-2016).** The pervasive ubiquity of parallel architectures and memory hierarchy has led to a new quest for parallel mathematical algorithms and software capable of exploiting the various levels of parallelism: from hardware acceleration technologies (multi-core and multi-processor system on chip, GPGPU, FPGA) to cluster and global computing platforms. For giving a greater scope to symbolic and algebraic computing, beyond the optimization of the application itself, the effective use of a large number of resources (memory and specialized computing units) is expected to enhance the performance multi-criteria objectives: time, resource usage, reliability, even energy consumption. The design and the implementation of mathematical algorithms with provable, adaptive and sustainable performance is a major challenge. In this context, this project is devoted to fundamental and practical research specifically in exact linear algebra and system solving that are two essential "dwarfs" (or "killer kernels") in scientific and algebraic computing. The project should lead to progress in matrix algorithms and challenge solving in cryptology, and should provide new insights into high performance programming and library design problems (J.-C. Faugère [contact], L. Perret, G. Renault, M. Safey El Din).

- **PIA grant RISQ: Regroupement of the Security Industry for Quantum-Safe security (2017-2020).** The goal of the RISQ project is to prepare the security industry to the upcoming shift of classical cryptography to quantum-safe cryptography. (J.-C. Faugère [contact], and L. Perret).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. A3

Type: PEOPLE

Instrument: Career Integration Grant

Duration: May 2013 - April 2017

Coordinator: Jean-Charles Faugère

Partner: Institut National de Recherche en Informatique et en Automatique (Inria), France

Inria contact: Elias Tsigaridas

Abstract: The project Algebraic Algorithms and Applications (A3) is an interdisciplinary and multidisciplinary project, with strong international synergy. It consists of four work packages The first (Algebraic Algorithms) focuses on fundamental problems of computational (real) algebraic geometry: effective zero bounds, that is estimations for the minimum distance of the roots of a polynomial system from zero, algorithms for solving polynomials and polynomial systems, derivation of non-asymptotic bounds for basic algorithms of real algebraic geometry and application of polynomial system solving techniques in optimization. We propose a novel approach that exploits structure and symmetry, combinatorial properties of high dimensional polytopes and tools from mathematical physics. Despite the great potential of the modern tools from algebraic algorithms, their use requires a combined effort to transfer this technology to specific problems. In the second package (Stochastic Games) we aim to derive optimal algorithms for computing the values of stochastic games, using techniques from real algebraic geometry, and to introduce a whole new arsenal of algebraic tools to computational game theory. The third work package (Non-linear

Computational Geometry), we focus on exact computations with implicitly defined plane and space curves. These are challenging problems that commonly arise in geometric modeling and computer aided design, but they also have applications in polynomial optimization. The final work package (Efficient Implementations) describes our plans for complete, robust and efficient implementations of algebraic algorithms.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: CryptoAction

Project title: Cryptography for Secure Digital Interaction

Duration: 04 2014 - 04 2018

Coordinator: Claudio ORLANDI

Abstract: As increasing amounts of sensitive data are exchanged and processed every day on the Internet, the need for security is paramount. Cryptography is the fundamental tool for securing digital interactions, and allows much more than secure communication: recent breakthroughs in cryptography enable the protection - at least from a theoretical point of view - of any interactive data processing task. This includes electronic voting, outsourcing of storage and computation, e-payments, electronic auctions, etc. However, as cryptography advances and becomes more complex, single research groups become specialized and lose contact with "the big picture". Fragmentation in this field can be dangerous, as a chain is only as strong as its weakest link. To ensure that the ideas produced in Europe's many excellent research groups will have a practical impact, coordination among national efforts and different skills is needed. The aim of this COST Action is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments. The Action will foster a network of European research centers thus promoting movement of ideas and people between partners.

Program: COST

Project acronym: CRYPTACUS

Project title: Cryptanalysis of ubiquitous computing systems

Duration: 12 2014 - 12 2018

Coordinator: Gildas AVOINE

Abstract: Recent technological advances in hardware and software have irrevocably affected the classical picture of computing systems. Today, these no longer consist only of connected servers, but involve a wide range of pervasive and embedded devices, leading to the concept of "ubiquitous computing systems". The objective of the Action is to improve and adapt the existent cryptanalysis methodologies and tools to the ubiquitous computing framework. Cryptanalysis, which is the assessment of theoretical and practical cryptographic mechanisms designed to ensure security and privacy, will be implemented along four axes: cryptographic models, cryptanalysis of building blocks, hardware and software security engineering, and security assessment of real-world systems. Researchers have only recently started to focus on the security of ubiquitous computing systems. Despite the critical flaws found, the required highly-specialized skills and the isolation of the involved disciplines are a true barrier for identifying additional issues. The Action will establish a network of complementary skills, so that expertise in cryptography, information security, privacy, and embedded systems can be put to work together. The outcome will directly help industry stakeholders and regulatory bodies to increase security and privacy in ubiquitous computing systems, in order to eventually make citizens better protected in their everyday life.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. GOAL

Title: Geometry and Optimization with ALgebraic methods.

International Partner (Institution - Laboratory - Researcher):

> University of California Berkeley (United States) - Dept. of Mathematics - Bernd Sturm-fels

Start year: 2015

See also: http://www-polsys.lip6.fr/GOAL/index.html

Polynomial optimization problems form a subclass of general global optimization problems, which have received a lot of attention from the research community recently; various solution techniques have been designed. One reason for the spectacular success of these methods is the potential impact in many fields: data mining, big data, energy savings, etc. More generally, many areas in mathematics, as well as applications in engineering, biology, statistics, robotics etc. require a deeper understanding of the algebraic structure of their underlying objects.

A new trend in the polynomial optimization community is the combination of algebraic and numerical methods. Understanding and characterizing the algebraic properties of the objects occurring in numerical algorithms can play an important role in improving the efficiency of exact methods. Moreover, this knowledge can be used to estimate the quality (for example the number of significant digits) of numerical algorithms. In many situations each coordinate of the optimum is an algebraic number. The degree of the minimal polynomials of these algebraic numbers is the Algebraic Degree of the problem. From a methodological point of view, this notion of Algebraic Degree emerges as an important complexity parameter for both numerical and the exact algorithms. However, algebraic systems occurring in applications often have special algebraic structures that deeply influence the geometry of the solution set. Therefore, the (true) algebraic degree could be much less than what is predicted by general worst case bounds (using Bézout bounds, mixed volume, etc.), and would be very worthwhile to understand it more precisely.

The goal of this proposal is to develop algorithms and mathematical tools to solve geometric and optimization problems through algebraic techniques. As a long-term goal, we plan to develop new software to solve these problems more efficiently. These objectives encompass the challenge of identifying instances of these problems that can be solved in polynomial time with respect to the number of solutions and modeling these problems with polynomial equations.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Carlos Améndola Cerón

> Date: May 2016
>
> Institution: Technische Universität Berlin, Germany

Christoph Koutschan

> Date: Nov. 2016
>
> Institution: Österreichische Akademie der Wissenschaften, Linz

Didier Henrion

> Date: Nov. 2016
>
> Institution: LAAS, CNRS

Simone Naldi

> Date: Nov. 2016
>
> Institution: TU Univ. Dortmund, Germany.

Ioannis Psarros

Date: May. 2016

Institution: University of Athens, Greece.

8.4.1.1. Internships

Vincent Guisse

Date: Apr. 2016 - Jul. 2016

Institution: Université Paris – Diderot

Supervisor: Jean-Charles Faugère, Jérémy Berthomieu

Ramon Ronzon

Date: Mar. 2016 - Sep. 2016

Institution: École polytechnique

Supervisor: Jean-Charles Faugère, Ludovic Perret

Sènan Dossa

Date: Mar. 2016 - Sep. 2016

Institution: ENS Lyon

Supervisor: Jean-Charles Faugère, Ludovic Perret

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. SCRIME

The Studio de Création et de Recherche en Informatique et Musiques Expérimentales (SCRIME) located on Bordeaux University Campus, is a *Groupement d'Intérêt Scientifique et Artistique (GIS&A)* gathering Université de Bordeaux, CNRS, Bordeaux INP, Ministère de la Culture et de la Communication, Ville de Bordeaux and Région Aquitaine. It is a privileged partner of the PoSET project. Most PoSET artistic projects are organized in cooperation with the SCRIME.

9.1.2. Idex Bordeaux

- 2 *Arts & Science* projects of Bordeaux eventually granted in 2016 by the Initiative of Excellence (Idex) of Bordeaux,

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

In 2016, PoSET members had active collaboration with

- Shlomo Dubnov, UCSD, USA,
- Mark Lawson, Herriot-Watt University, Edimbourg, UK,
- Camillo Rueda, Universidad Javaneria, Cali, Colombia,

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Shlomo Dubnov, Professor at UCSD (USA), was member of the PoSET project for nine months, thanks to an Bordeaux Idex fellowship in 2016.

PRIVATICS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. FUI

8.1.1.1. HuMa

>Title: HuMa.

>Type: FUI.

>Duration: Juin 2015 - Mai 2018.

>Coordinator: INTRINSEC.

>Others partners: Inria, SYDO, Wallix, INSA Lyon, CASSIDIAN Cybersecurity, Oberthur, INTRIN-SEC.

>Abstract:

>The goal of huMa is to improve the tools used to distinguish legitimate network flows from attacks in complex systems including IoT.

8.1.2. ANR

8.1.2.1. BIOPRIV

>Title: Application of privacy by design to biometric access control.

>Type: ANR.

>Duration: April 2013 - March 2017.

>Coordinator: Morpho (France).

>Others partners: Morpho (France), Inria (France), Trusted Labs (France).

>See also: http://planete.inrialpes.fr/biopriv/.

>Abstract: The objective of BIOPRIV is the definition of a framework for privacy by design suitable for the use of biometric technologies. The case study of the project is biometric access control. The project will follow a multidisciplinary approach considering the theoretical and technical aspects of privacy by design but also the legal framework for the use of biometrics and the evaluation of the privacy of the solutions.

8.1.3. Inria Project Labs

8.1.3.1. CAPPRIS

>Title: CAPPRIS

>Type: Inria Project Lab

>Duration: January 2011 - 2016.

>Coordinator: PRIVATICS

>Others partners: Inria (CIDRE, Comete, Secsi,Smis), Eurecom, LAAS and CRIDS

>Abstract: Cappris (Collaborative Action on the Protection of Privacy Rights in the Information Society) is an Inria Project Lab initiated in 2013. The general goal of Cappris is to foster the collaboration between research groups involved in privacy in France and the interaction between the computer science, law and social sciences communities in this area.

8.1.4. Inria CNIL project

8.1.4.1. MOBILITICS

Title: MOBILITICS

Type: joint project.

Duration: January 2012 - Ongoing.

Coordinator: CNIL.

Others partners: CNIL.

Abstract: Platform for mobile devices privacy evaluation. This project strives to deploy an experimental mobile platform for studying and analyzing the weaknesses of current online (smartphone) applications and operating systems and the privacy implications for end-users. For instance, one of the objectives is to understand trends and patterns collected when they are aimed at obtaining general knowledge that does not pertain to any specific individual. Examples of such tasks include learning of commuting patterns, inference of recommendation rules, and creation of advertising segments.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, ANR Chistera

8.2.1.1. COPES

Title: COnsumer-centric Privacy in smart Energy gridS

Programm: CHISTERA

Duration: December 2015 - december 2018

Coordinator: KTH Royal Institute of Technology

Inria contact: Cédric Lauradoux

Smart meters have the capability to measure and record consumption data at a high time resolution and communicate such data to the energy provider. This provides the opportunity to better monitor and control the power grid and to enable demand response at the residential level. This not only improves the reliability of grid operations but also constitutes a key enabler to integrate variable renewable generation, such as wind or solar. However, the communication of high resolution consumption data also poses privacy risks as such data allows the utility, or a third party, to derive detailed information about consumer behavior. Hence, the main research objective of COPES is to develop new technologies to protect consumer privacy, while not sacrificing the "smartness", i.e., advanced control and monitoring functionalities. The core idea is to overlay the original consumption pattern with additional physical consumption or generation, thereby hiding the consumer privacy sensitive consumption. The means to achieve this include the usage of storage, small scale distributed generation and/or elastic energy consumptions. Hence, COPES proposes and develops a radically new approach to alter the physical energy flow, instead of purely relying on encryption of meter readings, which provides protection against third party intruders but does not prevent the use of this data by the energy provider.

8.2.1.2. UPRISE-IoT

Title: User-centric PRIvacy & Security in IoT

Programm: CHISTERA

Duration: December 2016 - december 2019

Coordinator: SUPSI (Suisse)

Inria contact: Claude Castelluccia

The call states that "Traditional protection techniques are insufficient to guarantee users' security and privacy within the future unlimited interconnection": UPRISE-IoT will firstly identify the threats and model the behaviours in IoT world, and further will build new privacy mechanisms centred around the user. Further, as identified by the call "all aspects of security and privacy of the user data must be under the control of their original owner by means of as simple and efficient technical solutions as possible", UPRISE-IoT will rise the awareness of data privacy to the users. Finally, it will deeply develop transparency mechanisms to "guarantee both technically and regulatory the neutrality of the future internet." as requested by the call. The U-HIDE solution developed inn UPRISE-IoT will "empower them to understand and make their own decisions regarding their data, which is essential in gaining informed consent and in ensuring the take-up of IoT technologies", using a methodology that includes "co-design with users to address the key, fundamental, but inter-related and interdisciplinary aspects of privacy, security and trust."

8.3. Regional Initiatives

8.3.1. ACDC

Title: ACDC

Type: AGIR 2016 Pole MSTIC.

Duration: September 2016 - 2017.

Coordinator: Inria.

Others partners: UGA.

Abstract: The objective of this project is to evaluate the security and privacy impacts of drone. The project targets 2 milestones: the evaluation of the possiblity to tamper with the drone control/command systems and the capacity of drone to collect private information (for instance text recognition).

8.3.2. AMNECYS

- Title: AMNECYS
- Duration: 2015 - .
- Coordinator: CESICE, UPMF.
- Others partners: Inria/Privatics and LIG/Moais, Gipsa-lab, LJK, Institut Fourier, TIMA, Vérimag, LISTIC (Pole MSTIC) .
- Abstract: Privatics participates to the creation of an Alpine Multidisciplinary NEtwork on CYbersecurity Studies (AMNECYS). The academic teams and laboratories participating in this project have already developed great expertise on encryption technologies, vulnerabilities analysis, software engineering, protection of privacy and personal data, international & European aspects of cybersecurity. The first project proposal (ALPEPIC ALPs-Embedded security: Protecting Iot & Critical infrastructure) focuses on the protection of the Internet of Things (IoT) and Critical Infrastructure (CI).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Lucas Melis

Gergely Acs

PROSECCO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. AnaStaSec

Title: Static Analysis for Security Properties (ANR générique 2014.)

Other partners: Inria/Antique, Inria/Celtique, Airbus Operations SAS, AMOSSYS, CEA-LIST, TrustInSoft

Duration: January 2015 - December 2018.

Coordinator: Jérôme Féret, Inria Antique (France)

Participant: Bruno Blanchet

Abstract: The project aims at using automated static analysis techniques for verifying security and confidentiality properties of critical avionics software.

8.1.1.2. AJACS

Title: AJACS: Analyses of JavaScript Applications: Certification and Security

Other partners: Inria-Rennes/Celtique, Inria-Saclay/Toccata, Inria-Sophia Antipolis/INDES, Imperial College London

Duration: October 2014 - March 2019.

Coordinator: Alan Schmitt, Inria (France)

Abstract: The goal of the AJACS project is to provide strong security and privacy guarantees for web application scripts. To this end, we propose to define a mechanized semantics of the full JavaScript language, the most widely used language for the Web, to develop and prove correct analyses for JavaScript programs, and to design and certify security and privacy enforcement mechanisms.

8.1.1.3. SafeTLS

Title: SafeTLS: La se´curisation de l'Internet du futur avec TLS 1.

Other partners: Université Rennes 1, IRMAR, Inria Sophia Antipolis, SGDSN/ANSSI

Duration: October 2016 - September 2020

Coordinator: Pierre-Alain Fouque, Univesité de Rennes 1 (France)

Abstract: Our project, SafeTLS, addresses the security of both TLS 1.3 and of TLS 1.2 as they are (expected to be) used, in three important ways: (1) A better understanding: We will provide a better understanding of how TLS 1.2 and 1.3 are used in real-world applications; (2) Empowering clients: By developing a tool that will show clients the quality of their TLS connection and inform them of potential security and privacy risks; (3) Analyzing implementations: We will analyze the soundness of current TLS 1.2 implementations and use automated verification to provide a backbone of a secure TLS 1.3 implementation.

8.1.1.4. QuickChick

Title: QuickChick: Property-based Testing for Coq

Coordinator: Catalin Hritcu

Abstract: The goal of the project was to develop a property-based testing framework for Coq proofs. Catalin Hritcu was awarded an ANR Jeune Chercheur/Jeune Chercheuse grant to pursue this project, but he declined it in favour of his ERC Starting Grant SECOMP (described below.)

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. ERC Consolidator Grant: CIRCUS

Title: CIRCUS: An end-to-end verification architecture for building Certified Implementations of Robust, Cryptographically Secure web applications

Duration: April 2016 - March 2021

Coordinator: Karthikeyan Bhargavn, Inria

Abstract: The security of modern web applications depends on a variety of critical components including cryptographic libraries, Transport Layer Security (TLS), browser security mechanisms, and single sign-on protocols. Although these components are widely used, their security guarantees remain poorly understood, leading to subtle bugs and frequent attacks. Rather than fixing one attack at a time, we advocate the use of formal security verification to identify and eliminate entire classes of vulnerabilities in one go.

CIRCUS proposes to take on this challenge, by verifying the end-to-end security of web applications running in mainstream software. The key idea is to identify the core security components of web browsers and servers and replace them by rigorously verified components that offer the same functionality but with robust security guarantees.

8.2.1.2. ERC Starting Grant: SECOMP

Title: SECOMP: Efficient Formally Secure Compilers to a Tagged Architecture

Duration: Jan 2017 - December 2021

Coordinator: Catalin Hritcu, Inria

Abstract: This new ERC-funded project called SECOMP1 is aimed at leveraging emerging hardware capabilities for fine-grained protection to build the first, efficient secure compilers for realistic programming languages, both low-level (the C language) and high-level (F*, a dependently-typed ML variant). These compilers will provide a secure semantics for all programs and will ensure that high-level abstractions cannot be violated even when interacting with untrusted low-level code. To achieve this level of security without sacrificing efficiency, our secure compilers will target a tagged architecture, which associates a metadata tag to each word and efficiently propagates and checks tags according to software-defined rules. We will use property-based testing and formal verification to provide high confidence that our compilers are indeed secure.

8.2.1.3. NEXTLEAP

Title: NEXTLEAP: NEXT generation Legal Encryption And Privacy

Programm: H2020

Duration: January 2016 - December 2018

Coordinator: Harry Halpin, Inria

Other partners: IMDEA, University College London, CNRS, IRI, and Merlinux

Abstract: NEXTLEAP aims to create, validate, and deploy protocols that can serve as pillars for a secure, trust-worthy, and privacy-respecting Internet. For this purpose NEXTLEAP will develop an interdisciplinary study of decentralisation that provides the basis on which these protocols cann be designed, working with sociologists to understand user needs. The modular specification of decentralized protocols, implemented as verified open-source software modules, will be done for both privacy-preserving secure federated identity as well as decentralized secure messaging services that hide metadata (e.g., who, when, how often, etc.).

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

We have a range of long- and short-term collaborations with various universities and research labs. We summarize them by project:

- **F***: Microsoft Research (Cambdridge, Redmond), IMDEA (Madrid)
- **TLS analysis**: Microsoft Research (Cambridge), Johns Hopkins University, University of Michigan, University of Pennsylvania
- **Web Security**: Microsoft Research (Cambridge, Redmond), Imperial College (London)
- **Micro-Policies**: University of Pennsylvania, Portland State University

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Carmela Troncoso from IMDEA visited the group from 17-18th October and gave a seminar "Traffic Analysis - When Encryption is not Enough to Protect Privacy"

8.4.1.1. Internships

- Alejandro Aguirre: Apr 2016 until Aug 2016
- Abhishek Bichhawat: Sep 2016 until Dec 2016
- Diane Gallois-Wong: Mar 2016 until Aug 2016
- Ritobroto Maitra: May 2016 until Aug 2016
- Guido Martinez: Jan 2016 until Jun 2016
- Jianyang Pan: May 2016 until Aug 2016
- Marina Polubelova: Sep 2016 until Nov 2016
- Natalia Kulatova: May 2016 until Aug 2016
- Vinay Yogendra: May 2016 until Jul 2016

8.4.2. Visits to International Teams

- Bruno Blanchet, March 14 to June 10, 2016, Google, Mountain View.
- Catalin Hritcu, October to November 2016, Microsoft Research, Redmond, USA.

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SECRET Project-Team

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9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **ANR BLOC** ($10/11 \rightarrow 03/16$)
  Design and Analysis of block ciphers dedicated to constrained environments
  ANR program: Ingénierie numérique et sécurité
  Partners: INSA Lyon, Inria (project-team SECRET), University of Limoges (XLIM), CryptoExperts
  446 kEuros
  http://bloc.project.citi-lab.fr
  The BLOC project aims at providing strong theoretical and practical results in the domain of cryptanalysis and design of block ciphers.

- **ANR KISS** ($12/11 \rightarrow 02/16$)
  Keep your personal Information Safe and Secure
  ANR program: Ingénierie numérique et sécurité
  Partners: Inria (project-teams SMIS and SECRET), LIRIS, Gemalto, University of Versailles-St Quentin, Conseil Général des Yvelines
  64 kEuros
  The KISS project builds upon the emergence of new portable and secure devices known as Secure Portable Tokens (e.g., mass storage SIM cards, secure USB sticks, smart sensors) combining the security of smart cards and the storage capacity of NAND Flash chips. The idea promoted in KISS is to embed, in such devices, software components capable of acquiring, storing and managing securely personal data.

- **ANR BRUTUS** ($10/14 \rightarrow 09/18$)
  Authenticated Ciphers and Resistance against Side-Channel Attacks
  ANR program: Défi Société de l'information et de la communication
  Partners: ANSSI, Inria (project-team SECRET and project-team MARELLE), Orange, University of Lille, University of Rennes, University Versailles-Saint Quentin
  160 kEuros
  The Brutus project aims at investigating the security of authenticated encryption systems. We plan to evaluate carefully the security of the most promising candidates to the Caesar competition, by trying to attack the underlying primitives or to build security proofs of modes of operation. We target the traditional black-box setting, but also more "hostile" environments, including the hardware platforms where some side-channel information is available.

- **ANR DEREC** ($10/16 \rightarrow 09/21$)
  Relativistic cryptography
  ANR Program: jeunes chercheurs
  244 kEuros
  The goal of project DEREC is to demonstrate the feasibility of guaranteeing the security of some cryptographic protocols using the relativistic paradigm, which states that information propagation is limited by the speed of light. We plan to study some two party primitives such as bit commitment and their security against classical and quantum adversaries in this model. We then plan to the integration of those primitives into larger cryptosystems. Finally, we plan on performing a demonstration of those systems in real life conditions.

9.1.2. Others

- **DGA-MI** (09/15 → 09/16)
  Analysis of binary streams: reconstructing LDPC codes.
  28.6 kEuros.
  The objective of this contract was to examine the code reconstruction problem (from noisy observation) for LDPC codes.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. PQCRYPTO

Title: Post-quantum cryptography for long-term security

Programm: H2020

Duration: March 2015 - March 2018

Coordinator: Technische Universiteit Eindhoven (NL)

Partners:

Academia Sinica (Taiwan)

Bundesdruckerei (Germany)

Danmarks Tekniske Universitet (Denmark)

Katholieke Universiteit Leuven (Belgium)

Nxp Semiconductors Belgium Nv (Belgium)

Ruhr-Universität Bochum (Germany)

Stichting Katholieke Universiteit (Netherlands)

Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Darmstadt (Germany)

University of Haifa (Israel)

Inria contact: Nicolas Sendrier

Online banking, e-commerce, telemedicine, mobile communication, and cloud computing depend fundamentally on the security of the underlying cryptographic algorithms. Public-key algorithms are particularly crucial since they provide digital signatures and establish secure communication without requiring in-person meetings. Essentially all applications today are based on RSA or on the discrete-logarithm problem in finite fields or on elliptic curves. Cryptographers optimize parameter choices and implementation details for these systems and build protocols on top of these systems; cryptanalysts fine-tune attacks and establish exact security levels for these systems. Alternative systems are far less visible in research and unheard of in practice. It might seem that having three systems offers enough variation, but these systems are all broken as soon as large quantum computers are built. The EU and governments around the world are investing heavily in building quantum computers; society needs to be prepared for the consequences, including cryptanalytic attacks accelerated by these computers. Long-term confidential documents such as patient health-care records and state secrets have to guarantee security for many years, but information encrypted today using RSA or elliptic curves and stored until quantum computers are available will then be as easy to decipher as Enigma-encrypted messages are today. PQCRYPTO will allow users to switch to post-quantum cryptography: cryptographic systems that are not merely secure for today but that will also remain secure long-term against attacks by quantum computers. PQCRYPTO will design a portfolio of high-security post-quantum public-key systems, and will improve the speed of these systems, adapting to the different performance challenges of mobile devices, the cloud, and the Internet of Things. PQCRYPTO will provide efficient implementations of high-security post-quantum cryptography for a broad spectrum of real-world applications.

9.2.1.2. QCALL

Title: Quantum Communications for ALL

Programm: H2020-MSCA-ITN-2015

Duration: December 2016 - November 2020

Coordinator: University of Leeds (UK)

Other partners: see http://www.qcall-itn.eu/

Inria contact: Anthony Leverrier

QCALL is a European Innovative Training Network that endeavors to take the next necessary steps to bring the developing quantum technologies closer to the doorsteps of end users. QCALL will empower a nucleus of 15 doctoral researchers in this area to provide secure communications in the European continent and, in the long run, to its connections worldwide.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: ICT COST Action IC1306

Project title: Cryptography for Secure Digital Interaction

Duration: January 2014 - November 2017

Coordinator: Claudio Orlandi, Aarhus University, Denmark

Other partners: see http://www.cost.eu/domains_actions/ict/Actions/IC1306

Abstract: The aim of this COST action is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments.

Anne Canteaut is co-leader of the working group on cryptographic primitives. She co-organized a 2-day workshop for PhD students and early-career researchers in symmetric cryptography, DISC 2016 (Bochum, Germany, March 23-24 2016).

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

Title: Discrete Mathematics, Codes and Cryptography

International Partner (Institution - Laboratory - Researcher):

Indian Statistical Institute (India) - Cryptology Research Group - Bimal Roy

Duration: 2014 - 2018

Start year: 2014

Today's cryptology offers important challenges. Some are well-known: Can we understand existing cryptanalysis techniques well enough to devise criterion for the design of efficient and secure symmetric cryptographic primitives? Can we propose cryptographic protocols which offer provable security features under some reasonable algorithmic assumptions? Some are newer: How could we overcome the possible apparition of a quantum computer with its devastating consequences on public key cryptography as it is used today? Those challenges must be addressed, and some of the answers will involve tools borrowed to discrete mathematics, combinatorics, algebraic coding theory, algorithmic. The guideline of this proposal is to explore further and enrich the already well established connections between those scientific domains and their applications to cryptography and its challenges.

9.3.1.2. Informal International Partners

- Otto-von-Guericke Universität Magdeburg, Institut für Algebra und Geometrie (Germany): Study of Boolean functions for cryptographic applications
- Nanyang Technological University (Singapore): cryptanalysis of symmetric primitives.
- Ruhr-Universität Bochum (Germany): design and cryptanalysis of symmetric primitives.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Leo Perrin, University of Luxemburg, visiting PhD student, June 2016.
- Thomas Peyrin, NTU Singapore, visiting scientist, Feb.-March 2016 and June 2016.

9.4.1.1. Internships

- Xavier Bonnetain, MPRI and Telecom ParisTech, March-Aug. 2016
- Rémi Bricout, MPRI and ENS Paris, March-Aug. 2016
- Thomas Debris, MPRI and ENS Cachan, March-Aug. 2016
- Ghazal Kachigar, Master cryptographie et mathématiques de l'information, Univ. Rennes, March-Sept. 2016
- Vivien Londe, Master de mathématiques, UPMC, April-July 2016

9.4.2. Visits to International Teams

9.4.2.1. Short Research Stays Abroad

- Ruhr-Universität Bochum, Bochum, Germany, January 18-22, work with Gregor Leander (G. Leurent)
- Instituto Superior Tecnico, Lisbon, Portugal, May 18-20, 2016, invitation to visit the group of quantum computation of Paulo Mateus (A. Leverrier)
- University of Oxford Mathematical Institute, Oxford, UK, May 25-26, invitation to the cryptography seminar (G. Leurent)

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SPADES Project-Team

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8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CASERM (PERSYVAL-Lab project)

Participants: Pascal Fradet, Alain Girault, Gregor Goessler, Xiaojie Guo, Xavier Nicollin, Stephan Plassart, Sophie Quinton, Jean-Bernard Stefani.

Despite recent advances, there exist currently no integrated formal methods and tools for the design and analysis of reconfigurable multi-view embedded systems. This is the goal of the CASERM project.

The CASERM project represents a significant effort towards a COQ-based design method for reconfigurable multi-view embedded systems, in order to formalize the structure and behavior of systems and to prove their main properties. The use of a proof assistant to support such a framework is motivated by the fact that the targeted systems are both extremely complex and critical. The challenges addressed are threefold:

1. to model software architectures for embedded systems taking into account their dynamicity and multiple constraints (functional as well as non functional);
2. to propose novel scheduling techniques for dynamically reconfiguring embedded systems; and
3. to advance the state of the art in automated proving for such systems.

The objectives of CASERM that address these challenges are organized in three tasks. They consist respectively in designing an architecture description framework based on a process calculus, in proposing online optimization methods for dynamic reconfiguration systems (this is the topic of Stephan Plassart's PhD), and in developing a formal framework for real-time analysis in the COQ proof assistant (this is the topic of Xiaojie Guo's PhD). A fourth task focuses on common case studies for the evaluation of the obtained results.

The CASERM consortium gathers researchers from the G-SCOP, LIG and VERIMAG laboratories who are reknown specialists in these fields. The project started in November 2016 and will last three years.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

We have a strong collaboration with the Technische Universität Braunschweig in Germany. In particular, Sophie Quinton is involved in the CCC project (http://ccc-project.org/) to provide methods and mechanisms for the verification of software updates after deployment in safety-critical systems and in the TypicalCPA project which aims at computing deadline miss models for distributed systems.

We also a recent collaboration with the MPI-SWS in Kaiserslautern (Germany) on formal proofs for real-time systems.

8.3. International Initiatives

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. Causalysis

> Title: Causality Analysis for Safety-Critical Embedded Systems
>
> International Partner (Institution - Laboratory - Researcher):
>
>> University of Pennsylvania (United States) - PRECISE center - Oleg Sokolsky
>
> Start year: 2015

See also: https://team.inria.fr/causalysis/

Today's embedded systems become more and more complex, while an increasing number of safety-critical functions rely on them. Determining the cause(s) of a system-level failure and elucidating the exact scenario that led to the failure is today a complex and tedious task that requires significant expertise. The CAUSALYSIS project will develop automated approaches to causality analysis on execution logs.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Athena Abdi has been a visitor in the team from October 2015 to June 2016. She is doing her PhD at the Amirkabir University of Technology in Teheran, Iran. In the SPADES team, she is working on multi-criteria scheduling for real-time embedded systems, addressing the complex interplay between reliability, power consumption, temperature, and execution time (see 6.3.2).

- Ismail Assayad has been a visitor in the team in September 2015. He is assistant professor at the University of Casablanca, Morocco. In the SPADES team, he is working on adaptive scheduling methods and admission control for dynamic embedded applications (see 6.3.2).

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

FastRelax (ANR-14-CE25-0018).
Goal: Develop computer-aided proofs of numerical values, with certified and reasonably tight error bounds, without sacrificing efficiency.
Leader: B. Salvy (Inria, ÉNS Lyon). Participants: Assia Mahboubi, Th. Sibut-Pinote.
Website: http://fastrelax.gforge.inria.fr/.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

- Program: COST
- Project acronym: EUTYPES (CA15123)
- Project title: The European research network on types for programming and verification
- Duration: October 2015 - October 2019
- Coordinator: Herman Geuvers (Radboud University, Nijmegen, the Netherlands)
- Other partners: Czech Republic, Estonia, Macedonia, Germany, Greece, the Netherlands, Norway, Poland, Serbia, Slovenia, United Kingdom.
- Abstract: Types are pervasive in programming and information technology. A type defines a formal interface between software components, allowing the automatic verification of their connections, and greatly enhancing the robustness and reliability of computations and communications. In rich dependent type theories, the full functional specification of a program can be expressed as a type. Type systems have rapidly evolved over the past years, becoming more sophisticated, capturing new aspects of the behaviour of programs and the dynamics of their execution. This COST Action will give a strong impetus to research on type theory and its many applications in computer science, by promoting: (1) the synergy between theoretical computer scientists, logicians and mathematicians to develop new foundations for type theory, for example as based on the recent development of "homotopy type theory", (2) the joint development of type theoretic tools as proof assistants and integrated programming environments, (3) the study of dependent types for programming and its deployment in software development, (4) the study of dependent types for verification and its deployment in software analysis and verification. The action will also tie together these different areas and promote cross-fertilisation. Europe has a strong type theory community, ranging from foundational research to applications in programming languages, verification and theorem proving, which is in urgent need of better networking. A COST Action that crosses the borders will support the collaboration between groups and complementary expertise, and mobilise a critical mass of existing type theory research.

8.3. International Research Visitors

8.3.1. Research Stays Abroad

- Thomas Sibut-Pinote has spent two months at Microsoft Research Cambridge, visiting Georges Gonthier and working on mathematical libraries for the Lean proof assistant. He also participated in a hackathon internal to Microsoft Research with the goal to apply formal methods to the verification of the smart contracts involved in the Ethereum framework for cryptocurrency.

SUMO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

ANR STOCH-MC: Model-Checking of Stochastic Systems using approximated algorithms, 2014-2018, http://perso.crans.org/~genest/stoch.htmlweb site.
Led by SUMO.
Partners: Inria Project Team CONTRAINTES (Rocquencourt), LaBRI (Bordeaux), and LIAFA (Paris).
The aim of STOCH-MC is to perform model-checking of large stochastic systems, using controlled approximations. Two formalisms will be considered: Dynamic Bayesian Networks, which represent compactly large Markov Chains; and Markov Decision Processes, allowing non deterministic choices on top of probabilities.

ANR HeadWorks: Human-Centric Data-oriented WORKflows , 2016-2020
Led by Université Rennes 1.
Partners: Inria Project Team VALDA (LSV and ENS-ULM), Univestité Rennes 1 (DRUID), Inria SUMO, Inria Lille (LINKs), MNHN, Foule Factory.
Headwork was accepted in 2016. Participants : Loïc Hélouët, Éric Badouel.

Partners: IRISA (DRUID), ENS ULM (VALDA), Inria SUMO, Inria Lille (LINKs), MNHN, Foule Factory.

The objective of this project is to develop techniques to facilite development, deployment, and monitring of crowd-based participative applications. This requires handling complex workflows with multiple participants, incertainty in data collections, incentives, skills of contributors, ... To overcome these challenges, Headwork will define rich workflows with multiple participants, data and knowledge models to capture various kind of crowd applications with complex data acquisition tasks and human specificities. We will also address methods for deploying, verifying, optimizing, but also monitoring and adapting crowd- based workflow executions at run time.

9.1.2. IPL HAC SPECIS

The Inria Project Lab HAC SPECIS (High-performance Application and Computers, Studying PErformance and Correctness In Simulation, 2016-2020: http://hacspecis.gforge.inria.fr/) is a transversal project internal to Inria. The goal of the HAC SPECIS project is to answer the methodological needs raised by the recent evolution of HPC architectures by allowing application and runtime developers to study such systems both from the correctness and performance point of view. Inside this project, we collaborate with Martin Quinson (Myriads team) on the dynamic formal verification of high performance runtimes and applications. The PhD of The Anh Pham is granted by this project.

Partners: Inria teams AVALON (Lyon), POLARIS (Grenoble), HIEPACS, STORM (Bordeaux), MEXICO (Paris), MYRIADS, SUMO (Rennes), VERIDIS (Nancy).

Participants: Thierry Jéron, The Anh Pham.

9.1.3. National informal collaborations

The team collaborates with the following researchers:

- Yliès Falcone (CORSE LIG/Inria team in Grenoble) and Antoine Rollet (Labri Bordeaux) on the enforcement of timed properties,
- Arnaud Sangnier (IRIF) on the parameterized verification of probabilistic systems,
- Béatrice Bérard (LIP6) and Serge Haddad (LSV) on problems of opacity and diagnosis.
- Thomas Chatain, on problems related to concurrency and time,
- Eric Rutten and Gwenael delaval on the control of reconfigurable systems as well as making the ling between Reax and Heptagon / BZR (http://bzr.inria.fr/),
- Patricia Bouyer (LSV, ENS Cachan) on the analysis of probabilistic timed systems and quantitative aspects of verification,
- François Laroussinie (IRIF, UP7-Diderot) on logics for multi-agent systems.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Nicolas Markey is a member of Project ERC EQualIS whose principal investigator is Patricia Bouyer from LSV.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. QuantProb

Title: Quantitative analysis of non-standard properties in probabilistic models

International Partner (Institution - Laboratory - Researcher):

Technical University of Dresde (Germany) - Saxe - Christel Baier

Start year: 2016

See also: http://www.irisa.fr/sumo/QuantProb/

Quantitative information flow and fault diagnosis share two important characteristics: quantities (in the description of the system as well as in the properties of interest), and users partial knowledge. Yet, in spite of their similar nature, different formalisms have been proposed. Beyond these two motivating examples, defining a unified framework can be addressed by formal methods. Formal methods have proved to be effective to verify, diagnose, optimize and control qualitative properties of dynamic systems. However, they fall short of modelling and mastering quantitative features such as costs, energy, time, probabilities, and robustness, in a partial observation setting. This project proposal aims at developing theoretical foundations of formal methods for the quantitative analysis of partially observable systems.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

The team collaborates on runtime enforcement with the group of Prof. Stavros Tripakis (http://users.ics.aalto.fi/stavros/) at Aalto University (Finland), where our former PhD student Srinivas Pinisetty is doing a Post-doc and with Thomas Brihaye (University of Mons) on the analysis of probabilistic timed systems.

The team has well-established collaborations with several institutes in India. CMI (Chennai Mathematical Institute, M. Mukund and N.K. Kumar), IIT Bombay (S. Akshay).

The team is building a new collaboration with Ecole Polytechnique Montreal (J. Mullins).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

L. Ricker visited the SUMO team for 2 months in May-June 2016.

9.4.1.1. Internships

Robert Nsaibirni from the University of Yaoundé I joined the team from Sept. 2016 in the context of an Eiffel grant.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Nathalie Bertrand spent a month at the Simons Institute for the theory of computing, UC Berkeley, California. She participated to the program Logical Structure in Computation (https://simons.berkeley.edu/programs/logic2016).

<center>**TAMIS Team**</center>

9. Partnerships and Cooperations

9.1. Regional Initiatives

ARED grant for Nisrine Jafri.

Postdocs grants for Fabrizio Biondi, Jeffrey Paul Burdges, Florian Dold, Ronan Lashermes.

9.2. National Initiatives

9.2.1. ANR

- ANR MALTHY, Méthodes ALgèbriques pour la vérification de modèles Temporisés et HYbrides, Thao Dang, 4 years, Inria and VISEO and CEA and VERIMAG
- ANR COGITO, Runtime Code Generation to Secure Devices,, 3 years, Inria and CEA and ENSMSE and XLIM.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ACANTO

Participants: Axel Legay, Thomas Given-Wilson, Sean Sedwards, Olivier Zendra.

Start: 2015. End: 2018.

The population of the advanced countries is ageing. This simple and widely recognised fact has important implications for health, society and economics. The most evident is in the number of people who report activity limitations, which grows significantly with age as clearly shown in the following chart. Activity limitations have an adverse effect on a person's productivity, on the quality of her social relations and, ultimately, on her quality of life. Policy makers confronted with a problem of challenging complexity: how to develop an effective strategy to fight the physical and cognitive decline of older adults in the face of ever shrinking financial resources for health care and social services.

In this context, technology can be of considerable help to care–givers to extend the range and the efficacy of their actions. The ACANTO project (http://www.ict-acanto.eu) aims to develop a portfolio of technical solution that can serve this purpose. More specifically, our goal is to spur older adults into a sustainable and regular level of physical exercise under the guidance and the supervision of their carers.

The key elements of ACANTO are a robotic friend (the FriWalk) that sup-ports the user in the execution of daily activities that require physical exercise and an intelligent system that recommends activites that a senior user perceives as compelling and rewarding.

The FriWalk takes the form of a standard walking assistant, but it is in fact an intelligent robot that is able to localise itself, to sense the surrounding environment, to plan a course of action that suits the user needs and to guide the user along safe routes. The FriWalk is also a personal trainer that can support the user in the execution of a training programme, monitor the motion of the user in search of muscular or gait problems and report them into the user profile (that can be inspected by doctors and physicians).

The second key idea of ACANTO is that physical exercise is actually "concealed" within compelling activities (such as shopping, taking walks in museums and exhibitions etc.). Such activities have a social dimension (they are proposed to group of users) and are chosen based on the interest and on the past experiences of the user. At the heart of the recommendation system there is a social network which is created and developed by primarily using information collected by the FriWalk using "physical" observations on her behaviour and on her emotional state. For this reason, we call this social network "cyberphysical".

This project aims at developping an autonomous system to drive groups of citizens with respect to point of interest. Those citizens are supposed to communicate, and one of the objective of Tamis is to build a robust and secure system to guarantee this communication. Axel Legay and Olivier Zendra are the permanent researchers of Tamis involved in this project. The project supports two postdocs in Tamis.

9.3.1.2. DIVIDEND
Participant: Laurent Morin.

Start: 2014. End: 2017.

The DIVIDEND project (http://www.chistera.eu/projects/dividend) attacks the data centre energy efficiency bottleneck through vertical integration, specialisation, and cross-layer optimization. Our vision is to present heterogeneous data centres, combining CPUs, GPUs, and task-specific accelerators, as a unified entity to the application developer and let the runtime optimize the utilization of the system resources during task execution. DIVIDEND embraces heterogeneity to dramatically lower the energy per task through extensive hardware specialisation while maintaining the ease of programmability of a homogeneous architecture. To lower communication latency and energy, DIVIDEND refers a lean point-to-point messaging fabric over complex connection-oriented network protocols. DIVIDEND addresses the programmability challenge by adapting and extending the industry-led heterogeneous systems architecture programming language and runtime initiative to account for energy awareness and data movement. DIVIDEND provides for a cross-layer energy optimization framework via a set of APIs for energy accounting and feedback between hardware, compilation, runtime, and application layers. The DIVIDEND project will usher in a new class of vertically integrated data centres and will take a first stab at resolving the energy crisis by improving the power usage effectiveness of data centres.

Laurent Morin from Tamis is involved in this project

9.3.1.3. EMC^2
Participants: Axel Legay, Olivier Zendra.

Start: 2014. End: 2017.

EMC^2 (Embedded Multi-Core systems for Mixed Criticality applications in dynamic and changeable real-time environments https://www.artemis-emc2.eu) is an ARTEMIS Joint Undertaking project in the Innovation Pilot Programme 'Computing platforms for embedded systems' (AIPP5). Embedded systems are the key innovation driver to improve almost all mechatronic products with cheaper and even new functionalities. They support today's information society as inter-system communication enabler. A major industrial challenge arises from the need to face cost efficient integration of different applications with different levels of safety and security on a single computing platform in an open context. EMC^2 finds solutions for dynamic adaptability in open systems, provides handling of mixed criticality applications under real-time conditions, scalability and utmost flexibility, full scale deployment and management of integrated tool chains, through the entire lifecycle. The objective of EMC^2 is to establish Multi-Core technology in all relevant Embedded Systems domains. EMC^2 is a project of 99 partners of embedded industry and research from 19 European countries with an effort of about 800 person years and a total budget of about 100 million Euro.

EMC2 (2014–2017) is at the border between formal methods and security. We in Tamis are mainly using the fundings to develop the Plasma toolset that is used by our statistical model checking and symbolic model checking tools. The permanent members of Tamis who are involved are Axel Legay and Olivier Zendra. The project was initiated during the lifetime of the ESTASYS.Inria team.

9.3.1.4. ENABLE-S3
Participants: Axel Legay, Jean-Louis Lanet.

Start: 2016. End: 2019.

The objective of ENABLE-S3 (http://www.enable-s3.eu) is to establish cost-efficient cross-domain virtual and semi-virtual V&V platforms and methods for ACPS. Advanced functional, safety and security test methods will be developed in order to significantly reduce the verification and validation time but preserve the validity of the tests for the requested high operation range. ENABLE-S3 aspires to substitute today's physical validation and verification efforts by virtual testing and verification, coverage-oriented test selection methods and standardization. ENABLE-S3 is use-case driven; these use cases represent relevant environments and scenarios. Each of the models, methods and tools integrated into the validation platform will be applied to at least one use case (under the guidance of the V&V methodology), where they will be validated (TRL 5) and their usability demonstrated (TRL6). Representative use cases and according applications provide the base for the requirements of methods and tools, as well as for the evaluation of automated systems and respective safety.

This project is industry driven and has the objective of designing new technologies for autonomous transportation, including to secure them. Tamis tests its results on the case studies of the project. Axel Legay and Jean-Louis Lanet are involved in this project. The project supports one postdoc in Tamis starting in 2017.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Clémentine MAURICE (Graz University of Technology, Institute of Applied Information Processing and Communications, Austria) visited Tamis and also gave a talk on Reverse-engineering CPUs for fun and profit.

9.4.2. Visits to International Teams

- Axel Legay stayed at Namur University, Belgium.
- Axel Legay stayed at University of Limerick, Ireland.
- Axel Legay and Sean Sedwards stayed at Aalborg University, Denmark.
- Axel Legay, Fabrizio Biondi and Thomas Given-Wilson stayed at John Hopkins University, USA.

TASC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. EPOC

With the emergence of the Future Internet and the dawning of new IT models such as cloud computing, the usage of data centers (DC), and consequently their power consumption, increase dramatically. Besides the ecological impact, the energy consumption is a predominant criteria for DC providers since it determines the daily cost of their infrastructure. As a consequence, power management becomes one of the main challenges for DC infrastructures and more generally for large-scale distributed systems. In this paper, the EPOC project which focuses on optimising the energy consumption of mono-site DCs connected to the regular electrical grid and to renewable energy sources.

9.1.2. SmartCat

Participants: Eric Monfroy, Charlotte Truchet.

Title: Online optimization for chemical reactions.

Others partners: CEISAM.

The SmartCat project, started in 2015 on regional fundings, aims at developing an intelligent automatised tool for online chemistry. Contrarily to the traditional batch chemistry, where reactants are mixed in a glass, online chemistry consists in having a flow of reactants in a tube, possibly passing through ovens are pressure control mechanisms. This way, the reaction happens continuously and it can produce much more products within a system of reasonable size. SmartCat integrates a controller for which intelligent tools need to be developed. These tools will analyse the product of the reaction and adapt the conditions (stoechiometry, pressure, temperature, catalysis) in order to optimise the yield. TASC contributes to this project by developing these methods, based on local search techniques.

9.1.3. Atlanstic 1

Participant: Florian Richoux.

Title: Atlantic project about deep learning for games.

Duration: 2016.

Topic: deep learning for games.

9.1.4. Atlanstic 2

Participant: Charles Prud Homme.

Title: CoMe4ACloud.

Duration: 2016.

Topic: CoMe4ACloud is an Atlanstic2020 funded project whose objective is to provide an end-to-end solution for autonomic Cloud services. To that end, we rely on techniques of Constraint Programming so as a decision-making tool and Model-driven Engineering to ease the automatic generation of the so-called autonomic managers as well as their communication with the managed system (see Constraints and Model Engineering for Autonomic Clouds). The project is led by ASCOLA research team and involves also AtlanModels and TASC.

9.2. National Initiatives

9.2.1. ANR NetWMS2

Participants: Gilles Chabert, Ignacio Salas Donoso, Nicolas Beldiceanu.

Title: Networked Warehouse Management Systems 2: packing with complex shapes.

Duration: 2011-2014.

Type: cosinus research program.

Budget: 189909 Euros.

Others partners: KLS Optim and CONTRAINTES (Inria Rocquencourt).

This project builds on the former European FP6 Net-WMS Strep project that has shown that constraint-based optimisation techniques can considerably improve industrial practice for box packing problems, while identifying hard instances that cannot be solved optimally, especially in industrial 3D packing problems with rotations, the needs for dealing with more complex shapes (e.g. wheels, silencers) involving continuous values. This project aims at generalizing the geometric kernel *geost* for handling non-overlapping constraints for complex two and three dimensional curved shapes as well as domain specific heuristics. This will be done within the continuous solver IBEX, where discrete variables will be added for handling polymorphism (i.e., the fact that an object can take one shape out of a finite set of given shapes). A filtering algorithm has been devised in the case of objects described by nonlinear inequalities and is now under testing with the Ibex library. This work has been presented in a workshop on interval methods & geometry in ENSTA Bretagne.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Within the context of the First Future and Emerging Technologies (FET) Proactive projects under Horizon 2020 Framework Programme the GRACeFUL project started this year. From an application point of view the project develops scalable rapid assessment tools for collective policy making in global systems, and test these on climate-resilient urban design. From a technical point of view it provides domain specific languages that are embedded in functional programming and constraint programming languages. Within the project TASC is responsible for the constraint part. To interact with policy makers it uses some qualitative network model (see Figure 10) embedded with constraint programming models that also capture dependancy between potential actions as well as costs.

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. TASCMELB

Title: Synergy between Filtering and Explanations for Scheduling and Placement Constraints

International Partner (Institution - Laboratory - Researcher):

NICTA (Australia) - Optimisation Research Group (Optimisation) - Pascal van Hentenryck

Start year: 2014

See also: http://www.normalesup.org/~truchet/TASCMELB.html
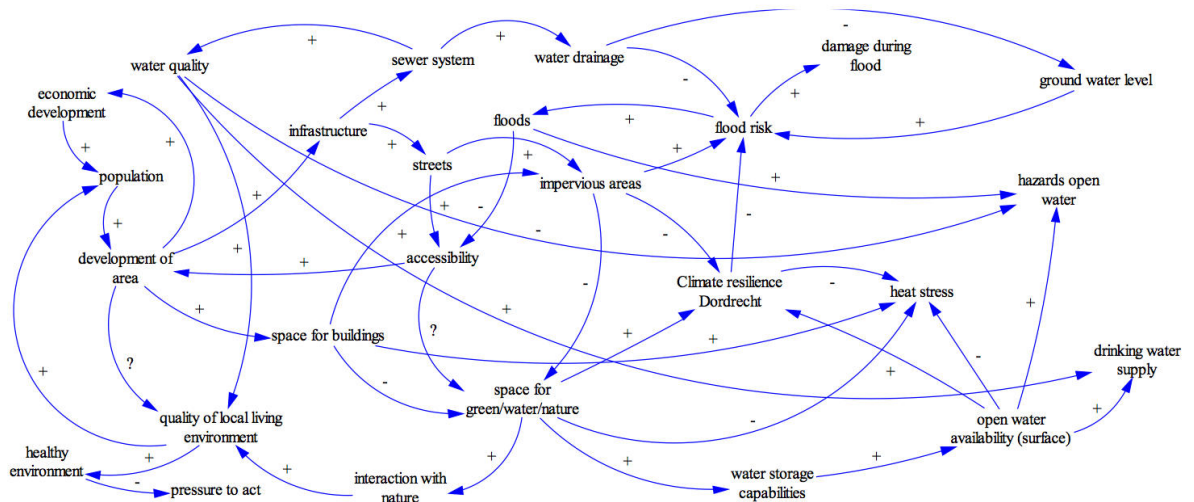
Figure 10. Illustration of some qualitative network capturing causality in the context of flooding prevention

In the context of Constraint Programming and SAT the project addresses the synergy between filtering (removing values from variables) and explanations (explaining why values were removed in term of clauses) in order to handle in a more efficient way correlated resource scheduling and placement constraints. It combines the strong point of Constraint Programming, namely removing value that leads to infeasibility, with the strong point of SAT, namely taking advantage from past failure in order to quickly identify infeasible sub-problems. In 2016 we got the following the following new result *using rewriting for synthesising filtering algorithm for the Allen constraint*: For all 8192 combinations of Allen's 13 relations between one task with origin oi and fixed length li and another task with origin oj and fixed length lj, we give a formula evaluating to a set of integers which are infeasible for a task origin for the given combination. Such forbidden regions are useful e.g. in a range-consistency maintaining propagator for an Allen constraint in finite domain constraint programming. No visit to Melbourne was done this year because of VISA problem. Consequently we also did remotly (i.e. from Nantes) the following result: the availability of the time-series constraints of the time-series constraint catalog available in the MiniZinc modelling language (and consequently made them accessible to solvers like Choco or Cplex).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- A visit regarding time-series constraints of Andreina Francisco RodriguezHelmut Simonis, Pierre Flener and Justin Pearson in Nantes in May.
- A visit regarding time-series constraints of Helmut Simonis, in July in May.

9.5.2. Visits to International Teams

- Two visits of E. Arafailova regarding time-series constraints in Cork (March 2016) and in Uppsala (April 2016)
- Three visits of N. Beldiceanu regarding time-series constraint in Cork (June 2016) and in Uppsala (February 2016, August 2016)

<p align="center" style="color:red">TEA Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

Program: ANR

Project acronym: **Feever**

Project title: Faust Environment Everyware

Duration: 2014-2016

Coordinator: Pierre Jouvelot, Mines ParisTech

Other partners: Grame, Inria Rennes, CIEREC

URL: http://www.feever.fr

Abstract:

The aim of project FEEVER is to ready the Faust music synthesis language for the Web. In this context, we collaborate with Mines ParisTech to define a type system suitable to model music signals timed at multiple rates and to formally support playing music synthesized from different physical locations.

9.1.2. PAI CORAC

Program: CORAC

Project acronym: CORAIL

Project title: Composants pour l'Avionique Modulaire Étendue

Duration: July 2013 - May 2017

Coordinator: Thales Avionics

Other partners: Airbus, Dassault Aviation, Eurocopter, Sagem...

Abstract:

The CORAIL project aims at defining components for Extended Modular Avionics. The contribution of project-team TEA is to define a specification method and to provide a generator of multi-task applications.

9.2. International Initiatives

9.2.1. International Project Grants

9.2.1.1. US Air Force Office for Scientific Research – Grant FA8655-13-1-3049

Title: Co-Modeling of Safety-Critical Multi-threaded Embedded Software for Multi-Core Embedded Platforms

Inria principal investigator: Jean-Pierre Talpin

International Partner (Institution - Laboratory - Researcher):

Virginia Tech Research Laboratories, Arlington (United States)

Embedded Systems Group, Teschnische Universität Kaiserslautern (Germany)

Duration: 2013 - 2016

See also: http://www.irisa.fr/espresso/Polycore

Abstract: The aim of the USAF OSR Grant FA8655-13-1-3049 is to support collaborative research entitled "Co-Modeling of safety-critical multi-threaded embedded software for multi-core embedded platforms" between Inria project-team ESPRESSO, the VTRL Fermat Laboratory and the TUKL embedded system research group, under the program of the Polycore associate-project.

9.2.1.2. Applied Science & Technology Research Institute (ASTRI, Hong Kong)

Title: Virtual Prototyping of Embedded Software Architectures

Inria principal investigator: Jean-Pierre Talpin

International Partner: ASTRI, Hong Kong

Duration: 2015 - 2016

Abstract: the topics of our present collaboration is essentially on heterogeneous time modeling for virtual prototyping in cyber-physical systems. Our project covers a wide spectrum of area of experience developed since 2012 and comprising

- model-based design and analysis of cyber-physical systems;
- system-level virtual prototyping and validation;
- design space exploration and system synthesis;

9.2.2. Inria International Labs

9.2.2.1. SACCADES

Title: Saccades

International Partner:

LIAMA

East China Normal University

Inria project-teams Aoste and Tea

Duration: 2003 - now

The SACCADES project is a LIAMA project hosted by East China Normal University and jointly led by Vania Joloboff (Inria) and Min Zhang (ECNU). The SACCADES project aims at improving the development of reliable cyber physical systems and more generally of distributed systems combining asynchronous with synchronous aspects, with different but complementary angles:

- develop the theoretical support for Models of Computations and Communications (MoCCs) that are the fundamentals basis of the tools.
- develop software tools (a) to enable the development and verification of executable models of the application software, which may be local or distributed and (b) to define and optimize the mapping of software components over the available resources.
- develop virtual prototyping technology enabling the validation of the application software on the target hardware platform.

The ambition of SACCADES project is to develop

- Theoretical Support for Cyber Physical Systems
- Software Tools for design and validation of CPS
- Virtual Prototyping of CPS

9.2.3. Inria International Partners

9.2.3.1. POLYCORE

Title: Models of computation for embedded software design

International Partner:

Virginia Tech Research Laboratories (USA)

University of Kanpur (India)

Duration: 2002 - now

Team TEA collaborates with Sandeep Shukla (now with IIT Kanpur) and his team at Virginia Tech, since 2002 (NSF-Inria BALBOA and Polycore projects, USAF OSR grant).

To date, our fruitful and sustained collaboration has yield the creation of the ACM-IEEE MEM-OCODE conference series in 2003, of the ACM-SIGDA FMGALS workshop series, and of a full-day tutorial at ACM-IEEE DATE'09 on formal methods in system design. We have jointly edited two books with Springer [0], two special issues of the IEEE Transactions on Computers and one of the IEEE Transactions on Industrial Informatics, and published more than 40 joint journal articles and conference papers. We published a joint paper at the 52nd. Digital Automation Conference in San Francisco [11].

9.2.3.2. VESA

Title: Virtual Prototyping of embedded software architectures

International Partner:

Applied Science & Technology Research Institute (ASTRI, Hong Kong)

The University of Hong Kong

Duration: 2012 - now

We collaborate with John Koo, now with ASTRI, and LIAMA since 2012 through visiting grants of the Chinese Academy of Science and of the University of Rennes on the topics of heterogeneous time modeling and virtual prototyping in cyber-physical systems.

In the context of project ITF ARD159 (System-Level Virtual Prototyping of Embedded Systems), ASTRI has used Polychrony and AADL to collaboratively develop a platform for conducting the design of an hardware-in-the-loop simulation of an UR5 robot arm, from its physical model described using Matlab/Simulink and powered using an Opal-RT/RT-Lab workstation, structured around an AADL system model, and using Polychrony to orchestrate real-time simulation down to FPGA analog outputs.

9.2.3.3. TIX

Title: Time In Cybernetic Systems

International Partner:

Rajesh Gupta, UCSD

Mani Srivastava, UCLA

Start year: 2015

The first topic of our collaboration is the formal definition of cross-domains clock models in system design and the formal verification of time stabilization and synchronization protocols used in distributed systems (sensor networks, data-bases). In this prospect, the NSF project Roseline is our basis of investigation (https://sites.google.com/site/roselineproject). Roseline aims at enabling robust, secure and efficient knowledge of time across the system stack.

Our second topic of collaboration is the refoundation of time modeling in high-level reactive and scripting languages, for application to the above using uni-kernels to cut through system stacks. We aim at applying the concepts of refinement types to formally specify and infer timing properties in CPS models from different system design view-point (physical, hardware, software) and using different levels of abstraction into multi-sorted 1st order logic (delta-decidability, linear arithmetic, Boolean logic, temporal logic).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Rajesh Gupta (UC San Diego) visited project TEA in July 2016 in the context of IIP TIX.

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[0]*Formal methods and models for system design*, R. Gupta, S. Shukla, J.-P. Talpin, Eds. ISBN 1-4020-8051-4. Springer, 2004.
[0]*Synthesis of embedded systems*. S. Shukla, J.-P. Talpin, Eds. ISBN 978-1-4419-6399-4. Springer, 2010

Brian Larson (FDA) visited project TEA in January and July 2016.

9.3.1.1. Internships

Daian Yue that was selected in the joint program between ENS Rennes and ECNU and joined project TEA for a six month internship in 2016.

9.3.2. *Visits to International Teams*

Vania Joloboff was invited for two short stays at University of East China Normal University in Shanghai and UC San Diego.

Jean-Pierre Talpin visited ASTRI in May and December, in the context of IIP VESA.

Jean-Pierre Talpin visited UC San Diego in October, in the context of IIP TIX.

Jean-Pierre Talpin visited IIT Kanpur in February and November for the preparation and Chair of MEM-OCODE'16.

<p style="text-align:center;color:red;font-weight:bold;font-size:larger;">TOCCATA Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. ELFIC

Participants: Sylvie Boldo [contact], Claude Marché, Guillaume Melquiond.

ELFIC is a working group of the Digicosme Labex. S. Boldo is the principal investigator. It began in 2014 for one year and was extended for one year. https://digicosme.lri.fr/GT+ELFIC

The ELFIC project focuses on proving the correctness of the FELiScE (Finite Elements for Life Sciences and Engineering) C++ library which implements the finite element method for approximating solutions to partial differential equations. Finite elements are at the core of numerous simulation programs used in industry. The formal verification of this library will greatly increase confidence in all the programs that rely on it. Verification methods developed in this project will be a breakthrough for the finite element method, but more generally for the reliability of critical software relying on intricate numerical algorithms.

Partners: Inria team Pomdapi; Ecole Polytechnique, LIX; CEA LIST; Université Paris 13, LIPN; UTC, LMAC (Compiègne).

9.1.2. ELEFFAN

Participant: Sylvie Boldo [contact].

ELEFFAN is a Digicosme project funding the PhD of F. Faissole. S. Boldo is the principal investigator. It began in 2016 for three years. https://project.inria.fr/eleffan/

The ELEFFAN project aims at formally proving rounding error bounds of numerical schemes.

Partners: ENSTA Paristech (A. Chapoutot)

9.2. National Initiatives

9.2.1. ANR CoLiS

Participants: Claude Marché [contact], Andrei Paskevich.

The CoLiS research project is funded by the programme "Société de l'information et de la communication" of the ANR, for a period of 48 months, starting on October 1st, 2015. http://colis.irif.univ-paris-diderot.fr/

The project aims at developing formal analysis and verification techniques and tools for scripts. These scripts are written in the POSIX or bash shell language. Our objective is to produce, at the end of the project, formal methods and tools allowing to analyze, test, and validate scripts. For this, the project will develop techniques and tools based on deductive verification and tree transducers stemming from the domain of XML documents.

Partners: Université Paris-Diderot, IRIF laboratory (formerly PPS & LIAFA), coordinator ; Inria Lille, team LINKS

9.2.2. ANR Vocal

Participants: Jean-Christophe Filliâtre [contact], Andrei Paskevich.

The Vocal research project is funded by the programme "Société de l'information et de la communication" of the ANR, for a period of 48 months, starting on October 1st, 2015. https://vocal.lri.fr/

The goal of the Vocal project is to develop the first formally verified library of efficient general-purpose data structures and algorithms. It targets the OCaml programming language, which allows for fairly efficient code and offers a simple programming model that eases reasoning about programs. The library will be readily available to implementers of safety-critical OCaml programs, such as Coq, Astrée, or Frama-C. It will provide the essential building blocks needed to significantly decrease the cost of developing safe software. The project intends to combine the strengths of three verification tools, namely Coq, Why3, and CFML. It will use Coq to obtain a common mathematical foundation for program specifications, as well as to verify purely functional components. It will use Why3 to verify a broad range of imperative programs with a high degree of proof automation. Finally, it will use CFML for formal reasoning about effectful higher-order functions and data structures making use of pointers and sharing.

Partners: team Gallium (Inria Paris-Rocquencourt), team DCS (Verimag), TrustInSoft, and OCamlPro.

9.2.3. ANR Ajacs

Participant: Arthur Charguéraud [contact].

The AJACS research project is funded by the programme "Société de l'information et de la communication" of the ANR, for a period of 42 months, starting on October 1st, 2014. http://ajacs.inria.fr/

The goal of the AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts implemented in JavaScript, the most widely used language for the Web. The proposal is to prove correct analyses for JavaScript programs, in particular information flow analyses that guarantee no secret information is leaked to malicious parties. The definition of sub-languages of JavaScript, with certified compilation techniques targeting them, will allow deriving more precise analyses. Another aspect of the proposal is the design and certification of security and privacy enforcement mechanisms for web applications, including the APIs used to program real-world applications. On the Toccata side, the focus will be on the formalization of secure subsets of JavaScript, and on the mechanization of proofs of translations from high-level languages into JavaScript.

Partners: team Celtique (Inria Rennes - Bretagne Atlantique), team Prosecco (Inria Paris - Rocquencourt), team Indes (Inria Sophia Antipolis - Méditerranée), and Imperial College (London).

9.2.4. ANR FastRelax

Participants: Sylvie Boldo [contact], Guillaume Melquiond.

This is a research project funded by the programme "Ingénierie Numérique & Sécurité" of the ANR. It is funded for a period of 48 months and it has started on October 1st, 2014. http://fastrelax.gforge.inria.fr/

Our aim is to develop computer-aided proofs of numerical values, with certified and reasonably tight error bounds, without sacrificing efficiency. Applications to zero-finding, numerical quadrature or global optimization can all benefit from using our results as building blocks. We expect our work to initiate a "fast and reliable" trend in the symbolic-numeric community. This will be achieved by developing interactions between our fields, designing and implementing prototype libraries and applying our results to concrete problems originating in optimal control theory.

Partners: team ARIC (Inria Grenoble Rhône-Alpes), team MARELLE (Inria Sophia Antipolis - Méditerranée), team SPECFUN (Inria Saclay - Île-de-France), Université Paris 6, and LAAS (Toulouse).

9.2.5. ANR Soprano

Participants: Sylvain Conchon [contact], Guillaume Melquiond.

The Soprano research project is funded by the programme "Sciences et technologies logicielles" of the ANR, for a period of 42 months, starting on October 1st, 2014. http://soprano-project.fr/

The SOPRANO project aims at preparing the next generation of verification-oriented solvers by gathering experts from academia and industry. We will design a new framework for the cooperation of solvers, focused on model generation and borrowing principles from SMT (current standard) and CP (well-known in optimization). Our main scientific and technical objectives are the following. The first objective is to design a new collaboration framework for solvers, centered around synthesis rather than satisfiability and allowing cooperation beyond that of Nelson-Oppen while still providing minimal interfaces with theoretical guarantees. The second objective is to design new decision procedures for industry-relevant and hard-to-solve theories. The third objective is to implement these results in a new open-source platform. The fourth objective is to ensure industrial-adequacy of the techniques and tools developed through periodical evaluations from the industrial partners.

Partners: team DIVERSE (Inria Rennes - Bretagne Atlantique), Adacore, CEA List, Université Paris-Sud, and OCamlPro.

9.2.6. ANR CAFEIN

Participant: Sylvain Conchon [contact].

The CAFEIN research project is funded by the programme "Ingénierie Numérique & Sécurité" of the ANR, for a period of 3 years, starting on February 1st, 2013. https://cavale.enseeiht.fr/CAFEIN/.

This project addresses the formal verification of functional properties at specification level, for safety critical reactive systems. In particular, we focus on command and control systems interacting with a physical environment, specified using the synchronous language Lustre.

A first goal of the project is to improve the level of automation of formal verification, by adapting and combining existing verification techniques such as SMT-based temporal induction, and abstract interpretation for invariant discovery. A second goal is to study how knowledge of the mathematical theory of hybrid command and control systems can help the analysis at the controller's specification level. Third, the project addresses the issue of implementing real valued specifications in Lustre using floating-point arithmetic.

Partners: ONERA, CEA List, ENSTA, teams Maxplus (Inria Saclay - Île-de-France), team Parkas (Inria Paris - Rocquencourt), Perpignan University, Prover Technology, Rockwell Collins.

9.2.7. ANR BWare

Participants: Sylvain Conchon [contact], Jean-Christophe Filliâtre, Andrei Paskevich, Claude Marché.

The BWare research project is funded by the programme "Ingénierie Numérique & Sécurité" of the ANR, a period of 4 years, starting on September 1st, 2012. http://bware.lri.fr.

BWare is an industrial research project that aims to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method and requiring high guarantee of confidence. The methodology used in this project consists of building a generic platform of verification relying on different theorem provers, such as first-order provers and SMT solvers. The variety of these theorem provers aims at allowing a wide panel of proof obligations to be automatically verified by the platform. The major part of the verification tools used in BWare have already been involved in some experiments, which have consisted in verifying proof obligations or proof rules coming from industrial applications [109]. This therefore should be a driving factor to reduce the risks of the project, which can then focus on the design of several extensions of the verification tools to deal with a larger amount of proof obligations.

The partners are: Cedric laboratory at CNAM (CPR Team, project leader); teams Gallium and Deducteam (Inria Paris - Rocquencourt) ; Mitsubishi Electric R&D Centre Europe, ClearSy (the company which develops and maintains *Atelier B*), and the start-up OCamlPro.

9.2.8. ANR Verasco

Participants: Guillaume Melquiond [contact], Sylvie Boldo, Arthur Charguéraud, Claude Marché.

The Verasco research project is funded by the programme "Ingénierie Numérique & Sécurité" of the ANR, for a period of 4 years and a half, starting on January 1st, 2012. Project website: http://verasco.imag.fr.

The main goal of the project is to investigate the formal verification of static analyzers and of compilers, two families of tools that play a crucial role in the development and validation of critical embedded software. More precisely, the project aims at developing a generic static analyzer based on abstract interpretation for the C language, along with a number of advanced abstract domains and domain combination operators, and prove the soundness of this analyzer using the *Coq* proof assistant. Likewise, the project keeps working on the CompCert C formally-verified compiler, the first realistic C compiler that has been mechanically proved to be free of miscompilation, and carry it to the point where it could be used in the critical software industry.

Partners: teams Gallium and Abstraction (Inria Paris - Rocquencourt), Airbus avionics and simulation (Toulouse), IRISA (Rennes), Verimag (Grenoble).

9.2.9. FUI LCHIP

Participant: Sylvain Conchon [contact].

LCHIP (Low Cost High Integrity Platform) is aimed at easing the development of safety critical applications (up to SIL4) by providing: (i) a complete IDE able to automatically generate and prove bounded complexity software (ii) a low cost, safe execution platform. The full support of DSLs and third party code generators will enable a seamless deployment into existing development cycles. LCHIP gathers scientific results obtained during the last 20 years in formal methods, proof, refinement, code generation, etc. as well as a unique return of experience on safety critical systems design. http://www.clearsy.com/en/2016/10/4260/

Partners: 2 technology providers (ClearSy, OcamlPro), in charge of building the architecture of the platform ; 3 labs (IFSTTAR, LIP6, LRI), to improve LCHIP IDE features ; 2 large companies (SNCF, RATP), representing public ordering parties, to check compliance with standard and industrial railway use-case.

The project lead by ClearSy has started in April 2016 and lasts 3 years. It is funded by BpiFrance as well as French regions.

9.2.10. ANR PARDI

Participant: Sylvain Conchon [contact].

Verification of parameterized distributed systems, 2016-2021.

Partners: Université Paris VI - Université Paris XI - Inria NANCY

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Project acronym: ERC Deepsea

Project title: Parallel dynamic computations

Duration: Jun. 2013 - Jun. 2018

Coordinator: Umut A. Acar

Other partners: Carnegie Mellon University

Abstract:

The objective of this project is to develop abstractions, algorithms and languages for parallelism and dynamic parallelism with applications to problems on large data sets. Umut A. Acar (affiliated to Carnegie Mellon University and Inria Paris - Rocquencourt) is the principal investigator of this ERC-funded project. The other main researchers involved are Mike Rainey (Inria, Gallium team), who is full-time on the project, and Arthur Charguéraud (Inria, Toccata team), who works 40% of his time to the project. Project website: http://deepsea.inria.fr/.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: COST (European Cooperation in Science and Technology).

Project acronym: EUTypes https://eutypes.cs.ru.nl/

Project title: The European research network on types for programming and verification

Duration: 2015-2019

Coordinator: Herman Geuvers, Radboud University Nijmegen, The Netherlands

Other partners: 36 members countries, see http://www.cost.eu/COST_Actions/ca/CA15123?parties

Abstract: Types are pervasive in programming and information technology. A type defines a formal interface between software components, allowing the automatic verification of their connections, and greatly enhancing the robustness and reliability of computations and communications. In rich dependent type theories, the full functional specification of a program can be expressed as a type. Type systems have rapidly evolved over the past years, becoming more sophisticated, capturing new aspects of the behaviour of programs and the dynamics of their execution.

This COST Action will give a strong impetus to research on type theory and its many applications in computer science, by promoting (1) the synergy between theoretical computer scientists, logicians and mathematicians to develop new foundations for type theory, for example as based on the recent development of "homotopy type theory", (2) the joint development of type theoretic tools as proof assistants and integrated programming environments, (3) the study of dependent types for programming and its deployment in software development, (4) the study of dependent types for verification and its deployment in software analysis and verification. The action will also tie together these different areas and promote cross-fertilisation.

9.3.3. Collaborations with Major European Organizations

Imperial College London (UK)

Certification of JavaScript, AJACS project

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Ran Chen is a PhD student from Institute of Software (Chinese Academy of Sciences, Beijing, China) visiting the team for 10 months under the supervision of C. Marché and J.-J. Lévy (PiR2 team, Inria Paris). She is working on the formal verification of graphs algorithms, and also in the context of the CoLiS project on verification of some aspects of the Unix file system and shell scripts. [34]

- Cláudio Belo Lourenço is a PhD student from Universidade do Minho, Portugal. He studies deductive verification of imperative programs and the behaviour of different kinds of verification condition generators [101]. The goal of his visit is to use Why3 as a platform for prototyping and experimental evaluation of these generators.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- F. Faissole has spent two months visiting B. Spitters at Aarhus University (Denmark) They proposed an extension of ALEA library to continuous datatypes.[32].

- M. Roux has spent three months with D. Jovanovic and B. Dutertre at SRI (California, USA). They worked on extending Sally, the new model checker of SRI based on SAL, to add the verification of parameterized cache coherence protocols. The software can be found on https://github.com/SRI-CSL/sally.

- S. Conchon has been invited a month at SRI by D. Jovanovic. During this visit, he has collaborated with CSL researchers to compare the design and implementation choices between the model checkers Sally and Cubicle.

VEGAS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

We organized, with IECL, a «journée Charles Hermite» about geometry and probability. A regular working group on the topic was started in november.

8.2. National Initiatives

8.2.1. ANR PRESAGE

The white ANR grant PRESAGE brings together computational geometers (from the VEGAS and GEOMET-RICA projects of Inria) and probabilistic geometers (from Universities of Rouen, Orléans and Poitiers) to tackle new probabilistic geometry problems arising from the design and analysis of geometric algorithms and data structures. We focus on properties of discrete structures induced by random continuous geometric objects.

The project, with a total budget of 400kE, started on Dec. 31st, 2011 and ended in March 2016. It is coordinated by Xavier Goaoc who moved from the Vegas team to Marne-la-Vallée university in 2013.

Project website: https://members.loria.fr/GMoroz/ANR-Presage/.

8.2.2. ANR SingCAST

The objective of the young-researcher ANR grant SingCAST is to intertwine further symbolic/numeric approaches to compute efficiently solution sets of polynomial systems with topological and geometrical guarantees in singular cases. We focus on two applications: the visualization of algebraic curves and surfaces and the mechanical design of robots.

After identifying classes of problems with restricted types of singularities, we plan to develop dedicated symbolic-numerical methods that take advantage of the structure of the associated polynomial systems that cannot be handled by purely symbolic or numerical methods. Thus we plan to extend the class of manipulators that can be analyzed, and the class of algebraic curves and surfaces that can be visualized with certification.

This is a 3.5 years project, with a total budget of 100kE, that started on March 1st 2014, coordinated by Guillaume Moroz.

The project funded the postdoc position of Rémi Imbach from November 2014 until October 2016. We organized two workshops in 2016 with the OPTI team in Nantes, on certified surface continuation.

Project website: https://project.inria.fr/singcast/.

8.3. International Initiatives

8.3.1. Participation in Other International Programs

8.3.1.1. Nancy Emerging Associate Team Astonishing

The objectives of the *ASsociate Team On Non-ISH euclIdeaN Geometry* is to study various structures and algorithms in non-Euclidean spaces, from a computational geometry viewpoint. Proposing algorithms operating in such spaces requires a prior deep study of the mathematical properties of the objects considered, which raises new fundamental and difficult questions that we want to tackle.

A key characteristic of the project is its interdisciplinarity: it gathers approaches, knowledge, and tools in mathematics and computer science. A mathematical study of the considered objects will be performed, together with the design of algorithms when applicable. Algorithms will be analyzed both in theory and in practice after prototype implementations. In the long term, implementations should be improved whenever it makes sense to target longer-term integrations into CGAL, in order to disseminate our results to end-users.

The partners are the Johann Bernouilli Institute of Mathematics and Computer Science of University of Groningen, the Mathematics Research Unit of University of Luxembourg, and the Talgo team of École Normale Supérieure. The project is coordinated by Monique Teillaud and supported by Inria Nancy - Grand Est.

Project website: https://members.loria.fr/Monique.Teillaud/collab/Astonishing/.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Invited Professor

Gert Vegter, Professor at Univerity of Groningen, was awarded an invited professor position by University of Lorraine and spent one month in the group in May. He is coordinating the NEAT Astonishing on the Dutch side.

8.4.1.2. PhD Visitor

Sény Diatta, Senegalese PhD student co-advised by Guillaume Moroz, Daouda Niang Diatta (Ziguinchor) and Marie-Françoise Roy (Rennes), obtained a bourse Eiffel from Campus France, which includes a salary for 10 months to visit LORIA.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Iordan Iordanov spent one month at University of Luxembourg in June. The visit was partially supported by by University of Luxembourg and by the NEAT Astonishing.

<p style="text-align:center; color:red">VERIDIS Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR-DFG Project SMArT

Participants: Haniel Barbosa, Pascal Fontaine, Marek Košta, Stephan Merz, Thomas Sturm.

The SMArT (Satisfiability Modulo Arithmetic Theories) project is funded by *ANR-DFG Programmes blancs 2013*, a program of the Agence Nationale de la Recherche and the (German) Deutsche Forschungsgemeinschaft DFG. It started in April 2014. The project gathers members of VeriDis in Nancy and Saarbrücken, and the Systerel company. The objective of the SMArT project is to provide advanced techniques for arithmetic reasoning beyond linear arithmetic for formal system verification, and particularly for SMT. The results feed back into the implementations of Redlog (section 6.2) and veriT (section 6.5), which also serve as experimentation platforms for theories, techniques and methods designed within this project.

More information on the project can be found on http://smart.gforge.inria.fr/.

9.1.2. ANR Project IMPEX

Participants: Souad Kherroubi, Dominique Méry.

The ANR Project IMPEX, within the INS program, started in December 2013 for 4 years. It is coordinated by Dominique Méry, the other partners are IRIT/ENSEIHT, Systerel, Supelec, and Telecom Sud Paris. The work reported here also included a cooperation with Pierre Castéran from LaBRI Bordeaux.

Modeling languages provide techniques and tool support for the design, synthesis, and analysis of the models resulting from a given modeling activity, as part of a system development process. These languages quite successfully focused on the analysis of the designed system exploiting the expressed semantic power of the underlying modeling language. The semantics of this modeling languages are well understood by the system designers and the users of the modeling language, i.e. the semantics is implicit in the model. In general, modeling languages are not equipped with resources, concepts or entities handling explicitly domain engineering features and characteristics (domain knowledge) underlying the modeled systems. Indeed, the designer has to explicitly handle the knowledge resulting from an analysis of this application domain [49], i.e. explicit semantics. Nowadays, making explicit the domain knowledge inside system design models does not obey any methodological rules validated by practice. The users of modeling languages introduce these domain knowledge features through types, constraints, profiles, etc. Our claim is that ontologies are good candidates for handling explicit domain knowledge. They define domain theories and provide resources for uniquely identifying domain knowledge concepts. Therefore, allowing models to make references to ontologies is a modular solution for models to explicitly handle domain knowledge. Overcoming the absence of explicit semantics expression in the modeling languages used to specify systems models will increase the robustness of the designed system models. Indeed, the axioms and theorems resulting from the ontologies can be used to strengthen the properties of the designed models. The objective [11] is to offer rigorous mechanisms for handling domain knowledge in design models.

9.1.3. Inria IPL HAC SPECIS

Participants: Marie Duflot-Kremer, Stephan Merz.

The goal of the HAC SPECIS (High-performance Application and Computers: Studying PErformance and Correctness In Simulation) project is to answer methodological needs of HPC application and runtime developers and to allow studying real HPC systems with respect to both correctness and performance. To this end, this Inria Project Lab assembles experts from the HPC, formal verification, and performance evaluation communities.

HAC SPECIS started in 2016. VeriDis contributes through its expertise in formal verification techniques. In particular, our goal is to extend the functionalities of exhaustive and statistical model checking within the SimGrid platform.

9.1.4. Inria Technological Development Action CUIC

Participants: Jasmin Christian Blanchette, Simon Cruanes.

Most "theorems" initially given to a proof assistant are incorrect, whether because of a typo, a missing assumption, or a fundamental flaw. Novices and experts alike can enter invalid formulas and find themselves wasting hours, or even days, on an impossible proof. This project, funded by Inria and running from 2015 to 2017, supports the development of a counterexample generator for higher-order logic. This new tool, called Nunchaku (cf. section 6.1), will be integrated in various proof assistants, including Isabelle, Coq, and the TLA$^+$ Proof System. The project is coordinated by Jasmin Blanchette and also involves Inria Saclay (Toccata group) and Inria Rennes (Celtique group), among others. Simon Cruanes was hired in October 2015 and has started the development of Nunchaku, whereas Blanchette has developed an Isabelle frontend. Three releases have taken place so far, and the tool is an integral part of the Isabelle2016-1 official release. Work has started on Coq and TLAPS frontends. The tool is described in a conference publication [33] and was presented at a workshop [28].

9.1.5. Inria ADT PLM (2014-2016)

Participant: Matthieu Nicolas.

Joint work with Gérald Oster (project-team Coast, Inria Nancy – Grand Est) and Martin Quinson (project-team Myriads, Inria Rennes – Bretagne Atlantique)

The goal of this project is to establish an experimental platform for studying the didactics of informatics, specifically centered on introductory programming courses.

The project builds upon a pedagogical platform for supervising programming exercises developed for our own teaching, and improves this base in several ways. We want to provide more adapted feedback to the learners, and gather more data to better understand how beginners learn programming.

This year, we finalized the web version of our framework, and submitted several project applications to pursue this work in the future. Unfortunately, none of these applications have been accepted so far. Martin Quinson invited Peter Hubwieser, professor of the Technical University of Munich (TUM) and specialist of the didactics of Computer Science, for two weeks in November. Developing the PLM and exploiting the data already gathered were central elements of this work meeting. A joint publication is currently prepared, targeting the ItiCSE'17 conference.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Program: H2020-FETOPEN-2015-CSA

Project acronym: SC^2

Project title: Satisfiability Checking and Symbolic Computation

Duration: July 2016 – September 2018

Coordinator: James H. Davenport (U. Bath, U.K.)

Other partners: RWTH Aachen (Germany), Fondazione Bruno Kessler (Italy), Università degli Studi di Genova (Italy), Maplesoft Europe Ltd (Germany), Coventry University (U.K.), University of Oxford (U.K.), Universität Kassel (Germany), Max Planck Institut für Informatik (Germany), Universität Linz (Austria)

Abstract: Whereas symbolic computation is concerned with efficient algorithms for determining exact solutions to complex mathematical problems, more recent developments in the area of satisfiability checking tackle similar problems with different algorithmic and technological solutions. Both communities have made remarkable progress in the last decades and address practical problems of rapidly increasing size and complexity. For example, satisfiability checking is an essential backend for assuring the security and the safety of computer systems. Techniques and tools of symbolic computation are used by different scientific communities for solving large mathematical problems that are out of reach of pencil and paper developments. Currently the two communities are largely disjoint and unaware of the achievements of each other, despite strong reasons for them to discuss and collaborate, as they share many central interests. Bridges between the communities in the form of common platforms and roadmaps are necessary to initiate an exchange, and to support and to direct their interaction. This Coordination and Support Action within the FET-Open framework will initiate a wide range of activities to bring the two communities together, identify common challenges, offer global events and bilateral visits, propose standards, and so on. Combining the knowledge, experience and the technologies in these communities will lead to cross-fertilization and mutual improvements, enabling the development of radically improved software tools.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. KANASA

Title: Kanazawa-Nancy for Satistifiability and Arithmetics

International Partner: Japan Advanced Institute for Science and Technology (Dept. Intelligent Robotics, Mizuhito Ogawa)

Starting year: 2016

During the last decade, there has been tremendous progress on symbolic verification techniques, spurred in particular by the development of SMT (satisfiability modulo theories) techniques and tools. Our first direction of research will be to investigate the theoretical background and the practical techniques to integrate Interval Constraint Propagation within a generic SMT framework, including other decision procedures and quantifier handling techniques. On the purely arithmetic side, we also want to study how to unite the reasoning power of all arithmetic techniques developed in the team, including simplex-based SMT-like reasoners, Virtual Substitution, and Cylindrical Algebraic Decomposition. In particular, this includes developing theory combination frameworks for linear and non-linear arithmetic. There is a strong incentive for these kind of combinations since even non-linear SMT problems contain a large proportion of linear constraints. The partnership is supported by a Memorandum of Understanding between JAIST and LORIA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Ilina Stoilkovska

Date: 1 September – 31 October

Institution: TU Wien (Austria)

Host: Stephan Merz

Ilina is a PhD student at TU Wien, Austria, and works on tailored abstractions for the parameterized verification of fault-tolerant distributed algorithms. During her stay in Nancy, she worked on a formal soundness proof of her abstractions in the TLA$^+$ Proof System.

Tung Vu Xuan

Date: 1 May 2016 – 30 April 2017

Institution: JAIST

Host: Pascal Fontaine

Tung Vu Xuan is a PhD student at JAIST, Japan. He is visiting VeriDis in the context of the KANASA project. He works mainly on Interval Constraint Propagation (ICP), a heuristic but powerful method for satisfiability checking of non-linear arithmetic (NLA) constraints. During his stay, we investigate techniques to combine ICP with decision procedures for NLA within an SMT context.

9.4.2. Internships

Anders Olav Candasamy

Date: 1 March – 31 July

Institution: Université de Lorraine (Erasmus Mundus DESEM)

Host: Dominique Méry

Anders Candasamy analyzed a hemodialysis case study using Event-B. Besides developing the formal model, he also reflected on the modeling process and proposed several methodological improvements.

Matthieu Lequesne

Date: 1 March – 31 July

Institution: École Polytechnique

Host: Stephan Merz

Matthieu Lequesne worked on translating formulas in a core sublanguage of TLA$^+$ to the input format of Nunchaku (section 6.1), with the aim of producing (counter)models for TLA$^+$ proof obligations.

Weichung Shaw

Date: 1 March – 31 August

Institution: Université de Lorraine (Erasmus Mundus DESEM)

Host: Stephan Merz

Weichung Shaw worked on formalizing a correctness proof of the Raft consensus algorithm [50] in TLA$^+$. He proved several fundamental lemmas and documented several methodological issues with the use of TLAPS.

<p align="center" style="color:red;">**ACUMES Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Project BOUM

G. Costeseque holds a BOUM (SMAI) project on *"Mathematical homogenization techniques for traffic flow models"* with W. Salazar and M. Zaydan (LMI, INSA Rouen) and J.A. Firozaly (CERMICS, Ecole des Ponts ParisTech and LAMA, Université Paris-Est Créteil).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. TraM3

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

Duration: October 2010 - March 2016

Coordinator: Inria

Inria contact: Paola Goatin

Abstract: The project intends to investigate traffic phenomena from the macroscopic point of view, using models derived from fluid-dynamics consisting in hyperbolic conservation laws. The scope is to develop a rigorous analytical framework and fast and efficient numerical tools for solving optimization and control problems, such as queues lengths control or buildings exits design. See also: http://www-sop.inria.fr/members/Paola.Goatin/tram3.html

8.3. International Initiatives

8.3.1. Inria International Labs

Inria@SiliconValley
Associate Team involved in the International Lab:

8.3.1.1. ORESTE

Title: Optimal REroute Strategies for Traffic managEment

International Partner (Institution - Laboratory - Researcher):

> University of California Berkeley (United States) - Electrical Engineering and Computer Science (EECS) (EECS) - Alexandre M. Bayen

Start year: 2015

See also: http://www-sop.inria.fr/members/Paola.Goatin/ORESTE/index.html

This project focuses on traffic flow modeling and optimal management on road networks. Based on the results obtained during the first three years, we aim at further develop a unified macroscopic approach for traffic monitoring, prediction and control. In particular, we aim at investigating user equilibrium inference and Lagrangian controls actuations using macroscopic models consisting of conservation laws or Hamilton-Jacobi equations.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- L.M. Villada-Osorio (February-July 2016, University of Bio-Bio, Chile): high order Discontinuous Galerkin and WENO finite volume schemes for non-local scalar conservation laws in one space-dimension.

- A. Borzí (June and October 2016, University of Wuerzburg): Stochastic differential games and Fokker-Planck equations.

- A. Keimer (November 2016, UC Berkeley): modeling and well-posedness study for Dynamic Traffic Assignement.

8.4.1.1. Internships

- C. De Filippis (April-August 2016, University of Milan - Bicohcca): well-posedness of initial-boundary value problems for non-local scalar conservation laws in one space-dimension.

ANJA Team (section vide)

<p style="text-align:center">**APICS Project-Team**</p>

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Contract Provence Alpes Côte d'Azur (PACA) Region - Inria, BDO (no. 2014-05764) funding the research grant of C. Papageorgakis, see Sections 5.1.5 , 6.3 .

- The team participates in the project WIMAG (Wave IMAGing) funded by the IDEX UCA-Jedi. It aims at identifying and gathering the research and development by partners of UCA involved in wave imaging systems. Other partners are UNS and CNRS (GéoAzur, I3S, LEAT, LJAD), together with Orange Labs.

- The team participates in the transversal action C4PO funded by the IDEX UCA-Jedi. This "Center for Planetary Origin" brings together scientists from various fields to advance and organize Planetary Science at the the University of Nice, and supports research and teaching initiatives within its framework.

7.2. National Initiatives

7.2.1. ANR COCORAM

The ANR (Astrid) project COCORAM (Co-design et co-intégration de réseaux d'antennes actives multi-bandes pour systèmes de radionavigation par satellite) started January 2014. We are associated with three other teams from XLIM (Limoges University), geared respectively towards filters, antennas and amplifiers design. The core idea of the project is to realize dual band reception an emission chains by co-conceiving the antenna, the filters, and the amplifier. We are specifically in charge of the theoretical design of the filters, matching the impedance of a bi-polarized dual band antenna. This is a perfect training ground to test, apply and adapt our work on matching problems (see Section 5.2).

7.2.2. ANR MagLune

The ANR project MagLune (Magnétisme de la Lune) has been approved July 2014. It involves the Cerege (Centre de Recherche et d'Enseignement de Géosciences de l'Environnement, joint laboratory between Université Aix-Marseille, CNRS and IRD), the IPGP (Institut de Physique du Globe de Paris) and ISTerre (Institut des Sciences de la Terre). Associated with Cerege are Inria (Apics team) and Irphe (Institut de Recherche sur les Phénomènes Hors Équilibre, joint laboratory between Université Aix-Marseille, CNRS and École Centrale de Marseille). The goal of this project (led by geologists) is to understand the past magnetic activity of the Moon, especially to answer the question whether it had a dynamo in the past and which mechanisms were at work to generate it. Apics participates in the project by providing mathematical tools and algorithms to recover the remanent magnetization of rock samples from the moon on the basis of measurements of the magnetic field it generates. The techniques described in Section 5.1 are instrumental for this purpose.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Apics is part of the European Research Network on System Identification (ERNSI) since 1992.

System identification deals with the derivation, estimation and validation of mathematical models of dynamical phenomena from experimental data.

7.4. International Initiatives

7.4.1. Inria Associate Teams Not Involved in an Inria International Labs

7.4.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

International Partner (Institution - Laboratory - Researcher):

Massachusetts Institute of Technology (United States) - Department of Earth, Atmospheric and Planetary Sciences - Benjamin P. Weiss

Start year: 2016

See also: http://www-sop.inria.fr/apics/IMPINGE/

The associate team IMPINGE is concerned with the inverse problem of recovering a magnetization distribution from measurements of the magnetic field above rock slabs using a SQUID microscope (developed at MIT). The application domain is to Earth and planetary sciences. Indeed, the remanent magnetization of rocks provides valuable information on their history. This is a renewal of the previous Associate Team IMPINGE that ended 2015. The US team also involves a group of Mathematicians (D. Hardin, M. Northington, E.B. Saff) at Vanderbilt University.

7.4.2. Inria International Partners

7.4.2.1. Declared Inria International Partners

MIT-France seed funding is a competitive collaborative research program ran by the Massachusetts Institute of Technology (Cambridge, Ma, USA). Together with E. Lima and B. Weiss from the Earth and Planetary Sciences dept. at MIT, Apics obtained two-years support from the above-mentioned program to run a project entitled: "Development of Ultra-high Sensitivity Magnetometry for Analyzing Ancient Rock Magnetism"

NSF Grant L. Baratchart, S. Chevillard and J. Leblond are external investigators in the NSF Grant 2015-2018, "Collaborative Research: Computational methods for ultra-high sensitivity magnetometry of geological samples" led by E.B. Saff (Vanderbilt Univ.) and B. Weiss (MIT).

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Christian Gerhards (Universität Wien, Vienna, Austria, September 5-9).
- Douglas Hardin (Vanderbilt University, Nashville, Tennessee, USA, June 11-21).
- Nuutti Hyvonen (Aalto University, Finland, June 13-14).
- Benjamin Lanfer (BESA, Munich, Germany, February 4-5).
- Eduardo Lima (MIT, Boston, Massachusetts, USA, June 13-17).
- Michael Northington (Vanderbilt University, Nashville, Tennessee, USA, June 11-22).
- Vladimir Peller (University of Michigan at East Lansing, June 10-24).
- Cristobal Villalobos (Vanderbilt University, Nashville, Tennessee, USA, June 8-21).

7.6. List of international and industrial partners

- Collaboration under contract with Thales Alenia Space (Toulouse, Cannes, and Paris), CNES (Toulouse), XLIM (Limoges), University of Bilbao (Universidad del País Vasco / Euskal Herriko Unibertsitatea, Spain), BESA company (Munich), Flextronics.

- Regular contacts with research groups at UST (Villeneuve d'Asq), Universities of Bordeaux-I (Talence), Orléans (MAPMO), Aix-Marseille (CMI-LATP), Nice Sophia Antipolis (Lab. JAD), Grenoble (IJF and LJK), Paris 6 (P. et M. Curie, Lab. JLL), Inria Saclay (Lab. Poems), Cerege-CNRS (Aix-en-Provence), CWI (the Netherlands), MIT (Boston, USA), Vanderbilt University (Nashville USA), Steklov Institute (Moscow), Michigan State University (East-Lansing, USA), Texas A&M University (College Station USA), Indiana University-Purdue University at Indianapolis, Politecnico di Milano (Milan, Italy), University of Trieste (Italy), RMC (Kingston, Canada), University of Leeds (UK), of Maastricht (the Netherlands), of Cork (Ireland), Vrije Universiteit Brussel (Belgium), TU-Wien and Universiät Wien (Austria), TFH-Berlin (Germany), ENIT (Tunis), KTH (Stockholm), University of Cyprus (Nicosia, Cyprus), University of Macau (Macau, China), SIAE Microelettronica (Milano).

- The project is involved in the GDR-project AFHP (CNRS), in the ANR (Astrid program) project COCORAM (with XLIM, Limoges, and DGA), in the ANR (Défis de tous les savoirs program) project MagLune (with Cerege, IPGP, ISTerre, Irphe), in a MIT-France collaborative seed funding, in the Associate Inria Team IMPINGE (with MIT, Boston), and in a NSF grant (with Vanderbilt University and MIT).

ASPI Project-Team

8. Partnerships and Cooperations

8.1. Regional initiatives

8.1.1. *Stochastic Model-Data Coupled Representations for the Upper Ocean Dynamics (SEACS) — inter labex project*
Participants: François Le Gland, Valérie Monbet.

January 2015 to December 2017.

This is a joint research initiative supported by the three labex active in Brittany, CominLabs (Communication and Information Sciences Laboratory), Lebesgue (Centre de Mathématiques Henri Lebesgue) and LabexMER (Frontiers in Marine Research).

This project aims at exploring novel statistical and stochastic methods to address the emulation, reconstruction and forecast of fine–scale upper ocean dynamics. The key objective is to investigate new tools and methods for the calibration and implementation of novel sound and efficient oceanic dynamical models, combining

- recent advances in the theoretical understanding, modeling and simulation of upper ocean dynamics,
- and mass of data routinely available to observe the ocean evolution.

In this respect, the emphasis will be given to stochastic frameworks to encompass multi–scale/multi–source approaches and benefit from the available observation and simulation massive data. The addressed scientific questions constitute basic research issues at the frontiers of several disciplines. It crosses in particular advanced data analysis approaches, physical oceanography and stochastic representations. To develop such an interdisciplinary initiative, the project gathers a set of research groups associated with these different scientific domains, which have already proven for several years their capacities to interact and collaborate on topics related to oceanic data and models. This project will place Brittany with an innovative and leading expertise at the frontiers of computer science, statistics and oceanography. This transdisciplinary research initiative is expected to resort to significant advances challenging the current thinking in computational oceanography.

8.2. National initiatives

8.2.1. *Computational Statistics and Molecular Simulation (COSMOS) — ANR challenge Information and Communication Society*
Participant: Frédéric Cérou.

Inria contract ALLOC 9452 — January 2015 to December 2017.

The COSMOS project aims at developing numerical techniques dedicated to the sampling of high–dimensional probability measures describing a system of interest. There are two application fields of interest: computational statistical physics (a field also known as molecular simulation), and computational statistics. These two fields share some common history, but it seems that, in view of the quite recent specialization of the scientists and the techniques used in these respective fields, the communication between molecular simulation and computational statistics is not as intense as it should be.

We believe that there are therefore many opportunities in considering both fields at the same time: in particular, the adaption of a successful simulation technique from one field to the other requires first some abstraction process where the features specific to the original field of application are discarded and only the heart of the method is kept. Such a cross–fertilization is however only possible if the techniques developed in a specific field are sufficiently mature: this is why some fundamental studies specific to one of the application fields are still required. Our belief is that the embedding in a more general framework of specific developments in a given field will accelerate and facilitate the diffusion to the other field.

8.2.2. *Advanced Geophysical Reduced–Order Model Construction from Image Observations (GERONIMO) — ANR programme Jeunes Chercheuses et Jeunes Chercheurs*
Participant: Patrick Héas.

Inria contract ALLOC 8102 — March 2014 to February 2018.

The GERONIMO project aims at devising new efficient and effective techniques for the design of geophysical reduced–order models (ROMs) from image data. The project both arises from the crucial need of accurate low–order descriptions of highly–complex geophysical phenomena and the recent numerical revolution which has supplied the geophysical scientists with an unprecedented volume of image data. Our research activities are concerned by the exploitation of the huge amount of information contained in image data in order to reduce the uncertainty on the unknown parameters of the models and improve the reduced–model accuracy. In other words, the objective of our researches to process the large amount of incomplete and noisy image data daily captured by satellites sensors to devise new advanced model reduction techniques. The construction of ROMs is placed into a probabilistic Bayesian inference context, allowing for the handling of uncertainties associated to image measurements and the characterization of parameters of the reduced dynamical system.

8.3. European initiatives

8.3.1. *Molecular Simulation: Modeling, Algorithms and Mathematical Analysis (MSMaths) — ERC Consolidator Grant*
Participant: Mathias Rousset.

January 2014 to December 2019.

PI: Tony Lelièvre, Civil Engineer in Chief, Ecole des Ponts Paris-Tech.

Note that $1/3$ of Mathias Rousset research activities are held within the MSMath ERC project.

With the development of large-scale computing facilities, simulations of materials at the molecular scale are now performed on a daily basis. The aim of these simulations is to understand the macroscopic properties of matter from a microscopic description, for example, its atomistic configuration.

In order to make these simulations efficient and precise, mathematics have a crucial role to play. Indeed, specific algorithms have to be used in order to bridge the time and space scales between the atomistic level and the macroscopic level. The objective of the MSMath ERC project is thus to develop and study efficient algorithms to simulate high-dimensional systems over very long times. These developments are done in collaboration with physicists, chemists and biologists who are using these numerical methods in an academic or industrial context.

In particular, we are developping mathematical tools at the interface between the analysis of partial differential equations and stochastic analysis in order to characterize and to quantify the metastability of stochastic processes. Metastability is a fundamental concept to understand the timescale separation between the microscopic model and the macroscopic world. Many algorithms which aim at bridging the timescales are built using this timescale separation.

8.3.2. *Design of Desalination Systems Based on Optimal Usage of Multiple Renewable Energy Sources (DESIRES) — ERANETMED NEXUS–14–049*
Participant: Valérie Monbet.

January 2016 to December 2018.

This project is funded by the ERA–NET Initiative ERANETMED (Euro–Mediterranean Cooperation through ERA–NET Joint Activities and Beyond). It is a collaboration with Greece, Tunisia and Marocco, coordinated by Technical University of Crete (TUC). The French staff includes: Pierre Ailliot (Université de Bretagne Occidentale, Brest), Denis Allard (INRA Avignon), Anne Cuzol (Université de Bretagne Sud, Vannes), Christophe Maisondieu (IFREMER Brest) and Valérie Monbet.

The aim of DESIRES is to develop an Internet–based, multi–parametric electronic platform for optimum design of desalination plants, supplied by renewable energy sources (RES). The platform will rely upon (i) a solar, wind and wave energy potential database, (ii) existing statistical algorithms for processing energy-related data, (iii) information regarding the inter-annual water needs, (iv) a database with the technical characteristics of desalination plant units and the RES components, and (v) existing algorithms for cost effective design, optimal sizing and location selection of desalination plants.

8.4. International initiatives

8.4.1. *Rare event simulation in epidemiology — PhD project at université de Ziguinchor*

Participants: Ramatoulaye Dabo, Frédéric Cérou, François Le Gland.

This is the subjet of the PhD project of Ramatoulaye Dabo (université Assane Seck de Ziguinchor and université de Rennes 1).

The question here is to develop adaptive multilevel splitting algorithms for models that are commonly used in epidemiology, such as SIR (susceptible, infectious, recovered) models [32], or more complex compartmental models. A significant advantage of adaptive multilevel splitting is its robustness, since it does not require too much knowledge about the behavior of the system under study. An interesting challenge would be to understand how to couple the algorithm with numerically efficient simulation methods such as τ–leaping [42]. Complexity bounds and estimation error bounds could also be studied.

BIPOP Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- SLOFADYBIO Slow-fast dynamics applied to the biosciences (january 2015 – december 2016), coordinateur: Mathieu Desroches (Inria Rocquencourt).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. GEM

Title: from GEometry to Motion, inverse modeling of complex mechanical structures

Programm: H2020

Type: ERC

Duration: September 2015 - August 2020

Coordinator: Inria

Inria contact: Florence BERTAILS

With the considerable advance of automatic image-based capture in Computer Vision and Computer Graphics these latest years, it becomes now affordable to acquire quickly and precisely the full 3D geometry of many mechanical objects featuring intricate shapes. Yet, while more and more geometrical data get collected and shared among the communities, there is currently very little study about how to infer the underlying mechanical properties of the captured objects merely from their geometrical configurations. The GEM challenge consists in developing a non-invasive method for inferring the mechanical properties of complex objects from a minimal set of geometrical poses, in order to predict their dynamics. In contrast to classical inverse reconstruction methods, my proposal is built upon the claim that 1/ the mere geometrical shape of physical objects reveals a lot about their underlying mechanical properties and 2/ this property can be fully leveraged for a wide range of objects featuring rich geometrical configurations, such as slender structures subject to frictional contact (e.g., folded cloth or twined filaments). To achieve this goal, we shall develop an original inverse modeling strategy based upon a/ the design of reduced and high-order discrete models for slender mechanical structures including rods, plates and shells, b/ a compact and well-posed mathematical formulation of our nonsmooth inverse problems, both in the static and dynamic cases, c/ the design of robust and efficient numerical tools for solving such complex problems, and d/ a thorough experimental validation of our methods relying on the most recent capturing tools. In addition to significant advances in fast image-based measurement of diverse mechanical materials stemming from physics, biology, or manufacturing, this research is expected in the long run to ease considerably the design of physically realistic virtual worlds, as well as to boost the creation of dynamic human doubles.

8.2.1.2. COMANOID

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: CNRS (Lirmm)

Partners:

>Centre national de la recherche scientifique (France)

>Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

>Airbus Groups (France)

>Universita Degli Studi di Roma Lapienza (Italy)

Inria contact: Francois Chaumette

COMANOID investigates the deployment of robotic solutions in well-identified Airbus airliner assembly operations that are laborious or tedious for human workers and for which access is impossible for wheeled or rail-ported robotic platforms. As a solution to these constraints a humanoid robot is proposed to achieve the described tasks in real-use cases provided by Airbus Group. At a first glance, a humanoid robotic solution appears extremely risky, since the operations to be conducted are in highly constrained aircraft cavities with non-uniform (cargo) structures. Furthermore, these tight spaces are to be shared with human workers. Recent developments, however, in multi-contact planning and control suggest that this is a much more plausible solution than current alternatives such as a manipulator mounted on multi-legged base. Indeed, if humanoid robots can efficiently exploit their surroundings in order to support themselves during motion and manipulation, they can ensure balance and stability, move in non-gaited (acyclic) ways through narrow passages, and also increase operational forces by creating closed-kinematic chains. Bipedal robots are well suited to narrow environments specifically because they are able to perform manipulation using only small support areas. Moreover, the stability benefits of multi-legged robots that have larger support areas are largely lost when the manipulator must be brought close, or even beyond, the support borders. COMANOID aims at assessing clearly how far the state-of-the-art stands from such novel technologies. In particular the project focuses on implementing a real-world humanoid robotics solution using the best of research and innovation. The main challenge will be to integrate current scientific and technological advances including multi-contact planning and control; advanced visual-haptic servoing; perception and localization; human-robot safety and the operational efficiency of cobotics solutions in airliner manufacturing.

8.3. International Research Visitors

8.3.1. Visits to International Teams

8.3.1.1. Sabbatical programme
- Vincent Acary, Inria Chile from September 2014 to August 2016.

<p style="text-align:center;color:red;font-weight:bold;font-size:large;">CAGIRE Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Predicting pressure losses in aeronautical fuel injectors

This is a 3-year programme, started mid-2015 and funded by Conseil Régional d'Aquitaine (2014 Call) and two small-size companies, AD Industrie (Gurmençon, France) and GDTECH (Bordes, France). The objective is to investigate the possibility of using advanced RANS or hybrid RANS-LES approaches to better predict the pressure losses in aeronautical fuel nozzles. A one-year post-doc [YM] (ending in May 2016) assessed the capability of EBRSM-based RANS simulations to predict the discharge coefficient and the pressure loss of a fluid flowing through a diaphragm [20].

9.2. National Initiatives

9.2.1. GIS Success

We are members of the CNRS GIS Success (Groupement d'Intérêt Scientifique) organised around two of the major CFD codes employed by the Safran group, namely AVBP and Yales 2. No specific technical activity has been devoted around those codes during 2016 to the noticeable exception of the post-processing and the publication of results previously obtained with AVBP [15].

9.2.2. CEMRACS 2016

Participants: Mohamed Essadki [PhD student, ECP], Jonathan Jung [UPPA, Cagire], Adam Larat [CNRS, ECP], Milan Peltier [PhD student, ECP], Vincent Perrier [Inria, Cagire].

The assessment of the use of a runtime (StarPU) in the context of the recourse to high order method has been at the origin of a joint project called Hodin (High Order DIscontinuous methods with ruNtime) started during CEMRACS 2016. As a first step, a low-order finite volume code has been written using a task driven implementation. This step was necessary to get acquainted with the specficities of StarPU. Then a DG based high order sequel of that FV program running only on CPU's has been developed and will serve as a basis for the progressive adaptation of AeroSol to such a kind of runtime.

9.2.3. CDMATH

Participation in the CNRS-Needs funded action [0] which is aimed at applying mathematics to hydraulic problems. [JJ]

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. IMPACT-AE

Participants: Vincent Perrier [responsible of the team contribution], Pascal Bruel [substitute], Simon Delmas [PhD].

> Program: Propulsion
>
> Project acronym: IMPACT-AE
>
> Project title: Intelligent Design Methodologies for Low Pollutant Combustors for Aero-Engines
>
> Duration: 01/11/2011 - 31/05/2016

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[0] http://cdmath.jimdo.com

Coordinator: Roll Royce Deutschland

Other partners:

- France: Insa of Rouen, ONERA, Snecma, Turbomeca.
- Germany: Rolls-Royce Deutschland, MTU Aeo Engine Gmbh, DLR, Technology Institute of Karlsruhe, University of Bundeswehr (Munich)
- Italy: AVIOPROP SRL, AVIO S.P.A., University of Florence
- United Kingdom: Rolls Royce PLC, Cambridge University, Imperial College of Science, Technology and Medecine, Loughborough University.

Abstract: The environmental benefits of low emission lean burn technology in reducing NOx emissions up to 80% will only be effective when these are deployed to a large range of new aero-engine applications. While integrating methodologies for advanced engine architectures and thermodynamic cycles. It will support European engine manufacturers to pick up and keep pace with the US competitors, being already able to exploit their new low emission combustion technology to various engine applications with short turn-around times. Key element of the project will be the development and validation of design methods for low emission combustors to reduce NOx and CO emissions by an optimization of the combustor aero-design process. Preliminary combustor design tools will be coupled with advanced parametrisation and automation tools. Improved heat transfer and NOx models will increase the accuracy of the numerical prediction. The contribution of our team is to create with AeroSol a direct numerical simulations (DNS) database relevant to the configuration of film cooling for subsequent improvement of RANS based simulations of isothermal and non isothermal wall flows with discrete mass transfer.

This program ended in May 2016 and the two final deliverables due by the team and devoted to the DNS of isothermal and non isothermal single jets in crossflow with and without gyration were issued in April and May 2016.

9.3.1.2. SOPRANO

Participants: Rémi Manceau [co-responsible for the team contribution], Pascal Bruel [co-responsible for the team contribution], ? ? [Post doc starting in 2018].

Topic: MG-1.2-2015 - Enhancing resource efficiency of aviation

Project acronym: SOPRANO

Project title: Soot Processes and Radiation in Aeronautical inNOvative combustors

Duration: 01/09/2016 - 31/08/2020

Coordinator: SAFRAN

Other partners:

- France: CNRS, CERFACS, INSA Rouen, SAFRAN SA, Snecma SAS, Turbomeca SA.
- Germany: DLR, GE-DE Gmbh, KIT, MTU, RRD,
- Italy: GE AVIO SRL, University of Florence
- United Kingdom: Rolls Royce PLC, Imperial College of Science, Technology and Medecine, Loughborough University.

Abstract: For decades, most of the aviation research activities have been focused on the reduction of noise and NOx and CO2 emissions. However, emissions from aircraft gas turbine engines of non-volatile PM, consisting primarily of soot particles, are of international concern today. Despite the lack of knowledge toward soot formation processes and characterization in terms of mass and size, engine manufacturers have now to deal with both gas and particles emissions. Furthermore, heat transfer understanding, that is also influenced by soot radiation, is an important matter for the improvement of the combustor's durability, as the key point when dealing with low-emissions combustor architectures is to adjust the air flow split between the injection system and the combustor's

walls. The SOPRANO initiative consequently aims at providing new elements of knowledge, analysis and improved design tools, opening the way to: • Alternative designs of combustion systems for future aircrafts that will enter into service after 2025 capable of simultaneously reducing gaseous pollutants and particles, • Improved liner lifetime assessment methods. Therefore, the SOPRANO project will deliver more accurate experimental and numerical methodologies for predicting the soot emissions in academic or semi-technical combustion systems. This will contribute to enhance the comprehension of soot particles formation and their impact on heat transfer through radiation. In parallel, the durability of cooling liner materials, related to the walls air flow rate, will be addressed by heat transfer measurements and predictions. Finally, the expected contribution of SOPRANO is to apply these developments in order to determine the main promising concepts, in the framework of current low-NOx technologies, able to control the emitted soot particles in terms of mass and size over a large range of operating conditions without compromising combustor's liner durability and performance toward NOx emissions.

In the SOPRANO project, our objective is to complement the experimental (ONERA) and LES (CERFACS) work by RANS computations of multiperforated plates, in order to build a database making possible a parametric study of mass, momentum and heat transfer through the plate and the development of multi-parameter-dependent equivalent boundary conditions.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

+ Collaboration with E. Dick (University of Ghent, Belgium) on the development of schemes for the simulation of unsteady all-Mach flows. [PB,YM]

+ Collaboration with A. Beketaeva and A. Naïmanova (Institute of Mathematics, Almaty, Kazakhstan) related to the simulation of supersonic flows.[PB]

+ Collaboration with S. Dellacherie (Montréal Polytechnic Institute, Canada) related to all-Mach flow simulations. [JJ]

+ Collaboration with S. Lardeau (CD-Adapco, Londres, UK) on the EB-RSM model for industrial applications. [RM]

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Sergio Elaskar (Conicet and University National of Cordoba, Argentina) visited LMAP-Cagire for a 3-week stay from October 17 to November 5, 2016. Common subjects of interest were identified regarding intermittency, unsteady boundary conditions for low Mach flow and future use of AeroSol.

- Alireza Mazaheri (Nasa, Langley, USA) Hyperbolic discretization of nonlinear diffusive terms for Navier Stokes equations.

9.5.1.1. Internships

- Nicolas Hernandez from Technical University S. Maria (Chile). The objective of the stay was to compare velocity measured by LDV and PIV. When applied to MAVERIC, the results of this analysis show that to improve the coherence between LDV and PIV, an increase in the pixel size of the PIV image of particles should be sought.

- Saad Jameel from the International Master Program *Turbulence* of the Ecole Centrale de Lille/University of Poitiers. This internship, in the framework of the just-started collaboration with PSA, aimed at evaluating and overcoming the limitations of eddy-viscosity models for turbulent flows in mixed/natural convection regimes representative of the flow in under-hood space of automobiles in some particular, critical situations.

<div align="center">**CARDAMOM Project-Team**</div>

8. Partnerships and Cooperations

8.1. Regional Initiatives

CRA 15/ THESE SANSON 10199

These co-funded by Airbus Safran Launchers and the Aquitaine Region during the period 2016-2019

Topic : uncertainty propagation approach in a system of codes

VIPER Projet

These co-funded by the Aquitaine Region and Inria. PhD student to recruit during the period 2017-2020

Topic : robust design of the EVE engine in collaboration with the SME EXOES.

Title: TIDES: Robust simulation tools for non-hydrostatic free surface flows

Type: Apple à Projets Recherche du Conseil de la Région Aquitaine

Coordinator: M. Ricchiuto

Other partners: UMR EPOC (P. Bonneton)

Abstract: This project proposes to combine modern high order adaptive finite elements techniques with state of the art nonlinear and non-hydrostatic models for free surface waves to provide an accurate tool for the simulation of near shore hydrodynamics, with application to the study and prediction of tidal bores. The Garonne river will be used as a case study. This project co-funds (50%) the PhD of A. Filippini.

8.2. National Initiatives

8.2.1. ANR MAIDESC

Title: Maillages adaptatifs pour les interfaces instationnaires avec deformations, etirements, courbures.

Type: ANR

Duration: 48 months

Starting date : 1st Oct 2013

Coordinator: Dervieux Alain (Inria Sophia)

Abstract: Mesh adaptive numerical methods allow computations which are otherwise impossible due to the computational resources required. We address in the proposed research several well identified main obstacles in order to maintain a high-order convergence for unsteady Computational Mechanics involving moving interfaces separating and coupling continuous media. A priori and a posteriori error analysis of Partial Differential Equations on static and moving meshes will be developed from interpolation error, goal-oriented error, and norm-oriented error. From the minimization of the chosen error, an optimal unsteady metric is defined. The optimal metric is then converted into a sequence of anisotropic unstructured adapted meshes by means of mesh regeneration, deformation, high stretching, and curvature. A particular effort will be devoted to build an accurate representation of physical phenomena involving curved boundaries and interfaces. In association with curved boundaries, a part of studies will address third-order accurate mesh adaption. Mesh optimality produces a nonlinear system coupling the physical fields (velocities, etc.) and the geometrical ones (unsteady metric, including mesh motion). Parallel solution algorithms for the implicit coupling of these different fields will be developed. Addressing efficiently these issues is a compulsory condition for the simulation of a number of challenging physical phenomena related to industrial unsolved or insufficiently solved problems. Non-trivial benchmark tests will be shared by consortium partners and by external attendees to workshops organized by the consortium. The various advances will be used by SME partners and proposed in software market.

8.2.2. PIA TANDEM

Title: Tsunamis in the Atlantic and the English ChaNnel: Definition of the Effects through numerical Modeling (TANDEM)

Type: PIA - RSNR (Investissement d'Avenir, "Recherches en matière de Sûreté Nucléaire et Radioprotection")

Duration: 48 months

Starting date : 1st Jan 2014

Coordinator: H. Hebert (CEA)

Abstract: TANDEM is a project dedicated to the appraisal of coastal effects due to tsunami waves on the French coastlines, with a special focus on the Atlantic and Channel coastlines, where French civil nuclear facilities have been operated since about 30 years. As identified in the call RSNR, this project aims at drawing conclusions from the 2011 catastrophic tsunami, in the sense that it will allow, together with a Japanese research partner, to design, adapt and check numerical methods of tsunami hazard assessment, against the outstanding observation database of the 2011 tsunami. Then these validated methods will be applied to define, as accurately as possible, the tsunami hazard for the French Atlantic and Channel coastlines, in order to provide guidance for risk assessment on the nuclear facilities.

8.2.3. APP Bordeaux 1

Title : Reactive fluid flows with interface : macroscopic models and application to self-healing materials

Type : Project Bordeaux 1

Duration : 36 months

Starting : September 2014

Coordinator : M. Colin

Abstract : Because of their high strength and low weight, ceramic-matrix composite materials (CMCs) are the focus of active research, for aerospace and energy applications involving high temperatures. Though based on brittle ceramic components, these composites are not brittle due to the use of a fiber/matrix interphase that manages to preserve the fibers from cracks appearing in the matrix. The lifetime-determining part of the material is the fibers, which are sensitive to oxidation; when the composite is in use, it contains cracks that provide a path for oxidation. The obtained lifetimes can be of the order of hundreds of thousands of hours. These time spans make most experimental investigations impractical. In this direction, the aim of this project is to furnish predictions based on computer models that have to take into account: 1) the multidimensional topology of the composite made up of a woven ceramic fabric; 2) the complex chemistry taking place in the material cracks; 3) the flow of the healing oxide in the material cracks.

8.2.4. APP University of Bordeaux

Title : Modélisation d'un système de dégivrage thermique

Type : Project University of Bordeaux

Duration : 36 months

Starting : October 2016

Coordinator : H. Beaugendre and M. Colin

Abstract : From the beginning of aeronautics, icing has been classified as a serious issue : ice accretion on airplanes is due to the presence of supercooled droplets inside clouds and can lead to major risks such as aircrash for example. As a consequence, each airplane has its own protection system : the most important one is an anti-icing system which runs permanently. In order to reduce gas consumption, de-icing systems are developed by manufacturers. One alternative to real

experiment consists in developing robust and reliable numerical models : this is the aim of this project. These new models have to take into account multi-physics and multi-scale environnement : phase change, thermal transfer, aerodynamics flows, etc. We aim to use thin films equations coupled to level-set methods in order to describe the phase change of water. The overall objective is to provide a simulation plateform, able to provide a complete design of these systems.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. UTOPIA

Type: COOPERATION

Instrument: Specific Targeted Research Project

Objectif: The main objectives of this research programme are to develop, through the ESR's individual projects, fundamental mathematical methods and algorithms to bridge the gap between Uncertainty Quantification and Optimisation and between Probability Theory and Imprecise Probability Theory for Uncertainty Quantification, and to efficiently solve high-dimensional, expensive and complex engineering problems.

Duration: 2017 - 2021

Coordinator: University of Strathclyde (Scotland, UK)

Partner: University of Strathclyde (Scotland, UK), Inria Bordeaux Sud-Ouest (France), ESTECO (Italy), CIRA, Centro Italiano Aerospaziali (Italy), Politecnico di Milano (Italy), Jozef Stefan Institute (Slovenia), Cologne University of Applied Sciences (Germany), University of Durham (England, UK), Ghent University (Belgium), Von Karman Institute (Belgium), DLR, Institute of Aerodynamics and Flow Technology (Germany), National Physical Laboratory (England, UK), Leonardo Aircraft S.p.A (Italy), Airbus Operations Gmbh (England, UK), Stanford University (USA)

Inria contact: Pietro Marco Congedo

Abstract: Research activities will be developed in the context of the European project - UTOPIAE http://utopiae.eu (520 K euros for Inria). The aim of this project is to develop, through the ESRs individual projects, fundamental mathematical methods and algorithms to efficiently solve high-dimensional, expensive and complex engineering problems. Two PhD thesis will be recruited at the beginning of 2017.

8.3.1.2. STORM

Type: COOPERATION

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2016

Coordinator: SNECMA (France)

Partner: SNECMA SA (FR), AEROTEX UK LLP (UK), AIRBUS OPERATIONS SL (ES), Airbus Operations Limites (UK), AIRCELLE SA (FR), ARTTIC (FR), CENTRO ITALIANO RICERCHE AEROSPAZIALI SCPA (IT), CRANFIELD UNIVERSITY (UK), DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV (DE), EADS DEUTSCHLAND GMBH (DE), ONERA (FR), TECHSAPACE AERO SA (BE)

Inria contact: Héloise Beaugendre

Abstract: During the different phases of a flight, aircraft face severe icing conditions. When this ice then breaks away, and is ingested through the reminder of the engine and nacelle it creates multiple damages which have a serious negative impact on the operations costs and may also generate some incident issues. To minimise ice accretion, propulsion systems (engine and nacelle) are equipped with Ice Protection Systems (IPS), which however have themselves performance issues. Design methodologies used to characterise icing conditions are based on empirical methods and past experience. Cautious design margins are used non-optimised designs solutions. In addition, engine and nacelle manufacturers are now limited in their future architectures solutions development because of lack of knowledge of icing behaviour within the next generation of propulsive systems solutions, and of new regulations adopted that require aero engine manufacturers to address an extended range of icing conditions.

In this context that STORM proposes to: characterise ice accretion and release through partial tests ; Model ice accretion, ice release and ice trajectories ; Develop validated tools for runback ; characterise ice phobic coatings ; select and develop innovative low cost and low energy anti-icing and de-icing systems. Thus, STORM will strengthen the predictability of the industrial design tools and reduce the number of tests needed. It will permit lower design margins of aircraft systems, and thus reduce the energy consumption as well as prevent incidents and break downs due to icing issues.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: OCEANEraNET

Project acronym: MIDWEST

Project title: Multi-fIdelity Decision making tools for Wave Energy SysTems

Duration: December 2015 - December 2018

Coordinator: Mario Ricchiuto

Other partners: Chalmers University (Sweden), DTU Compute (Denmark), IST Lisbon (Portugal)

Abstract: Wave energy converters (WECs) design currently relies on low-fidelity linear hydrodynamic models. While these models disregard fundamental nonlinear and viscous effects - which might lead provide sub-optimal designs - high-fidelity fully nonlinear Navier-Stokes models are prohibitively computational expensive for optimization. The MIDWEST project will provide an efficient asymptotic nonlinear finite element model of intermediate fidelity, investigate the required fidelity level to resolve a given engineering output, construct a multi-fidelity optimization platform using surrogate models blending different fidelity models. Combining know how in wave energy technology, finite element modelling, high performance computing, and robust optimization, the MIDWEST project will provide a new efficient decision making framework for the design of the next generation WECs which will benefit all industrial actors of the European wave energy sector.

8.4. International Initiatives

8.4.1. Inria International Labs

Inria@SiliconValley
Associate Team involved in the International Lab:

8.4.1.1. AQUARIUS2

Title: Advanced methods for uncertainty quantification in compressible flows

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Mechanical Engineering - Gianluca Iaccarino

Start year: 2014

See also: http://www.stanford.edu/group/uq/aquarius/index3.html

This research project deals with uncertainty quantification in computational fluid dynamics. Uncertainty Quantification (UQ) aims at developing rigorous methods to characterize the impact of limited knowledge on quantities of interest. Main objective of this collaboration is to build a flexible and efficient numerical platform, using intrusive methods, for solving stochastic partial differential equations. In particular, the idea is to handle highly non-linear system responses driven by shocks.

8.4.1.2. AMoSS

Title: Advanced Modeling on Shear Shallow Flows for Curved Topography : water and granular flows.

International Partner (Institution - Laboratory - Researcher):

Inria Sophia-Antipolis and University of Nice (France)

Inria Bordeaux and University of Bordeaux (France)

University of Marseille (France)

National Cheng Kung University, Tainan, Taiwan

National Taiwan University and Academia Sinica,Taipei, Taiwan

Duration: 2014 - 2016

See also: https://team.inria.fr/amoss/

Our objective is to generalize the promising modeling strategy proposed in G.L. Richard and S.L. Gavrilyuk 2012, to genuinely 3D shear flows and also take into account the curvature effects related to topography. Special care will be exercised to ensure that the numerical methodology can take full advantage of massively parallel computational platforms and serve as a practical engineering tool. At first we will consider quasi-2D sheared flows on a curve topography defined by an arc, such as to derive a model parameterized by the local curvature and the nonlinear profile of the bed. Experimental measurements and numerical simulations will be used to validate and improve the proposed modeling on curved topography for quasi-2D flows. Thereafter, we will focus on 3D flows first on simple geometries (inclined plane) before an extension to quadric surfaces and thus prepare the generalization of complex topography in the context of geophysical flows.

8.4.1.3. Informal International Partners

University of Zurich : R. Abgrall. Collaboration on penalisation on unstructured grids and high order adaptive methods for CFD and uncertainty quantification.

Politecnico di Milano, Aerospace Department (Italy) : Pr. A. Guardone. Collaboration on ALE for complex flows (compressible flows with complex equations of state, free surface flows with moving shorelines).

von Karman Institute for Fluid Dynamics (Belgium). With Pr. T. Magin we work on Uncertainty Quantification problems for the identification of inflow condition of hypersonic nozzle flows. With Pr. H. Deconinck we work on the design of high order methods, including goal oriented mesh adaptation strategies

NASA Langley: Dr. Alireza Mazaheri. Collaboration on high order schemes for PDEs with second and third order derivatives, with particular emphasis on high order approximations of solution derivatives.

Technical University of Crete, School of Production Engineering & Management : Pr. A.I. Delis. Collaboration on high order schemes for depth averaged free surface flow models, including robust code to code validation

Chalmers University (C. Eskilsson) and Technical University of Denmark (A.-P. Engsig-Karup) : our collaboration with Chalmers and with DTU compute in Denmark aims at developing high order non hydrostatic finite element Boussinesq type models for the simulation floating wave energy conversion devices such as floating point absorbers ;

University of Delaware: F. Veron. Collaboration on the modelling of rain effects on wave propagation.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- From 27/11 to 03/12/2016 Pascal POULLET (Université des Antilles) has visited M. Ricchiuto to work on nonlinear residual based approximations of free sudface flows with moving bathymetries.

- From 21/11 to 09/12/2016 Luca CIRROTTOLA (Politecnico di Milano) has visited C. Dobrizinsky to work on parallel mesh adaptation.

- From 21/10 to 05/11/2016 François MORENCY (ETS, University of Québec, Montréal) has visited us to work on LESCAPE code with Héloïse, Léo and Aurore. The Spalart-Allmaras turbulent model has been validated using the perodic channel flow test case.

- From 01/10 to 29/10/2016 Claes ESKILSSON (Chalmers University of Technology, Sweden) has visited us to work with Mario Ricchiuto and U. Bosi on spectral element methods for Boussinesq models with floating structures.

- From 12/09 to 22/09/2016 Kazuo AOKI (University of Taiwan) has visited us to work with Luc Mieussens on models for reentry flows.

- From 07/07 to 09/07/2016 Volker ROEBER (Tohoku University, International Research Institute of Disaster Science) has visited us to work with Maria Kazolea and Mario Ricchiuto on robust code to code validation, on coastal engineering problems.

- From 27/03 to 01/04/2016 Alireza MAZAHERI (NASA Langley) came to visit Mario Ricchiuto and V. Perrier to work on the implementation of a hyperbolic formulation of the Navier-Stokes equations in the AeroSol platform.

- From 16/03/2016 Guglielmo SCOVAZZI (Duke University) has visited M. Ricchiuto to work on stabilized finite elements for geo-mechanics.

- From 1/01/2016 to 31/04/2016 Gianluca IACCARINO (Stanford University) has visited the Team in the context of AQUARIUS Team, collaborating actively with all the PhD student involved in uncertainty quantification research. All the students involved (Razaaly, Sanson and Cortesi) have then visited the group of G. Iaccarino in Stanford University in the fall 2016.

- From 15/05/2016 to 17/07/2016 Fabrice VERON (University of Delaware at Newark, USA) has visited us to work with Luc Mieussens on a project dedicated to the modelling and simulation of the interaction rain/water waves.

- From April 2015 to April 2016 : T. WATANABE, Department of Mathematics, Faculty of Science Kyoto Sangyo University visited M. Colin to work on the approximation of solitary wave solutions of nonlinear dispersive PDEs.

8.5.1.1. Internships

- From Feb 2016 to Jul 2016 Rama Ayoub (Inria, M. Sc. Student)
- From Apr 2016 to Sep 2016 Toufik Boubehziz (EDF, M. Sc. Student)
- From Jan 2016 to Mar 2016 Maxence Claeys (CEA, Phd Student)
- From Feb 2016 to Jul 2016 Antoine Fondaneche (Inria, M. Sc. Student)
- From Oct 2016 to Feb 2016 Esben Grange (Inria, M. Sc. Student)
- From Jun 2016 to Sep 2016 Adrien Paumelle (Inria, Univ. Bordeaux)
- From May 2016 to Sep 2016 Raphael Robyn (Inria, Univ. Bordeaux)

COMMANDS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Gaspard Monge Program for Optimization and Operational Research (Fondation Jacques Hadamard)

Title	:	Optimal control of partial differential equations using parameterizing manifolds, model reduction, and dynamic programming,
Funding	:	9,000 Euro (for 2015-16), 10,000 Euro (for 2016-17)
PI	:	Axel Kröner
Period	:	$2015 - 2017$
Further members	:	Frédéric Bonnans (Inria Saclay and CMAP, École Polytechnique), Mickaël Chekroun (UCLA, Los Angeles), Martin Gubisch (University of Konstanz), Karl Kunisch (University of Graz), Hasnaa Zidani (ENSTA ParisTech).

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

- Michael D. Chekroun, U.C.L.A, collaboration on the approximation and reduction of optimal control problems in infinite dimension.
- Alejandro Jofré, CMM, U. Chile, Santiago de Chile. Cosupervision of B. Heymann's PhD thesis.
- Pablo Lotito, U. Tandil, Argentina, supervision of Justina Gianatti's PhD.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- M. Chekroun (University of California, Los Angeles), 12.-14.12.2016.
- Johannes Pfefffer (Technische Universität München), 12.-14.12.2016.

9.3.1.1. Internships

- Luis Alberto Croquevielle Rendic: Classification of probability measures based on Optimal Transportation theory. January-March 2016. U. Catolica, Santiago, Chile.
- Justina Gianatti, Discretization of stochastic control problems, U. Rosario (Argentina), May-July 2016.

<div align="center">

CQFD Project-Team

</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MATCHABLE project

Matchable is a startup incubated at IRA (Incubateur Régional d'Aquitaine) since Mars 2014. This startup predicts how players will behave, who is likely to spend money, who you should target with promotions/product placement, and who the developer has to pay attention to in order to prevent churners. The members of CQFD have supervised two masters internships and a postdoctoral researcher, granded by two PEPS contracts from AMIES.

9.1.2. project LabEx CPU TIMIC

The topic of the project is TIMIC is the multivariate treatment of human brain imaging and its application to the analysis of cerebral connectivity graph during rest. The project focuses on the analysis of variability of cerebral organisation on a large population using several methods of supervised and unsupervised classification. The volume of data and the iterative aspect of the methods will lead to implement the classification process on infrastructure of distributed computing.

Alexandre Laurent has been hired as full time research engineer this project for 12 months in 2016.

9.2. National Initiatives

9.2.1. ANR Piece

ANR Piece (2013-2016) of the program *Jeunes chercheuses et jeunes chercheurs* of the French National Agency of Research (ANR), lead by F. Malrieu (Univ. Tours). The Piecewise Deterministic Markov Processes (PDMP) are non-diffusive stochastic processes which naturally appear in many areas of applications as communication networks, neuron activities, biological populations or reliability of complex systems. Their mathematical study has been intensively carried out in the past two decades but many challenging problems remain completely open. This project aims at federating a group of experts with different backgrounds (probability, statistics, analysis, partial derivative equations, modeling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

9.2.2. ANR BNPSI "Bayesian Non Parametric methods for Signal and Image Processing"

Statistical methods have become more and more popular in signal and image processing over the past decades. These methods have been able to tackle various applications such as speech recognition, object tracking, image segmentation or restoration, classification, clustering, etc. We propose here to investigate the use of Bayesian nonparametric methods in statistical signal and image processing. Similarly to Bayesian parametric methods, this set of methods is concerned with the elicitation of prior and computation of posterior distributions, but now on infinite-dimensional parameter spaces. Although these methods have become very popular in statistics and machine learning over the last 15 years, their potential is largely underexploited in signal and image processing. The aim of the overall project, which gathers researchers in applied probabilities, statistics, machine learning and signal and image processing, is to develop a new framework for the statistical signal and image processing communities. Based on results from statistics and machine learning we aim at defining new models, methods and algorithms for statistical signal and image processing. Applications to hyperspectral image analysis, image segmentation, GPS localization, image restoration or space-time tomographic reconstruction will allow various concrete illustrations of the theoretical advances and validation on real data coming from realistic contexts.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

IRSES ACOBSEC

Project reference: 612689 Funded under: FP7-PEOPLE

Coordinator : Pierrick Legrand

Participants UNIVERSITE VICTOR SEGALEN BORDEAUX II Participation ended

UNIVERSITE DE BORDEAUX

FUNDACAO DA FACULDADE DE CIENCIAS DA UNIVERSIDADE DE LISBOA Portugal

UNIVERSIDAD DE EXTREMADURA Spain

INESC ID - INSTITUTO DE ENGENHARIA DE SISTEMAS E COMPUTADORES, INVESTIGACAO E DESENVOLVIMENTO EM LISBOA Participation ended

Over the last decade, Human-Computer Interaction (HCI) has grown and matured as a field. Gone are the days when only a mouse and keyboard could be used to interact with a computer. The most ambitious of such interfaces are Brain-Computer Interaction (BCI) systems. BCI's goal is to allow a person to interact with an artificial system using brain activity. A common approach towards BCI is to analyze, categorize and interpret Electroencephalography (EEG) signals in such a way that they alter the state of a computer. ACoBSEC's objective is to study the development of computer systems for the automatic analysis and classification of mental states of vigilance; i.e., a person's state of alertness. Such a task is relevant to diverse domains, where a person is required to be in a particular state. This problem is not a trivial one. In fact, EEG signals are known to be noisy, irregular and tend to vary from person to person, making the development of general techniques a very difficult scientific endeavor. Our aim is to develop new search and optimization strategies, based on evolutionary computation (EC) and genetic programming (GP) for the automatic induction of efficient and accurate classifiers. EC and GP are search techniques that can reach good solutions in multi-modal, non-differentiable and discontinuous spaces; and such is the case for the problem addressed here. This project combines the expertise of research partners from five converging fields: Classification, Neurosciences, Signal Processing, Evolutionary Computation and Parallel Computing in Europe (France Inria, Portugal INESC-ID, Spain UNEX, Bordeaux university, Sciences University of Lisbon) and South America (Mexico ITT, CICESE). The exchange program goals and milestones give a comprehensive strategy for the strengthening of current scientific relations amongst partners, as well as for the construction of long-lasting scientific relationships that produce high quality theoretical and applied research.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: Direcion General de Investigacion Cientifica y Tecnica, Gobierno de Espana

Project acronym: GAMECONAPX

Project title: Numerical approximations for Markov decision processes and Markov games

Duration: 01/2017 - 12/2019

Coordinator: Tomas Prieto-Rumeau, Department of Statistics and Operations Research, UNED (Spain)

Abstract:

This project is funded by the Gobierno de Espana, Direcion General de Investigacion Cientifica y Tecnica (reference number: MTM2016-75497-P) for three years to support the scientific collaboration between Tomas Prieto-Rumeau, Jonatha Anselmi and François Dufour. This research project is concerned with numerical approximations for Markov decision processes and Markov games. Our goal is to propose techniques allowing to approximate numerically the optimal value function and the optimal strategies of such problems. Although such decision models have been widely studied theoretically and, in general, it is well known how to characterize their optimal value function and

their optimal strategies, the explicit calculation of these optimal solutions is not possible except for a few particular cases. This shows the need for numerical procedures to estimate or to approximate the optimal solutions of Markov decision processes and Markov games, so that the decision maker can really have at hand some approximation of his optimal strategies and his optimal value function. This project will explore areas of research that have been, so far, very little investigated. In this sense, we expect our techniques to be a breakthrough in the field of numerical methods for continuous-time Markov decision processes, but particularly in the area of numerical methods for Markov game models. Our techniques herein will cover a wide range of models, including discrete- and continuous-time models, problems with unbounded cost and transition rates, even allowing for discontinuities of these rate functions. Our research results will combine, on one hand, mathematical rigor (with the application of advanced tools from probability and measure theory) and, on the other hand, computational efficiency (providing accurate and ?applicable? numerical methods). In this sense, particular attention will be paid to models of practical interest, including population dynamics, queueing systems, or birth-and-death processes, among others. So, we expect to develop a generic and robust methodology in which, by suitably specifying the data of the decision problem, an algorithm will provide the approximations of the value function and the optimal strategies. Therefore, the results that we intend to obtain in this research project will be of interest for researchers in the fields of Markov decision processes and Markov games, both for the theoretical and the applied or practitioners communities

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. CDSS

Title: Control of Dynamic Systems Subject to Stochastic Jumps

International Partner (Institution - Laboratory - Researcher):

Universidade de São Paulo (Brazil) - Departamento de Matemática Aplicada e Estatística (ICMC) - Costa Eduardo

Start year: 2014

See also: https://team.inria.fr/cdss/fr/

The main goals of this joint team CDSS is to study the control of dynamic systems subject to stochastic jumps. Three topics will be considered throughout the next 3 years. In the first topic we study the control problem of piecewise-deterministic Markov processes (PDMP?s) considering constraints. In this case the main goal is to obtain a theoretical formulation for the equivalence between the original optimal control of PDMP?s with constrains and an infinite dimensional static linear optimization problem over a space of occupation measures of the controlled process. F. Dufour (CQFD, Inria) and O. Costa (Escola Politécnica da Universidade de São Paulo, Brazil) mainly carry out this topic. In the second topic we focus on numerical methods for solving control and filtering problems related to Markov jump linear systems (MJLS). This project will allow a first cooperation between B. de Saporta (Univ. Montpellier II) and E. Costa (Universidade de São Paulo, Brazil). The third research subject is focused on quantum control by using Lyapunov-like stochastic methods conducted by P. Rouchon (Ecole des Mines de Paris) and P. Pereira da Silva (Escola Politécnica da Universidade de São Paulo, Brazil).

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

Tree-Lab, ITT. TREE-LAB is part of the Cybernetics research line within the Engineering Science graduate program offered by the Department of Electric and Electronic Engineering at Tijuana's Institute of Technology (ITT), in Tijuana Mexico. TREE-LAB is mainly focused on scientific and engineering research within the intersection of broad scientific fields, particularly Computer Science, Heuristic Optimization and Pattern

Analysis. In particular, specific domains studied at TREE-LAB include Genetic Programming, Classification, Feature Based Recognition, Bio-Medical signal analysis and Behavior-Based Robotics. Currently, TREE-LAB incorporates the collaboration of several top researchers, as well as the participation of graduate (doctoral and masters) and undergraduate students, from ITT. Moreover, TREE-LAB is actively collaborating with top researchers from around the world, including Mexico, France, Spain, Portugal and USA.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Oswaldo Costa (Escola Politécnica da Universidade de São Paulo, Brazil) collaborate with the team on the theoretical aspects of continuous control of piecewise-deterministic Markov processes. He visited the team during two weeks in 2016 supported by the Associate Team Inria: CDSS.

Alexey Piunovskiy (University of Liverpool) visited the team during 2 weeks in 2016. The main subject of the collaboration is the linear programming approach for Markov Decision Processes. This research was supported by the Clusters d'excellence CPU.

<div align="center" style="color:red">**DEFI Project-Team**</div>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR Metamath: Modelization and numerical simulation of wave propagation in metamaterials, program MN, September 2011- November 2016. This is a joint ANR with POEMS, Inria Scalay Ile de France project team (Coordinator, S. Fliss), DMIA, Département de Mathématiques de l'ISAE and IMATH, Laboratoire de Mathématiques de l'Université de Toulon. https://www.rocq.inria.fr/poems/metamath

- ANR CIACM "Computational Imaging of the Aging Cerebral Microvasculature", funded by ANR Program "US-French Collaboration". French Partners (Coordinating partner CEA Neurospin): CEA Neurospin (Coordinator Luisa Ciobanu), Inria Saclay (Coordinator Jing-Rebecca Li). US Partner: Univ of Illinois, bioengineering department (Coordinator Brad Sutton). Duration: Sept 2013-Sept 2016.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Declared Inria International Partners

QUASI

Title: Qualitative Approaches to Scattering and Imaging

International Partner (Institution - Laboratory - Researcher):

University of Rutgers (United States) - Fioralba Cakoni

Duration: 2013 - 2017

Start year: 2013

We concentrate on the use of qualitative methods in acoustic and electromagnetic inverse scattering theory with applications to nondestructive evaluation of materials and medical imaging. In particular, we would like to address theoretical and numerical reconstruction techniques to solve the inverse scattering problems using either time harmonic or time dependent measurements of the scattered field. The main goal of research in this field is to not only detect but also identify geometric and physical properties of unknown objects in real time.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Fioralba Cakoni (4 months)
- David Colton (1 week)
- Semra Ahmetola (11 months)
- Armin Lechleiter (1 week)
- Bojan Guzina (1 week)
- Helle Majander (12 months)

9.3.1.1. Internships

- Irene De Teresa-Trueba (University of Delaware) 3 months
- Jacob Rezac (University of Delaware) 3 months
- Marwa Kchaou (ENIT) 3 months
- BumsuKim (Ecole Polytechnique), from Jul 2016 until Nov 2016
- KevishNapal (Inria), from May 2016 until Oct 2016
- Hoang An Tran (Ecole Polytechnique), from Apr 2016 until Jun 2016

DISCO Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- DIGITEO Project (DIM LSC) ALMA3

  Project title: Mathematical Analysis of Acute Myeloid Leukemia (AML) and its treatments

  September 2014 - August 2017

  Coordinator: Catherine Bonnet

  Other partners: Inria Paris-Rocquencourt, France, L2S, France, UPMC, St Antoine Hospital Paris

  Abstract: this project follows the regional projects ALMA (2010-2014) and ALMA2 (2011-2013). Starting from the work of J. L. Avila Alonso's PhD thesis in ALMA the aim of this project is to provide a refined coupled model of healthy and cancer cell dynamics in AML whose (stability) analysis will enable evaluation of polychemiotherapies delivered in the case of AML which have a high level of Flt-3 duplication (Flt-3-ITD).

7.2. National Initiatives

7.2.1. Industrial-Academic Institute

Guillaume Sandou is the head of the RISEGrid Institute. The Institute is dedicated to the study, modelling and simulation of smart electric distribution grids and their interactions with the whole electric power system. It is located in Supélec and gathers about 20 people (academic and industrial researchers, PhD students, post-doctoral researchers).

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

Program: ITN

Project acronym: TEMPO

Project title: Training in Embedded Predictive Control and Optimization

Duration: January 2014 - January 2018

Coordinator: Tor Arne Johanson; with Sorin Olaru (as French PI)

Other partners: U. Frieburg, Oxford, Imperial College; NTNU Trondheim; STUBA Bratislava; EPFL Lausanne; KU Leuven, Renault, ABB, Ampyx Power

Abstract: TEMPO is an international PhD program for highly motivated young scientists, where state-of-the-art research is combined with a comprehensive training program. The network is funded by the European Communityâs Seventh Framework program. The European Commission wants to make research careers more attractive to young people and therefore offers early-stage researchers (ESRs) a PhD program the opportunity to improve their research skills, join established research teams and enhance their career prospects via the Marie Curie Initial Training Networks (ITN) in the area of Embedded Predictive Control and Optimization.

Program: IEF

Project acronym: FUTURISM

Project title: Multiple sensor FaUlt ToleRant control for management of Interconnected nonlinear SysteMs

Duration: May 2014 - April 2016

Coordinator: Sorin Olaru

Abstract: The primary research objective of this project is the design and analysis of novel methods for diagnosing multiple sensor faults and compensating their effects on multi-sensory schemes used for controlling interconnected, nonlinear systems. The second main objective of this project is the application of these methods to complex systems.

7.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: PHC STEFANIK 2016 (Slovakia)

Project acronym: AIMPC

Project title: Advanced techniques for practical implementation of model predictive control strategies

Duration: January 2016 - December 2017

Coordinator:Cristina Stoica (France), Martin Gulan (Slovakia)

Abstract: The proposed project is dedicated to the model predictive control with a particular emphasis on its practical implementations. The main objective is to explore new techniques allowing for an efficient deployment of control algorithms on embedded, preferably low-cost microcontrollerbased computing platforms. The inherent hardware memory/speed issues that become particularly challenging for fast real-time applications are to be addressed by appropriate acceleration and complexity reduction techniques targeting either the implicit or the explicit control laws while preserving the optimality of associated solutions. The run-time performance of the proposed control policies will be experimentally verified and monitored in chosen existing applications.

Program: PHC BOSPHORE 2016 (Turkey)

Project title: Robust Control of Time Delayed Linear Parameter Varying Systems via Switched Controllers.

Duration: January 2016 - December 2017

Coordinator: Frédéric Mazenc (France), Hitay Özbay (Turkey).

Abstract: The main goal of this project is to develop computational algorithms for robust controller design for different classes of time delay systems appearing in various engineering applications such as chemical processes, transportation systems and communications networks. The participants will consider control problems of significant practical implications in this area: (i) developing new computational techniques for simple (low order) reliable and scalable decentralized controllers for control of (and control over) networks; and (ii) reducing conservatism in recently developed dwell-time based stability results for the analysis of switched time delay systems. Moreover, design of scalable low order controllers for reducing the effect of time delays is an important problem investigated in this project. One of the objectives of this collaboration is to generalize the design techniques already developed by the French and Turkish teams to larger classes of time delay systems, in particular multi-input-multi-output (MIMO) systems with time varying delays.

Program: COST Action

Project acronym: FRACTAL

Project title: Fractional-order systems; analysis, synthesis and their importance for future design

Duration: November 2016 - October 2020

Coordinator: Jaroslav Koton Czech Republic

Abstract: Fractional-order systems have lately been attracting significant attention and gaining more acceptance as generalization to classical integer-order systems. Mathematical basics of fractional-order calculus were laid nearly 300 years ago and since that it has gained deeply rooted mathematical concepts. Today, it is known that many real dynamic systems cannot be described by a system of simple differential equation or of integer-order system. In practice we can encounter such systems in electronics, signal processing, thermodynamics, biology, medicine, control theory, etc. The Action will favour scientific advancement in above mentioned areas by coordinating activities of academic research groups towards an efficient deployment of fractal theory to industry applications.

7.4. International Initiatives

Catherine Bonnet is the co-supervisor together with André Fioravanti of a PhD student of Unicamp (Brazil).

Guillaume Sandou is the co-supervisor of a PhD student in the Ecole nationale d'ingénieur de Tunis, on the optimal tuning of MPC controllers using stochastic optimization methods.

7.4.1. Inria International Labs

7.4.1.1. Informal International Partners

- College of Mathematics and Information Science, Shaanxi Normal University, China

- School of Control Science and Engineering, Dalian University of Technology, Dalian, China

- Louisiana State University, Baton Rouge, USA

- School of Electrical Engineering at the Tel-Aviv University, Israel

- The University of Texas at Austin, Dept. of Aerospace Engineering & Engineering Mechanics, USA

- Blikent University, Turkey

- Universidad de Chile, Chile

- School of Mathematics, University of Leeds, U.K.

- University Federale Rio de Janeiro, Brazil

- UNICAMP, Brazil

- Kyoto University, Japan

7.4.2. Participation in Other International Programs

7.4.2.1. International Initiatives

STADE

Title: Stability and Dichotomies in Differential Equations (Ordinary & Delay).

International Partners (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Mathematics Department - Gonzalo Robledo

Universidad de la Republica Uruguay (Uruguay) - Faculty of Engineering - Pablo Monzon

Duration: 2016 - 2017

Start year: 2016

See also: http://www.stade.cl/pages/list.html

The ship-flags of this project are the concepts of dichotomy and stability in an ODE & DDE framework. We intend to study some theoretical and applied problems involving these concepts and its relations. In particular, converse stability results (expressed in the existence of density functions), feedback stabilization, stability in delay differential equations and some applications to bioprocesses.

7.5. International Research Visitors

Gonzalo Robledo, Universidad de Chile, Chile, $14/11 - 28/11$.

Hitay Ozbay, Bilkent University, $26/10 - 02/11$.

Saed Ahmed, Bilkent University, $04/12 - 16/12$.

7.5.1. Visits of International Scientists

Stefanella Boatto, Federale University Rio de Janeiro, Brazil, 2 October-23 December

André Fioravanti, UNICAMP, Sao Paulo, Brazil, 24 November-31 December

Emilia Fridman, Tel-Aviv University, Israel, 23-30 September

Yutaka Yamamoto, Kyoto University, Japan, 6 September-19 November

7.5.2. Visits to International Teams

7.5.2.1. Research Stays Abroad

Matsumae International Foundation (MIF) fellowship - 3 months research visit of Sorin Olaru (June-September 2016) to Kyushu Institute of Technology (Hosted by Prof. Hiroshi Ito).

Mitacs Globalink Research Award – 3 months research visit of Dina Irofti (July – October 2016) to University of Lethbridge, Alberta, Canada (hosted by Marc R. Roussel).

<p align="center">**DOLPHIN Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

- CPER "data" (2015-2020): co-leader of a workpackage "Research infrastructures". The objective is to support research related to data science including high performance computing for combinatorial optimization using the Grid'5000 grid infrastructure.
- ELSAT (2015-2019) of CPER (Contrat Plan Etat Région) : transversal research action "Planning and scheduling of maintenance logistics in transportation".

9.2. National Initiatives

9.2.1. ANR

- ANR project Modèles Numériques "NumBBO - Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers" (2012-2016) in collaboration with Inria Saclay, TAO team, Ecole des Mines de St. Etienne, CROCUS team, and TU Dortmund University, Germany (2012-2016).
- ANR project TECSAN (Technologies pour la Santé) "ClinMine - Optimisation de la prise en Charge des Patients à l'Hôpital", in collaboration with University Lille 1, Université Lille 2, Inria, CHRU Lille, CHICL, Alicante (7 partners) (2014-2017) - Coordinator -
- Bilateral ANR/RGC France/Hong Kong PRCI "Big Multiobjective Optimization" (2016-2021) in collaboration with City University of Hong Kong.
- PGMO project "Towards a Complexity Theory for Black-Box Optimization", together with Carola Doerr (CNRS, LIP6), Benjamin Doerr (Ecole Polytechnique), Anne Auger, Nikolaus Hansen (both Inria Saclay), Timo Koetzing (University of Jena, Germany), Johannes Lengler (ETH Zurich, Switzerland), and Jonathan Rowe (The University of Birmingham, UK), (2014-2016)
- PGMO project "Demand side management in smart grids", together with EDF, (2015-2017).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: H2020

Project acronym: SYNERGY

Project title: Synergy for Smart Multi-Objective Optimisation

Duration: 02 2016 - 01 2019

Coordinator: Jožef Stefan Institute (JSI), Ljubljana, Slovenia

Other partners: University of Lille (France), Cologne University of Applied Sciences (Germany)

Abstract: Many real-world application areas, such as advanced manufacturing, involve optimisation of several, often time-consuming and conflicting objectives. For example, they require the maximisation of the product quality while minimising the production cost, and rely on demanding numerical simulations in order to assess the objectives. These, so-called multi-objective optimisation problems can be solved more efficiently if parallelisation is used to execute the simulations simultaneously and if the simulations are partly replaced by accurate surrogate models.

9.3.2. Collaborations with Major European Organizations

University of Luxembourg: (Luxembourg)

Energy aware scheduling in Cloud computing systems

University of Oviedo: (Spain)

Optimization under uncertainty for fuzzy flow shop scheduling

University of Elche and University of Murcia: (Spain)

Matheuristics for DEA

9.4. International Initiatives

9.4.1. Inria International Labs

- LIRIMA Afrique: Equipe associér avec l'EMI (Ecole Mohammadia d'Ingénieurs), Morocco

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

9.4.2.1. MOHA

Title: Mixed Multi-objective Optimization using Hybrid Algorithms: Application to smart grids

International Partner (Institution - Laboratory - Researcher):

Ecole Mohammadia d'Ingénieurs (Morocco) - LERMA (Laboratoire d'Etudes et de Recherches en Mathématiques Appliquées) - Rachid Ellaia

Start year: 2016

See also: https://ocm.univ-lille1.fr/ talbi/momh

The key challenge of this project is to propose new optimization models and new hybrid algorithms to the demand side management of smart grids in a context of uncertainty and in the presence of several conflicting objectives.

Those complex optimization problems are also characterized by the presence of both continuous and discrete variables. We need to design new efficient optimization algorithms combining state of the art exact and metaheuristic algorithms from the global optimization and combinatorial optimization communities

9.4.2.2. s3-bbo

Title: Threefold Scalability in Any-objective Black-Box Optimization (s3-bbo)

International Partner (Institution - Laboratory - Researcher):

Shinshu University, Japan

Duration: 2015-2017

See also: http://francejapan.gforge.inria.fr/doku.php?id=associateteam

The main scientific goals of this collaboration is to theoretically derive, analyze, design, and develop scalable evolutionary and other stochastic local search algorithms for large-scale optimization considering three different axes of scalability: (i) decision space, (ii) objective space, and (iii) availability of distributed and parallel computing resources. This research will allow us to design, control, predict, analyze and optimize parameters of recent complex, large-scale, and computationally expensive systems, providing the basic support for problem solution and decision-making in a variety of real world applications. For single-objective continuous optimization, we want to theoretically derive variants of the state-of-the-art CMA-ES with linear time and space complexity scalings with respect to the number of variables. We will exploit the information geometry framework to derive updates using parametrization of the underlying family of probability distribution involving a linear number of components. The challenges are related to finding good representations that are theoretically tractable and meaningful. For the design of robust algorithms, implementing the derived updates, we plan to follow the same approach as for the design of CMA-ES. For multi- and many-objective optimization, we will start by characterizing and defining new metrics and methodologies to analyze scalability in the objective space and in terms of computational resources. The first challenge is to

accurately measure the impact of adding objectives on the search behavior and on the performance of evolutionary multi- and many- objective optimization (EMyO) algorithms. The second challenge is to investigate the new opportunities offered by large-scale computing platforms to design new effective algorithms for EMyO optimization. To this end, we plan to follow a feature-based performance analysis of EMyO algorithms, to design new algorithms using decomposition-based approaches, and to investigate their mapping to a practical parallel and distributed setting.

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

- Memorandum of Understanding between Shinshu University (Japan) and Inria, signed on March 2014

9.4.3.2. Informal International Partners

- University of Coimbra, Portugal
- University of Manchester, U.K.
- Collaboration with Université de Mons (UMONS). The collaboration consists mainly in the joint supervision of the Ph.D thesis of Jan Gmys started in 2014.

9.4.4. Participation in Other International Programs

- JSPS-MEXT project on Evolutionary multi-objective optimization, landscape analysis, and search performance, with Shinshu University, Japan (2013—2016)

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Hernan Aguirre, Shinshu University, Japan
- Fabio Daolio, University of Stirling, U.K.
- Luis Paquete, University of Coimbra, Portugal
- Kiyoshi Tanaka, Shinshu University, Japan
- Saúl Zapotecas-Martínez, Shinshu University, Japan
- Qingfu Zhang, City University, Hong Kong
- Dr. Myriam Delgado (Federal University of Technology of Paraná, Brazil), 1 week, April 2016
- Prof. Fred Glover (University of Colorado, USA), 1 month, Nov 2016
- Dr Lakhdar Loukil from Université d'Oran, Algeria (January 18-22, 2016).

9.5.1.1. Internships

- Oliver Cuate, CINVESTAV, Mexico
- Miyako Sagawa, Shinshu University, Japan

9.5.2. Visits to International Teams

9.5.2.1. Sabbatical programme

- E-G. Talbi has a one-year sabbatical program for 2016 and 2017.

9.5.2.2. Research Stays Abroad

- E-G. Talbi: University of Florida, USA, 1 month, 2016.
- E-G. Talbi: University of Colorado, USA, 1 month, 2016.

<p style="text-align:center">**ECUADOR Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. MAIDESC

Ecuador is coordinator of the ANR project MAIDESC, with Inria team Gamma3, University of Montpellier II, CEMEF-Ecole des Mines, Inria-Bordeaux, Lemma and Transvalor. MAIDESC concentrates on mesh adaptation and in particular meshes for interfaces, third-order accuracy, meshes for boundary layers, and curved meshes.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. AboutFlow

       Type: PEOPLE
       Instrument: Initial Training Network
       Duration: 2012-2016
       Coordinator: Jens-Dominik Mueller
       Partner: Queen Mary University of London (UK)
       Inria contact: Laurent Hascoët
       Abstract: The aim of AboutFlow is to develop robust gradient-based optimisation methods using adjoint sensitivities for numerical optimisation of flows. http://aboutflow.sems.qmul.ac.uk/

8.2.1.2. UMRIDA

       Type:AAT
       Instrument:Aeronautics and Air Transport
       Duration: 2013-2016
       Coordinator: Charles Hirsch
       Partner: Numeca S.A. (Belgium)
       Inria contact: Alain Dervieux
       Abstract: UMRIDA addresses major research challenges in Uncertainty Quantification and Robust Design: develop new methods that handle large numbers of simultaneous uncertainties and generalized geometrical uncertainties. Apply these methods to representative industrial configurations.

8.3. International Initiatives

8.3.1. Inria International Labs

Ecuador participates in the Joint Laboratory for Exascale Computing (JLESC) together with colleagues at Argonne National Laboratory. Laurent Hascoët attended the JLESC meeting in Lyon, France, june 27-29.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Krishna Narayanan from Argonne National Laboratory, june 29-july 1.

8.4.2. Internships

- Georgios Ntanakas from Rolls-Royce, Germany, january 18-30.
- Ala Taftaf to Rolls-Royce, Germany, may 6-27.

8.4.3. Visits to International Teams

- Laurent Hascoët visited Argonne National Laboratory, november 14-22.

GAMMA3 Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

F. Alauzet, N. Barral, V. Menier and A. Loseille are part of the MAIDESC ANR (2013-2015) on mesh adaptation for moving interfaces in CFD.

T. Grosges, D. Barchiesi, A. Cherouat, H. Borouchaki, L. Giraud-Moreau and A. Chaari sont membres de l'ANR NONOMOPRH (2011-2016) sur le développement et la mise au point d'une instrumentation optique pour déterminer la distribution en tailles et le coefficient de forme de nanofils (NF) ou de nanotubes (NT) en suspension dans un écoulement.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

- UMRIDA https://sites.google.com/a/numeca.be/umrida/

6.3. International Initiatives

6.3.1. Inria Associate Teams Not Involved in an Inria International Labs

6.3.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

Mississippi State University (United States) - Center for Advanced Vehicular Systems - Computational Fluid Dynamics Dept. (CAVS-CFD) - Marcum David

Start year: 2014

See also: https://www.rocq.inria.fr/gamma/gamma/Membres/CIPD/Frederic.Alauzet/ AssociateTeam_AM2NS/AT_am2ns.html

Numerical simulation is now mature and has become an integral part of design in science and engineering applications. Meshing, i.e., discretizing the computational domain, is at the core of the computational pipeline and a key element to significant improvements. The AM2NS Associate Team focus on developing the next generation of automated meshing methods to improve their robustness and the mesh quality to solve the ever increasing complexity of numerical simulations. Four major meshing issues are targeted: (i) more robustness for mesh generation methods in recovering a given data set, (ii) higher quality for anisotropic adapted meshes via constraint alignment, (iii) higher quality for boundary layer meshes near geometry singularities, and (iv) more robustness in handling complex displacement for moving mesh methods. The impact of this collaborative research will be to provide more reliable solution output predictions in an automated manner by using these new meshing methods.

GECO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project *Stabilité des systèmes à excitation persistante*, Program MathIng, Labex LMH, 2013-2016. This project is about different stability properties for systems whose damping is intermittently activated. The coordinator is Mario Sigalotti. The other members are Yacine Chitour and Guilherme Mazanti.
- iCODE is the Institute for Control and Decision of the Idex Paris Saclay. It was launched in March 2014 for two years until June 2016. We have been involved in three actions funded by iCODE:
    - one action on control of quantum systems, in collaboration with Nicoals Boulant of Neurospin. The action was coordinated by Ugo Boscain;
    - one action on control of wave propagation on networks. The action was coordinated by Mario Sigalotti;
    - one action on switched system. The action was coordinated by Marianne Akian (and handled by MAXPLUS).

  Starting from November 2016, iCODE has been renewed for three years as a IRS (*Institut de Recherche Strategique*) by the Idex Paris Saclay. The funded actions have still not been identified.
- Starting from the end of 2015, we obtained a grant by PGMO (Gaspard Monge Program for Optimisation and operational research) on Geometric Optimal Control. The grant duration is one year, has been renewed in 2016 and is still renewable for a third year. The grant is coordinated by Mario Sigalotti (up to August, it was co-coordinated by Luca Rizzi as well).

8.2. National Initiatives

8.2.1. ANR

The ANR SRGI starts at the end of 2015, for a duration of four years. GECO is one of one of the partners of the ANR. The national coordinator is Emmanuel Trélat (UPMC) and the local one Ugo Boscain.

SRGI deals with sub-Riemannian geometry, hypoelliptic diffusion and geometric control.

8.2.2. Other initiatives

Ugo Boscain and Mario Sigalotti are members of the project DISQUO of the program Inphyniti of the CNRS (duration: one year renewable). Coordinator: Thomas Chambrion (Nancy).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Program: ERC Starting Grant

Project acronym: GeCoMethods

Project title: Geometric Control Methods for the Heat and Schroedinger Equations

Duration: Initially accepted from 1/5/2010 to 1/5/2015, the project has been extended for one additional year, up to 1/5/2016.

Coordinator: Ugo Boscain

Abstract: The aim of this project is to study certain PDEs for which geometric control techniques open new horizons. More precisely we plan to exploit the relation between the sub-Riemannian distance and the properties of the kernel of the corresponding hypoelliptic heat equation and to study controllability properties of the Schroedinger equation.

All subjects studied in this project are applications-driven: the problem of controllability of the Schroedinger equation has direct applications in Laser spectroscopy and in Nuclear Magnetic Resonance; the problem of nonisotropic diffusion has applications in cognitive neuroscience (in particular for models of human vision).

Participants. Main collaborator: Mario Sigalotti. Other members of the team: Andrei Agrachev, Riccardo Adami, Thomas Chambrion, Grégoire Charlot, Yacine Chitour, Jean-Paul Gauthier, Frédéric Jean.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

SISSA (Scuola Internazionale Superiore di Studi Avanzati), Trieste, Italy.

Sector of Functional Analysis and Applications, Geometric Control group. Coordinator: Andrei A. Agrachev.

We collaborate with the Geometric Control group at SISSA mainly on subjects related with sub-Riemannian geometry. Thanks partly to our collaboration, SISSA has established an official research partnership with École Polytechnique.

8.4.2. Participation in Other International Programs

- Laboratoire Euro Maghrébin de Mathématiques et de leurs Interactions (LEM2I)
  http://lem2i.math.cnrs.fr/
- GDRE Control of Partial Differential Equations (CONEDP)
  http://www.ceremade.dauphine.fr/~glass/GDRE/

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Andrei Agrachev (SISSA, Italy) is visiting the GECO team for one year, starting in September 2016.

GEOSTAT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

GEOSTAT is working with the following regional partners:

- GEOSTAT has a decade-long close scientific collaboration with team SYSCO2 (LEGOS LAboratory UMR 5566): V. Garçon, B. Dewitte, J. Sudre.
- Laboratoire d'Astrophysique de Bordeaux (S. Bontemps, N. Schneider).
- Flood monitoring in Equator : Luc Bourrel (GET Toulouse / IRD) and Frédéric Frappart (GET / UMR EPOC). Co-supervision of Christophe Fatras (post-doc).
- With Bruno Castelle (EPOC).
- With LOMA (Laboratoire Ondes & Matière d'Aquitaine): A. Arneodo & F. Argoul.
- With Dominique Gibert (OSUR) on signal and image processing.
- CHU Bordeaux : Prof. Wassilios Meissner (IMN), Dr. Solange Milhé de Saint Victor (service ORL).
- CHU Toulouse : Dr. Anne Pavy Le traon (service Neurologie), Prof. Virginie Woisard (service ORL)
- IRIT : Prof. Régine André-Obrecht, Dr. Julie Mauclair
- IMT (Institut de Mathématique de Toulouse) : Dr. Sébastien Déjean, Dr. Laurent Risser.
- Mercator Océan: Dr. Abdelali El Moussaoui.

8.2. National Initiatives

- ANR project *Voice4PD-MSA*, led by K. Daoudi, which targets the differential diagnosis between Parkinson's disease and Multiple System Atrophy, has been accepted. The total amount of the grant is 468555 euros, from which GeoStat has 203078 euros. The duration of the project is 42 months. Partners: CHU Bordeaux (Bordeaux), CHU Toulouse, IRIT, IMT (Toulouse).
- ICARODE [2013-2016]. Participants : Hussein Yahia, Oriol Pont, Véronique Garçon, Joel Sudre, Antonio Turiel, Christine Provost [LOCEAN]. 4-year contract, CNES-NASA funding, started 2013. Title: *ICARODE: Integration and cascading for high resolution ocean dynamics*. Project leader: H. Yahia.
- PhD grant for C. Artnana from UPMC University, under co-supervision with H. Yahia and C. Provost (LOCEAN, Paris).
- PhD grant for G. Singh from IIT Roorkee, under co-supervision with D. Singh (IIT Roorkee).
- PhD grant for A. El Aouni from PHC Toubkal and Morrocan governement, under co-supervision with K. Minaoui and D. Aboutajdine (LRIT).

8.3. International Initiatives

8.3.1. *OPTIC*

Title: Optimal inference in Complex and Turbulent data

International Partner (Institution - Laboratory - Researcher):

IITR (India) - Dept. Of Electrical Engineering - Dharmendra Singh

Start year: 2014

See also: https://optic.bordeaux.inria.fr/

The OptIC associated team targets the extension and development of a strong collaboration between Inria GEOSTAT team and INDIAN INSTITUTE OF TECHNOLOGY ROORKEE Dept of Electronics and Computer Engineering (Prof. D. Singh's group) on non-linear Signal Processing for Universe Sciences, with a strong emphasis on data fusion in Earth Observation and monitoring. Non-linear Physics puts strong evidence of the fundamental role played by multiscale hierarchies in complex and turbulent data: in these data, the information content is statistically localized in geometrical arrangements in the signal's domain, while such geometrical organization is not attainable by classical methods in linear signal processing. This is one of the major drawbacks in the classical analysis of complex and turbulent signals. The goal of this associated team is to show that inference of physical variables along the scales of complex and turbulent signals can be performed through optimal multiresolution analysis performed on non-linear features and data extracted from the signals, resulting in novel and powerful approaches for data fusion between different acquisitions (in temporal/spatial/spectral resolutions). This program needs both strong expertise in the physical processes beyond the acquisitions and the application of non-linear physics ideas on the behavior of the acquired physical phenomena. The proposal will focus on specific applications in Earth Observation and monitoring for which the Indian partner has developed a very strong expertise, notably in its knowledge and use of the physical processes in remote sensing acquisitions. This partnership is an extremely interesting and high potential collaboration between two teams which focus separately either on the acquisition of the physical processes or their analysis by Complex Systems and non-linear physics methodologies. The recent results obtained in super-resolution by GEOSTAT promises strong applications to a much wider range of Universe Sciences problems, notably with a strong emphasis on data fusion between the physical variables acquired on related but different acquisitions. OptiC builds on a collaboration between Inria and IIT ROORKEE teams, added with partners in Universe Sciences and earth observation (ONERA, CNRS) already involved in research actions with GEOSTAT.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

- Laboratory LRIT from Rabat University (K. Minaoui, D. Aboutajdine).
- Czech Technical University in Prague (Jan Rusz).
- Brno University of Technology (Jiri Mekyska).
- University of Heidelberg (C. Garbe).

8.3.3. Participation in Other International Programs

8.3.3.1. Indo-French Center of Applied Mathematics

OPTIC

Title: Optimal Inference in complex and turbulent data

International Partner (Institution - Laboratory - Researcher):

Institutions: Inria and IIT Roorkee

Duration: 2013 - 2016

Start year: 2013

See above.

8.3.3.2. PHC-Toubkal

PHC-Toubkal

Title: Caractérisation multi-capteurs et suivi spatio-temporel de l'Upwelling sur la côte atlantique marocaine par imagerie satellitaire

International Partner (Institution - Laboratory - Researcher):

- GEOSTAT.

- CRTS (Centre Royal de Télédetection Spatiale), Rabat.
- Faculté des sciences de Rabat.
- Mercator-Océan.

Duration: from January 1st 2016 to 31 December 2018.

Start year: 2016.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Prof. D. Singh (IIT roorkee, OPTIC Associated Team). Duration: 1 month.
- G. Singh (phd student in co-supervision, IIT roorkee, OPTIC Associated Team).
- A. El Aouni (PhD student in co-supervision, PHC Toubkal).
- Dr. Nicola Schneider (Koln University): nonlinear signal processing for astronomical data.

<div align="center">

I4S Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MONEOL - project with CEAtech Pays de Loire

Participants: Ivan Guéguen, Guillaume Gautier, Laurent Mevel.

Type: CEAtech PDL

Objectif: Modal analysis of wind turbines using new sensors

Duration: 11/2015 to 11/2017.

Coordinator: Louis Marie Cotineau (IFSTTAR)

Inria contact: Guillaume Gautier

Abstract: The MONEOL project aims to demonstrate the feasibility of using Morphosense as a vibration monitoring system for wind turbines. It is proposed to set up a demonstrator consisting of a monitoring system placed in the mast of the wind turbine, a vibration analysis system and a visualization of the vibratory state at the CEA-Tech premises, located on the Technocampus Ocean of Nantes allowing to visualize in real time (quasi) the modal deformations of the mast of the wind turbine. This system consists of the following elements:

The demonstrator consists of the monitoring system placed in the wind turbine of a video screen displaying in real time indicators to evaluate the state of health of the structure:

- Modal parameters (eigen frequencies, modal damping, modal deformations) over time and associated uncertainties.
- Indicators of detection and localization of damage.

The demonstrator will also be able to display a video of the wind turbine in operation. In order to validate the Morphosense sensor, a reference system is added to it, consisting of conventional accelerometer sensors.

9.1.2. Interactive Communication (InterCom): Massive random access to subsets of compressed correlated data

Participants: Jean Dumoulin, Antoine Crinière.

Type: Labex COMINLABS

Objectif: Massive random access to large-scale sensor network (Smart Cities)

Duration: Since November 2016 to Nov. 2019.

Coordinator :Aline Roumy, Thomas Maugey (Sirocco), Jean Dumoulin (I4S)

Partners: Elsa Dupraz (Lab-STICC), Aline Roumy (IRISA, Sirocco team), Michel Kieffer (L2S), Thomas Maugey(IRISA, Sirocco team), CentraleSupelec, Univ. Paris Sud.

Inria contact: Jean Dumoulin

Abstract: This project aims to develop novel compression techniques allowing massive random access to large databases. Indeed, we consider a database that is so large that, to be stored on a single server, the data have to be compressed efficiently, meaning that the redundancy/correlation between the data have to be exploited. The dataset is then stored on a server and made available to users that may want to access only a subset of the data. Such a request for a subset of the data is indeed random, since the choice of the subset is user-dependent. Finally, massive requests are made, meaning that, upon request, the server can only perform low complexity operations (such as bit extraction but no decompression/compression).

Algorithms for two emerging applications of this problem will be developed: Free-viewpoint Television (FTV) and massive requests to a database collecting data from a large-scale sensor network (such as Smart Cities) in which I4S is involved.

9.1.3. MAG2C-Pont Tabarly

Participants: Ivan Guéguen, Jean Dumoulin.

Type: GIS

Objectif: bridge instrumentation

Duration: Since 2014

Coordinator: LIRGEC

Partners: IFSTTAR, CSTB, Nantes Métropole, Université de Nantes

Inria contact: Ivan Guéguen

Abstract: The project deals with the instrumentation of the Tabarly Bridge.

Based on accelerometer measurements, the vibration behaviour will be monitored and structural defects detected. Coupled with a wireless data transmission system type or wifi 3g, remote monitoring is envisaged. The different objectives are

- Experimentation on a bridge
- Equipment qualification in real conditions over long term
- Apply different vibration processing algorithms
- Monitoring and detection
- Measurement database

An accelerometer-based distributed network on the structure is installed and connected to a data acquisition system and a modem 3g for continuous remote measurements, which will be available on the internet.

9.1.4. MAG2C-MOSIWIND (MOnitoring of Structural Integrity of an onshore WIND turbine's slab foundation and tower)

Participants: Xavier Chapeleau, Ivan Guéguen.

Type: GIS

Objectif: MOnitoring of Structural Integrity of an onshore WIND turbine's slab foundation and tower

Duration: Since 2015

Coordinator : LIRGEC

Partners: IFSTTAR, CSTB, Nantes Métropole, Université de Nantes, ECN, Valorem, Valréa and Valémo

Inria contact: Xavier Chapeleau

Abstract: The project deals with the instrumentation of an onshore WIND turbine's slab foundation and tower. The aim is to experiment sensors and methods for structural integrity monitoring of an onshore wind turbine under real conditions and to qualify them over long term. Before casting, the concrete slab foundation (20m in diameter, 3.85m high, 450m3 of concrete, 48T of reinforcement) was first instrumented with continuous optical fibers, optical strain gauges, temperature sensors and accelerometers. Afterwards, accelerometers were placed in the mast. Data obtained by these different sensors will help, on the one hand, to monitor changes in the dynamic behavior of the structure in order to verify that they remain within the limits fixed during the design and, on the other hand, to detect any damage that could be critical for the safety of the structure. For this, SSI methods under ambient vibration will be applied.

9.1.5. Collaboration with GEM

Participants: Laurent Mevel, Michael Doehler, Md Delwar Hossain Bhuyan.

Md Delwar Hossain Bhuyan has started a PhD on Damage localisation on offshore platforms, The thesis is co-directed by L. Mevel and F. Schoefs from GEM, Nantes, with supervision shared with M. Doehler and Y. Lecieux from GEM. It is funded by the Brittany region for 3 years.

9.2. National Initiatives

9.2.1. High speed rail track instrumentation

Participant: Ivan Guéguen.

Type: IRT

Objective: rail track SHM

Duration: 11/2014 to 11/2018

Coordinator: RAILENIUM

Partners: IFSTTAR, EIFFAGE, RFF, LGCgE

Inria contact: Ivan Guéguen

Abstract: This project aims at instrumenting multiple sections of a high-speed route (classical section with granular layer, transition zone). The proposed instrumentation concerns all the different layers of the structure, and is designed to allow monitoring of the overall track behavior.

The instrumentation will include:

- A weather station for environmental conditions (temperature, precipitation on the site).
- Accelerometers, to monitor the dynamic behavior of the track, with measurements at several levels: the hammer beams on top of the grave-bitumen layer, on top of the soil.
- Instrumentation of severe bitumen strain gauges for measuring the longitudinal and transverse tensile strains, and temperature probes (top and bottom layer). This instrumentation will estimate the fatigue life of the GB, temperature changes in this layer, and will calculate a temperature equivalent to the layer of GB.
- Instrumentation subgrade by means of measurement gauges at the top of the vertical deformation of the soil, and TDR probes to measure changes in water content. Its objective is to measure the levels of distortion in the upper part of the soil, and their variations, in conjunction with the seasonal variations in water content.
- An anchored sensor, measuring the total deflection between the top of the GB and a reference point that is 4 m deep. This sensor will measure the total displacement of the structure beneath the ballast (GB + layer of granular soil leveling + support). These will also serve as a reference for comparison with the movements deducted from accelerometer measurements.
- Continuous optical fiber, to measure static permanent deformation in the transverse direction over the entire width of the structure at the base of the sub-layer.

9.2.2. ANR Resbati

Participant: Jean Dumoulin.

Type: ANR

Objectif: In-situ measurements of thermal wall resistance

Duration: 10/2016 to 10/2019

Coordinator: Laurent ibos

Partners : IFSTTAR, CERTES, CEREMA, CSTB, LNE, THEMACS, AFNOR

Inria contact: Jean Dumoulin

Abstract: Thermal insulation of opaque walls remains an essential point for improving the energy efficiency in buildings. Indeed, the number of badly insulated buildings in France is still very important. In addition, current thermal regulations set high requirements in terms of thermal insulation and will continue to be more rigorous as new building will be energy-positive with the French RT2020. However, there is no systematic method for measuring the thermal insulation level of the building walls. Their thermal performance must be controlled for renovation of the building, during its construction, for its delivery or during use. The need of a method of in-situ control of walls is more relevant than ever. Such a measurement at the wall level is an interesting complement to global methods (co-heating, etc.) that concern the whole building energy balance. The physical parameter representing the quality of the wall thermal insulation is its thermal resistance. Currently, methods for measuring this parameter exist, either in the form of laboratory or exploratory methods, or in the form of international standards or draft standards. However, each of these methods does not meet all the conditions guaranteeing a general measurement: use on any type of wall and at any time of the year, low measurement duration, ease of use, moderate cost. The RESBATI project (in-situ measurement of the thermal resistance of building walls) aims at developing an in-situ measurement device that respects these specifications. The measuring means is infrared thermography in active approach. The uncertainty and the limitations of the measurement will be identified during the project. Infrared thermography in passive mode has demonstrated for many years its ability to reveal the presence of insulation defects in buildings. However, it is essentially a qualitative tool. The active approach of infrared thermography is not very used for building investigation and is a promising way for obtaining quantitative information such as the thermal resistance of the wall to investigate. Indeed research results have already shown that this approach could be used to obtain quantitative estimations of the thermal resistance of opaque building walls. The RESBATI project will demonstrate the potential of the active approach so that control can be performed in any season, for any type of building and any use (occupied or not) and quickly. The passive approach might nevertheless be used as a complement because it does not require the use of additional equipment ensuring the thermal load of the wall to diagnose and provides access to larger wall surfaces to analyze. The consortium brings complementary partners together working at different levels of the building: research laboratories, technical center, national metrology laboratory, company and standards organization. The advanced knowledge and past achievements of the various partners on the subject make it possible to develop such a method with measurement uncertainty and the associated prototypes. Many facilities will be available for qualification of prototypes: climate rooms for laboratory testing, existing buildings for in-situ qualifications. Thus, a wide variety of walls (structure and isolation level) can be tested. Moreover, these buildings have different uses (residential or service buildings). In conclusion of the project, measurements will be carried out by future end-users of the device.

9.2.3. *Equipex Sense-City*

Participants: Jean Dumoulin, Laurent Mevel, Antoine Crinière.

Through the ADT Cloud2SM, participation of I4S in SenseCity was possible. IFSTTAR's SensorBox developed by Jean Dumoulin was installed and presented at SEnseCity Kick off and is installed on-site. Cloud2IR and Cloud2SM software have been deployed within the ADT of A. Crinière. (http://sense-city.ifsttar.fr/)

9.3. European Initiatives

9.3.1. *FP7 & H2020 Projects*

9.3.1.1. *Built to Specifications (Built2Spec)*
Participants: Jean Dumoulin, Alexandre Nassiopoulos, Jordan Brouns.

Type: Horizon 2020

Defi: Model Driven Physical Systems Operation

Objectif: Reduce the gap between a building?s designed and as-built energy performance.

Duration: January 2015 to January 2019

Coordinator: Manager and project head : NOBATEK, Germain Adell. For CERMA : Marjorie Musy

Inria teams I4S

Inria contact: J. Dumoulin

Partners: Consortium of 20 Public and Industrial actors

Website: http://built2spec-project.eu/

Abstract: Built to Specifications (Built2Spec) is a Horizon 2020 EU-funded project involving 20 European partners that seeks to reduce the gap between a building?s designed and as-built energy performance. To do this, the project will put a new set of breakthrough technological advances for self-inspection checks and quality assurance measures into the hands of construction professionals. This collection of smart tools will help building stakeholders at all levels in meeting EU energy efficiency targets, new build standards and related policy goals.

Built2Spec will deliver a new set of tools:

- 3D and Imagery Tools
- Building Information Modelling (BIM)
- Smart Building Components
- Energy Efficiency Quality Checks
- Indoor Air Quality Tools
- Airtightness Test Tools with Air-pulse Checks
- Thermal Imaging Tools
- Acoustic Tools

All connected to a Virtual Construction Management Platform supporting the collection and sharing of all project data, from initial design to the delivery. During the project, this platform will be integrated into the operations of small and medium-sized enterprise (SME) contractors, large construction firms and end user clients directly within the consortium and work program activities, assuring systematic and scientific performance measures, feedback and powerful exploitation.

9.3.1.2. INFRASTAR (Innovation and Networking for Fatigue and Reliability Analysis of Structures – Training for Assessment of Risk)

Participant: Xavier Chapeleau.

Call: H2020-MSCA-ITN-2015 (Horizon 2020 – Marie-Sklodowska Curie Actions – Innovative Training Networks)

Type of Action: MSCA-ITN-ETN

Objectif: Reduce the gap between a building?s designed and as-built energy performance.

Duration: 48 months since 2016 May 1st

Coordinator: Odile Abraham (IFSTTAR)

Academic and industrial Partners: IFSTTAR, UNIVERSITY OF AALBORG, BAM, EPFL, GuD Consult Gmbh, COWI A/S, NeoStrain, PHIMECA

Inria contact: X. Chapeleau

Website: http://infrastar.eu/

Abstract: The aim of INFRASTAR project is to develop tools combining modeling and measurements for the prediction of the fatigue behavior of concrete structures (bridges and foundations of wind turbines) with the ultimate objective of establishing an efficient strategy for inspection and reinforcement operations. In the second half of 2016, 12 young researchers were recruited to carry out and cross-examine research on monitoring and auscultation (WP 1), structural models (WP 2) and reliability of approaches for decision-making (WP 3). In this project, a phd student (Antoine Bassil) was recruited (Nov. 2016) on the fatigue monitoring of concrete structure by fibre-optic sensors.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. European Research Network on System Identification (ERNSI)
Participants: Qinghua Zhang, Michael Doehler, Laurent Mevel.

The I4S project-team is involved in the activities of the European Research Network on System Identification (ERNSI) federating major European research teams on system identification. Modeling of dynamical systems is fundamental in almost all disciplines of science and engineering, ranging from life science to process control. System identification concerns the construction, estimation and validation of mathematical models of dynamical physical or engineering phenomena from experimental data.

9.3.2.2. COST Action TU 1402
Participants: Michael Doehler, Laurent Mevel.

L. Mevel is member of the management committee of the COST Action.

M. Doehler is co-leader of working group 2 "SHM strategies and structural performance" and member of the steering committee.

   Type: COST

   Objectif: Quantifying the value of structural health monitoring

   Duration: 11/2014 - 11/2018

   Coordinator: S. Thoens (DTU Denmark)

   Partner: 23 countries, see http://www.cost.eu/COST_Actions/tud/Actions/TU1402

   Inria contact: Laurent Mevel

   Abstract: This COST Action enhances the benefit of Structural Health Monitoring (SHM) by novel utilization of applied decision analysis on how to assess the value of SHM - even before it is implemented. This improves decision basis for design, operation and life-cycle integrity management of structures and facilitates more cost efficient, reliable and safe strategies for maintaining and developing the built environment to the benefit of society. SHM is increasingly applied for collecting information on loads and aggressive environments acting on structures, structural performances, deterioration processes and changes in the use of structures. However, there is an urgent need to establish a better understanding of the value of SHM before its implementation, together with practically applicable methods and tools for its quantification. This Action thus aims to develop and describe a theoretical framework, together with methods, tools, guidelines, examples and educational activities, for the quantification of the value of SHM. The COST Action will be conducted with the support of the Joint Committee on Structural Safety (JCSS). The networks of researchers and industries established during COST Actions TU0601, C26, E55 and E24, the EU FP7 project IRIS, the Marie Curie Network SmartEn and the JCSS will ensure visibility, impact and dissemination.

9.3.3. Other European Programs

9.3.3.1. Innobooster
Participants: Michael Doehler, Laurent Mevel.

Together with SVS, we got the Danish Innobooster innovation grant "Robust Operational Modal Analysis using Modal Uncertainty Quantification" 2015-2016, for industrial research and transfer. The result of the development in this project is the transfer of our uncertainty quantification algorithm [19] to SVS' ARTeMIS software http://www.svibs.com/newsletter/newsletter_2016_09.aspx.

9.4. International Initiatives

9.4.1. Informal International Partners

9.4.1.1. Collaboration with CNR, Italy
Participants: Jean Dumoulin, Nicolas Le Touz.

Non destructive testing on outdoor structures by coupling infrared thermography with ground penetrating radar is one of the topic addressed in this collaboration. A new one about TerHertz is starting.

9.4.1.2. Collaboration with British Columbia University, Canada
Participants: Laurent Mevel, Michael Doehler, Saeid Allahdadian.

Saeid Allahdadian is currently PhD student of professor Carlos Ventura in Vancouver. Following our recent papers, Michael Doehler has been invited to co-supervise the PhD of Saeid Allahdadian starting in 2015 for 3 years.

9.4.1.3. Collaboration with BAM, Germany
Participants: Laurent Mevel, Michael Doehler, Eva Viefhues.

Eva Viefhues is currently PhD student of Laurent Mevel and Michel Doehler in Berlin, financed by BAM. M. Doehler is also associate researcher of the BAM institut since 2016.

9.4.1.4. Collaboration with Politecnico di Milano, Italy
Participants: Michael Doehler, Dominique Siegert, Ivan Guéguen, Xavier Chapeleau.

During COST Action TU 1402 and M.P. Limongelli's research stay at IFSTTAR, collaboration with Politecnico di Milano has started, resulting in several joint publications in 2016 [35], [18], [21]. A joint Master student project is in progress, and a french-italian PhD project is planned.

9.4.2. Participation in Other International Programs

The team has been awarded a MITACS grant. It allowed us to host S. Allahdadian for 3 months in 2016.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

S. Allahdadian from British Columbia University has visited us for 3 months in 2016 thanks to a MITACS grant.

<p style="text-align:center;color:red;">INOCS Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

The ELSAT research program addresses the issues involved in sustainable transportation and mobility. Within ELSAT, INOCS is involved on two projects devoted to hybrid optimization methods in logistics and to city logistics in collaboration with LAMIH (University of Valenciennes), LGI2A (University of Artois) and LEOST (IFSTTAR). ELSAT is supported by the CPER 2015-2020 (State-Region Contract).

8.2. National Initiatives

8.2.1. ANR

ANR project PI-Commodality "Co-modal freight transportation chains: an approach based on physical internet" in collaboration with CGS-ARMINES (Paris), LAAS (Toulouse), DHL (2016 - 2018). The PI-co-modality project aims to design new sustainable logistic services between preset origins and destinations. It is based on innovative approaches both in terms of: 1) Logistics and transportation services : by considering the PI-internet approach, specifically: mesh logistics and transportation networks based on available capacities, by designing consistent integrated co-modal chains; 2)Methodology : by addressing the underlying problems according to two approaches: centralized and decentralized, by proposing news realistic models relevant for practitioner taking into account the consistency, by developing state-of-the-art decision making algorithms.

8.2.2. National Initiatives (Belgium)

Combinatorial Optimization: Meta-heuristics and Exact Methods (2012-2017, coordinator: Bernard Fortz (GOM-ULB/INOCS-Inria). Inter-university Attraction Pole funded by the Belgian Federal Science Policy Office. Study and modeling of combinatorial optimization problems; Advancements in algorithmic techniques; Implementation of solution methods for large-scale, practically relevant problems.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: TD1207

Project title: Mathematical Optimization in the Decision Support Systems for Efficient and Robust Energy Networks

Duration: 04/2014 - 04/2017

Coordinator: Thorsten Koch (ZIB, Germany)

INOCS partners: Bernard Fortz, Martine Labbé

Abstract: Energy Production and Distribution (EP&D) is among the biggest challenges of our time, since energy is a scarce resource whose efficient production and fair distribution is associated with many technical, economical, political and ethical issues like environmental protection and people health. EP&D networks have rapidly increased their size and complexity, e.g. with the introduction and interconnection of markets within the EU. Thus, there is an increasing need of systems supporting the operational, regulatory and design decisions through a highly inter-disciplinary approach, where experts of all the concerned fields contribute to the definition of appropriate mathematical models. This is particularly challenging because these models require the simultaneous use of many different mathematical optimization tools and the verification by experts of the underlying engineering and financial issues. The COST framework is instrumental for this Action to be able to coordinate the inter-disciplinary efforts of scientists and industrial players at the European level.

Program: JPI Urban Europe

Project acronym: e4-share

Project title: Models for Ecological, Economical, Efficient, Electric Car-Sharing

Duration: 10/2014 - 09/2017

Coordinator: Markus Leitner (University of Vienna, Austria)

Other partners:

- Austrian Institute of Technology, Austria
- Université Libre de Bruxelles (INOCS), Belgium
- University of Bologna, Italy
- tbw research GesmbH, Austria

Abstract: Car-sharing systems and the usage of electric cars become increasingly popular among urban citizens. Thus, providing vast opportunities to meet today's challenges in terms of environmental objectives, sustainability and living quality. Our society needs to manage a transformation process that ultimately shall lead to fewer emissions and less energy consumption while increasing the quality of public space available. In e4-share, the team will lay the foundations for efficient and economically viable electric car-sharing systems by studying and solving the optimization problems arising in their design and operations. A main goal is to derive generic methods and strategies for optimized planning and operating in particular for flexible variants which best meet preferences of customers but impose nontrivial challenges to operators. This project will develop novel, exact and heuristic, numerical methods for finding suitable solutions to the optimization problems arising at the various planning levels as well as new, innovative approaches considering these levels simultaneously.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- Department of Statistics and Operations Research, University of Vienna, Austria.
- Centre for Quantitative Methods and Operations Management, HEC-Liège, Belgique.
- Interuniversity Centre on Entreprise Networks, Transportation and Logistics, Montreal, Canada.
- Instituto Sistemas Complejos de Ingeniería (ISCI), Santiago, Chile.
- The Centre for Business Analytics, University College Dublin, Ireland.
- Department of Electrical, Electronic, and Information Engineering, University of Bologna, Italy.
- Department of Mathematics, University of Aveiro, Portugal.
- Department of Statistics and Operations Research, University of Lisbon, Portugal.
- Instituto de Matemáticas, University of Seville.
- Dipartimento di Matematica, Universita degli studi di Padova.

8.4.2. Participation in Other International Programs

- STIC Algérie, University of Oran, Algeria.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Yasemin Arda Da Silveira, HEC-École de gestion de l'Université de Liège, Visiting Scientist from Oct 2016 until Nov 2016
- Bernard Gendron, Université de Montréal, Visiting Scientist from Oct 2016 to Dec 2016
- Juan Alejandro Gomez Herrera, Ecole Polytechnique de Montréal, Visiting Scientist Oct 2016
- Daniele Vigo, Université de Bologne, Visiting Scientist, Dec 2016.

<div align="center">

IPSO Project-Team

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5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. *ANR MOONRISE: 2015-2019*

Participants: François Castella, Philippe Chartier, Nicolas Crouseilles, Mohammed Lemou, Florian Méhats.

The project *Moonrise* submitted by Florian Méhats has been funded by the ANR for 4 years, for the period 2015-2019. This project aims at exploring modeling, mathematical and numerical issues originating from the presence of high-oscillations in nonlinear PDEs from the physics of nanotechnologies (quantum transport) and from the physics of plasmas (magnetized transport in tokamaks). The partners of the project are the IRMAR (Rennes), the IMT (Toulouse) and the CEA Cadarache. In the IPSO team, François Castella, Philippe Chartier, Nicolas Crouseilles and Mohammed Lemou are members of the project Moonrise.

Postdocs

- Loïc Le Treust has been hired as a Postdoc, under the supervision of Philippe Chartier and Florian Méhats. His contract started in september 2015 and ended in august 2016. Loïc Le Treust is now assistant professor at the university of Marseille.
- Xiaofei Zhao has been hired as a Postdoc from september 2015 to september 2016 under the supervision of Florian Méhats.

5.1.2. *ANR MFG: 2016-2020*

Participant: Arnaud Debussche.

Mean Field Games (MFG) theory is a new and challenging mathematical topic which analyzes the dynamics of a very large number of interacting rational agents. Introduced ten years ago, the MFG models have been used in many areas such as, e.g., economics (heterogeneous agent models, growth modeling,...), finance (formation of volatility, models of bank runs,...), social sciences (crowd models, models of segregation) and engineering (data networks, energy systems...). Their importance comes from the fact that they are the simplest ("stochastic control"-type) models taking into account interactions between rational agents (thus getting beyond optimization), yet without entering into the issues of strategic interactions. MFG theory lies at the intersection of mean field theories (it studies systems with a very large number of agents), game theory, optimal control and stochastic analysis (the agents optimize a payoff in a possibly noisy setting), calculus of variations (MFG equilibria may arise as minima of suitable functionals) and partial differential equations (PDE): In the simplest cases, the value of each agent is found by solving a backward Hamilton-Jacobi equation whereas the distribution of the agents' states evolves according to a forward Fokker-Planck equation. The "Master" equation (stated in the space of probability measures) subsumes the individual and collective behaviors. Finally, modeling, numerical analysis and scientific computing are crucial for the applications. French mathematicians play a world-leading role in the research on MFG: The terminology itself comes from a series of pioneering works by J.-M. Lasry and P.-L. Lions who introduced most of the key ideas for the mathematical analysis of MFG; the last conference on MFG was held last June in Paris and organized by Y. Achdou, P. Cardaliaguet and J.-M. Lasry. As testifies the proposal, the number of researchers working on MFG in France (and also abroad) is extremely fast-growing, not only because the theoretical aspects are exciting and challenging, but also because MFG models find more and more applications. The aim of the project is to better coordinate the French mathematical research on MFG and to achieve significant progress in the theory and its applications.

The partners of the project are the CEREMADE laboratory (Paris Dauphine), the IRMAR laboratory (Rennes I), the university of Nice and of Tours.

5.1.3. IPL (FRATRES)

IPSO is associated to IPL FRATRES which started in june 2015. The aim of this project is to organize Inria teams activities which develop mathematical and numerical tools in magnetically confined nuclear fusion. The ambition is to prepare the next generation of numerical modeling methodologies able to use in an optimal way the processing capabilities of modern massively parallel architectures. This objective requires close collaboration between a) applied mathematicians and physicists that develop and study mathematical models of PDE; b) numerical analysts developing approximation schemes; c) specialists of algorithmics proposing solvers and libraries using the many levels of parallelism offered by the modern architecture and d) computer scientists. The project road map ambitions to contribute in close connection with National and European initiatives devoted to nuclear Fusion to the improvement and design of numerical simulation technologies applied to plasma physics and in particular to the ITER project for magnetic confinement fusion.

Postdoc

- Xiaofei Zhao has been hired as a Postdoc, under the supervision of Nicolas Crouseilles and Sever Hirstoaga (Inria-Nancy). His contract started in october 2015 and will end in august 2016.

5.2. European Initiatives

5.2.1. FP7 & H2020 Projects

Project acronym: GEOPARDI

Program: FP7

Project title: Numerical integration of Geometric Partial Differential Equations

Duration: September 2011 - August 2016

Coordinator: Erwan Faou, Inria

Abstract: The goal of this project is to develop new numerical methods for the approximation of evolution equations possessing strong geometric properties such as Hamiltonian systems or stochastic differential equations. In such situations the exact solutions endow with many physical properties that are consequences of the geometric structure: Preservation of the total energy, momentum conservation or existence of ergodic invariant measures. However the preservation of such qualitative properties of the original system by numerical methods at a reasonable cost is not guaranteed at all, even for very precise (high order) methods. The principal aim of geometric numerical integration is the understanding and analysis of such problems: How (and to which extend) reproduce qualitative behavior of differential equations over long time? The extension of this theory to partial differential equations is a fundamental ongoing challenge, which require the invention of a new mathematical framework bridging the most recent techniques used in the theory of nonlinear PDEs and stochastic ordinary and partial differential equations. The development of new efficient numerical schemes for geometric PDEs has to go together with the most recent progress in analysis (stability phenomena, energy transfers, multiscale problems, etc..) The major challenges of the project are to derive new schemes by bridging the world of numerical simulation and the analysis community, and to consider deterministic and stochastic equations, with a general aim at deriving hybrid methods. We also aim to create a research platform devoted to extensive numerical simulations of difficult academic PDEs in order to highlight new nonlinear phenomena and test numerical methods.

Erwan Faou was the principal investigator of the ERC Starting Grant Project Geopardi (2011-2016).

Between 2011 and 2016, Erwan Faou was the principal investigator of this ERC Starting grant project. This research project is centered on the numerical simulation of geometric evolution partial differential equations (PDEs). Typical examples are given by Hamiltonian Partial Differential Equations (PDE) such as wave equations in nonlinear propagations problems, Schrödinger equations in quantum mechanics, or Vlasov equations in plasma physics. The main goals of the project can be summarized as follows:

- Analyze numerical schemes for Hamiltonian PDEs and stochastic differential equations as mathematical objects in their own right, and study their global behavior (invariant preservation, ergodicity with respect to some invariant measure, averaging properties, scattering, etc...)
- Develop new numerical methods in connection with the most recent advances in the theoretical studies, and devoted to specific situations (high frequency computations, stochastic and hybrid methods, Vlasov and Euler equations). In particular, an important objective is the analysis of the long time behavior of these equations.

The main originality of the Geopardi project is the combination of rigorous nonlinear analysis, numerical analysis and numerical simulations, as well as its hybrid nature mixing deterministic and stochastic problems. The project has an excellent international visibility. The participants have been invited in many conferences to present their works in the last year (Scicade 13 & 15, Numdiff 13, workhops in Toronto, Harvard, IHES, Oberwolfach or Luminy, etc..). The research outcomes are published in high level international journals such as J. Amer. Math. Soc., Numer. Math., SIAM J. Numer. Anal. or Math. Comp. The project has also been used to invite collaborators and researcher to visit Inria. In particular, E. Faou organized with T. Lelièvre and J. Erhel in september 2013 the NASPDE conference whose main topic is the numerical simulation of stochastic PDEs, and that was mainly funded by the Geopardi project.

5.2.2. Collaborations in European Programs, Except FP7 & H2020

Project acronym: WPENR

Program: EUROFusion Enabling Research project ER15-IPP-01

Project title: Verification and development of new algorithms for gyrokinetic codes

Duration: January 2015 - December 2018

Coordinator: Eric Sonnenndrücker (Max-Planck-Institut für Plasmaphysik (IPP), Germany)

Other partners: IPP (Germany), EPFL (Switzerland), CEA-Cadarache (France), university of Strasbourg, Toulouse, Marseille, Paris 6 (France).

Abstract: Gyrokinetic codes play a major role in understanding the development and saturation of micro- turbulence in a magnetic fusion plasma and its influence on energy confinement time. The first aim of this proposal is to assess the reliability of gyrokinetic codes by extensive verification and benchmarking. All the major european gyrokinetic codes are involved in the proposal and this will enable them to define comparison elements, which ultimately will also facilitate the cross-validation of new physics. On the other hand we will develop new algorithms for extending the physics capabilities or the computational efficiency of different gyrokinetic codes. Finally we will also perform a prospective investigation of models and numerical methods that could help in the future to address physics where kinetic effects might play an important role but that cannot be handled with today's gyrokinetic codes, like L-H (low to high confinement) transition, edge physics or MHD time scales simulations.

5.3. International Research Visitors

5.3.1. Visits of International Scientists

- Philippe Chartier and Nicolas Crouseilles invited Eric Sonnendrücker (IPP Max Planck) for one week in june 2016.
- Nicolas Crouseilles and Mohammed Lemou invited Shi Jin and Liu Liu (university of Wisconsin) for two weeks in june 2016.
- Arnaud Debussche invited Martina Hofmanova (TU Berlin) for one week in november 2016.
- Erwan Faou invited Chuchu Chen (Michigan state university) for two weeks in november 2016.

5.3.2. Visits to International Teams

5.3.2.1. Research Stays Abroad

- Philippe Chartier was invited for a one-week working visit by Gilles Vilmart, university of Geneva (Switzerland).

- Nicolas Crouseilles was invited for a one-week working visit by Gilles Vilmart, university of Geneva (Switzerland).

- Arnaud Debussche was invited at SNS Pisa (Italy) for two periods of one week in april and november 2016.

- Erwan Faou was invited in the university of Trondheim (Norway) in october 2016.

<p style="text-align: center; color: red;">**MATHERIALS Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

The project-team is involved in several ANR projects:

- S. Boyaval's SEDIFLO project, funded by ANR as a JCJC (Jeunes Chercheuses Jeunes Chercheurs) grant, has started investigating new numerical models of solid transport in rivers that include new non-Newtonian terms.
- E. Cancès is involved in the ANR BECASIM, which is concerned with the numerical simulation of Bose-Einstein condensates. This ANR has been accepted in June 2012, and is coordinated by I. Danaila (Université de Rouen).
- T. Lelièvre is member of the ANR-project "STAB" (PI: I. Gentil, Université de Lyon).
- F. Legoll is a member of the ANR project CINE-PARA (PI: Y. Maday, Paris 6)
- The ANR COSMOS (PI: G. Stoltz) focuses on the development of efficient numerical techniques to simulate high-dimensional systems in molecular dynamics and computational statistics. It includes research teams from Institut Mines-Telecom, Inria Rennes and IBPC Paris.

In addition, the project-team is participating in

- the GdR CORREL (correlated methods in electronic structure computations),
- the GdR EGRIN (gravity flows),
- the GdR MASCOT-NUM (stochastic methods for the analysis of numerical codes),
- the GdR Maths-entreprise (math/industry collaboration),
- the GdR DYNQUA (time evolution of quantum systems, with applications to transport problems, nonequilibrium systems, etc.),
- the GdR REST (theoretical spectroscopy),
- the GdR CHOCOLAS (experimental and numerical study of shock waves).

The project-team is involved in two Labex, namely the Labex Bezout (started in 2011) and the Labex MMCD (started in 2012).

8.2. European Initiatives

The ERC consolidator Grant MSMATH (ERC Grant Agreement number 614492, PI T. Lelièvre) is running (it started in June 2014).

8.3. International Initiatives

The *Germaine de Staël* grant to S. Boyaval (from CampusFrance Hubert-Curien program) has been renewed for 2017 to pursue the collaboration with A. Caboussat (Lausanne) about 3D numerical simulations of free-surface flows.

T. Lelièvre, G. Stoltz and F. Legoll participate in the Laboratoire International Associé (LIA) CNRS / University of Illinois at Urbana-Champaign on complex biological systems and their simulation by high performance computers. This LIA involves French research teams from Université de Nancy, Université de Lyon and Inria Rennes.

MATHRISK Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR Stab 2013-2016, Participant : B. Jourdain, Partners : Lyon 1, Paris-Dauphine
- ANR Cosmos 2015-2018, Participant: B. Jourdain ; Partners : Ecole des Ponts, Telecom, INIRIA Rennes and IBPC

9.1.2. Competitivity Clusters

Pôle Finance Innovation.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

- Center of Excellence program in Mathematics and Life Sciences at the Department of Mathematics, University of Oslo, Norway, (B. Øksendal).
- Department of Mathematics, University of Manchester (Tusheng Zhang, currently in charge of an EU-ITN program on BSDEs and Applications).
- Kensas University (Yaozhong Hu)
- Mannheim University (Alexander Schied, Chair of Mathematics in Business and Economics, Department of Mathematics)
- Roma Tor Vergata University (Lucia Caramellino)
- Ritsumeikan University (A. Kohatsu-Higa).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Oleg Kudryavtsev, Rostov University (Russia), 2 months

9.3.1.1. Internships

- Babacar Diallo [Inria, Trainee, from Mar 2016 until Aug 2016]
- Nicolas Le Mouel [Inria, Trainee, from Jul 2016 until Oct 2016]
- Mouad Ramil [Inria, Trainee, from Mar 2016 until Aug 2016]

9.3.2. Visits to International Teams

9.3.2.1. Research Stays Abroad

- Vlad Bally visited Tor Vergata University, Roma. (Collboration with Lucia Caramellino)

<p align="center">**MCTAO Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

The PhD thesis of Jeremy Rouot [2] has been co-funded by Région PACA.

8.2. National Initiatives

8.2.1. ANR

Weak KAM beyond Hamilton-Jacobi (WKBHJ). Started 2013 (decision ANR-12-BS01-0020 of December 19, 2012), duration: 4 years. L. Rifford is in the scientific committee.

Sub-Riemannian Geometry and Interactions (SRGI). Started 2015 (decision ANR-15-CE40-0018), duration: 4 years. L. Rifford is a member.

Intéractions Systèmes Dynamiques Équations d'Évolution et Contrôle (ISDEEC). Started 2016 (decision ANR-16-CE40-0013), duration: 4 years. L. Rifford is a member.

8.2.2. Others

The McTAO team participates in the GdR MOA, a CNRS network on Mathematics of Optimization and Applications.

PEPS project of AMIES Labex, "Dealing with exclusion constraints in orbital transfer" with Thalès Alenia Space (PI J.-B. Caillau). This project funded two master internships during summer 2016 (M. Brunengo and Y. El Alaoui Faris, co-supervised with T. Dargent from Thalès).

PGMO grant (2016-2017) on "Metric approximation of minimizing trajectories and applications" (PI J.-B. Caillau). This project involves colleagues from Université Paris Dauphine and has funding for one year, including one intership (M2 level).

J.-B. Caillau is associate researcher of the team Optimization & Control at ENSTA-Paristech and of the CNRS team Parallel Algorithms & Optimization team at ENSEEIHT, Univ. Toulouse.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, other than FP7 & H2020

8.3.1.1. Bilateral program with Portugal

Program: FCT (Fundação para a Ciência e a Tecnologia)

Grant no. : PTDC/MAT-CAL/4334/2014

Project title: "Extremal spectral quantities and related problems"

Duration: 05/2016-05/2019

Coordinator: P. Freitas (Univ. Lisbon)

Team member involved: J.-B. Caillau

Other partners: Univ. Lisbon, Univ. Luxembourg, Czech Nuclear Physics Institute, Univ. Bern

Link: https://team.inria.fr/mctao/fct-project-extremal-spectral-quantities-and-related-problems-2016-2019

8.3.1.2. Bilateral program with Germany

Program: Projets de recherche collaborative-internationale ANR-DFG (Germany)

Grant no. : ANR-14-CE35-0013-01; DFG-Gl 203/9-1

Project title: "**Exploring the physical limits of spin systems (Explosys).**"

Duration: 11/2014-10/2018

Coordinator: D. Sugny (Univ. de Bourgogne) for France, Glaser (TU München) for Germany.

Team member involved: Bernard Bonnard is in the (scientific committee).

Other partners: TU München, Univ. de Bourgogne (IMB and UCB).

This project involves specialists in physics and control theory in order to make important progresses in the use of spin dynamics, in particular for Magnetic Resonance Medical Imaging.

Link: http://www.agence-nationale-recherche.fr/fileadmin/aap/2014/selection/pa-2014-selection-franco-allemand-dfg.pdf

<p style="text-align:center;color:red;font-weight:bold;">MEMPHIS Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

The project members are actively participating to the CPU cluster of excellence of Idex Bordeaux (http://cpu.labex.u-bordeaux.fr/)

9.2. National Initiatives

We belong to the GDR AMORE on ROMs.

9.2.1. *Starting grants*

A PEPS project ("Programme Exploratoire Premier Soutien"), initiated by Afaf Bouharguane, about Optimal Transport Theory. Angelo Iollo and Lisl Weynans are also involved in this project.

A PEPS project ("Programme Exploratoire Premier Soutien") on the numerical simulation of the biomimetic undulatory swimming for both under water vehicle optimisation and the Modeling of human locomotor system, initiated by Michel Bergmann with the MRGM laboratory (Laboratoire Maladies Rares : Génétique et Métabolism, https://mrgm.u-bordeaux.fr/). Afaf Bouharguane and Angelo Iollo are also involved in this project.

NEMO (A Numerical Enabler for MultiPhysics Simulations on Octrees) is an action to improve and merge all the main MEMPHIS numerical codes. To achieve this goal we have a 12 months financial support (Inria BSO FRM) for a young engineer. This work will be done with strong interaction the the local Inria BSO SED as well as Philippe Depouilly from the IMB "SED".

SMecH is a start-up project in software edition, carried on by Florian Bernard, research engineer in the MEMPHIS team. The project aims at porting to an industrial level the numerical codes developed by the MEMPHIS team. The different collaboration with industrial partners have highlighted the need of new numerical tools to simulate high complexity phenomena such as atmospheric reentries, multi-material flows or fund-structure interactions, but also to highly automatize the numerical simulation workflow to save engineer time. The research codes developed in the MEMPHIS team could match perfectly to this need thanks to:

- the various innovative multi-physics models implemented
- the use of Hierarchical Cartesian schemes that automatize the treatment of moving geometry with accuracy
- the development of schemes suitable for High Parallel Computing.

This year, the project has been submitted to the DGDT, the Inria department in charge of technological transfert, and has been granted an engineer for 6 months as well as the support of IT-Translation.

9.3. European Initiatives

9.3.1. *FP7 & H2020 Projects*

EU research projects were and will be a privileged instrument of diffusion and transfer of our results. The AEROGUST H2020 project involves aeronautical industry (Airbus, Dassault, Piaggio..) and research labs (University of Bristol, DLR, NLR, University of Cape Town) and is dedicated to modeling of aerodynamic gust response for applications. We take part in this project by developing simulation models for unsteady aeroelastic problems and data-driven reduced-order models. We played a similar role for the past in the FP7 project FFAST with the same partners.

9.3.1.1. AEROGUST

Title: Aeroelastic Gust Modelling

Programm: H2020

Duration: May 2015 - April 2018

Coordinator: University of Bristol

Partners:

Airbus Defence and Space (Germany)

University of Cape Town (South Africa)

Dassault Aviation (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Stichting Nationaal Lucht- en Ruimtevaartlaboratorium (Netherlands)

Numerical Mechanics Applications International (Belgium)

Optimad Engineering S.R.L. (Italy)

Piaggio Aero Industries Spa (Italy)

The University of Liverpool (United Kingdom)

University of Bristol (United Kingdom)

Valeol (France)

Inria contact: Angelo IOLLO and Michel Bergmann

Encounters with atmospheric turbulence are a vitally important in the design and certification of many manmade structures such as aircraft and wind turbines. Gusts cause rapid changes in the flow about the structures which leads to rigid and flexible unsteady responses. Knowledge of aircraft/gust interactions is therefore vital for loads estimation during aircraft design as it impacts on control systems and often defines the maximum loads that these structures will experience in service. At present industry typically uses the linear doublet lattice method with static loads corrections from expensive wind tunnel data. The wind tunnel data is created using the final aerodynamic surface in the predicted cruise shape. This means that gust loads come relatively late when the design options have been narrowed. Increased competition and environmental concerns are likely to lead to the adoption of more flexible materials and the consideration of novel configurations, in which case the linear assumptions of the current gust loads process will become unacceptable. To introduce non-linearity into the gust loads process without significantly increasing the cost and time, this project has three main objectives: to carry out investigations using CFD so that the non-linearities in gust interactions are understood; to create a gust loads process that does not require wind tunnel data and hence reduces the need for wind tunnel testing; to develop updated reduced order models for gust prediction that account for non-linearity at an acceptable cost. These investigations will reduce the need for expensive wind tunnel testing and hence lead to time and cost savings at the design stage therefore ensuring that the European aerospace and defense industry remain competitive in the future. The wind turbine industry has similar concerns, with gusts and wind shear restricting the locations available for wind farms. The project will also address these issues using common methodology.

9.3.2. Collaborations with Major European Organizations

Partner 1: Chalmers University (Sweden)

This activity is complemented by several international interactions, in particular with Chalmers University in order to converge towards the real implementation of new control technologies on cars, buses and trucks.

Partner 2: Optimad Engineering , Torino (Italy)

We have a crucial partnership with Optimad Engineering, a spin-off of the Politecnico di Torino. This society has implemented in industrial codes several schemes that we have developed for the past. In exchange, we have access to these codes. One example is Pablo, an octree managing parallel library (http://www.optimad.it/products/pablo/). Three former PhD students at Inria are presently employed in Optimad and several others have spent or will spend a research period in this company in order to get acquainted with code architecture and massive parallelism. This company represents for us an ideal partner for the actual industrial feedback on our methods. As mentioned, we plan to create a local start-up in close collaboration with Optimad. This start-up will respond to actual industrial needs by specific software packages built starting from open source tools that are made available to the applied research community via a consortium. Florian Bernard has been recruited in Memphis for two years with the objective of bringing to a higher maturity level a set of modules developed within the team. He plans to fully invest himself in the creation of the start-up. As for the consortium, we are discussing with several partners including Cineca (Italy HPC center) and Optimad about how to structure such a mutual effort. The Storm Inria team is included in the discussions as a possible partner.

Partner 3: W4E (Wave for Energy) (Italy)

One project is the design of an ISWEC (Inertial See Wave Energy Converter) in collaboration with W4E (Wave for Energy), Optimad and others. The ISWEC is a floater prototype that can extract energy form the sea waves. The mechanism is based on a gyroscope that is rotating due to the passive motion of the floater. This prototype is actually tested in the Mediterranean sea in Italy. We will develop the numerical simulation as well as the shape optimization of the ISWEC.

Partner 4: MRGM (Maladies Rares : Génétique et Métabolisme), Bordeaux University (France)

We develop a collaboration with the MRGM lab. They are interested in the swimming of a zebrafish larvae under genetic modifications. One aim is to quantify the power spent by such fishes to swim after a stimuli reaction. The numerical simulation we develop can help computing integral quantities such as the power. This simulation is challenging due to the coupling several methods like image treatment (from movies given by MRGM), optimal transport and numerical simulations.

Partner 5: CRPP (Centre de recherche Paul Pascal), LOF (Laboratoire du Futur) and LOMA (Laboratoire Ondes et Matière d'Aquitaine) labs, Bordeaux University, France.

We established collaborations with physics and chemistry labs in Bordeaux, namely the CRPP, the LOF and the LOMA. They are concerned with the behavior of many passive (CRPP and LOF) and active (LOMA) particles in an incompressible flow. With these partners, we intend to use a combined experimental and computational approach to calibrate models in the case of dilute and concentrated suspensions. The numerical simulations of such particles can help to understand some underlying phenomena at the particles scale and thus to develop mesoscopic models for the whole system (PhD of Baptiste Lambert, oct. 2015).

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. Declared Inria International Partners

Collaboration with Optimad Engineering.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Giovanni Russo, Professor at the Catane university, has visiting our team several times this year.

Johnny Guzman, associate professor, Université de Brown, USA, one week.

9.5.1.1. Internships

Mohsen Broumand, a PhD visitor from Winnipeg university, has a collaboration with Lisl Weynans for bi-fluid simulations (from October 2016).

<p style="text-align:center;color:red;font-weight:bold;">MEPHYSTO Project-Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR BECASIM

G. Dujardin is a member of the ANR BECASIM project (http://becasim.math.cnrs.fr/). This ANR project gathers mathematicians with theoretical and numerical backgrounds together with engineers. The objective is to develop numerical methods to accurately simulate the behavior of Bose-Einstein condensates.

> Title: Simulation numérique avancée pour les condensats de Bose-Einstein.
>
> Type: Modèles Numériques - 2012
>
> ANR reference: ANR-12-MONU-0007
>
> Coordinator: Ionut DANAILA, Université de Rouen.
>
> Duration: January 2013 - December 2017.
>
> Partners: Université Lille 1, UPMC, Ecole des Ponts ParisTech, Inria-Nancy Grand-Est, Université Montpellier 2, Université Toulouse 3.

8.1.2. ANR EDNHS

M. Simon is a member of the ANR EDNHS project.

> Title: Diffusion de l'énergie dans des système hamiltoniens bruités.
>
> Type: Défi de tous les savoirs (DS10) 2014.
>
> ANR reference: ANR-14-CE25-0011.
>
> Coordinator: Cédric Bernardin, Université de Rennes.
>
> Duration: October 2014 - October 2019.

8.1.3. Labex CEMPI

> Title: Centre Européen pour les Mathématiques, la Physique et leurs interactions
>
> Coordinator: Stephan De Bièvre.
>
> Duration: January 2012 - December 2019.
>
> Partners: Laboratoire Paul Painlevé and Laser physics department (PhLAM), Université Lille 1.

The "Laboratoire d'Excellence" Centre Européen pour les Mathématiques, la Physique et leurs interactions (CEMPI), a project of the Laboratoire de Mathématiques Paul Painlevé and the Laboratoire de Physique des Lasers, Atomes et Molécules (PhLAM), was created in the context of the "Programme d'Investissements d'Avenir" in February 2012.

The association Painlevé-PhLAM creates in Lille a research unit for fundamental and applied research and for training and technological development that covers a wide spectrum of knowledge stretching from pure and applied mathematics to experimental and applied physics.

One of the three focus areas of CEMPI research is the interface between mathematics and physics. This focus area encompasses three themes. The first is concerned with key problems of a mathematical, physical and technological nature coming from the study of complex behaviour in cold atoms physics and non-linear optics, in particular fibre optics. The two other themes deal with fields of mathematics such as algebraic geometry, modular forms, operator algebras, harmonic analysis and quantum groups that have promising interactions with several branches of theoretical physics.

8.1.4. PEPS "Jeunes Chercheurs"

M. Simon obtained a CNRS grant "PEPS Jeunes Chercheurs" for a project in collaboration with Oriane Blondel (Université Lyon 1), Clément Erignoux (IMPA, Rio de Janeiro) and Makiko Sasada (Tokyo University)

8.1.5. MIS

Incentive Grant for Scientific Research (MIS) of the Fonds National de la Recherche Scientifique (Belgium)

Title: Patterns, Phase Transitions, 4NLS & BIon.

Coordinator: D. Bonheure.

Duration: January 2014 - December 2016.

Partner: Université libre de Bruxelles.

8.1.6. PDR

Research Project (PDR) of the Fonds National de la Recherche Scientifique (Belgium).

D. Bonheure is co-investigator of this PDR.

Title: Asymptotic properties of semilinear systems.

Coordinator: Christophe Troestler (UMons).

Duration: July 2014 - June 2018.

Partner: Université de Mons, Université catholique de Louvain, Université libre de Bruxelles.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. QUANTHOM

Title: Quantitative methods in stochastic homogenization

Programm: FP7

Duration: February 2014 - January 2019

Coordinator: Université Libre de Bruxelles (Belgium)

Partner: Inria

Inria contact: A. Gloria

'This proposal deals with the development of quantitative tools in stochastic homogenization, and their applications to materials science. Three main challenges will be addressed. First, a complete quantitative theory of stochastic homogenization of linear elliptic equations will be developed starting from results I recently obtained on the subject combining tools originally introduced for statistical physics, such as spectral gap and logarithmic Sobolev inequalities, with elliptic regularity theory. The ultimate goal is to prove a central limit theorem for solutions to elliptic PDEs with random coefficients. The second challenge consists in developing an adaptive multiscale numerical method for diffusion in inhomogeneous media. Many powerful numerical methods were introduced in the last few years, and analyzed in the case of periodic coefficients. Relying on my recent results on quantitative stochastic homogenization, I have made a sharp numerical analysis of these methods, and introduced more efficient variants, so that the three academic examples of periodic, quasi-periodic, and random stationary diffusion coefficients can be dealt with efficiently. The emphasis of this challenge is put on the adaptivity with respect to the local structure of the diffusion coefficients, in order to deal with more complex examples of interest to practitioners. The last and larger objective is to make a rigorous connection between the continuum theory of nonlinear elastic materials and polymer-chain physics through stochastic homogenization of nonlinear problems and random graphs. Analytic and numerical preliminary results show the potential of this approach. I plan to derive explicit constitutive laws for rubber from polymer chain properties, using the insight of the first two challenges. This requires a good understanding of polymer physics in addition to qualitative and quantitative stochastic homogenization.'

8.2.2. Collaborations with Major European Organizations

Max Planck Institute for Mathematics in the Sciences (Germany)

Long-term collaboration with F. Otto on the development of a quantitative theory of stochastic homogenization of linear elliptic systems.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Milton Jara, Professor Adjunto, IMPA, Rio de Janeiro (Brazil), was an invited professor at Université Lille 1 funded by the LabeX CEMPI.

8.3.1.1. Internships

Pierre Mennuni, MA2 Université Lille 1, Internship, 3 months

8.3.1.2. Research Stays Abroad

M. Simon spent one month at Universidade Federal Fluminense (Niteroi, Brazil) in march 2016, sponsored by the "Réseau France-Brésil", as a guest of Freddy Hernandez.

S. De Bièvre visited C. Mejia-Monasterio at the Technical University of Madrid in June 2016.

<p style="text-align:center">**MISTIS Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

- MISTIS participates in the weekly statistical seminar of Grenoble. Jean-Baptiste Durand is in charge of the organization and several lecturers have been invited in this context.

- F. Forbes and P. Mesejo are co-organizing a reading group on Deep Learning with R. Horaud and K. Alahari.

9.2. National Initiatives

9.2.1. *Grenoble Idex projects*

MISTIS is involved in a newly accepted transdiciplinary project **NeuroCoG** (December 2016). F. Forbes is also responsible for a workpackage in another project entitled "Institut des sciences des données".

9.2.2. *Competitivity Clusters*

The MINALOGIC VISION 4.0 project:MISTIS is involved in a new (October 2016) three-year *Pôle de competitivité Minalogic* project. The project is led by VI-Technology (http://www.vitechnology.com), a world leader in Automated Optical Inspection (AOI) of a broad range of electronic components. The other partners are the G-Scope Lab in Grenoble and ACTIA company based in Toulouse. Our goal is to exploit more intensively statistical techniques to exploit the large amount of data registered by AOI machines.

9.2.3. *Defi Mastodons CNRS*

Defi La qualité des données dans le Big Data (2016-17). S. Girard is involved in a 1-year project entitled "Classification de Données Hétérogènes avec valeurs manquantes appliquée au Traitement des Données Satellitaires en écologie et Cartographie du Paysage", the other partners being members of Modal (Inria Lille Nord-Europe) or ENSAT-Toulouse. The total funding is 10 keuros.

9.2.4. *Defi Imag'IN CNRS*

Defi Imag'IN MultiPlanNet (2015-2016). This is a 2-year project to build a network for the analysis and fusion of multimodal data from planetology. There are 8 partners: IRCCYN Nantes, GIPSA-lab Grenoble, IPAG Grenoble, CEA Saclay, UPS Toulouse, LGL Lyon1, GEOPS University Orsay and Inria Mistis. F. Forbes is in charge of one work package entitled *Massive inversion of multimodal data*. Our contribution will be based on our previous work in the VAHINE project on hyperspectral images and recent developments on inverse regression methods. The CNRS support for the network is of 20 keuros.

9.2.5. *GDR Madics*

Apprentissage, opTimisation à Large-échelle et cAlcul diStribué (ATLAS). Mistis is participating to this action supported by the GDR in 2016 (3 keuros).

9.2.6. *Networks*

MSTGA and AIGM INRA (French National Institute for Agricultural Research) networks: F. Forbes is a member of the INRA network called AIGM (ex MSTGA) network since 2006, http://carlit.toulouse.inra.fr/AIGM, on Algorithmic issues for Inference in Graphical Models. It is funded by INRA MIA and RNSC/ISC Paris. This network gathers researchers from different disciplines. F. Forbes co-organized and hosted 2 of the network meetings in 2008 and 2015 in Grenoble.

9.3. International Initiatives

9.3.1. Inria International Labs

LIRIMA

Associate Team involved in the International Lab:

9.3.1.1. SIMERGE

Title: Statistical Inference for the Management of Extreme Risks and Global Epidemiology

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LERSTAD - Abdou Kâ Diongue

Starting year: 2015

See also: http://mistis.inrialpes.fr/simerge

The objective of the associate team is to federate some researchers from LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger) and MISTIS (Inria Grenoble Rhône-Alpes). The associate team will consolidate the existing collaborations between these two laboratories. Since 2010, the collaborations have been achieved through the co-advising of two PhD theses. They have led to three publications in international journals. The associate team will also involve statisticians from EQUIPPE laboratory (Economie QUantitative Intégration Politiques Publiques Econométrie, Université de Lille) and associated members of MODAL (Inria Lille Nord-Europe) as well as an epidemiologist from IRD (Institut de Recherche pour le Développement) at Dakar. We aim at developing two research themes: 1) Spatial extremes with application to management of extreme risks and 2) Classification with application to global epidemiology.

9.3.1.2. Informal International Partners

The context of our research is also the collaboration between MISTIS and a number of international partners such as the Statistics Department of University of Washington in Seattle, Université Gaston Berger in Senegal and Universities of Melbourne and Brisbane in Australia. In 2016, new collaborations had started with the statistics department of University of Michigan, in Ann Arbor, USA and with the statistics department of McGill University in Montreal, Canada.

The main active international collaborations in 2016 are with:

- F. Durante, Free University of Bozen-Bolzano, Italy.
- K. Qin and D. Wraith resp. from RMIT in Melbourne, Australia and Queensland University of Technology in Brisbane, Australia.
- E. Deme and S. Sylla from Gaston Berger university and IRD in Senegal.
- M. Stehlik from Johannes Kepler Universitat Linz, Austria and Universidad de Valparaiso, Chile.
- A. Nazin from Russian Academy of Science in Moscow, Russia.
- M. Houle from National Institute of Informatics, Tokyo, Japan.
- N. Wang and C-C. Tu from University of Michigan, Ann Arbor, USA.
- R. Steele, from McGill university, Montreal, Canada.

9.3.2. Participation in Other International Programs

Alexis Arnaud received an award from the MITACS program, for a 5 months visit to McGill university in Montreal.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Seydou Nourou Sylla (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for two months.
- Naisyin Wang and Chun-Chen Tu from University of Michigan, Ann Arbor, USA, have been hosted by the MISTIS team for one week.

9.4.2. Visits to International Teams

S. Girard went to univ. Gaston Berger in St Louis Senegal in the context of the SIMERGE associated team.

9.4.2.1. Research Stays Abroad

Alexis Arnaud spent 5 months at McGill university in Montreal.

<p align="center" style="color:red">MODAL Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. L'impact de l'évolution de l'état émotionnel et cognitif ressenti sur la reprise de l'activité de femmes atteintes d'un cancer du sein (Protocole FACEBROK)

Participant: Sophie Dabo.

Partners: LAPCOS (EA 7278), UMR 9193 SCALab, LEM UMR 9221 LEM, Modal-Inria, EA CRDP

9.1.2. Main partners of bilille

Participant: Guillemette Marot.

bilille, the bioinformatics platform of Lille officially gathers from Nov. 2015 a few bioinformaticians, biostatisticians and bioanalysts from the following teams:

EA2694 (Univ. Lille 2, CHRU, Inria)

FRABIO, FR3688 (Univ. Lille 1,CNRS)

CBP / GFS (Univ. Lille 2, CHRU)

TAG (Univ. Lille 2, CNRS, INSERM, Institut Pasteur de Lille)

U1167 (Univ. Lille 2, CHRU, INSERM et Institut Pasteur de Lille)

U1011 (Univ. Lille 2, INSERM)

UMR8198 (Univ. Lille 1, CNRS)

LIGAN PM (Univ. Lille 2, CNRS)

BONSAI (Inria, Univ. Lille 1, CNRS)

Those teams are thus the main partners of MODAL concerning biostatistics for bioinformatics. Guillemette Marot is the leader of the platform and works in close collaboration with the following people for the leadership of the scientific strategy related to the platform:

H. Touzet, BONSAI (deputy head of bilille)

P. Touzet, UMR8198 (deputy head of bilille)

V. Chouraki, U1167

M. Figeac, CBP / GFS

D. Hot, TAG

V. Leclère, Insitut Charles Viollette

M. Lensink, UGSF

9.1.3. New collaborations of the year linked to bilille, the bioinformatics and bioanalysis platform

Participants: Guillemette Marot, Samuel Blanck.

Guillemette Marot has supervised the data analysis part or support in biostatistics tools testing for the following research projects involving Samuel Blanck or engineers from bilille (only the names of the principal investigators of the project are given even if several partners are sometimes involved in the project):

U 1011, H. Duez, circadiomics project

CIIL, J.C. Sirard, Flagnew project

JPARC, M.H. David, biostatistics related to DNAse-seq

9.1.4. Collaboration linked to SIRIC Oncolille

Participants: Sophie Dabo, Guillemette Marot.

During the 'Plan Cancer 2' period, eight SIRICs ('Site de Recherche Intégrée sur le Cancer') were created in France, including the SIRIC ONCOLille (Link). More recently, the SFR Cancer has been created and Sophie Dabo-Niang is a member of the board that aims to create an Interdisciplinary Cancer Research Institute in Lille, based on ONCOLille. Guillemette Marot is still involved in several collaborations linked to cancer, through the projects analysed by the bilille platform.

9.2. National Initiatives

9.2.1. Programme of Investments for the Future (PIA)

Bilille is a member of two PIA "Infrastructures en biologie-santé":

> France Génomique https://www.france-genomique.org/spip/?lang=en
>
> IFB (French Institute of Bioinformatics) https://www.france-bioinformatique.fr/en

As leader of the platform, Guillemette Marot is thus involved in these networks.

9.2.2. Working groups

Sophie Dabo-Niang belongs to the following working groups.

- STAFAV (STatistiques pour l'Afrique Francophone et Applications au Vivant)
- ERCIM Working Group on computational and Methodological Statistics, Nonparametric Statistics Team
- Ameriska

Benjamin Guedj belongs to the following working groups (GdR) of CNRS: ISIS (local referee for Inria Lille - Nord Europe), MaDICS, MASCOT-NUM (local referee for Inria Lille - Nord Europe).

Guillemette Marot belongs to the StatOmique working group.

9.2.3. ANR

Participant: Cristian Preda.

> ClinMine Project-2014-2017
>
> ANR project (ANR TECSAN - Technologie de la santé)
>
> Main coordinator of the project: Clarisse Dhaenens, CRIStAL, USTL
>
> 7 partners - EA 1046 (Maladie d'Alzheimer et pathologies vasculaires, Faculté de Médecine, Lille), EA 2694 (Centre d'Etudes et de Recherche en Informatique Médicale - Faculté de Médecine, Lille), MODAL (Inria LNE), Alicante (Entreprise), CHRU de Montpelier, GHICL (Groupe Hospitalier de l'Institut Catholique de Lille), CRIStAL, USTL

9.2.4. Other initiatives

Serge Iovleff is the head of the project CloHe granted in 2016 by the Mastodons CNRS challenge "Big data and data quality". The project is axed on the design of classification and clustering algorithms for mixed data with missing values with applications to high spatial resolution multispectral satellite image time-series. Website.

9.3. European Initiatives

9.3.1. European Research Council

Benjamin Guedj has participated in the 2017 Starting call of the European Research Council (ERC), by submitting a project (called BEAGLE, standing for PAC-Bayesian Agnostic Learning) in October 2016.

9.3.2. Collaborations with Major European Organizations

EMS (European Mathematical Society), Sophie Dabo-Niang

Nominated (November 2016) as member of EMS-CDC (Committee of Developing counties)

CIMPA (International Center of Pure and Applied Mathematics), Sophie Dabo-Niang

Nominated (June 2016) as member

9.4. International Initiatives

9.4.1. Inria International Labs

Sophie Dabo-Niang is a member of SIMERGE, a LIRIMA project-team started in January 2015. It includes researchers from Mistis (Inria Grenoble - Rhône-Alpes, France), LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger, Sénégal), IRD (Institut de Recherche pour le Développement, Unité de Recherche sur les Maladies Infectieuses et Tropicales Emergentes, Dakar, Sénégal) and LEM lab (Lille Economie et Management, Université Lille 1, 2, 3, Modal, Inria Lille Nord-Europe, France).

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

Benjamin Guedj and Christophe Biernacki began a two years collaboration as "Equipes associées nord-européennes" with the Irish team "INSIGHT". The Centre for Data Analytics INSIGHT is about the size of Inria Lille - Nord Europe and is the main Irish research facility in Statistics and Machine Learning. It is focused on the next generation of machine learning (ML) and statistics (Stat) algorithms that can operate on large-scale, dynamic data. Nial Friel is the leader of the ML/Stat axis of INSIGHT, Brendan Murphy is a professor. The topic of this project is to manage statistical models inflation by the means of model clustering.

9.4.2.1. Informal International Partners

Benjamin Guedj regularly collaborates with Olivier Wintenberger from Københavns Universitet (KU, Denmark).

Benjamin Guedj regularly collaborates with Sylvain Robbiano from University College London (UCL, UK).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

Rohit Uttam Bhagwat

    Date: June 2016 - July 2016

    Institution: Indian Institute of Science Education and Research, Kolkata (India)

    Supervisor: Vincent Vandewalle

Siddharth Sharma Siddharth

    Date: Nov 2015 - May 2016

    Institution: LNM Institute of Information Technology (India)

    Supervisor: Guillemette Marot

Miguel Assuncao

    Date: September 2016 - February 2017

    Institution: University of Lille

    Supervisor: Christophe Biernacki and Vincent Kubicki

Ghazouani Yannis

Date: Oct 2015 - Sept 2016

Institution: École Centrale Lille - VEKIA

Supervisor: Alain Celisse

Hamza Tajmouati

Date: Oct 2015 - Sept 2016

Institution: École Centrale Lille

Supervisor: Alain Celisse

Astha Gupta

Date: May 2016 - Jul 2016

Institution: BITS Pilani (India)

Supervisor: Benjamin Guedj

Bhargav Srinivasa Desikan

Date: Aug 2016 - Jul 2017

Institution: BITS Pilani (India)

Supervisor: Benjamin Guedj

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Sophie Dabo-Niang has visited AIMS-Senegal (African Institute of Mathematical Sciences) and SIMERGE (Inria International Lab of University Gaston-Berger, Senegal) from July to mid-August, 2016.

<p style="text-align:center">**MOKAPLAN Project-Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

J-D. Benamou is the coordinator of the ANR ISOTACE (Interacting Systems and Optimal Transportation, Applications to Computational Economics) ANR-12-MONU-0013 (2012-2016). The consortium explores new numerical methods in Optimal Transportation AND Mean Field Game theory with applications in Economics and congested crowd motion. Check https://project.inria.fr/isotace/.

J-D. Benamou and G. Carlier are members of the ANR MFG (ANR-16-CE40-0015-01). Scientific topics of the project: Mean field analysis Analysis of the MFG systems and of the Master equation Numerical analysis Models and applications

J-D. Benamou G. Carlier and F-X. Vialard are members of ANR MAGA The Monge-Ampère equation is a fully nonlinear elliptic equation, which plays a central role in geometry and in the theory of optimal transport. However, the singular and non-linear nature of the equation is a serious obstruction to its efficient numerical resolution. The first aim of the MAGA project is to study and to implement discretizations of optimal transport and Monge-Ampère equations which rely on tools from computational geometry (Laguerre diagrams). In a second step, these solvers will be applied to concrete problems from various fields involving optimal transport or Monge-Ampère equations such as computational physics: early universe reconstruction problem, congestion/incompressibility constraints economics: principal agent problems, geometry: variational problems over convex bodies, reflector and refractor design for non-imaging optics

9.1.2. CNRS Mission pour l'interdisciplinarité (Défi Imag'In)

V. Duval and F-X. Vialard are members of the CAVALIERI project (CAlcul des VAriations pour L'Imagerie, l'Edition et la Recherche d'Images). This project, coordinated by V. Duval, aims at proposing new methods for comparing and reconstructing images relying on recent progress in the calculus of variations. Typical applications are co-segmentation, statistics transfer and interpolation, as well as tomographic reconstruction. A major emphasis is given on methods derived from (generalized) Optimal Transportation. See http://image. math.u-bordeaux1.fr/cavalieri/

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Gabriel Peyré is the principal investigator of the ERC project SIGMA-Vision (http://gpeyre.github.io/sigma-vision/), running in 2011-2016. This project tackles theory, numerics and applications at the interface between imaging sciences, optimization and neurosciences. It features in particular several contributions on sparse regularization techniques for inverse problems, and optimal transport approaches for color and texture image processing. This theoretical and numerical contributions are applied to compute vision, computer graphics and neurosciences of the visual brain. Gabriel Peyré is the recipient of a second ERC grand (consolidator), project NORIA (http://www.gpeyre.com/noria/) on Numerical Optimal tRansport for ImAging, that will start on Oct. 2017.

9.3. International Initiatives

9.3.1. MOKALIEN

Title: Numerical Optimal Transportation in (Mathematical) Economics

International Partner (Institution - Laboratory - Researcher):

McGill University (Canada) - mathematics - Oberman Adam

Start year: 2014

See also: https://team.inria.fr/mokaplan/mokalien/

The team investigates new modelling and numerical resolution methods in Mathematical Economics using the theory of Optimal Transportation.

9.3.2. Participation in International Programs

F-X. Vialard was invited to participate in Mathematics of Shapes and Applications (4 - 31 July 2016) held in Singapore.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

The following people visited MOKAPLAN during 2016.

- Lina Mallozzi (Professor, Napoli): Feb. 28-March 5
- Andrei Sobolevski (Research Associate, Moscow) and Aleksei Kroshnin (PhD Student, Moscow): Oct 17-Oct 21
- Teresa Radice (Research Associate, Napoli): Jan. 25-Jan. 31, Apr. 7-Apr. 15 and Jul. 25-Aug. 10
- Giuseppe Buttazzo (Professor, Pisa): Nov. 29-Dec. 2

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Carlier stayed three weeks in Canada in July, one week in Victoria for a collaboration with Agueh (and a master committee) and two weeks in Montreal for the mokalien meeting and then duscussions with Oberman, he visited Naples twice (one week each time, to work with Mallozzi and Radice), Pisa twice (one week each time, to work with Buttazzo), NYU (3 days).

NACHOS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *Inria Project Lab*

8.1.1.1. *C2S@Exa (Computer and Computational Sciences at Exascale)*

Participants: Olivier Aumage [STORM project-team, Inria Bordeaux - Sud-Ouest], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri [Coordinator of the project], Jean-François Méhaut [CORSE project-team, Inria Grenoble - Rhône-Alpes], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is coordinating the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.1.2. *ANR project*

8.1.2.1. *TECSER*

Participants: Emmanuel Agullo [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Xavier Antoine [CORIDA project-team, Inria Nancy - Grand-Est], Patrick Breuil [Nuclétudes, Les Ulis], Thomas Frachon, Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri, Ludovic Moya, Guillaume Sylvand [Airbus Group Innovations].

Type: ANR ASTRID

Duration: May 2014 - April 2017

Coordinator: Inria

Partner: Airbus Group Innovations, Inria, Nuclétudes

Inria contact: Stéphane Lanteri

Abstract: the objective of the TECSER project is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. DEEP-ER

Title: Dynamic Exascale Entry Platform - Extended Reach

Program: FP7

Duration: October 2013 - September 2016

Coordinator: Forschungszentrum Juelich Gmbh (Germany)

Partner: Intel Gmbh (Germany), Bayerische Akademie der Wissenschaften (Germany), Ruprecht-Karls-Universitaet Heidelberg (Germany), Universitaet Regensburg (Germany), Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V (Germany), Eurotech Spa (Italy), Consorzio Interuniversitario Cineca (Italy), Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain), Xyratex Technology Limited (United Kingdom), Katholieke Universiteit Leuven (Belgium), Stichting Astronomisch Onderzoek in Nederland (The Netherlands) and Inria (France).

Inria contact: Stéphane Lanteri

Abstract: the DEEP-ER project aims at extending the Cluster-Booster Architecture that has been developed within the DEEP project with a highly scalable, efficient, easy-to-use parallel I/O system and resiliency mechanisms. A Prototype will be constructed leveraging advances in hardware components and integrate new storage technologies. They will be the basis to develop a highly scalable, efficient and user-friendly parallel I/O system tailored to HPC applications. Building on this I/O functionality a unified user-level checkpointing system with reduced overhead will be developed, exploiting multiple levels of storage. The DEEP programming model will be extended to introduce easy-to-use annotations to control checkpointing, and to combine automatic re-execution of failed tasks and recovery of long-running tasks from multi-level checkpoint. The requirements of HPC codes with regards to I/O and resiliency will guide the design of the DEEP-ER hardware and software components. Seven applications will be optimised for the DEEP-ER Prototype to demonstrate and validate the benefits of the DEEP-ER extensions to the Cluster-Booster Architecture.

8.2.1.2. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partner: Barcelona Supercomputing Center (Spain), Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas - CIEMAT (Spain), REPSOL SA (Spain), Iberdrola Renovables Energia SA (spain), Lancaster University (United Kingdom), COPPE/UFRJ - Universidade Federal do Rio de Janeiro (Brazil), LNCC (Brazil), INF/UFRGS - Universidade Federal do Rio Grande do Sul (Brazil), CER/UFPE - Universidade Federal de Pernambuco (Brazil), PETROBRAS (Brazil), TOTAL SA (France), and Inria (France).

Inria contact: Stéphane Lanteri

Abstract: This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e.

biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO_2 emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

8.3. International Initiatives

8.3.1. Inria Associate Teams not involved in an Inria International Labs

8.3.1.1. HOMAR

Title: High performance Multiscale Algorithms for wave pRopagation problems

International Partner (Institution - Laboratory - Researcher):

Laboratório Nacional de Computaçao Científica (Brazil) - Coordenaçao de Matemática Aplicada e Computaciona - Frédéric Valentin

Start year: 2015

See also: http://www-sop.inria.fr/nachos/index.php/Main/HOMAR

The general scientific context of the collaboration proposed in the HOMAR project is the study of time dependent wave propagation problems presenting multiscale features (in space and time). The general goal is the design, analysis and implementation of a family of innovative high performance numerical methods particularly well suited to the simulation of such multiscale wave propagation problems. Mathematical models based on partial differential equations (PDE) embedding multiscale features occur in a wide range of scientific and technological applications involving wave propagation in heterogeneous media. Electromagnetic wave propagation and seismic wave propagation are two relevant physical settings that will be considered in the project. Indeed, the present collaborative project will focus on two particular application contexts: the interaction of light (i.e. optical wave) with nanometer scale structure (i.e. nanophotonics) and, the interaction of seismic wave propagation with geological media for quantitative and non destructive evaluation of imperfect interfaces.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Prof. Kurt Busch, Humboldt-Universität zu Berlin, Institut für Physik, Theoretical Optics & Photonics

Prof. Martijn Wubs, Technical University of Denmark (DTU), Structured Electromagnetic Materials Theory group

Dr. Maciej Klemm, University of Bristol, Communication Systems & Networks Laboratory, Centre for Communications Research (United Kingdom)

Dr. Urs Aeberhard and Dr. Markus Ermes, Theory and Multiscale Simulation, IEK-5 Photovoltaik, Forschungszentrum Jülich, Germany

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Prof. Liang Li, School of Mathematical Sciences, University of Electronic Science and Technology of China, Chengdu. From March 2016 to February 2017.

Dr. Antonio Tadeu Gomez and Dr. Frédéric Valentin, LNCC, Petropolis, Brazil. From December 15, 2016 to February 15, 2017.

Prof. Bin Li and Prof. Li Xu, School of Physical Electronics, University of Electronic Science and Technology of China, Chengdu. From August 1st to Agust 12, 2016.

NANO-D Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

We have an ARC grant from the Rhone-Alpes region.

7.2. National Initiatives

7.2.1. ANR

In 2015, NANO-D had funding from one ANR program:

- **ANR Modeles Numeriques (MN)**: 180,000 Euros over four years (2011-2015). This project, coordinated by NANO-D (S. Grudinin), gathers biologists and computer scientists from three research groups: Dave Ritchie at LORIA, Valentin Gordeliy at IBS (total grant: 360,000 Euros).

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. ADAPT

Title: Theory and Algorithms for Adaptive Particle Simulation

Programm: FP7

Duration: September 2012 - August 2017

Coordinator: Inria

Inria contact: Stephane Redon

'During the twentieth century, the development of macroscopic engineering has been largely stimulated by progress in digital prototyping: cars, planes, boats, etc. are nowadays designed and tested on computers. Digital prototypes have progressively replaced actual ones, and effective computer-aided engineering tools have helped cut costs and reduce production cycles of these macroscopic systems. The twenty-first century is most likely to see a similar development at the atomic scale. Indeed, the recent years have seen tremendous progress in nanotechnology - in particular in the ability to control matter at the atomic scale. Similar to what has happened with macroscopic engineering, powerful and generic computational tools will be needed to engineer complex nanosystems, through modeling and simulation. As a result, a major challenge is to develop efficient simulation methods and algorithms. NANO-D, the Inria research group I started in January 2008 in Grenoble, France, aims at developing efficient computational methods for modeling and simulating complex nanosystems, both natural and artificial. In particular, NANO-D develops SAMSON, a software application which gathers all algorithms designed by the group and its collaborators (SAMSON: Software for Adaptive Modeling and Simulation Of Nanosystems). In this project, I propose to develop a unified theory, and associated algorithms, for adaptive particle simulation. The proposed theory will avoid problems that plague current popular multi-scale or hybrid simulation approaches by simulating a single potential throughout the system, while allowing users to finely trade precision for computational speed. I believe the full development of the adaptive particle simulation theory will have an important impact on current modeling and simulation practices, and will enable practical design of complex nanosystems on desktop computers, which should significantly boost the emergence of generic nano-engineering.'

7.4. International Initiatives

7.4.1. Inria Associate Teams Not Involved in an Inria International Labs

7.4.1.1. PPI-3D

Title: Structure Meets Genomics

International Partner (Institution - Laboratory - Researcher):

Boston University (United States) - ___DEPARTMENT???___ - Dima Kozakov

Start year: 2015

See also: https://team.inria.fr/nano-d/research/ppi-3d-structure-meets-genomics/

Protein–protein interactions are integral to many mechanisms of cellular control, and therefore their characterization has become an important task for both experimental and computational approaches in systems biology. Genome-wide proteomics studies provide a growing list of putative protein-protein interactions, and demonstrate that most if not all proteins have interacting partners in the cell. A fraction of these interaction has been reliably established, however, one can only identify whether two proteins interact and, in the best cases, which are the individual domains mediating the interaction. A full comprehension of how proteins bind and form complexes can only come from high-resolution three-dimensional structures. While the most complete structural characterization of a complex is provided by X-ray crystallography, protein-protein hetero-complexes constitute less than 6%Â§ of protein structures in the Protein Data Bank. Thus, it is important to develop computational methods that, starting from the structures of component proteins, can determine the structure of their complexes.

The basic problem of predictive protein docking is to start with the structures (or sequences) of unbound component proteins A and B, and to obtain computationally a model of the bound complex AB, as detailed structural knowledge of the interactions facilitates understanding of protein function and mechanism. Our current docking approaches performs ab initio docking of the two structures without the use of any additional information. The goal of this proposal is to speed up docking approaches to tackle genome-scale problems, and utilize additional information on interactions, sequences, and structures that is available for virtually any protein.

This project includes several methodological and application research directions: 1) Developing fast sampling approaches; 2) Development of new scoring functions; 3) Integrative approaches for structure determination.

Overall, during the course of the project we will (i) jointly develop new methodology and algorithms in the field of genomic-scale protein complex prediction; (ii) provide server-based applications built upon services of the Boston team; (iii) and finally develop modular applications coded inside the SAMSON software platform created by the Inria team.

7.4.2. Inria International Partners

7.4.2.1. BIOTOOLS

Title: Novel Computational Tools for Structural Bioinformatics

International Partner (Institution - Laboratory - Researcher):

MIPT (Russia (Russian Federation)) - Vadim Strijov

Duration: 2016 - 2020

7.5. International Research Visitors

7.5.1. Visits of International Scientists

7.5.1.1. Internships

Sergey Kravchenko

Supervisor: Sergey Grudinin

7.5.2. Visits to International Teams

7.5.2.1. Research Stays Abroad

Leonard Jaillet, Alexandre Hoffmann and Sergei Grudinin visited the lab of Dima Kozakov.

NECS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. ProCyPhyS

ProCyPhyS is a one year project funded by University Grenoble Alps, MSTIC department, with the aim to study privacy in cyberphysical system. A post-doc (H. Nouasse) has been hired to perform analysis of privacy protection through system-theoretic measures. We are interested with cyber-physical systems that can be viewed as systems of interconnected entities which are locally governed by difference equations of partial differential equations, namely intelligent transportation systems and indoor navigation. A first approach to analyze privacy preservation is to study observability of the overall system, see [8] where a large family of non-observable networks have been characterized for homogeneous systems of consensus type. In this approach, the network structure immunizes the overall system. A second approach, consists in adding information (noise) to the sensitive one: that is the differential privacy concept that leads to differential filtering where the aim is to develop an estimator that is robust enough according to the added noise [33]. In ProCyPhyS the main goal is to make the system partially nonobservable. The idea is to compress the state space while adding noise to the sensitive information in a smarter way.

9.1.2. Collaboration with IFSTTAR, Lyon, and LICIT team

The group has begun a collaboration with IFSTTAR in Lyon and namely with the LICIT team. We held two informal workshops: the first one in Grenoble, where we presented the team, and the second one in Lyon, which was focused on traffic modeling. During this workshop, the NeCS team proposed the following talks:

- C. Canudas de Wit, A variable-length cell transmission model for road traffic system;
- M. L. Delle Monache, Coupled PDE-ODE models for traffic flow.

A third workshop is planned next March and we expect a sustained collaboration during the coming year.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. SPEEDD (Scalable ProactivE Event-Driven Decision making)

> Type: STREP
>
> Objective: ICT-2013.4.2a – Scalable data analytics – Scalable Algorithms, software frameworks and viualisation
>
> Duration: Feb. 2014 to Jan. 2017.
>
> Coordinator: National Centre of Scientific Research 'Demokritos' (Greece)
>
> Partners: IBM Israel, ETH Zurich (CH), Technion (Israel), Univ. of Birmingham (UK), NECS CNRS (France), FeedZai (Portugal)
>
> Inria contact: C. Canudas de Wit
>
> Abstract: SPEEDD is developing a prototype for robust forecasting and proactive event-driven decision-making, with on-the-fly processing of Big Data, and resilient to the inherent data uncertainties. NECS leads the intelligent traffic-management use and show case.
>
> See also: http://speedd-project.eu

9.2.1.2. Scale-FreeBack

> Type: ERC Advanced Grant

Duration: Sep. 2016 to Aug. 2021

Coordinator: C. Canudas de Wit

Inria contact: C. Canudas de Wit

Abstract: The overall aim of Scale-FreeBack is to develop holistic scale-free control methods of controlling complex network systems in the widest sense, and to set the foundations for a new control theory dealing with complex physical networks with an arbitrary size. Scale-FreeBack envisions devising a complete, coherent design approach ensuring the scalability of the whole chain (modelling, observation, and control). It is also expected to find specific breakthrough solutions to the problems involved in managing and monitoring large-scale road traffic networks. Field tests and other realistic simulations to validate the theory will be performed using the equipment available at the Grenoble Traffic Lab center (see GTL), and a microscopic traffic simulator replicating the full complexity of the Grenoble urban network.

See also: http://scale-freeback.eu

9.3. International Initiatives

9.3.1. *Inria International Labs*

Inria@SiliconValley

Associate Team involved in the International Lab:

9.3.1.1. *COMFORT*

Title: COntrol and FOrecasting in Transportation networks

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Mechanical Engineering - Roberto Horowitz

Start year: 2014

See also: http://necs.inrialpes.fr/v2/pages/comfort/EA_homepage_COMFORT.html

COMFORT addresses open issues for Intelligent Transportation Systems (ITS). The goal of these systems is to use information technologies (sensing, signal processing, machine learning, communications, and control) to improve traffic flow, as well as enhance the safety and comfort of drivers. It has been established over the past several decades, through field studies and many scholarly publications, that the tools of ITS can significantly improve the flow of traffic on congested freeways and streets. Traffic operators can manage the system in a top-down fashion, for example, by changing the speed limit on a freeway, or by controlling the flow on the onramps (ramp metering). Individual drivers can also affect traffic conditions from the bottom up, by making decisions based on reliable predictions. These predictions must be provided by a centralized system that can evaluate the decisions based on global information and sophisticate modeling techniques. It is now crucial to develop efficient algorithms for control and prediction that are well adapted to current and emerging sensing and communication technologies. The areas of traffic modeling and calibration, state estimation, and traffic control remain central to this effort. Specifically, COMFORT addresses issues related to model validation and development of new traffic forecasting and distributed control algorithms. The efficiency of the derived methods will be assessed using large networks simulators and real data obtained from the Californian and the Grenoble's testbed.

This year is the final one of the current project: however, the positive results from the project have lead to the request of its extension, which is pending approval.

9.3.2. *Participation in Other International Programs*

9.3.2.1. *TICO-MED*

TicoMed (Traitement du signal Traitement numérique multidimensionnel de l'Information avec applications aux Télécommunications et au génie Biomédical) is a French-Brazilian project funded by CAPES-COFECUB. It started in February 2015 with University of Nice Sophia Antipolis (I3S Laboratory), CNAM, SUPELEC, University of Grenoble Alpes (Gipsa-Lab), Universidade Federal do Ceara, Universidade Federal do Rio de Janeiro, and Universidade Federal do Santa Catarina as partners.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Prof. Andre L.F. de Almeida from (Universidade Federal do Ceara, Fortaleza, Brazil) visited the team in June 2015 within the framework of the French-Brazilian CAPES-COFECUB project TICO-MED.

Dr. Thibault Liard (University Pierre et Marie Curie, Paris VI) visited the team in November. He gave a seminar to the team with the title "A Kalman rank condition for the indirect controllability of coupled systems of linear operator groups" and discussed with M. L. Delle Monache on traffic flow modeling and control using conservation laws.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Maria Laura Delle Monache and Giacomo Casadei visited UC Berkeley in December. They had research meeting with faculty and students at ITS and PATH and in particular with Prof. M. Arcak.

A. Kibangou visited the Nelson Mandela Metropolitan University (Port Elizabeth) and the University of Johanesburg (UJ) in May 2016. During his stay, he gave a lecture to students of Department of Town and Regional Planning of UJ on Mobility and traffic management.

A. Kibangou visited Universidade Federal do Ceara (UFC) in Fortaleza (Brazil) in November 2016 within the framework of the Tico-Med bilateral project. During his stay, he worked with Prof. Andre L.F. de Almeida on tensor models for graph filters and gave a course on Graph Signal Processing to researchers and doctoral students of UFC.

NON-A Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Project ARCIR ESTIREZ "Estimation distribuée de systèmes dynamiques en réseaux", coordinators: D. Efimov, M. Petreczky, 2013-2017.
- CPER DATA 2016-2020 (involved in two projects: "FIT" related to the wireless robots and sensors network and "DATA", related to platform). FIT includes our robotic activity and DATA corresponds to our computation need in fluid mechanics as well as possible security issues in the ControlHub development platform.
- ELSAT20202 (Ecomobilité, Logistique, Sécurité, Adaptabilité dans les Transports) is a Regional consortium gathering aeronautics (ONERA), micro/nano technologies (IEMN), control sciences (Non-A) and fluid mechanics (LAMIH, LML) and working on technologies and methods for the active control of separated flows.

9.2. National Initiatives

- ANR project Finite4SoS (Finite time control and estimation for Systems of Systems), coordinator: W. Perruquetti, 2015-2020.
- ANR project WaQMoS (Coastal waters quality surveillance using bivalve mollusk-based sensors), coordinator: D. Efimov, 2015-2019.
- ANR project TurboTouch (High-performance touch interactions), coordinator: G. Casiez (MJOL-NIR team, Inria), 2014-2018.
- ANR project ROCC-SYS (Robust Control of Cyber-Physical Systems), coordinator: L. Hetel (CNRS, EC de Lille), 2013-2018.
- ANR project MSDOS (Multidimentional System: Digression on Stability), coordinator: Nima Yeganefar (Poitiers University), 2014-2018.
- We are also involved in several technical groups of the GDR MACS (CNRS, "Modélisation, Analyse de Conduite des Systèmes dynamiques", see http://www.univ-valenciennes.fr/GDR-MACS), in particular: Technical Groups "Identification", "Time Delay Systems", "Hybrid Systems", "Complex Systems, Biological Systems and Automatic Control," and "Control in Electrical Engineering".
- Model-free control: collaborations with the startup ALIEN SAS (created by C. Join and M. Fliess).

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

Partner 1: KULeuven, labo 1 (Belgium)
Supervisor: W. Michiels
Partner 2: TU/Eindhoven, labo 1 (The Netherlands)
Supervisor: H. Nijmeijer
Partner 3: Centrale Lille, labo 1 (France)
Supervisor: J.-P. Richard

H2020 project UCoCoS ("Understanding and Controlling of Complex Systems", 2016-2020) is a European Joint Doctorate aiming at creating a framework for complex systems, and at defining a common language, common methods, tools and software for the complexity scientist. It strongly relies on a control theory point of view. Six ESR (early stage researchers) perform a cutting-edge project, strongly relying on the complementary expertise of the 3 academic beneficiaries and benefiting from training by 4 non-academic partners from different sectors. ESR1: Analytical and numerical bifurcation analysis of delay-coupled systems; ESR2: Estimation in complex systems; ESR3: Grip on partial synchronization in delay-coupled networks; ESR4: Reduced modelling of large-scale networks ; ESR5: Network design for decentralized control ; ESR6: Networks with event triggered computing. Non-A is firstly invested on ESR 2 (Haik Silm), 4 (Quentin Voortman), 5 (Deesh Dileep), 6 (Jijju Thomas).

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

HoTSMoCE "Homogeneity Tools for Sliding Mode Control and Estimation", project with UNAM (Mexico), supervisor: D. Efimov, 2015-2018.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

Arie Levant, Tel Aviv University, Israel (Invited Professor, 4 months, 2015-2016).

9.4.2.2. Informal International Partners

- Emilia Fridman, Tel Aviv University, Israel
- Leonid Fridman, UNAM, Mexico
- Jaime Moreno, UNAM, Mexico
- Johannes Schiffer, Leeds University, UK
- ITMO University, Saint-Petersburg, Russia
- Eva Zerz, Aachen University, Germany

9.4.3. Participation in Other International Programs

- "Robust and Reliable Control of Aerial Syste"', Beihang University, China, 2016, in charge: G. Zheng
- PHC Amadeus "Computer Algebra and Functional Equations", 2016-2017, with the University of Limoges (XLIM) and the University of Linz (Austria).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Leonid Fridman, UNAM, Mexico, 10/07/2016-22/07/2016, "Stability analysis of a sliding-mode control algorithm of second order with time delays".
- Emilia Fridman, Tel Aviv University, Israel, 27/06/2016-11/07/2016, "Design of interval observers for distributed-parameters systems".
- Jaime Alberto Moreno Pérez, UNAM, Mexico, 27/06/2016-08/07/2016, "Recursive design of Lyapunov functions for finite-time stable systems".
- Tonametl Sanchez Ramirez, UNAM, Mexico, 24/10/2016-18/11/2016, "Homogeneity for discrete-time systems".
- Juan Gustavo Rueda Escobedo, UNAM, Mexico, 24/10/2016-18/11/2016, "Finite-time and fixed-time identification of parameters".
- Konstantin Zimenko, ITMO, Russia, 26/09/2016-28/10/2016, "Delay independent stabilization via implicit Lyapunov function approach".
- Damiano Rotondo, NTNU, Norway, 17/10/2016-21/10/2016, "Fault detection for LPV systems using interval observers".

9.5.1.1. Internships

- Paul Lesur, "Robust control of blimp", 05-07/2016 , supervisor: G. Zheng
- Baihui Du, "Robust control of fast dynamical systems", 05-07/2016, supervisor: G. Zheng

9.5.2. Visits to International Teams

G. Zheng visited Beihang University (China) for two weeks in July 2016.

9.5.2.1. Explorer programme

COSY (under evaluation) Real-time Control of Synthetic microbial communities. While some precursory work has appeared in recent years, the control of microbial communities remains largely unexplored. This proposal aims at exploiting the potential of state-of-art biological modelling, control techniques, synthetic biology and experimental equipment to achieve a paradigm shift in control of microbial communities. Lead by E. Cinquemani as a collaboration of 4 Inria teams IBIS, BIOCORE, COMMANDS, Non-A), the Inria Exploratory Action INBIO and external partners BIOP (CNRS), MaIAge (INRA), and YoukLAB (TU Delft).

9.5.2.2. Research Stays Abroad

G. Zheng held a visiting professor position in Nanjing University of Science and Technology (China) for two months stay in August 2016.

<div align="center">POEMS Project-Team</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

The post-doc of Maryna Kachanovska si funded by the Fondation Mathématique Jacques Hadamard (FMJH).

9.2. National Initiatives

9.2.1. ANR

- ANR project *METAMATH: modélisation mathématique et numérique pour la propagation des ondes en présence de métamatériaux.* Partners: EPI DEFI (Inria Saclay), IMATH-Université de Toulon, LJLL-Paris 6 University.
  Start : 12/01/2011, End : 11/30/2016. Administrator : Inria. Coordinator : Sonia Fliss.
- ANR project *CHROME: Chauffage , réflectométrie et Ondes pour les plasmas magnétiques*
  Partners: LJLL-Paris 6 University, Université de Lorraine
  Start : 10/01/2012, End : 19/09/2016 Administrator : Inria Coordinator for POEMS: Eliane Bécache
- ANR project *RAFFINE: Robustesse, Automatisation et Fiabilité des Formulations INtégrales en propagation d'ondes : Estimateurs a posteriori et adaptivité*
  Partners: EADS, IMACS, ONERA, Thales
  Start : January 2013. End : June 2017. Administrator : Inria. Coordinator: Marc Bonnet.
- ANR project *Non-Local Domain Decomposition Methods in Electromagnetism.*
  Partners: Inria Alpines, Inria POEMS, Inria Magique 3D.
  Start : 2015, End : 2019. Administrator : Inria. Coordinator: Xavier Claeys.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. BATWOMAN

Type: FP7 Marie Curie
Objectif: Basic Acoustics Training - & Workprogram On Methodologies for Acoustics - Network
Duration: September 2013 - August 2017
Coordinator: Martin Wifling, VIRTUAL VEHICLE (AT)
Inria contact: P. Joly
Abstract: The BATWOMAN ITN aims at structuring research training in basic and advanced acoustics and setting up a work program on methodologies for acoustics for skills development in a highly diverse research field offering multiple career options.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Wilkins Aquino (Duke University)
Eric Chung (Chinese University of Hong Kong)
Bojan Guzina (University of Minnesota)
Sergei Nazarov (Saint-Petersburg University)
Jeronimo Rodriguez (University of Santiago de Compostela)
Adrien Semin (Technische Universitat Berlin)
Julian Ott (Karlsruhe Institut für Technologie)

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Stefan Sauter, University of Zürich, Switzerland (2 months)

<div align="center" style="color:red">**QUANTIC Project-Team**</div>

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Emergences-Ville de Paris program, QuMotel project*

This project, entitled "Quantum memory for microwaves: towards quantum error correction and quantum state teleportation" and led by François Mallet, started on september 2013 and ran till september 2016. It was composed of the members of the QUANTIC project-team. In this project we worked on the development of a decoherence free quantum memory with the tools of circuit quantum electrodynamics. This crucial device is still missing in any implementations of quantum information processing. It aims at capturing, in an efficient manner, the quantum information encoded by flying photons, protect this information over long times, and release it on demand towards a desired channel. The realization of this memory is based on a high quality factor cavity connected to a superconducting circuit performing three-wave mixing. We will entangle the memory state with a propagating microwave signal, then use it to perform quantum teleportation from one memory to another, generate Schrödinger cat states in the memory and realize quantum error correction protocols in order to stabilize a cat state in the memory for an arbitrary time.

7.2. National Initiatives

7.2.1. *ANR project GEARED*

This three-year collaborative ANR project, entitled "Reservoir engineering quantum entanglement in the microwave domain" and coordinated by Mazyar Mirrahimi, started on October 2014. The participants of the project are Mazyar Mirrahimi, François Mallet and Benjamin Huard (QUANTIC project-team), Daniel Esteve and Fabien Portier (Quantronics group, CEA Saclay), Nicolas Roch and Olivier Buisson (Institut Neel, Grenoble). This project deals with robust generation of entanglement as a key resource for quantum information processing (quantum simulation, computation and communication). The entangled states are difficult to generate and sustain as interaction with a noisy environment leads to rapid loss of their unique quantum properties. Through Geared we intend to investigate different complementary approaches to master the entanglement of microwave photons coupled to quantum superconducting circuits.

7.2.2. *ANR project ENDURANCE*

In the framework of the ANR program "Accueil de chercheur de haut niveau", Zaki Leghtas has received a funding for his research program "Multi-photon processes in superconducting circuits for quantum error correction". This grant of 400k euros has allowed to purchase the experimental equipment to build a new experiment based at ENS.

7.3. European Initiatives

7.3.1. *Collaborations with Major European Organizations*

Partner 1: University of Padova

Alain Sarlette has been pursued a fruitful collaboration with the group of Francesco Ticozzi on "dynamical systems aspects of quantum systems". A novel line of work in the direction of quantum thermalization and quantum random walks has been explored, in the framework of the PhD of S. Apers (Ghent University) supervised by A. Sarlette. Further joint work for the future is planned about among others generalized Markovian feedback and, reservoir engineering, and linear Lyapunov functions for quantum systems. F. Ticozzi has visited us for one week.

Partner 2: Ghent University.

A. Sarlette is collaborating with applied mathematicians interested in quantum control at UGent (Dirk Aeyels, Lode Wylleman, Gert De Cooman) in the framework of thesis co-supervisions. One PhD student is co-supervised with Dirk Aeyels in the framework of Belgian Inter-University Attraction Poles "Dynamical Systems, Control and Optimization" network 2013-2017. A second PhD student is also co-supervised with Dirk Aeyels in the framework of Chinese Scholarship Council and Flanders Research Fund grant "Developing control mechanisms to counter biases and drifts in coordination", 2013-2016. Finally, benefiting from a UGent starting grant on "Coordination control algorithms inspired from nonlinear PDEs and lattices", 2013-2017, Alain Sarlette also supervises a third PhD student at Ghent University.

7.4. International Initiatives

7.4.1. *Inria Associate Teams Not Involved in an Inria International Labs*

TAQUILLA: is an Inria associate team (between Quantic team and Yale university) with principal Inria investigator, Mazyar Mirrahimi, and principal Yale investigator Michel Devoret. In this framework we had many exchanges between Inria and Yale in 2016. Shantanu Mundhada from Yale visited Inria for 2 months. Nicolas Didier and Lucas Verney visited Yale for 3 months, and Joachim Cohen for 3 weeks.

Pierre Rouchon is a participant to the Inria associate Team CDSS with principal Inria investigator, François Dufour of the Inria Team Project CQFD on the topic "Control of dynamic systems subject to stochastic jumps".

7.4.2. *Inria International Partners*

7.4.2.1. *Informal International Partners*

Partner 1: University of Yale

The long-term collaborations with the teams of Michel H. Devoret, Robert J. Schoelkopf, Liang Jiang and Steven M. Girvin, enforced through a two year sabbatical visit of Mazyar Mirrahimi at Yale university, have led to a set of contributions ranging from the theoretical analysis and performance optimization of ongoing experiments on weak quantum measurements [71] and preparation of non-classical field states through single photon Kerr effect [75] to the design of new experiments on single qubit cooling [67] and stabilization of maximally entangled states of superconducting qubits [9] by reservoir engineering techniques. Through these collaborations, Zaki Leghtas and Mazyar Mirrahimi have introduced a new direction for hardware-efficient universal quantum computation [81], [90]. These theoretical proposals have already led to groundbreaking experiments [5], [6], [10]. This collaboration is partially formalized through the Taquilla associate team.

Partner 2: University of SaoPaulo and Federal University of Santa Catarina

Pierre Rouchon is collaborating with P. S. Pereira da Silva (Escola Politecnica, PTC, University of SaoPaulo, Brazil) and H. B. Silveira Federal (University of Santa Catarina (UFSC), Florianopolis, Brazil) on the system theory problems behind the experiment on the feedback stabilization of the photon box.

7.5. International Research Visitors

7.5.1. *Visits of International Scientists*

Francesca Chittaro from Université de Toulon made a 6-month sabbatical visit (February-July 2016) working on adiabatic elimination for composite quantum systems. Preliminary results have been submitted to the IFAC World Congress 2017 [32].

P. S. Pereira da Silva (Escola Politécnica, PTC, University of SaoPaulo, Brazil) made a 3-week visit (June 27 to July 15) to investigate with Mazyar Mirrahimi and Pierre Rouchon controllability issues on composite quantum systems.

7.5.1.1. Internships

In the framework of the Inria-MITACS program, Pantita Palittapongarnpim, student in the group of Barry Sanders at University of Calgary, visited QUANTIC for a period of 4 months working on optimal control methods for photon-number parity measurements.

In the framework of TAQUILLA associate team, Shantanu Mundhada, student in the group of Michel Devoret at Yale University, visited QUANTIC for a period of 2 months working on circuit designs for high-order non-linear quantum dissipation.

Partner: University of Calgary

In the framework of the Inria-MITACS program, Pantita Palittapongarnpim, student in the group of Barry Sanders visited QUANTIC for a period of 4 months working on optimal control methods for photon-number parity measurements.

7.5.2. Visits to International Teams

7.5.2.1. Research Stays Abroad

In the framework of TAQUILLA associate team, Mazyar Mirrahimi spent four months in the Quantronics Laboratory of Michel H. Devoret and in the Rob Schoelkopf Lab at Yale University. Also, in this same framework Nicolas Didier and Lucas Verney spent three months and Joachim Cohen three weeks in the same group.

Pierre Rouchon was invited to give a one-week visit and several lectures on modelling and control of open-quantum systems at Zhejiang University (Hangzhou, China), College of control and Engineering (28 May – 7 June 2016).

RAPSODI Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The PhD program of Ahmed Aït Hammou Oulhaj is partially supported (50%) by the Region Nord-Pas-de-Calais.

9.2. National Initiatives

9.2.1. ANR

C. Cancès is the coordinator of the ANR GEOPOR project. (https://www.ljll.math.upmc.fr/cances/ANR-GEOPOR/). This project aims to study realistic models for complex porous media flows from a variational point of view, and to take advantage of this new approach to design and analyze some efficient numerical methods.

> Title: Approche géométrique pour les écoulements en milieux poreux : théorie et numérique.
>
> Type: Jeunes Chercheuses Jeunes Chercheurs SIMI 1- 2013
>
> ANR Reference: ANR-13-JS01-0007-01
>
> Coordinator: Clément Cancès, Inria Lille - Nord Europe.
>
> Duration: January 2014 – June 2017

I. Lacroix is the local coordinator at Université Lille 1 of the ANR BECASIM project (`http://becasim.math.cnrs.fr/`). This ANR project gathers mathematicians with theoretical and numerical backgrounds together with engineers. The objective is to develop numerical methods to accurately simulate the behavior of Bose-Einstein condensates.

> Title: Simulation numérique avancée pour les condensats de Bose-Einstein.
>
> Type: Modèles Numériques - 2012
>
> ANR reference: ANR-12-MONU-0007
>
> Coordinator: Ionut DANAILA, Université de Rouen.
>
> Duration: January 2013 - November 2017.

C. Chainais-Hillairet is a member of the ANR MOONRISE project (`http://moonrise.math.cnrs.fr/`). The MOONRISE project aims at exploring modeling, mathematical and numerical issues originating from the presence of high oscillations in nonlinear PDEs mainly from the physics of nanotechnologies and from the physics of plasmas.

> Title: Modèles, Oscillations et schémas numériques.
>
> Type: Fondements du numérique (DS0705) - 2014
>
> ANR reference: ANR-14-CE23-0007
>
> Coordinator: Florian MEHATS, Université de Rennes 1.
>
> Duration: October 2014 - September 2019.

B. Merlet is a member of the ANR GEOMETRYA project

(https://www.ljll.math.upmc.fr/lemenant/GEOMETRYA/) The GEOMETRYA project addresses several problems within the framework of geometric measure theory, from both theoretical and numerical viewpoints. Most of these problems are derived from the modeling of physical phenomenons. The main topics are: the Geometric Measure Theory in singular metric spaces, the Plateau problem, the Mumford-Shah functional, irrigation and branched transport problems, the Willmore energy.

Title: Théorie gémométrique de la mesure et applications

Type: Blanc SIMI 1 - 2012

ANR reference: ANR-12-BS01-0014

Coordinator: Hervé Pajot, Université Joseph Fourier (Grenoble).

Duration: january 2013 - december 2016.

9.2.2. *Labex CEMPI*

Title: Centre Européen pour les Mathématiques, la Physique et leurs interactions

Coordinator: Stephan De Bièvre.

Duration: January 2012 - December 2019.

Partners: Laboratoire Paul Painlevé and Laser physics department (PhLAM), Université Lille 1.

The "Laboratoire d'Excellence" Centre Européen pour les Mathématiques, la Physique et leurs interactions (CEMPI), a project of the Laboratoire de Mathématiques Paul Painlevé and the Laboratoire de Physique des Lasers, Atomes et Molécules (PhLAM), was created in the context of the "Programme d'Investissements d'Avenir" in February 2012.

The association Painlevé-PhLAM creates in Lille a research unit for fundamental and applied research and for training and technological development that covers a wide spectrum of knowledge stretching from pure and applied mathematics to experimental and applied physics.

One of the three focus areas of CEMPI research is the interface between mathematics and physics. This focus area encompasses three themes. The first is concerned with key problems of a mathematical, physical and technological nature coming from the study of complex behavior in cold atoms physics and non-linear optics, in particular fibre optics. The two other themes deal with fields of mathematics such as algebraic geometry, modular forms, operator algebras, harmonic analysis and quantum groups that have promising interactions with several branches of theoretical physics.

9.3. International Research Visitors

9.3.1. *Visits of International Scientists*

Alexis Vasseur (UT Austin, Texas) was invited in Lille in June 2016 thanks to a support of the Labex CEMPI.

We have a long time collaboration with Ansgar Jüngel's team from TU Wien. In 2016, we hosted 2 PhD students advised by A. Jüngel : Anita Gerstenmayer for a first one month and a second one week research stays, Polina Shpartko for a one week research stay.

Kyle Talbot, a PhD student advised by Jérôme Droniou at Monash University (Melbourne, Australia), and Ward Melis, a PhD student supervised by Giovanni Samaey (KU Leuven, Belgium), spent both one week in our team.

9.3.2. *Visits to International Teams*

Claire Chainais-Hillairet and Ingrid Lacroix-Violet visited Ansgar Jüngel in Vienna (May 17-20, 2016). Claire Chainais-Hillairet visited Jürgen Fuhrmann, Patricio Farrell and Nella Rotundo at WIAS (Berlin) to work on numerical schemes for semiconductor devices models. Clément Cancès visited Léonard Monsaingeon in Lisbon (Feb. 29 to March 4, 2016) Clément Cancès and Flore Nabet visited Daniel Matthes in Munich (June 6-8).

<h2 style="text-align:center; color:red">REALOPT Project-Team</h2>

9. Partnerships and Cooperations

9.1. Regional Initiatives

We have received support from the regional authorities (Region Aquitaine) for a research project on the planning under uncertainty. A postdoc, Agnès Leroux, has been recruited on this project. She currently develops dynamic programming approaches for scheduling problems and their application to building planning for phytosanitary treatments.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR Solhar (ANR-13-MONU-0007)

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computing platforms equipped with accelerators. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool. The focus of RealOpt in this project is on the scheduling aspect. Indeed, executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.
See also: http://solhar.gforge.inria.fr/

9.2.1.2. ANR SONGS (ANR 11 INFRA 13)

The goal of the SONGS project is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management. The contribution of RealOpt in this project revolves around enabling peer-to-peer simulation, and providing use cases for Cloud Computing simulations.
See also: http://infra-songs.gforge.inria.fr/

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. SAMBA

Title: Synergies for Ameliorations and Mastering of Branch-and-Price Algorithms

International Partner (Institution - Laboratory - Researcher):

Universidade Federal Fluminense (Brazil) - LIGOS - Eduardo Uchoa

Start year: 2011

See also: https://realopt.bordeaux.inria.fr/?page_id=573

SAMBA is a research project between the Inria project team ReAlOpt (Bordeaux, France), the ADT-Lab Pontifícia Universidade Católica do Rio de Janeiro, and the LOGIS at the Universidade Federal Fluminense. The project is supported by Inria under the "associate team" framework for an initial period of three years (2011-2013) and was renewed for another three years period (2014-2016) with additional partners at the Operations Research and Complex Systems Group School of Business, Universidad Adolfo Ibanez, Chile, and the LIRMM at the University of Montpellier.

Quantitative models are important tools for strategic, tactical, and operational decision-making. Many underlying optimization problems are discrete in nature. They are modeled as linear programs with integer variables, so called Mixed Integer Programs (MIP). Their solution is es- sentially based on enumeration techniques, which is notoriously difficult given the huge size ofthe solution set. Powerful generic commercial solvers for MIP are available, but despite continuous progress, the existing tools can be overwhelmed when problem complexity or size increases.

Decomposition approaches are primary tools to expand the capabilities of MIP solution techniques. When the application presents a decomposable constraint system, the so-called "Dantzig-Wolfe decomposition" consists in reformulating the problem as a selection of a specific solution for each individual subsystems that together satisfy the linking constraints. In practice, the individual subsystem solutions are brough in the formulation in the course of the opti- mization if they can lead to improvement in the objective value. On the other hand, "Benders' decomposition applies when the the application presents a decomposable system of variables, as traditional in stocahstic two-stage optimization models where main decisions are taken prior to knowing the realization ofr random data, while second stage decision are adjusments that can be done once the true value of data is revealed. In this context, one solves the first stage model and check a posteriori the feasibilility of the second stage. In case the second stage is infeasible, a constraint on the first stage variables is induced that aim to account for the cause of second stage infeasibility, and the processus reiterates.

Both of these decomposition approaches are perceived as requiring an application specific imple- mentation for tractability in scaling-up to real-life applications. Our research aim at developing generic methods for these and algorithmic enhancements to can yield significant speed-ups in prac- tice and have sound theoretical basis. Such research includes methodological developments (such as stabilization techniques for improved convergence, preprocessing rules, dynamic aggregation-and-disagregation), algorithms strategies (such as mutli-column/cut generation strategies, pre-evaluation of enumerated subproblem strategies – so-called strong branching), and efficient implementations (code re-engineering of our software platform BaPCod).

Beyond the methodological developments, our motivations are to set new benchmarks on standard combinatorial problems and industrial applications. In particular, we proceed to extend our tech-niques to the context of dynamic optimization. In a stochastic environment, the aim is to build a planning that are robust to perturbations in the sense that it can be adapted dynamically in reaction to the observed changes in the predicted data.

The project builds on the accumulated experience of both the Brazilian, the Chilean and the French teams that have done pioneering work in tackling complex applications and deriving generic solution strategies using this decomposition approach.

9.4. International Research Visitors

9.4.1. *Visits of International Scientists*

- LEITE BULHOES Teobaldo, from Universidade Federal Fluminense (Niteroi, Brazil), visited the team from November 2nd to December 9th.

9.4.2. *Visits to International Teams*

9.4.2.1. *Sabbatical programme*

Sadykov Ruslan

Date: Aug 2015 - Jul 2016

Institution: Universidade Federal Fluminense (Brazil)

9.4.2.2. Research Stays Abroad

- Thomas Lambert

  Date: Feb 8 - Mar 4

  Institution: University College of Dublin (Ireland)

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Gilles Celeux and Christine Keribin have a collaboration with the Pharmacoepidemiology and Infectious Diseases (PhEMI, INSERM) groups.

Christine Keribin is treasurer of the Société Française de Statistique (SFdS).

Sylvain Arlot and Pascal Massart co-organize a working group at ENS (Ulm) on statistical learning.

8.2. National Initiatives

8.2.1. ANR

SELECT is part of the ANR funded MixStatSeq.

8.3. International Initiatives

Gilles Celeux is one of the co-organizers of the international working group on model-based clustering. This year this workshop took place in Paris.

Julie Josse was chair of useR!2016, Stanford, CA, USA, July 2016. http://user2016.org/

Juile Josse is member of the R foundation.

<div align="center">**SEQUEL Project-Team**</div>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR BoB

Participant: Michal Valko.

- *Title*: Bayesian statistics for expensive models and tall data
- *Type*: National Research Agency
- *Coordinator*: CNRS (R. Bardenet)
- *Duration*: 2016-2020
- *Abstract*:

Bayesian methods are a popular class of statistical algorithms for updating scientific beliefs. They turn data into decisions and models, taking into account uncertainty about models and their parameters. This makes Bayesian methods popular among applied scientists such as biologists, physicists, or engineers. However, at the heart of Bayesian analysis lie 1) repeated sweeps over the full dataset considered, and 2) repeated evaluations of the model that describes the observed physical process. The current trends to large-scale data collection and complex models thus raises two main issues. Experiments, observations, and numerical simulations in many areas of science nowadays generate terabytes of data, as does the LHC in particle physics for instance. Simultaneously, knowledge creation is becoming more and more data-driven, which requires new paradigms addressing how data are captured, processed, discovered, exchanged, distributed, and analyzed. For statistical algorithms to scale up, reaching a given performance must require as few iterations and as little access to data as possible. It is not only experimental measurements that are growing at a rapid pace. Cell biologists tend to have scarce data but large-scale models of tens of nonlinear differential equations to describe complex dynamics. In such settings, evaluating the model once requires numerically solving a large system of differential equations, which may take minutes for some tens of differential equations on today's hardware. Iterative statistical processing that requires a million sequential runs of the model is thus out of the question. In this project, we tackle the fundamental cost-accuracy trade-off for Bayesian methods, in order to produce generic inference algorithms that scale favourably with the number of measurements in an experiment and the number of runs of a statistical model. We propose a collection of objectives with different risk-reward trade-offs to tackle these two goals. In particular, for experiments with large numbers of measurements, we further develop existing subsampling-based Monte Carlo methods, while developing a novel decision theory framework that includes data constraints. For expensive models, we build an ambitious programme around Monte Carlo methods that leverage determinantal processes, a rich class of probabilistic tools that lead to accurate inference with limited model evaluations. In short, using innovative techniques such as subsampling-based Monte Carlo and determinantal point processes, we propose in this project to push the boundaries of the applicability of Bayesian inference.

9.1.2. ANR Badass

Participants: Odalric Maillard, Emilie Kaufmann.

- *Title*:
- *Type*: National Research Agency
- *Coordinator*: Inria Lille (O. Maillard)
- *Duration*: 2016-2020

- *Abstract*: Motivated by the fact that a number of modern applications of sequential decision making require developing strategies that are especially robust to change in the stationarity of the signal, and in order to anticipate and impact the next generation of applications of the field, the BADASS project intends to push theory and application of MAB to the next level by incorporating non-stationary observations while retaining near optimality against the best not necessarily constant decision strategy. Since a non-stationary process typically decomposes into chunks associated with some possibly hidden variables (states), each corresponding to a stationary process, handling non-stationarity crucially requires exploiting the (possibly hidden) structure of the decision problem. For the same reason, a MAB for which arms can be arbitrary non-stationary processes is powerful enough to capture MDPs and even partially observable MDPs as special cases, and it is thus important to jointly address the issue of non-stationarity together with that of structure. In order to advance these two nested challenges from a solid theoretical standpoint, we intend to focus on the following objectives: *(i)* To broaden the range of optimal strategies for stationary MABs: current strategies are only known to be provably optimal in a limited range of scenarios for which the class of distribution (structure) is perfectly known; also, recent heuristics possibly adaptive to the class need to be further analyzed. *(ii)* To strengthen the literature on pure sequential prediction (focusing on a single arm) for non-stationary signals via the construction of adaptive confidence sets and a novel measure of complexity: traditional approaches consider a worst-case scenario and are thus overly conservative and non-adaptive to simpler signals. *(iii)* To embed the low-rank matrix completion and spectral methods in the context of reinforcement learning, and further study models of structured environments: promising heuristics in the context of e.g. contextual MABs or Predictive State Representations require stronger theoretical guarantees.

  This project will result in the development of a novel generation of strategies to handle non-stationarity and structure that will be evaluated in a number of test beds and validated by a rigorous theoretical analysis. Beyond the significant advancement of the state of the art in MAB and RL theory and the mathematical value of the program, this JCJC BADASS is expected to strategically impact societal and industrial applications, ranging from personalized health-care and e-learning to computational sustainability or rain-adaptive river-bank management to cite a few.

9.1.3. ANR ExTra-Learn

Participants: Alessandro Lazaric, Jérémie Mary, Rémi Munos, Michal Valko.

- *Title*: Extraction and Transfer of Knowledge in Reinforcement Learning
- *Type*: National Research Agency (ANR-9011)
- *Coordinator*: Inria Lille (A. Lazaric)
- *Duration*: 2014-2018
- *Abstract*: ExTra-Learn is directly motivated by the evidence that one of the key features that allows humans to accomplish complicated tasks is their ability of building knowledge from past experience and transfer it while learning new tasks. We believe that integrating transfer of learning in machine learning algorithms will dramatically improve their learning performance and enable them to solve complex tasks. We identify in the reinforcement learning (RL) framework the most suitable candidate for this integration. RL formalizes the problem of learning an optimal control policy from the experience directly collected from an unknown environment. Nonetheless, practical limitations of current algorithms encouraged research to focus on how to integrate prior knowledge into the learning process. Although this improves the performance of RL algorithms, it dramatically reduces their autonomy. In this project we pursue a paradigm shift from designing RL algorithms incorporating prior knowledge, to methods able to incrementally discover, construct, and transfer "prior" knowledge in a fully automatic way. More in detail, three main elements of RL algorithms would significantly benefit from transfer of knowledge. *(i)* For every new task, RL algorithms need exploring the environment for a long time, and this corresponds to slow learning processes for large environments. Transfer learning would enable RL algorithms to dramatically reduce the exploration

of each new task by exploiting its resemblance with tasks solved in the past. *(ii)* RL algorithms evaluate the quality of a policy by computing its state-value function. Whenever the number of states is too large, approximation is needed. Since approximation may cause instability, designing suitable approximation schemes is particularly critical. While this is currently done by a domain expert, we propose to perform this step automatically by constructing features that incrementally adapt to the tasks encountered over time. This would significantly reduce human supervision and increase the accuracy and stability of RL algorithms across different tasks. *(iii)* In order to deal with complex environments, hierarchical RL solutions have been proposed, where state representations and policies are organized over a hierarchy of subtasks. This requires a careful definition of the hierarchy, which, if not properly constructed, may lead to very poor learning performance. The ambitious goal of transfer learning is to automatically construct a hierarchy of skills, which can be effectively reused over a wide range of similar tasks.

- *Activity Report*: Research in ExTra-Learn continued in investigating how knowledge can be transferred into reinforcement learning algorithms to improve their performance. Pierre-Victor Chaumier did a 4 months internship in SequeL studying how to perform transfer neural networks across different games in the Atari platform. Unfortunately, the preliminary results we obtained were not very positive. We investigated different transfer models, from basic transfer of a fully trained network, to co-train over multiple games and retrain with initialization from a previous network. In most of the cases, the improvement from transfer was rather limited and in some cases even negative transfer effects appeared. This seems to be intrinsic in the neural network architecture which tends to overfit on one single task and it poorly generlizes over alternative tasks. Another activity was related to the study of macro-actions in RL. We proved for the first time under which conditions macro-actions can actually improve the learning speed of an RL exploration-exploitation algorithm. This is the first step towards the automatic identification and construction of useful macro-actions across multiple tasks.

9.1.4. ANR KEHATH

Participant: Olivier Pietquin.

- *Acronym*: KEHATH
- *Title*: Advanced Quality Methods for Post-Edition of Machine Translation
- *Type*: ANR
- *Coordinator*: Lingua & Machina
- *Duration*: 2014-2017
- *Other partners*: Univ. Lille 1, Laboratoire d'Informatique de Grenoble (LIG)
- *Abstract*: The translation community has seen a major change over the last five years. Thanks to progress in the training of statistical machine translation engines on corpora of existing translations, machine translation has become good enough so that it has become advantageous for translators to post-edit machine outputs rather than translate from scratch. However, current enhancement of machine translation (MT) systems from human post-edition (PE) are rather basic: the post-edited output is added to the training corpus and the translation model and language model are re-trained, with no clear view of how much has been improved and how much is left to be improved. Moreover, the final PE result is the only feedback used: available technologies do not take advantages of logged sequences of post-edition actions, which inform on the cognitive processes of the post-editor. The KEHATH project intends to address these issues in two ways. Firstly, we will optimise advanced machine learning techniques in the MT+PE loop. Our goal is to boost the impact of PE, that is, reach the same performance with less PE or better performance with the same amount of PE. In other words, we want to improve machine translation learning curves. For this purpose, active learning and reinforcement learning techniques will be proposed and evaluated. Along with this, we will have to face challenges such as MT systems heterogeneity (statistical and/or rule-based), and ML scalability so as to improve domain-specific MT. Secondly, since quality prediction (QP) on MT outputs is

crucial for translation project managers, we will implement and evaluate in real-world conditions several confidence estimation and error detection techniques previously developed at a laboratory scale. A shared concern will be to work on continuous domain-specific data flows to improve both MT and the performance of indicators for quality prediction. The overall goal of the KEHATH project is straightforward: gain additional machine translation performance as fast as possible in each and every new industrial translation project, so that post-edition time and cost is drastically reduced. Basic research is the best way to reach this goal, for an industrial impact that is powerful and immediate.

9.1.5. ANR MaRDi

Participants: Olivier Pietquin, Bilal Piot.

- *Acronym*: MaRDi
- *Title*: Man-Robot Dialogue
- *Type*: ANR
- *Coordinator*: Univ. Lille 1 (Olivier Pietquin)
- *Duration*: 2012-2016
- *Other partners*: Laboratoire d'Informatique d'Avignon (LIA), CNRS - LAAS (Toulouse), Acapela group (Toulouse)
- *Abstract*: In the MaRDi project, we study the interaction between humans and machines as a situated problem in which human users and machines share the same environment. Especially, we investigate how the physical environment of robots interacting with humans can be used to improve the performance of spoken interaction which is known to be imperfect and sensible to noise. To achieve this objectif, we study three main problems. First, how to interactively build a multimodal representation of the current dialogue context from perception and proprioception signals. Second, how to automatically learn a strategy of interaction using methods such as reinforcement learning. Third, how to provide expressive feedbacks to users about how the machine is confident about its behaviour and to reflect its current state (also the physical state).

9.1.6. National Partners

- CentraleSupélec
  - J.Perolat, B.Piot and O.Pietquin worked with M.Geist on Stochastic Games. it led to a conference publication in ICML 2016.
- Inria Nancy - Grand Est
  - J.Perolat, B.Piot and O.Pietquin worked with Bruno Scherrer on Stochastic Games. It led to a conference publication in AISTATS 2016 [47] and ICML 2016.
- Institut de Mathématiques de Toulouse
  - É. Kaufmann had publications at COLT, ALT and NIPS with Aurélie Garivier.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Program: H2020

Project acronym: BabyRobot

Project title: Child-Robot Communication and Collaboration

Duration: 01/2016 - 12/2018

Coordinator: Alexandros Potamianos (Athena Research and Innovation Center in Information Communication and Knowledge Technologies, Greece)

Other partners: Institute of Communication and Computer Systems (Greece), The University of Hertfordshire Higher Education Corporation (UK), Universitaet Bielefeld (Germany), Kunlgliga Tekniska Hoegskolan (Sweden), Blue Ocean Robotics ApS (Denmark), Univ. Lille (France), Furhat Robotics AB (Sweden)

Abstract: The crowning achievement of human communication is our unique ability to share intentionality, create and execute on joint plans. Using this paradigm we model human-robot communication as a three step process: sharing attention, establishing common ground and forming shared goals. Prerequisites for successful communication are being able to decode the cognitive state of people around us (mindreading) and building trust. Our main goal is to create robots that analyze and track human behavior over time in the context of their surroundings (situational) using audio-visual monitoring in order to establish common ground and mind-reading capabilities. On BabyRobot we focus on the typically developing and autistic spectrum children user population. Children have unique communication skills, are quick and adaptive learners, eager to embrace new robotic technologies. This is especially relevant for special eduation where the development of social skills is delayed or never fully develops without intervention or therapy. Thus our second goal is to define, implement and evaluate child-robot interaction application scenarios for developing specific socio-affective, communication and collaboration skills in typically developing and autistic spectrum children. We will support not supplant the therapist or educator, working hand-inhand to create a low risk environment for learning and cognitive development. Breakthroughs in core robotic technologies are needed to support this research mainly in the areas of motion planning and control in constrained spaces, gestural kinematics, sensorimotor learning and adaptation. Our third goal is to push beyond the state-of-the-art in core robotic technologies to support natural human-robot interaction and collaboration for edutainment and healthcare applications. Creating robots that can establish communication protocols and form collaboration plans on the fly will have impact beyond the application scenarios investigated here.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

Program: CHIST-ERA

Project acronym: IGLU

Project title: Interactively Grounded Language Understanding

Duration: 11/2015 - 10/2018

Coordinator: Jean Rouat (Université de Sherbrooke, Canada)

Other partners: UMONS (Belgique), Inria (France), Univ-Lille (France), KTH (sweden), Universidad de Zaragoza (Spain)

Abstract: Language is an ability that develops in young children through joint interaction with their caretakers and their physical environment. At this level, human language understanding could be referred as interpreting and expressing semantic concepts (e.g. objects, actions and relations) through what can be perceived (or inferred) from current context in the environment. Previous work in the field of artificial intelligence has failed to address the acquisition of such perceptually-grounded knowledge in virtual agents (avatars), mainly because of the lack of physical embodiment (ability to interact physically) and dialogue, communication skills (ability to interact verbally). We believe that robotic agents are more appropriate for this task, and that interaction is a so important aspect of human language learning and understanding that pragmatic knowledge (identifying or conveying intention) must be present to complement semantic knowledge. Through a developmental approach where knowledge grows in complexity while driven by multimodal experience and language interaction with a human, we propose an agent that will incorporate models of dialogues, human emotions and intentions as part of its decision-making process. This will lead anticipation and reaction not only based on its internal state (own goal and intention, perception of the environment), but also on the perceived state and intention of the human interactant. This will be possible through the development of advanced machine learning methods (combining developmental, deep and reinforcement

learning) to handle large-scale multimodal inputs, besides leveraging state-of-the-art technological components involved in a language-based dialog system available within the consortium. Evaluations of learned skills and knowledge will be performed using an integrated architecture in a culinary use-case, and novel databases enabling research in grounded human language understanding will be released.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. EduBand

Title: Educational Bandits

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Department of Computer Science, Theory of computation lab - Emma Brunskill

Start year: 2015

See also: https://project.inria.fr/eduband/

Education can transform an individual's capacity and the opportunities available to him. The proposed collaboration will build on and develop novel machine learning approaches towards enhancing (human) learning. Massive open online classes (MOOCs) are enabling many more people to access education, but mostly operate using status quo teaching methods. Even more important than access is the opportunity for online software to radically improve the efficiency, engagement and effectiveness of education. Existing intelligent tutoring systems (ITSs) have had some promising successes, but mostly rely on learning sciences research to construct hand-built strategies for automated teaching. Online systems make it possible to actively collect substantial amount of data about how people learn, and offer a huge opportunity to substantially accelerate progress in improving education. An essential aspect of teaching is providing the right learning experience for the student, but it is often unknown a priori exactly how this should be achieved. This challenge can often be cast as an instance of decision-making under uncertainty. In particular, prior work by Brunskill and colleagues demonstrated that reinforcement learning (RL) and multi-arm bandit (MAB) can be very effective approaches to solve the problem of automated teaching. The proposed collaboration is thus intended to explore the potential interactions of the fields of online education and RL and MAB. On the one hand, we will define novel RL and MAB settings and problems in online education. On the other hand, we will investigate how solutions developed in RL and MAB could be integrated in ITS and MOOCs and improve their effectiveness.

9.3.2. Inria International Partners

9.3.2.1. With CWI

Title: Learning theory

"North-European Associate Team"

Centrum Wiskunde & Informatica (CWI), Amsterdam (NL) - Peter Grünwald

Duration: 2016 - 2018

Start year: 2016

ABSTRACT: The aim is to develop the theory of learning for sequential decision making under uncertainty problems.

In 2016, this collaboration involved D. Ryabko, É. Kaufmann, J. Ridgway, M. Valko, A. Lazaric, O. Maillard. A post-doc funded by Inria has been recruited in Fall 2016.

This collaboration aims at developing through the Inria International Laboratory with CWI.

9.3.2.2. With University of Leoben

Title: The multi-armed bandit problem

International Partner (Institution - Laboratory - Researcher):

University of Leoben (Austria) - Peter Auer

Duration: 2016 - 2016

Start year: 2016

ABSTRACT: Study of the multi-armed bandit problem.

9.3.2.3. Informal International Partners

- University of California Irvine (USA)

    Anima Anandkumar *Collaborator*

    A. Lazaric collaborates with A. Anandkumar on the use of spectral methods for reinforcement learning.

- University of Lancaster (UK)

    Borja Balle *Collaborator*

    O-A. Maillard collaborates with B. Balle on concentration inequalities for Hankel matrices.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

- Cricia Zilda Felicio Paixao, University Uberlandia, Brasil, Sep. 2015-Jul. 2016, working on recommendation systems in collaboration with Philippe Preux

- Maryam Aziz, Northeastern University, May-Aug. 2016, working on multi-armed bandits for clinical trials in collaboration with Emilie Kaufmann

- Kamyar Azizzadenesheli, University of California at Irvine, Aug-Oct. 2016, working on latent variable models for reinforcement learning in collaboration with Alessandro Lazaric

- Pierre-Victor Chaumier, Ecole Polytechnique, Jan-Jun. 2016, working on transfer learning in collaboration with Alessandro Lazaric

- Firas Jarboui, ENSTA ParisTech, France, May-July.@ 2016, working on Human-AI co-operation, in collaboration with Christos Dimitrakakis.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Christos Dimitrakakis visited SEAS, Harvard University, USA in the context of a Swedish/EU project "Market Mechanisms for Multiple Minds", and the future of life institute project "Mechanism Design for Multiple AIs", May-June, September-December 2016.

- Christos Dimitrakakis visited ETHZ, Switzerland, in the context of the Swiss SNSF project "Differential Privacy and Approximate Decision Making", July-September 2016.

<h1 style="text-align:center; color:red;">SIERRA Project-Team</h1>

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. SIPA

Title: Semidefinite Programming with Applications in Statistical Learning

Type: FP7

Instrument: ERC Starting Grant Duration: May 2011 - May 2016 Coordinator: A. d'Aspremont (CNRS)

Abstract: Interior point algorithms and a dramatic growth in computing power have revolutionized optimization in the last two decades. Highly nonlinear problems which were previously thought intractable are now routinely solved at reasonable scales. Semidefinite programs (i.e. linear programs on the cone of positive semidefinite matrices) are a perfect example of this trend: reasonably large, highly nonlinear but convex eigenvalue optimization problems are now solved efficiently by reliable numerical packages. This in turn means that a wide array of new applications for semidefinite programming have been discovered, mimicking the early development of linear programming. To cite only a few examples, semidefinite programs have been used to solve collaborative filtering problems (e.g. make personalized movie recommendations), approximate the solution of combinatorial programs, optimize the mixing rate of Markov chains over networks, infer dependence patterns from multivariate time series or produce optimal kernels in classification problems. These new applications also come with radically different algorithmic requirements. While interior point methods solve relatively small problems with a high precision, most recent applications of semidefinite programming in statistical learning for example form very large-scale problems with comparatively low precision targets, programs for which current algorithms cannot form even a single iteration. This proposal seeks to break this limit on problem size by deriving reliable first-order algorithms for solving large-scale semidefinite programs with a significantly lower cost per iteration, using for example subsampling techniques to considerably reduce the cost of forming gradients. Beyond these algorithmic challenges, the proposed research will focus heavily on applications of convex programming to statistical learning and signal processing theory where optimization and duality results quantify the statistical performance of coding or variable selection algorithms for example. Finally, another central goal of this work will be to produce efficient, customized algorithms for some key problems arising in machine learning and statistics.

8.1.1.2. MacSeNet

Title: Machine Sensing Training Network

Type: H2020

Instrument: Initial Training Network

Duration: January 2015 - January 2019

Coordinator: Mark Plumbley (University of Surrey)

Inria contact: Francis Bach

Abstract: The aim of this Innovative Training Network is to train a new generation of creative, entrepreneurial and innovative early stage researchers (ESRs) in the research area of measurement and estimation of signals using knowledge or data about the underlying structure. We will develop new robust and efficient Machine Sensing theory and algorithms, together methods for a wide range of signals, including: advanced brain imaging; inverse imaging problems; audio and music signals; and non-traditional signals such as signals on graphs. We will apply these methods to real-world problems, through work with non-Academic partners, and disseminate the results of this research to a wide range of academic and non-academic audiences, including through publications, data, software and public engagement events. MacSeNet is funded under the H2020-MSCA-ITN-2014 call and is part of the Marie Sklodowska- Curie Actions — Innovative Training Networks (ITN) funding scheme.

8.1.1.3. Spartan

Title: Sparse Representations and Compressed Sensing Training Network Type: FP7

Instrument: Initial Training Network

Duration: October 2014 to October 2018

Coordinator: Mark Plumbley (University of Surrey)

Inria contact: Francis Bach

Abstract: The SpaRTaN Initial Training Network will train a new generation of interdisciplinary researchers in sparse representations and compressed sensing, contributing to Europe's leading role in scientific innovation. By bringing together leading academic and industry groups with expertise in sparse representations, compressed sensing, machine learning and optimisation, and with an interest in applications such as hyperspectral imaging, audio signal processing and video analytics, this project will create an interdisciplinary, trans-national and inter-sectorial training network to enhance mobility and training of researchers in this area. SpaRTaN is funded under the FP7-PEOPLE-2013-ITN call and is part of the Marie Curie Actions — Initial Training Networks (ITN) funding scheme: Project number - 607290

8.1.1.4. SEQUOIA

Title: Robust algorithms for learning from modern data

Programm: H2020

Type: ERC

Duration: 2017-202

Coordinator: Inria

Inria contact: Francis BACH

8.2. International Initiatives

8.2.1. Inria Associate Teams Not Involved in an Inria International Labs

8.2.1.1. BigFOKS2

Title: Learning from Big Data: First-Order methods for Kernels and Submodular functions

International Partner (Institution - Laboratory - Researcher):

> IISc Bangalore (India) - Computer Science Department - Chiranjib Bhattacharyya

Start year: 2016

See also: http://mllab.csa.iisc.ernet.in/indo-french.html

Recent advances in sensor technologies have resulted in large amounts of data being generated in a wide array of scientific disciplines. Deriving models from such large datasets, often known as "Big Data", is one of the important challenges facing many engineering and scientific disciplines. In this proposal we investigate the problem of learning supervised models from Big Data, which has immediate applications in Computational Biology, Computer vision, Natural language processing, Web, E-commerce, etc., where specific structure is often present and hard to take into account with current algorithms. Our focus will be on the algorithmic aspects. Often supervised learning problems can be cast as convex programs. The goal of this proposal will be to derive first-order methods which can be effective for solving such convex programs arising in the Big-Data setting. Keeping this broad goal in mind we investigate two foundational problems which are not well addressed in existing literature. The first problem investigates Stochastic Gradient Descent Algorithms in the context of First-order methods for designing algorithms for Kernel based prediction functions on Large Datasets. The second problem involves solving discrete optimization problems arising in Submodular formulations in Machine Learning, for which first-order methods have not reached the level of speed required for practical applications (notably in computer vision).

SPHINX Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- David Dos Santos Ferreira is the coordinator (PI) of a Young Researcher Program of the French National Research Agency (ANR) :
  Project Acronym : iproblems
  Project Title : Inverse Problems
  Coordinator : David Dos Santos Ferreira
  Duration : 48 months (2013-2017)

- Takéo Takahashi is the coordinator (PI) of a Researcher Program of the French National Research Agency (ANR) :
  Project Acronym : IFSMACS
  Project Title : Fluid-Structure Interaction: Modeling, Analysis, Control and Simulation
  Coordinator: Takéo Takahashi
  Duration : 48 months (starting on October 1st, 2016)
  URL: http://ifsmacs.iecl.univ-lorraine.fr/

- Xavier Antoine is member of the project TECSER funded by the French armament procurement agency in the framework of the Specific Support for Research Works and Innovation Defense (ASTRID 2013 program) operated by the French National Research Agency.
  Project Acronym: TECSER
  Project Title : Nouvelles techniques de résolution adaptées à la simulation haute performance pour le calcul SER
  Coordinator: Stéphane Lanteri (Inria, NACHOS project-team)
  Duration: 36 months (starting on May 1st, 2014)
  URL: http://www-sop.inria.fr/nachos/projects/tecser/index.php/Main/HomePage

- Xavier Antoine is member of the project BoND.
  Project Acronym: BoND
  Project Title: Boundaries, Numerics and Dispersion.
  Coordinator: Sylvie Benzoni (Institut Camille Jordan, Lyon, France)
  Duration: 48 months (starting on October 15th, 2013)
  URL: http://bond.math.cnrs.fr

- Xavier Antoine is the local coordinator of the ANR project BECASIM.
  Project acronym: BECASIM
  Project Title: Bose-Einstein Condensates: Advanced SIMulation Deterministic and Stochastic Computational Models, HPC Implementation, Simulation of Experiments.
  Coordinator: Ionut Danaila (Université de Rouen, France)
  Duration: 48 months (plus an extension of 12 months, until November 2017)
  URL: http://becasim.math.cnrs.fr

9.1.2. CNRS

Thomas Chambrion is the coordinator of the Research Project from CNRS Inphynity "DISQUO" (5300 euros, 2016).

9.2. International Initiatives

9.2.1. Participation in Other International Programs

Within the PHC Utique programme, a project of French-Tunisian collaboration involving some members of our team has been selected by Campus France. The exact amount of the budget is not known yet and will be comprised between 9000 and 16000 euros.

9.3. International Research Visitors

9.3.1. Visits to International Teams

Xavier ANTOINE has been a visitor of the Beijing CSRC for 4 weeks during the summer 2016.

<div align="center">

TAO Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

- **PGMO NUMBBER** 2016-2018 (60 kEuros)
  Coordinator: FMJH(Fondation mathématiques Jacques Hadamard - Paris Saclay) & Anne Auger
  Participants: Anne Auger, Nikolaus Hansen

9.2. National Initiatives

- **ROM***Model Reduction and Multiphysics Optimization* 2014-2016 (50 Keuros)
  Coordinator: IRT System X
  Participants: Marc Schoenauer, Michèle Sebag, François Gonard (PhD)

- **MAJORE***A Collaborative Filtering Approach to Matching Job Openings and Job Seekers*, 2013-2016 (105 kEuros)
  Thomas Schmitt's PhD (funded by ISN).
  Participants: Philippe Caillou, Michèle Sebag, Thomas Schmitt (PhD)

- **AutoML***An empirical approach to Machine Learning* 2014-2017 (104 kEuros)
  Sourava Mishra's PhD
  Participants: Michèle Sebag, Balazs Kégl, Sourava Mishra

- **ReMODeL***Rewarded Multimodal Online Deep Learning* 2015-2016 (31,5 kEuros)
  This project lies at the junction of reinforcement learning, deep learning, computational neuroscience and developmental robotic fields. It is closely related to the transversal DIGITEO robotic theme, Roboteo.
  Participants: Michèle Sebag, Mathieu Lefort, Alexander Gepperth

- **AMIQAP** 2015-2016 (12 months of Postdoctoral fellow). Project funded by ISN
  Participants: Philippe Caillou, Olivier Goudet, Isabelle Guyon, Michèle Sebag, Paola Tubaro, Diviyan Kalavanathan (2016 intern, 2017 PhD)

- **NUMBBO** 2012-2017 (290kEuros for TAO). Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers, ANR project, Coordinator Anne Auger, Inria. Other partners: Dolphin, Inria Lille, Ecole des Mines de Saint-Etienne, TU Dortmund
  Participants: Anne Auger, Nikolaus Hansen, Marc Schoenauer, Ouassim Ait ElHara

- **ACTEUR** 2014-2018 (236kEuros). Cognitive agent development for urban simulations, ANR project, Coordinator P. Taillandier (IDEES, Univ Rouen).
  Participant: Philippe Caillou

9.2.1. Other

- **POST** 2014-2017 (1,220 MEuros, including 500 kEuros for a 'private' cluster). Platform for the optimization and simulation of trans-continental grids
  ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie)
  Coordinator: ARTELYS
  Participants: Olivier Teytaud, Marie-Liesse Cauwet, Jérémie Decock, Sandra Cecilia Astete Morales, David L. Saint-Pierre, J. Decock

- **E-LUCID** 2014-2017 (194 kEuros)
  Coordinator: Thales Communications & Security S.A.S
  Participants: Marc Schoenauer, Cyril Furtlehner

- **PIA ADAMME** 2015-2018 (258 kEuros)
  Coordinator: Bull SAS
  Participants: Marc Schoenauer, Yann Ollivier, Gaetan Marceau Caron, Guillaume Charpiat, Cécile Germain-Renaud, Michèle Sebag
- **CNES contract** 2015-2017 (70 kEuros)
  Coordinator: Manuel Grizonnet (CNES) & Yuliya Tarabalka (Inria Sophia-Antipolis, Titane team)
  Participant: Guillaume Charpiat
- **ESA Tender** 2016-2017 (52 kEuros)
  Coordinator: Oana Togt (TNO) & Marc Schoenauer
  Participant: Marc Schoenauer

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

EHRI-II 2015-2019 (7 969 kEuros). European Holcaust Research Infrastructure, H2020, Coordinator NIOD, Amsterdam. Digital Humanities.
Participants: Gregory Grefenstette

See.4C 2016-2017 (2 700 kEuros). SpatiotEmporal ForEcasting: Coopetition to meet Current Crossmodal Challenges
Participants: Isabelle Guyon

9.3.2. Collaborations with Major European Organizations

MLSpaceWeather 2015-2019. Coupling physics-based simulations with Artificial Intelligence.
Coordinator: CWI
Participants: Michèle Sebag, Aurélien Decelle, Cyril Furtlehner.

ESA tender 2015-2016, through collaboration with TNO (see Section 9.2.1).

9.4. International Initiatives

9.4.1. CIADM

Title: Computational intelligence and Decision making

International Partner (Institution - Laboratory - Researcher):

NUTN (Taiwan) - Multimedia Informatics Lab - Chang-Shing Lee

Start year: 2015

See also: http://www.lri.fr/~teytaud/indema.html

The associate team works on computation intelligence for decision making, with different application fields for the various partners: - power systems (Tao) - eLearning (Oase) - games (Ailab)

9.4.2. S3-BBO

Title: Threefold Scalability in Any-objective Black-Box Optimization

International Partner (Institution - Laboratory - Researcher):

Shinshu (Japan) - Tanaka-Hernan-Akimoto Laboratory - Hernan Aguirre

Start year: 2015

See also: http://francejapan.gforge.inria.fr/doku.php?id=associateteam

This associate team brings together researchers from the TAO and Dolphin Inria teams with researchers from Shinshu university in Japan. Additionally, researchers from the University of Calais are external collaborators to the team. The common interest is on black-box single and multi-objective optimization with complementary expertises ranging from theoretical and fundamental aspects over algorithm design to solving industrial applications. The work that we want to pursue in the context of the associate team is focused on black-box optimization of problems with a large number of decision variables and one or several functions to evaluate solutions, employing distributed and parallel computing resources. The objective is to theoretically derive, analyze, design, and develop scalable black-box stochastic algorithms including evolutionary algorithms for large-scale optimization considering three different axes of scalability: (i) decision space, (ii) objective space, and (iii) availability of distributed and parallel computing resources.

We foresee that the associate team will make easier the collaboration already existing through a proposal funded by Japan and open-up a long term fruitful collaboration between Inria and Shinshu university. The collaboration will be through exchanging researchers and Ph.D. students and co-organization of workshops.

9.4.3. Informal International Partners

Marc Schoenauer partner of the ARC-DP (Australian Research Council Discovery Project) *bio-inspired computing methods for dynamically changing environments*. Coordinator: University of Adelaide (Frank Neumann), 5 years from Nov. 2015, 400 k$-AUS. Visit to Adelaide planned in Feb. 2017.

Isabelle Guyon partner of UC Berkeley *Fingerprint verification with deep siamese neural networks using ultratonic sensor data*. Co-advisor of a master student (Baiyu Chen). Partners: Alyosha Efros, Bernhard Boser.

9.4.4. Participation in Other International Programs

9.4.4.1. Indo-French Center of Applied Mathematics

Contextual multi-armed bandits with hidden structure

Title: Contextual multi-armed bandits with hidden structure

International Partner (Institution - Laboratory - Researcher):

  IISc Bangalore (India) - ECE - Aditya Gopalan

Duration: 12 months - April 2017

Start year: April 2016

Recent advances in Multi-Armed Bandit (MAB) theory have yielded key insights into, and driven the design of applications in, sequential decision making in stochastic dynamical systems. Notable among these are recommender systems, which have benefited greatly from the study of contextual MABs incorporating user-specific information (the context) into the decision problem from a rigorous theoretical standpoint. In the proposed initiative, the key features of (a) sequential interaction between a learner and the users, and (b) a relatively small number of interactions per user with the system, motivate the goal of efficiently exploiting the underlying collective structure of users. The state-of-the-art lacks a wellgrounded strategy with provably near-optimal guarantees for general, low-rank user structure. Combining expertise in the foundations of MAB theory together with recent advances in spectral methods and low-rank matrix completion, we target the first provably near-optimal sequential low-rank MAB

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- **Edgar Galvan Lopez** University College Dublin, April 2015 - December 2016, funded by the ELEVATE Fellowship, the Irish Research Council's Career Development Fellowship co-funded by Marie Curie Actions.

9.5.1.1. Internships

- **Borja Seijo** Universidade da Coruña, Galicia, Spain, October-November 2016, self-funded. Worked on missing data under the supervision of Isabelle Guyon.

- **Tomas Lungenstrass**, June 2016 - June 2017, self-funded. Worked on magnetic storm prediction under A. Decelle's, C. Furtlehner's and M. Sebag's supervision.

TOSCA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, 2014–2018) coordinated by F. Hamel (Univ. Aix-Marseille).

- E. Tanré is member of the ANR SloFaDyBio (Slow Fast Dynamics in Biology, ANR-14-CE25-0019, 2015-2017) coordinated by M. Desroches (EPI MATHNEURO, Inria Sophia Antipolis).

8.2. International Initiatives

8.2.1. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

8.2.1.1. ANESTOC-TOSCA

Title: Stochastic modelling of biology and renewable energies

International Partner (Institution - Laboratory - Researcher):

> Pontificia Universidad Católica de Chile (Chile) - ANESTOC Center (ANESTOC) - Rebolledo Rolando

Start year: 2014

See also: http://www.incidechile.cl/anestoc/teams-involved/

This French-Chilean Associated Team deals with stochastic modeling and simulation issues for renewable energies (wind and waves) and neurosciences. It is a follow-up of a long collaboration in which each of the side takes benefit from the other side know-how and structures. In particular, this Associated Team is strongly related to the CIRIC project "Stochastic Analysis of Renewable Energy". This project aims at transfering and valuing to Chilean companies the results of researches on renewable energies, mainly wind prediction at the windfarm's scale and waves energy potential of a site using video.

8.2.2. Participation in Other International Programs

8.2.2.1. International Initiatives

ECOS Discrelongmem

Title: On discretization procedures in Non-Gaussian long memory processes with applications in non parametric statistics and time series analysis

International Partner (Institution - Laboratory - Researcher):

> Universidad de Valparaiso (Chile) - CIMFAV – Facultad de Ingenieria

PI: E. Tanré (France), S. Torrès (Chile)

Duration: 2016 - 2018

Start year: 2016

Keywords: Approximations of non-Gaussian long-memory processes. Fractional Poisson processes (fPp). Skew Fractional Process (SfP).

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- L. Beznea (Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucarest) has been visiting TOSCA Nancy for 11 days in July.
- O. Lupaşcu (Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucarest) has been visiting TOSCA Nancy for one week in October.
- The TOSCA seminar organized by A. Richard in Sophia Antipolis has received the following speakers: Pierre-Emmanuel Jabin (University of Maryland), Christophe Henry (Institute of Lluid Flow Machinery, Polish Academy of Sciences), Tony Lelièvre (ENPC), D. Alberici (University of Bologna), Nicolas Fournier (Université Pierre et Marie Curie), Philip Protter (Columbia University), Jean-François Jabir (CIMFAV – Valparaiso, Chile), Roberto Cortez Milan (CIMFAV – Valparaiso, Chile), Areski Cousin (ISFA, Lyon).

8.3.1.1. Internships

BICHAT Antoine

> Subject: Modélisation de populations de cellules irradiées: une approche par processus de branchement
>
> Date: Sep. 2015 - June 2016 (projet recherche)
>
> Institution: Écoles des Mines de Nancy.

CORMIER Quentin

> Subject: Study of invariants associated to the dynamic of a neuron network subject to STDP
>
> Date: Oct. 2015 - Feb. 2016
>
> Institution: ENS Lyon

DUPRE Aurore

> Subject: Analyse et évaluation de l'adjonction de la modélisation de phénomènes convectifs dans un modèle numérique lagrangien de la couche limite atmosphérique
>
> Date: April 2016 - Oct. 2016
>
> Institution: Université de Reims Champagne-Ardenne

GEORGES Thomas

> Subject: Single Particle Tracking Techniques
>
> Date: Sept. 2016 - June 2017 (research project)
>
> Institution: Écoles des Mines de Nancy.

GUERBAB Ismail

> Subject: Sums of Pareto distributions
>
> Date: June 2016 - Aug. 2016
>
> Institution: Écoles des Mines de Nancy.

HELSON Pascal

> Subject: Spikking Neurons in interaction with Plasticity
>
> Date: April 2016 - Aug. 2016
>
> Institution: Ecole des Ponts et chaussées.

KANTASSI Ameni

> Subject: Processus du plus récent ancêtre commun dans des arbres de Galton-Watson
>
> Date: April 2015 - Aug. 2015

Institution: Univ. Lorraine et École Supérieure des Sciences et Technologies d'Hammam Sousse (Tunisie).

PAPIC Alexis

Subject: States Reduction on Markov Processes

Date: Mai 2016 - Aug. 2016

Institution: Univ. Pierre et Marie Curie.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

- N. Champagnat and D. Villemonais spent one week in Neuchâtel (Switzerland) in September, to work with Michel Benaïm.
- P. Pigato has spent two weeks in Valparaiso and Santiago (Chile) in March, working with R. Rebolledo and S. Torres.
- P. Pigato has spent one week in Padova (Italy), in June, for a collaboration with P. Dai Pra.
- A. Richard and E. Tanré have spent one week in Valparaíso and one week in Santiago (Chile) in December within the ECOS program (PIs: E. Tanré, S. Torres, C. Tudor), working with S. Torres (Univ. of Valparaiso).
- D. Talay spent ten days at Columbia University in October.

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Participation of Cormac Walsh to the ANR white project FINSLER (Géométrie de Finsler et applications), 2012-2016.

- Projet ANR CAFEIN (Combinaison d'approches formelles pour l'étude d'invariants numériques), responsable P.L. Garoche. Partenaires : ONERA, CEA LIST, ENSTA Paristech, Inria Saclay (Maxplus, Toccata, Parkas), Université de Perpignan, Prover, Rockwell Collins France.

- Projet ANR MALTHY (Méthodes ALgébriques pour la vérification de modèles Temporisés et HYbrides), responsable T. Dang. Partenaires : Verimag, CEA LIST, Inria Rennes, Inria Saclay, VISEO/Object Direct.

- Projet ANR DEMOCRITE ("DEmonstrateur d'un MOteur de Couverture des Risques sur un TErritoire), responsable Emmanuel Lapébie (CEA). Partenaires : CEA-GRAMAT, BSPP, Inria Saclay (Maxplus), Institut PPRIME - UPR3346 (CNRS, Univ. Poitiers, ISAE-ENSMA), IPSIS, SYSTEL, ARMINES-E.M. Alès-ISR, CERDACC (Univ. de Haute-Alsace).

9.1.2. Programme Gaspard Monge pour l'Optimisation

- Projet intitulé "Méthodes tropicales pour l'optimisation", responsable X. Allamigeon, faisant intervenir M. Akian, V. Boeuf, S. Gaubert, A.Hochart, R. Katz, et M. Skomra.

9.1.3. iCODE (Institut pour le Contrôle et la Décision de l'Idex Paris-Saclay)

- White project "Stabilité et stabilisation des systèmes commutés" (Oct 2014-June 2016), including M. Akian, X. Allamigeon, S. Gaubert, and members of EPI Geco, L2S, LIX, LSV (ENS Cachan), UVSQ.

9.2. International Research Visitors

9.2.1. Visits of International Scientists

- Ricardo Katz (Conicet and Cifasis, Argentina), May–June 2016
- Rajendra Bhatia (Indian Statistical Institute, New Delhi), 2 weeks in June 2016.
- Vladimir Gurvich (Rutgers), 2 weeks in Dec 2016.

9.2.2. Visits to International Teams

9.2.2.1. Research Stays Abroad

- S. Gaubert, invitation of one week to HKU, Hong-Kong, collaboration with Zheng Qu.

ABS Project-Team (section vide)

<p style="text-align:center">AIRSEA Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

N. Feyeux PhD is sponsored by the action ARC3 Environment of the Region Rhone-Alpes.

Clémentine Prieur obtained a 8kE two-years funding for a local project on risk by the Labex Persyval. Philippe Naveau (from LSCE, Paris) will visit the team during one month in this context.

9.2. National Initiatives

9.2.1. ANR

A 3.5 year ANR contract: ANR CITiES (numerical models project selected in 2012). https://team.inria.fr/steep/projects/.

A 4-year ANR contract: ANR TOMMI (Transport Optimal et Modèles Multiphysiques de l'Image), see paragraphs 7.4.2 , 7.4 .

A 5 year ANR contract (2011-2016): ANR COMODO (Communauté de Modélisation Océanographique) on the thematic "Numerical Methods in Ocean Modelling". (coordinator L. Debreu), see 7.1.1 .

A 4-year contract : ANR HEAT (Highly Efficient ATmospheric modelling) http://www.agence-nationale-recherche.fr/?Project=ANR-14-CE23-0010.

9.2.2. Other Initiatives

A. Vidard leads a group of projects gathering multiple partners in France and UK on the topic "Variational Data Assimilation for the NEMO/OPA9 Ocean Model", see 6.5 .

C. Prieur chaired GdR MASCOT NUM 2010-2015, in which are also involved M. Nodet, E. Blayo, C. Helbert, E. Arnaud, L. Viry, S. Nanty, L. Gilquin. She is still strong involved in thie group (co-chair) http://www.gdr-mascotnum.fr/doku.php.

C. Prieur is the leader of the LEFE/MANU project MULTIRISK (2014-2016) on multivariate risk analysis, which gathers experts from Lyon 1 University, CNAM, LSCE and Grenoble University mainly.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERA-CLIM2

Type: COOPERATION

Instrument: Specific Targeted Research Project

Program: Collaborative project FP7-SPACE-2013-1

Project acronym: ERA-CLIM2

Project title: European Reanalysis of the Global Climate System

Duration: 01/2014 - 12/2016

Coordinator: Dick Dee (ECMWF, Europe)

Other partners: Met Office (UK), EUMETSAT (Europe), Univ Bern (CH), Univ. Vienne (AT), FFCUL (PT), RIHMI-WDC (RU), Mercator-Océan (FR), Météo-France (FR), DWD (DE), CER-FACS (FR), CMCC (IT), FMI (FI), Univ. Pacifico (CL), Univ. Reading (UK), Univ. Versailles St Quentin en Yvelines (FR)

Inria contact: Arthur Vidard

9.3.2. Collaborations with Major European Organizations

Partner: European Centre for Medium Range Weather Forecast. Reading (UK)

World leading Numerical Weather Center, that include an ocean analysis section in order to provide ocean initial condition for the coupled ocean atmosphere forecast. They play a significant role in the NEMOVAR project in which we are also partner.

Partner: Met Office (U.K) National British Numerical Weather and Oceanographic service. Exceter (UK).

We do have a strong collaboration with their ocean initialization team through both our NEMO, NEMO-ASSIM and NEMOVAR activities. They also are our partner in the NEMOVAR consortium.

Partner: University of Reading, Department of Meteorology, Department of Mathematics

Subject: Data assimilation for geophysical systems.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

F. Lemarié and L. Debreu collaborate with Hans Burchard and Knut Klingbeil from the Leibniz-Institut für Ostseeforschung in Warnemünde.

C. Prieur collaborates with Jose R. Leon (UCV, Central University of Caracas), who is funded by the international Inria chair program.

C. Prieur is collaborating with AC Favre (LTHE, Grenoble) in the framework of a two-years canadian funding from CFQCU (Conseil franco-québécois de coopération universitaire) 2015-2016.

9.4.2. Participation in Other International Programs

9.4.2.1. International Initiatives

SIDRE

Title: Statistical inference for dependent stochastic processes and application in renewable energy

International Partners (Institution - Laboratory - Researcher):

> Universidad de Valparaiso (Chile) - Karine Bertin

> Universidad Central de Venezuela (Venezuela) - Jose León

Duration: 2016 - 2017

Start year: 2016

C. Prieur is one of the two french coordinators of the MATH AmSud project SIDRE. We want to develop, apply and study the properties of statistical tools in several non-parametric models, segmentation models, time series and random fields models, and to study some classes of long-range dependent processes, for their possible application in renewable energies and other domains. In particular non-parametric statistical procedure in Markov switching non-linear autoregressive models, finite mixture, non-parametric functional test and non-parametric estimators in stochastic damping Hamiltonian systems will be considered. Statistical tools for segmenting dependent multiples series, censoring processes in time series models and a new model interpolation scheme will be studied.

9.5. International Research Visitors

9.5.1. Visits to International Teams

F.-X. Le Dimet has been invited for 2 weeks in October 2016 at Florida State University. He has delivered a seminar.

F.-X. Le Dimet has been invited for 3 weeks at the Harbin Institute of Technology in June 2016 to work with Ma Jianwei and Long Li. He delivered 2 seminars and 2 courses on data assimilation.

F.-X. Le Dimet has been invited for a week at Universidad Complutense in Maddrid in November 2016 to lecture (8 hours) on Variational Data Assimilation. A collaboration has been started on oil pollution on the ocean. The project will include the developments of Assimilation of Images and data assimilation for pollution carried out at the Institute of Mechanics in Hanoi.

<p style="text-align:center; color:red;">**AMIB Project-Team**</p>

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. FRM

Yann Ponty is the Bioinformatics PI for a *Fondation de la Recherche Médicale*-funded project.

Fondation pour la Recherche Medicale – *Analyse Bio-informatique pour la recherche en Biologie* program

- Approche comparatives haut-débit pour la modelisation de l'architecture 3D des ARN à partir de données experimentales
- 2015–2018
- Yann Ponty, A. Denise, M. Regnier, A. Saaidi (PhD funded by FRM)
- B. Sargueil (Paris V – Experimental partner), J. Waldispuhl (Univ. McGill)

6.2. European Initiatives

6.2.1. Collaborations in European Programs, Except FP7 & H2020

Yann Ponty is the French PI for the French/Austrian RNALANDS project, jointly funded by the French ANR and the Austrian FWF, in partnership with the Theoretical Biochemistry Institute (University of Vienna, Austria), LRI (Univ. Paris-Sud) and EPI BONSAI (Inria Lille-Nord Europe).

French/Austrian International Program

RNALANDS (ANR-14-CE34-0011)

Fast and efficient sampling of structures in RNA folding landscapes

01/10/2014–30/09/2018

Coordinated by AMIB (Inria Saclay) and TBI Vienna (University of Vienna)

EPI BONSAI/INRIA Lille - Nord Europe, Vienna University (Austria), LRI, Université Paris-Sud (France)

The main goal of the RNALands project is to provide efficient tools for studying the kinetics of RiboNucleic Acids, based on efficient sampling strategies.

Partenariat Henri Curien (CampusFrance, programme Staël)

Random constrained permutations: Algorithms and Analysis

01/01/2015–31/12/2016

Coordinated by CMAP (Ecole Polytechnique) and Maths Dept (Univ. Zürich, Switzerland)

LIX (Ecole Polytechnique), LIPN (Univ Paris XIII), LIGM (Univ Marne-la-Vallée)

The goals of this collaborative network is to initiate or push several collaborations related to the structure of random constrained permutations. AMIB bring their strength in random generation and discrete algorithms, and benefit from the considerable expertise accumulated at University of Zürich on permutation patterns.

6.3. International Initiatives

6.3.1. Inria International Labs

6.3.1.1. Declared Inria International Partners

Title: AMAVI - Combinatorics and Algorithms for the Genomic sequences

International Partner (Institution - Laboratory - Researcher):

Vavilov Institute of General Genetics (Russia (Russian Federation)) - Department of Computational Biology - Vsevolod Makeev

Duration: 2013 - 2017

Start year: 2013

VIGG and AMIB teams has a more than 12 years long collaboration on sequence analysis. The two groups aim at identifying DNA motifs for a functional annotation, with a special focus on conserved regulatory regions. In the current 3-years project CARNAGE, our collaboration, that includes Inria-team MAGNOME, is oriented towards new trends that arise from Next Generation Sequencing data. Combinatorial issues in genome assembly are addressed. RNA structure and interactions are also studied.

The toolkit is pattern matching algorithms and analytic combinatorics, leading to common software.

6.3.1.2. Regular International Partners

AMIB enjoys regular interactions with the following institutions:

- Simon Fraser University (Vancouver, Canada). The Mathematics department at SFU has ongoing projects on RNA design, comparative genomics and RNA structure comparison with our team. M. Mishna (SFU) will also visit Inria Saclay in January 2017 to push an oingoing collaboration on 2D walks;
- McGill University (Montréal, Canada). Following our productive collaboration with J. Waldispühl (Computer Science Dept, McGill), and the recent defense of V. Reinharz's PhD, whose thesis was co-supervised by AMIB members, we plan to increase our interactions on SHAPE data analysis by applying for an Inria associate team;
- King's college (London, UK). Our collaboration with L. Mouchard (AMIB associate) and S. Pissis on string processing and data structures is at the core of Alice Héliou's PhD. To finalize the implementation of her algorithms and apply them on real data, Alice has spent a two month period during the summer of 2016 at the EBI.

6.3.2. Participation in Other International Programs

France-Stanford exchange program

Duration: 2014 - 2016

Start year: 2014

See also: http://francestanford.stanford.edu/collaborative_projects

Amélie Héliou is co-supervised by H. Van Den Bedem in Stanford. Her tow-months visit to Stanford during the Fall of 2016 was funded by France-Stanford.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

6.4.1.1. Internships

Frédéric Lavner

Date: 01/07/2016- 31/08/2016

Institution: ENSEA (France)

Supervisor: Mireille Régnier

Maria Waldl

Date: 01/08/2016 - 31/09/2016

Institution: TBI, University of Vienna (Austria)

Supervisor: Yann Ponty

6.4.2. Visits to International Teams

- Yann Ponty has visited M. Mishna and C. Chauve at the Simon Fraser University for two weeks in July 2016;

- Juraj Michalik has visited A. Tanzer and I. Hofacker at the university of Vienna (Austria) for one week in November 2016;

- Mireille Régnier has visited MIPT (Moscow) and Novossibirsk University to enhance student exchanges between these universities and Ecole polytechnique.

6.4.2.1. Research Stays Abroad

- Alice Héliou has visited the EBI (UK) for two months during the Fall of 2016;

- Amélie Héliou has visited Stanford University (USA) for two months during the Summer of 2016;

ANGE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Plasticity of geophysical flows and seismic emissions (2013-2016)*
Participant: Anne Mangeney.

This project is funded by Sorbonne Paris Cité (80.000 euros) and is a collaboration between IPGP and Univ. Paris 13.

9.1.2. *LRC Manon (2014-2018)*
Participants: Edwige Godlewski, Yohan Penel, Nicolas Seguin.

CEA and Laboratory Jacques-Louis Lions launched a collaboration in order to carry out studies about complex fluids (modelling, numerical simulations and optimisation), in particular about compressible two-phase flows. This includes the derivation of strategies for model coupling, for instance in the case of an asymptotic hierarchy of models.

9.2. National Initiatives

9.2.1. *ANR SEDIFLO (2015-2019)*
Participants: Emmanuel Audusse, Martin Parisot.

> Program: ANR Défi 1 "Gestion sobre des ressources et adaptation au changement climatique" (JCJC)
>
> Project acronym: SEDIFLO
>
> Project title: Modelling and simulation of solid transport in rivers
>
> Coordinator: Sébastien Boyaval (LHSV/ENPC)

Based on recent theoretical and experimental results, this project is aimed at modelling transport of sediments within rivers. It will rely on innovations from the point of view of rheology as well as advanced mathematical tools (asymptotic model reduction, PDE discretisation).

9.2.2. *ANR Hyflo-Eflu (2016-2020)*
Participants: Jérérmy Ledoux, Martin Parisot, Jacques Sainte-Marie, Julien Salomon.

> ANR project call: Energies marines renouvelables
>
> Project acronym: Hyflo-Eflu
>
> Project title: Hydroliennes flottantes et énergie fluviale
>
> Coordinator: Julien Salomon

The project is a collaboration between the Inria-team ANGE, specialist of free surface flow and optimization, and the industrial developers of the turbine, HYDROTUBE ENERGIE. The objective of the project HyFlo-EFlu is to deliver a numerical software able to simulate the dynamic of a floating water turbine in real context. For the academic partner, the main challenge is in the simulation of the floating structure at the scale of the river, and the modelling of the vertical and horizontal axis turbine. For the industrial partner, the objective is the validation of the stability of the structure and the performance in term of energy production.

9.2.3. CNRS CORSURF (2016)

Participants: Bernard Di Martino, Cindy Guichard, Anne Mangeney, Jacques Sainte-Marie.

>   CNRS project call: INSU-INSMI
>
>   Project acronym: CORSURF
>
>   Project title: COmplex Rheology SURface Flows
>
>   Coordinator: Cindy Guichard

In collaboration with E. Fernández-Nieto (Sevilla, Spain).

Geophysical flows like avalanches (mud, snow) or landslides involve surface flows with non-Newtonian fluids. The goal is to develop numerical models, both accurate with respect to the material behavior and industrially efficient.

9.2.4. CNRS MOCHA (2016)

Participant: Martin Parisot.

>   CNRS project call: PEPS
>
>   Project acronym: MOCHA
>
>   Project title: Multi-dimensiOnal Coupling in Hydraulics and data Assimilation
>
>   Coordinator: Martin Parisot

Multi-dimensionnal coupling in river hydrodynamics offers a convenient solution to properly model complex flow while limiting the computational cost and making the most of pre-existing models. The project aims to adapt the lateral interface coupling proposed in [37] to the implicit version and test it on real data for the Garonne River.

9.2.5. CNRS Moset (2016-2017)

Participants: Emmanuel Audusse, Martin Parisot.

>   CNRS project call: INSU Tellus
>
>   Project acronym: Moset
>
>   Project title: Modélisation des suspensions concentrées naturelles
>
>   Coordinator: Emmanuel Audusse

In collaboration with G. Antoine (EDF), S. Boyaval (LHSV), C. Le Bouteiller (Irstea), M. Jodeau (EDF).

Gathering mathematicians (numerical analysis) and geophysicists, this project focuses on the quantitative prediction of solid transport. This issue raises several questions about rheology when the sediment concentration is high enough. It is crucial for modelling the dynamics of suspension. The collaboration aims at assessing models by means of experimental data and at providing preliminary numerical results to evaluate the order of magnitude of constraints.

9.2.6. Inria Project Lab "Algae in Silico" (2015-2018)

Participants: Nora Aïssiouene, Marie-Odile Bristeau, David Froger, Yohan Penel, Jacques Sainte-Marie, Fabien Souille.

In the aftermath of the ADT In@lgae (2013–2015), we developed a simulation tool for microalgae culture. An Inria Project Lab "Algae in Silico" has started in collaboration with Inria teams BIOCORE and DYLISS. It concerns microalgae culture for biofuel production and the aim is to provide an integrated platform for numerical simulation "from genes to industrial processes".

9.2.7. ANR MIMOSA (2014–2017)

Participants: Nora Aïssiouene, Marie-Odile Bristeau, Anne Mangeney, Bernard Di Martino, Jacques Sainte-Marie.

Program: ANR Défi 1 "Gestion sobre des ressources et adaptation au changement climatique"

Project acronym: MIMOSA

Project title: MIcroseism MOdeling and Seismic Applications

Coordinator: Eleonore Stutzmann (IPGP)

Seismic noise is recorded by broadband seismometers in the absence of earthquakes. It is generated by the atmosphere-ocean system with different mechanisms in the different frequency bands. Even though some mechanisms have been known for decades, an integrated understanding of the noise in the broadband period band 1-300sec is still missing. Using novel theoretical, numerical and signal processing methods, this project will provide a unified understanding of the noise sources and quantitative models for broadband noise. Conversely, we will be able to interpret seismic noise in terms of ocean wave properties. This first analysis step will lead to the identification and characterization of source events, which we will use to improve noise tomography, and seismic monitoring.

9.2.8. ANR LANDQUAKES (2012–2016)

Participant: Anne Mangeney.

Program: ANR Blanc "Mathématiques et interactions"

Project acronym: LANDQUAKES

Project title: Modélisation des glissements de terrain et des ondes sismiques générées pour détecter et comprendre les instabilités gravitaires

Coordinator: Anne Mangeney

Within the ANR domain "Mathematics and Interfaces", this ANR project (between Univ. Paris-Est – LAMA, Univ. Denis Diderot Paris 7 – IPGP, Univ. Nantes – LPGN, Univ. Strasbourg EOST, 180.000 euros) deals with the mathematical and numerical modelling of landslides and generated seismic waves.

A. Mangeney is also involved in the CARIB ANR program (2014–2017) entitled "Comprendre les processus de construction et de destruction des volcans de l'Arc des Petites Antilles".

9.2.9. GdR EGRIN (2013–2017)

Participants: Emmanuel Audusse, Bernard Di Martino, Nicole Goutal, Cindy Guichard, Anne Mangeney, Martin Parisot, Jacques Sainte-Marie.

EGRIN stands for Gravity-driven flows and natural hazards. J. Sainte-Marie is the head of the scientific committee of this CNRS research group and A. Mangeney is a member of the committee. Other members of the team involved in the project are local correspondents. The scientific goals of this project are the modelling, analysis and simulation of complex fluids by means of reduced-complexity models in the framework of geophysical flows.

9.3. European Initiatives

9.3.1. ERC Consolidator Grant (2013-2018)

Participants: Anne Mangeney, Hugo Martin.

The project SLIDEQUAKES is about detection and understanding of landslides by observing and modelling gravitational flows and generated earthquakes and is funded by the European Research Council (2 million euros). More precisely, it deals with the mathematical, numerical and experimental modelling of gravitational flows and generated seismic waves coupled with field measurements to better understand and predict these natural hazards and their link with volcanic, seismic and climatic activities.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

The collaboration with IMUS (Institute of Mathematics of the university of Sevilla, Spain) was informaly launched in 2016 through several visits in Spain of members of ANGE and the writing of a paper. To go further, a submission was made to create an Inria Associate Team.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

In the framework of the collaboration with researchers at the university of Sevilla (Spain), Enrique Fernández-Nieto spent two weeks (weeks n. 13 and 41) at Inria. IPGP hosted several researchers who work with A. Mangeney: Pere Roig (PhD, Departamento de Geodinámica i Geofísica, University of Barcelona, Spain), Giulia Bossi (postdoc, ETH, Zürich), Andrea Wolter and Margherita Spreafico (permanent positions, ETH, Zürich).

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Y. Penel spent three months (Jan.-Mar.) at the university of Sevilla (Spain) to collaborate with E. Fernández-Nieto.
- N. Aissiouene went to the university of Málaga for one month (Apr.) and was involved in the project EDANYA.
- C. Guichard, Y. Penel and J. Sainte-Marie were invited to the university of Sevilla for one week (week n. 42) to set up a forthcoming project.
- A. Mangeney went to Sevilla in November (week n. 47).

We also mention that M. Parisot spent one week (week n. 48) at the university of Toulouse (CERFACS).

ARAMIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR-NIH CRCNS
Participants: Fabrizio de Vico Fallani [Correspondant], Mario Chavez, Denis Schwartz.

Project acronym: NETBCI

Project title: Modeling and predicting brain-computer interface learning from dynamic networks

Duration: Avr 2016 - Avr 2020

Amount: 322k€

Coordinator: Fabrizio De Vico Fallani

Other partners: Complex system group, Université Penn, Etats-units

Abstract: This project will bring together expertise in computational and experimental neuroscience, signal processing and network science, statistics, modeling and simulation, to establish innovative methods to model and analyze temporally dynamic brain networks, and to apply these tools to develop predictive models of brain-computer interface (BCI) skill acquisition that can be used to improve performance. Leveraging experimental data and interdisciplinary theoretical techniques, this project will characterize brain networks at multiple temporal and spatial scales, and will develop models to predict the ability to control the BCI as well as methods to engineer BCI frameworks for adapting to neural plasticity. This project will enable a comprehensive understanding of the neural mechanisms of BCI learning, and will foster the design of viable BCI frameworks that improve usability and performance.

9.1.1.2. ANR PREV-DEMALS
Participants: Olivier Colliot [Correspondant], Marie Chupin, Stanley Durrleman, Anne Bertrand.

Project acronym: PREV-DEMALS

Project title: Predict to prevent frontotemporal lobar degeneration (FTLD) and amyotrophic lateral sclerosis (ALS)

Duration: Avr 2015 - Avr 2019

Amount: 487k€

Coordinator: Isabelle Le Ber

Other partners: ICM, AP-HP, CHR de Lille, CHU Limoges, CHU Rouen, Laboratory of Biomedical Imaging

Abstract: The project focuses on C9ORF72, the most frequent genetic form of frontotemporal lobar degeneration (FTLD) and amyotrophic lateral sclerosis (ALS). Since 2006, major discoveries have helped elucidate the pathological bases and linked FTLD and ALS: 1) TDP-43 aggregates in neurons and 2) C9ORF72 mutations in both disorders. Two major pathological subtypes are now defined in FTLD, FTLD-TDP and FTLD-TAU. C9ORF72 mutations (associated to FTLD-TDP) are the most frequent genetic causes of FTLD (15%), FTLD-ALS (65%) and ALS (40%). No curative treatment actually exists, but therapeutics emerged against tau aggregation. The objectives of the project are to develop appropriate cognitive, brain imaging markers and peripheral biomarkers of the early phase of FTLD, to follow disease progression and to guide future targeted therapeutic trials. To address this questions, we will conduct a multimodal study (cognition, brain structural MRI, brain metabolism

- FDG-PET) in C9ORF72 families. The cohort will be followed at 3-time points (M0, M18, M36). Longitudinal analyses will aim at characterizing the trajectory of decline across time. Brain structural changes will be evaluated by 1) morphometric analysis to assess global brain atrophy, cortical thickness and study of the cortical sulci; 2) functional connectivity analysis of resting-state MR data; 3) structural connectivity analysis of diffusion-weighted MRI. Brain metabolism will be evaluated with FDG-PET. We will use the most recent RNA sequencing technology to detect gene expression and RNA splicing alterations in lymphocytes of patients and presymptomatic carriers. The discovery of new markers involved in FTLD will have practical consequences for early and accurate diagnosis of FLD and ALS disease.

9.1.1.3. ANR IVMRS

Participants: Anne Bertrand [Correspondant], Alexandra Petiet, Mathieu Santin, Francesca Branzoli, Benoit Delatour, Marc Sanson.

Project acronym: IVMRS

Project title: Implantable miniaturized probe for In-vivo Magnetic Resonance Spectroscopy: Application to Murine models of Alzheimer's disease and Gliomas.

Duration: Oct 2016 - Oct 2020

Amount: 633k€

Coordinator: Luc Hebrard

Other partners: ICube - Unistra, Strasbourg; ISA Laboratory, Lyon; NYU School of Medicine, NY, USA.

Abstract: During the development of new therapeutics against brain diseases, the pre-clinical phase, i.e. the validation of treatment delivery, safety and efficacy in animal models of the disease, represents a crucial step. Magnetic Resonance Imaging (MRI) is a method of particular interest at this stage, as it provides non-invasive surrogate endpoints that can help selecting appropriate candidates during the process of drug development. Single Voxel Magnetic Resonance Spectroscopy (SVS) provides non-invasive, in-vivo quantitative measurements of brain metabolites, which reflects functional changes at the cellular and subcellular levels, and can be repeated longitudinally. As high-field MRI has become the benchmark in preclinical research on animal models, it appears possible to investigate the cerebral metabolomics changes in animals, and to use it as a surrogate marker in preclinical therapeutic trials. However, the number of relevant metabolites is much higher than the low number of measurable metabolites with conventional in-vivo high-field SVS. Moreover, considering also the subtle changes of these metabolites at the early stage of the disease, the use of conventional high-field SVS in preclinical studies remains strongly limited. The high volume of the Voxel-of-Interest (VOI), ranging from 10 to 30mm3, which is required to have a usable signal in conventional SVS, and the inherent variability of longitudinal SVS measurement due to the variable position of the VOI in the successive experiments, remain the two major issues when looking during time for small changes in metabolic concentrations and metabolites ratios in a specific small region of the animal brain. The IvMRS project aims at filling this gap by developing the first chronic implantable MRS micro-probe (μ- probe), minimally invasive, exhibiting very high signal sensitivity, and sharp spectral peaks, from sub-millimetric VOI. Such a probe will allow detecting a much higher number of metabolites than conventional in-vivo SVS. The μ-probe will work at frequencies ranging from 300MHz to 500MHz in ultra-high field Magnetic Resonance Imaging scanners, 7T and 11.7T. It will embed a specific micro-coil antenna, a low-noise signal conditioning circuit designed in CMOS microelectronics technology, as well as an accurate on-chip positioning sensor. It will be dedicated to the study of changes in brain metabolite markers of two major diseases, Alzheimer's disease and cerebral gliomas, and to the assessment of effective therapeutic strategies.

9.1.2. IHU

9.1.2.1. General program

Participants: Olivier Colliot, Mario Chavez, Stanley Durrleman, Marie Chupin, Didier Dormont, Dominique Hasboun, Damien Galanaud, Fabrizio de Vico Fallani.

Project acronym: IHU-A-ICM

Project title: Institute of Translational Neuroscience

Founded in 2011

General Director: Bertrand Fontaine

The IHU-A-ICM program was selected, in 2011, in a highly competitive national call for projects. A 10-year, 55M€ program, has been implemented by a recently created foundation for scientific cooperation. Based on the clinical and scientific strenghts of the ICM and the hospital Department of Nervous System Diseases, it mainly supports neuroscience research, but is also invested in improving care and teaching. ARAMIS is strongly involved in the IHU-A-ICM project, in particular in WP6 (neuroimaging and electrophysiology), WP7 (biostatistics), WP2 (Alzheimer) and WP5 (epilepsy). We have started collaborations with the new bioinformatics/biostatistics platform (IHU WP7, head: Ivan Moszer), in particular through a joint project on the integration of imaging and genomics data.

9.1.2.2. ICM-Internal Research projects

Participants: Anne Bertrand [Correspondant], Takoua Kaaouana, Benoit Delatour, Alexandra Petiet.

Project title: The Histo-MRI project: targeting MR signature of tauopathy from micro- to macroscopy

Founded in 2014

Coordinator: Anne Bertrand

Identifying morphological MR signatures of brain diseases usually follows a top-down process, which starts by describing a pattern of MR signal changes in patients, hypothesizes an underlying pathological mechanism, and confirms this mechanism by correlating the observed MR signal changes with histological lesions on post-mortem examination. This top-down process, relevant for large, centimetric brain lesions, becomes inappropriate when targeting the MR signal intensity changes associated with microscopic lesions. Our project aims at developing an MR biomarker of NFT using a new bottom-up approach. We will start by identifying the MR signal changes associated with the presence of NFT at the level of the histological slice, and utilize these findings to develop a method of NFT quantification on clinical, millimetric 3D MR images. To achieve this goal, we will develop and implement a 11.7T histological coil dedicated to the scanning of histological slices, which allows both ultra-high resolution MR imaging (up to 33 microns in-plane) and perfect co-registration with histological staining, performed subsequently on the same slice. This method has the potential to provide a novel biomarker of tauopathy that could not have been identified using the usual top-down approach. It also envisions the possibility to describe and understand new MRI contrasts in other neurodegenerative diseases associated with microscopic deposition of various proteins.

9.1.2.3. ICM-Internal Research projects

Participants: Mario Chavez [Correspondant], Fabrizio de Vico Fallani [Correspondant].

Project title: Non-invasive manipulation of brain synchrony to enhance brain function and rehabilitate faulty cognition in humans: A proof of concept

Founded in 2014

Coordinator: Antoni Valero Cabre (ICM-team "Dynamiques Cérébrales, Plasticité et Rééducation")

Other partners: Service des Urgences Cérébro-Vasculaires de l'Hôpital Pitié-Salpêtrière, Paris.

The long-term goal of this project is to develop the use of non-invasive manipulation of abnormal cerebral oscillations underlying cognitive activity to restore brain function in neurological patients. Cognitive functions emerge from large distributed networks organized in space and time. The short-term goal of this application is to study the causal role played by oscillatory activity in visual awareness and test whether their manipulation by non-invasive brain stimulation has the potential to restore its function in stroke patients.

9.1.2.4. ICM Big Brain Theory Program
Participants: Stanley Durrleman [Correspondant], Harald Hampel [Correspondant], Sabrina Fontanella, Simone Lista, Olivier Colliot, Stephanie Allassonniere, Jean-Baptiste Schiratti, Bruno Dubois, Hovagim Bakardjian, Remi Genthon, Enrica Cavedo, Katrine Rojkowa.

Project title: Dynamic models of disease progression across Alzheimer's disease stages informed by multimodal neuroimaging and biological data

Founded in 2016-2017

Coordinator: Stanley Durrleman and Harald Hampel

Other partners: Institut de la Mémoire et de la maladie d'Alzheimer

The estimation of data-driven models of disease progression for neurodegenerative diseases, including Alzheimer's disease (AD), is crucial to confirm, refine and extend the current hypothetical models. The estimation of such quantitative models from longitudinal data sets is notably difficult because of the lack of principled methodological frameworks for the analysis of spatiotemporal data.

The project builds on an innovative mathematical, statistical, and computational framework to automatically align the dynamics and the direction of individual trajectories of the evolving pathology, and then to infer a normative scenario of disease progression across different disease stages. The estimated scenario will combine spatiotemporal maps of lesion propagation, such as maps of amyloid deposition or cortical atrophy, and global measurements such as levels of CSF biomarkers. It will be possible to estimate not only a normative scenario but also the inter-individual variability in the values, dynamics and direction of both topographical and pathophysiological biomarkers changes during the course of the disease.

The application of this technology to publicly available and in-house longitudinal data sets of individuals from the asymptomatic at risk to the prodromal and dementia stages will yield new insights into the pathophysiology of AD from the preclinical to the AD dementia stages. This quantitative data-driven approach will be exploited to assess and refine the current qualitative hypothetical models of AD progression. Notably, it will complement these models with typical pathways of lesion propagation in the brain during disease progression. It will also highlight the effect of the known risk factors of AD such as apolipoprotein E genotype on the disease progression profile.

The project will open up the concrete possibility to derive a computer-aided diagnosis, staging, and prognosis tool for a better recruitment of patients in clinical studies and to assist clinicians in the diagnosis and the monitoring of both disease progression and treatment efficacy.

9.1.2.5. IFR49-Internal Research projects
Participants: Mario Chavez [Correspondant], Fabrizio de Vico Fallani [Correspondant].

Project title: Exploring the impact and time frequency signature of rhythmic patterns of Transcranial Magnetic Stimulation (TMS) on network activity by Magneto-Encephalography (MEG)

Founded in 2014

Coordinator: Antoni Valero Cabre (ICM-team "Dynamiques Cérébrales, Plasticité et Rééducation")

Other partners: TMS, EEG and MEG technical platforms of the ICM at the Hopital Pitié-Salptrière; and Service des Urgences Cérébro-Vasculaires de l'Hôpital Pitié-Salpêtrière, Paris.

The long-term goal of this project is to better understand the ability of non invasive neurostimulation to induce lasting local and distributed reorganization effects in the human brain to better plan and document therapies for patients. The short-term goal of this application is to develop a new mapping procedure to be able to capture and characterize in terms of oscillatory activity the lasting impact of repetitive Transcranial Magnetic Stimulation (TMS) on specific brain regions and associated networks.

9.1.3. CATI (Alzheimer Plan)

Participants: Olivier Colliot [Correspondant], Marie Chupin [Correspondant], Stanley Durrleman, Didier Dormont, Chabha Azouani, Ali Bouyahia, Johanne Germain, Kelly Martineau, Sonia Djobeir, Hugo Dary, Ludovic Fillon, Takoua Kaaouana, Alexandre Routier, Mathieu Dubois.

> Project acronym: CATI
>
> Project title: Centre d'Acquisition et de Traitement des Images
>
> Funded in 2011
>
> Amount: 9M€
>
> Coordinator: Jean-François Mangin
>
> Other partners: Neurospin, CENIR, Inserm U678, IM2A
>
> Abstract: The CATI project (funded by the National Alzheimer Plan for 9M€, 2.1M€ for ARAMIS) aims at creating a national platform for multicenter neuroimaging studies. CATI aims to be a national resource for the scientific, medical and industrial research community and will provide a wide range of services: access to a national acquisition network, standardization of acquisitions, image quality control, image analysis, databasing/archiving, meta-analyses. Through CATI, our team coordinates a large network composed of over 30 image acquisition centers. CATI already supports over 15 multicenter projects including the national cohort MEMENTO (2300 subjects). CATI is integrated with France Life Imaging (PI: F. Lethimonnier) and the Neugrid for you (N4U, PI: G. Frisoni) network.

9.1.4. National Networks

- GdR Statistics and Medicine - http://gdr.statsante.fr/Accueil.html
- GdR (MaDICS) Masses de Données, Informations et Connaissances en Sciences Big Data - Data ScienceStatistics and Medicine - http://www.madics.fr/reseaux/

9.1.5. Other National Programs

9.1.5.1. Programme Hospitalier de Recherche Clinique (PHRC)

Participants: Olivier Colliot, Marie Chupin, Stanley Durrleman, Didier Dormont, Damien Galanaud.

- PHRC PredictPGRN, co-funding by Alzheimer Plan, *Caractérisation multimodale prospective de la démence frontotemporale dûe à des mutations du gène PGRN à un stade symptomatique et présymptomatique*. (Coordinator : A. Brice)
- PHRC ImaBio3, co-funding by Roche (pharmaceutical industry), *Rôle des réactions cellulaires sanguines, inflammatoires et immunitaires anti-amyloïde centrales et périphériques dans la maladie d'Alzheimer débutante*. (Coordinator : M. Sarazin)
- PHRC CAPP, *Caractérisation linguistique, anatomique/métabolique et biologique des différentes formes d'aphasie primaire progressive : vers le rationnel pour des essais pharmacologiques et des rééducations du langage ciblées*. (Coordinator: M. Teichmann)

9.1.5.2. Institut Universitaire d'Ingénierie pour la Santé (IUIS)

Participants: Mario Chavez, Xavier Navarro.

> Project acronym: DYSPEV
>
> Project title: Dépistage de la dyspnée par potentiels évoqués visuels
>
> Funded in 2014
>
> Amount: 38K€
>
> Coordinator: Thomas Similowski
>
> Other partners: UPMC, Inserm UMR 1158
>
> Abstract: Steady state visual evoked potentials (SSVEP) have been widely utilized in brain computer interfacing (BCI) in last years. In this project, we explore the possibilities of SSVEP to manage the communication between patients suffering from respiratory disorders and health care providers. By imposing different breathing constraints, we use a SSVEP-based brain computer interface to help those subjects to communicate their breathing sensations (breathing well/breathing bad).

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. H2020 - Project EuroPOND

Participants: Olivier Colliot, Stanley Durrleman, Manon Ansart, Igor Koval, Alexandre Bône.

Project acronym: EuroPOND

Project title: Data-driven models for Progression Of Neurological Disease

Duration: Jan 2016 - Dec 2019

Amount: 6M€

Coordinator: Daniel Alexander

Other partners: University College London (UK), EMC Rotterdam (The Netherlands), VUMC (The Netherlands), Fate Bene Fratelli (Italy), Carol Besta Institute (Italy), Université de Genève (Switzerland), Icometrix (Belgium)

Abstract: EuroPOND will develop a data-driven statistical and computational modeling framework for neurological disease progression. This will enable major advances in differential and personalized diagnosis, prognosis, monitoring, and treatment and care decisions, positioning Europe as world leaders in one of the biggest societal challenges of 21st century healthcare. The inherent complexity of neurological disease, the overlap of symptoms and pathologies, and the high comorbidity rate suggests a systems medicine approach, which matches the specific challenge of this call. We take a uniquely holistic approach that, in the spirit of systems medicine, integrates a variety of clinical and biomedical research data including risk factors, biomarkers, and interactions. Our consortium has a multidisciplinary balance of essential expertise in mathematical/statistical/computational modelling; clinical, biomedical and epidemiological expertise; and access to a diverse range of datasets for sporadic and well-phenotyped disease types.The project will devise and implement, as open-source software tools, advanced statistical and computational techniques for reconstructing long-term temporal evolution of disease markers from cross-sectional or short-term longitudinal data. We will apply the techniques to generate new and uniquely detailed pictures of a range of important diseases. This will support the development of new evidence-based treatments in Europe through deeper disease understanding, better patient stratification for clinical trials, and improved accuracy of diagnosis and prognosis. For example, Alzheimer's disease alone costs European citizens around €200B every year in care and loss of productivity. No disease modifying treatments are yet available. Clinical trials repeatedly fail because disease heterogeneity prevents bulk response. Our models enable fine stratification into phenotypes enabling more focussed analysis to identify subgroups that respond to putative treatments.

9.2.1.2. FET Flagship - Human Brain Project

Participants: Olivier Colliot, Stanley Durrleman.

Project acronym: HBP

Project title: Human Brain Project

Sub-project: SP8 - Medical Informatics Platform

Duration (for this phase): 2016-2018

Abstract: The Human Brain Project (HBP) is a European Commission Future and Emerging Technologies Flagship. The HBP aims to put in place a cutting-edge, ICT-based scientific Research Infrastructure for brain research, cognitive neuroscience and brain-inspired computing. The Project promotes collaboration across the globe, and is committed to driving forward European industry. Our team is involved in the Subproject SP8 (Medical Informatics Platform). The Medical Informatics Platform (MIP) is an innovative data management system that gives researchers the means to access and analyse large amounts of anonymized clinical neuroscience data. Within that framework, we will develop and implement a method to construct disease progression models from longitudinal biomarkers. The method will use statistical learning techniques to infer a long-term disease progression model from multiple short term data from a series of individuals. The model will account for variability in age at disease onset, pace of disease progression and trajectories of biomarkers changes across individuals in the observed population.

9.2.1.3. ERC - LEASP
Participant: Stanley Durrleman.

Project acronym: LEASP

Project title: Learning Spatiotemporal Patterns in Longitudinal Image Data Sets of the Aging Brain

Duration: 2016-2021

Abstract: Time-series of multimodal medical images offer a unique opportunity to track anatomical and functional alterations of the brain in aging individuals. A collection of such time series for several individuals forms a longitudinal data set, each data being a rich iconic-geometric representation of the brain anatomy and function. These data are already extraordinary complex and variable across individuals. Taking the temporal component into account further adds difficulty, in that each individual follows a different trajectory of changes, and at a different pace. Furthermore, a disease is here a progressive departure from an otherwise normal scenario of aging, so that one could not think of normal and pathologic brain aging as distinct categories, as in the standard case-control paradigm.

Bio-statisticians lack a suitable methodological framework to exhibit from these data the typical trajectories and dynamics of brain alterations, and the effects of a disease on these trajectories, thus limiting the investigation of essential clinical questions. To change this situation, we propose to construct virtual dynamical models of brain aging by learning typical spatiotemporal patterns of alterations propagation from longitudinal iconic-geometric data sets.

By including concepts of the Riemannian geometry into Bayesian mixed effect models, the project will introduce general principles to average complex individual trajectories of iconic-geometric changes and align the pace at which these trajectories are followed. It will estimate a set of elementary spatiotemporal patterns, which combine to yield a personal aging scenario for each individual. Disease-specific patterns will be detected with an increasing likelihood.

This new generation of statistical and computational tools will unveil clusters of patients sharing similar lesion propagation profiles, paving the way to design more specific treatments, and care patients when treatments have the highest chance of success.

9.3. International Initiatives

9.3.1. Informal International Partners

F. De Vico Fallani has a collaboration with the University Penn, Philadelphia, US (Prof. Danielle Bassett).

S. Durrleman has an enduring collaboration with professor Guido Gerig, Tandon School of Engineering, NYU. He is consultant for NIH Grant "4D shape analysis for modeling spatiotemporal change trajectories in Huntington's Disease "predict-HD".

M. Chupin and O. Colliot have an enduring collaboration with the Center for Magnetic Resonance Research, University of Minnesota, USA (P-F Van de Moortele, T. Henry, M. Marjanska, K. Ugurbil) a leading center in 7T MRI.

S. Durrleman and O. Colliot have a collaboration with the Center for Medical Image Computing (CMIC) at University College London (UCL), London, UK (S. Ourselin, D. Alexander, M. Modat).

D. Galanaud has an enduring collaboration with the Massachusetts General Hospital, Harvard University, USA (R. Gupta).

M. Chavez has different collaborations with the Mathematics Departement of the Queen Mary University of London, UK (Prof. V. Latora); and the Physics Department of the Universitat de Barcelona, Spain (Prof. Albert Diaz-Guilera)

F. De Vico Fallani has an enduring collaboration with the University Sapienza, Rome, Italy (Profs. Fabio and Claudio Babiloni) and with the IRCCS Fondazione Santa Lucia, Rome, Italy (M. Molinari and D. Mattia).

A. Bertrand has an enduring collaboration with professor Youssef Z. Wadghiri, head of the Preclinical Imaging Core, Center for Biomedical Imaging, NYU School of Medicine, New York, NY, USA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

Kuldeep Kumar (Ecole de Technologie Supérieure, Montréal, Canada) is visiting ARAMIS from October 2016 to March 2017 under the MITACS programme.

<div align="center" style="color:red">**ASCLEPIOS Project-Team**</div>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Consulting for Industry

Nicholas Ayache is a scientific consultant for the company Mauna Kea Technologies (Paris).

8.1.2. Collaboration with national hospitals

The Asclepios-project team collaborates with the following 3 French IHU (University Hospital Institute): the IHU-Strasbourg (Pr J. Marescaux and L. Soler) on image-guided surgery, the IHU-Bordeaux (Pr M. Haïssaguere and Pr P. Jaïs) on cardiac imaging and modeling and the IHU-Pitié Salpétrière (Dr. O. Colliot and S. Durrleman) on neuroimaging.

We also have long term collaborations with the CHU Nice and Centre Antoine Lacassagne in Nice.

The Asclepios-project team is part of the EQUIPEX MUSIC consortium with Bordeaux University Hospital, which aim is to exploit an XMR interventional room equipped with a MUSIC workstation.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. MD PAEDIGREE

Title: Model-Driven European Paediatric Digital Repository

Programme: FP7

Period: March 2013 - February 2017

Coordinator: Ospedale Pediatrico Bambini Gesù, Rome.

Partners:

Athena Research and Innovation Center in Information Communication & Knowledge Technologies (Greece)

Biomolecular Research Genomics (Italy)

Deutsches Herzzentrum Berlin (Germany)

Empirica Gesellschaft für Kommunikations- und Technologie Forschung Mbh (Germany)

Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

Haute Ecole Specialisée de Suisse Occidentale (Switzerland)

Istituto Giannina Gaslini (Italy)

Katholieke Universiteit Leuven (Belgium)

Lynkeus (Italy)

Motek Medical B.V. (Netherlands)

Ospedale Pediatrico Bambino Gesu (Italy)

Siemens Aktiengesellschaft (Germany)

Siemens Corporation (United States)

Technische Universiteit Delft (Netherlands)

University College London (United Kingdom)

Universitair Medisch Centrum Utrecht (Netherlands)

Universita Degli Studi di Roma Lapienza (Italy)

The University of Sheffield (United Kingdom)

Universitatea Transilvania Din Brasov (Romania)

Stichting Vu-Vumc (Netherlands)

Maat Francerl (France)

Inria contact: Xavier Pennec

MD-Paedigree is a clinically-led VPH project that addresses both the first and the second actions of part B of Objective ICT-2011.5.2:

1. it enhances existing disease models stemming from former EC-funded research projects (Health-e-Child and Sim-e-Child) and from industry and academia, by developing robust and reusable multi-scale models for more predictive, individualised, effective and safer healthcare in several disease areas;

2. it builds on the eHealth platform already developed for Health-e-Child and Sim-e-Child to establish a worldwide advanced paediatric digital repository.

Integrating the point of care through state-of-the-art and fast response interfaces, MD-Paedigree services a broad range of off-the-shelf models and simulations to support physicians and clinical researchers in their daily work. MD-Paedigree vertically integrates data, information and knowledge of incoming patients, in participating hospitals from across Europe and the USA, and provides innovative tools to define new workflows of models towards personalised predictive medicine. Conceived as a part of the 'VPH Infostructure' described in the ARGOS, MD-Paedigree encompasses a set of services for storage, sharing, similarity search, outcome analysis, risk stratification, and personalised decision support in paediatrics within its innovative model-driven data and workflow-based digital repository. As a specific implementation of the VPH-Share project, MD-Paedigree fully interoperates with it. It has the ambition to be the dominant tool within its purview. MD-Paedigree integrates methodological approaches from the targeted specialties and consequently analyzes biomedical data derived from a multitude of heterogeneous sources (from clinical, genetic and metagenomic analysis, to MRI and US image analytics, to haemodynamics, to real-time processing of musculoskeletal parameters and fibres biomechanical data, etc.), as well as specialised biomechanical and imaging VPH simulation models.

8.2.1.2. VP2HF

Title: Computer model derived indices for optimal patient-specific treatment selection and planning in Heart Failure

Programme: FP7

Period: October 2013 - September 2016

Coordinator: King's College, London.

Partners:

Centron Diagnostics Ltd (United Kingdom)

CHU Côte de Nacre, Caen (France)

King's College London (United Kingdom)

Philips Technologie (Germany)

Philips France (France)

Simula Research Laboratory As (Norway)

Université Catholique de Louvain (Belgium)

Universitat Pompeu Fabra (Spain)

Inria contact: Dominique Chapelle / Maxime Sermesant

Heart failure (HF) is one of the major health issues in Europe affecting 6 million patients and growing substantially because of the ageing population and improving survival following myocardial infarction. The poor short to medium term prognosis of these patients means that treatments, such as cardiac re-synchronisation therapy and mitral valve repair, can have substantial impact. However, these therapies, are ineffective in up to 50% of treated patients and involve significant morbidity and substantial cost. The primary aim of VP2HF is to bring together image and data processing tools with statistical and integrated biophysical models mainly developed in previous VPH projects, into a single clinical workflow to improve therapy selection and treatment optimisation in HF. The tools will be tested and validated on 200 patients (including 50 historical datasets) across 3 clinical sites, including a prospective clinical study on 50 patients in the last year of the project. The key innovations in VP2HF, which make it likely that the project results will be commercially exploited and have major clinical impact, are:

1. all tools to process images and signals, and to obtain the statistical and biophysical models will be integrated into one clinical software platform that can be easily and intuitively used by clinicians and tried out in the prospective clinical study;

2. to select only the appropriate parts of the tool chain, we use a decision tree stratification approach, which will add maximum value to the predictions that will be used in individual patients, so that the more resource intensive parts will be used when they will add real value.

We expect that the study will result in substantially improved efficacy of the decision making process compared with current guidelines, and that an integrated package that is used as part of clinical workflow will ensure the industrial project partners, in particular Philips, will develop project outputs into dedicated products that will have significant clinical impact.

8.2.1.3. MedYMA

Title: Biophysical Modeling and Analysis of Dynamic Medical Images

Programme: FP7

Type: ERC

Period: April 2012 - March 2017

Coordinator: Inria

Inria contact: Nicholas Ayache

During the past decades, exceptional progress was made with in vivo medical imaging technologies to capture the anatomical, structural and physiological properties of tissues and organs in patients, with an ever increasing spatial and temporal resolution. Physicians are now faced with a formidable overflow of information, especially when a time dimension is added to the already hard to integrate 3-D spatial, multimodal and multiscale dimensions of modern medical images. This increasingly hampers the early detection and understanding of subtle image modifications, which can have a vital impact on the patient's health. To change this situation, a new generation of computational models for the simulation and analysis of dynamic medical images is introduced. Thanks to their generative nature, they will allow the construction of databases of synthetic and realistic medical image sequences simulating various evolving diseases, producing an invaluable new resource for training and benchmarking. Leveraging on their principled biophysical and statistical foundations, these new models will bring an added clinical value once they have been personalized with innovative methods to fit the medical images of any specific patient. By explicitly revealing the underlying evolving biophysical processes observable in the images, this approach will yield new groundbreaking image processing tools to correctly interpret the patient's condition (computer aided diagnosis), to accurately predict the future evolution (computer aided prognosis), and to precisely simulate and monitor an optimal and personalized therapeutic strategy (computer aided therapy). First applications concern high impact diseases including brain tumors, Alzheimer's disease, heart failure and cardiac arrhythmia and will open new horizons in computational medical imaging.

8.3. International Initiatives

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. GeomStats

Title: Geometric Statistics in Computational Anatomy: Non-linear Subspace Learning Beyond the Riemannian Structure

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Statistics - Susan Holmes

Start year: 2015

See also: http://www-sop.inria.fr/asclepios/projects/GeomStats/

The scientific goal of the associated team is to develop the field of geometric statistics with key applications in computational anatomy.

Computational anatomy is an emerging discipline at the interface of geometry, statistics, image analysis and medicine that aims at analyzing and modeling the biological variability of the organs shapes at the population level. An important application in neuroimaging is the spatial normalization of subjects which is necessary to compare anatomies and functions through images in populations with different clinical conditions.

The research directions have been broken into three axes, the first two being methodologically driven and the last one being application driven. The first axis aims at generalizing the statistical framework from Riemannian to more general geometric structures and even non-manifold spaces (e.g. stratified spaces). The goal is to understand what is gained or lost using each geometric structure. The second axis aims at developing subspace learning methods in non-linear manifolds. This objective contrasts with most manifold learning methods which assumes that subspaces are embedded in a large enough Euclidean space. The third scientific direction is application driven with cross-sectional and longitudinal brain neuroimaging studies. The goal will be to extract reduced models of the brain anatomy that best describe and discriminate the populations under study. One intend for instance to show where is impact of a treatment for traumatic brain injuries.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

8.3.2.1.1. St Thomas' Hospital, King's College London, United Kingdom

Maxime Sermesant is a visiting lecturer in the Division of Imaging Sciences and Biomedical Engineering, St Thomas' Hospital, King's College London lead by Pr Reza Razavi. The XMR facility within this hospital is a unique opportunity to validate and exploit the cardiovascular modelling work.

8.3.2.1.2. Massachusetts General Hospital, Boston

A collaboration with Dr Jan Unklebach, Assistant Professor of Radiation Oncology and Dr Jayashree Kalpathy-Cramer, radiology instructor was initiated in 2013 around the topics of tumor growth modeling, radiotherapy planning and edema characterization from MRI.

8.3.2.1.3. University College London (UCL), London, UK

Marco Lorenzi holds an honorary position with the Translational Imaging Group of UCL, led by Prof. Sebastien Ourselin. His collaboration is around the topic of spatio-temporal analysis of medical images, with special focus on brain imaging analysis and biomarker development in Alzheim disease. He is also collaborating with the "Progression Over Neurodegenerative Disorders" (POND) group (Prof. Daniel Alexander) for developing new computational models and techniques for learning characteristic patterns of disease progression using large longitudinal clinical data sets, with special focus on dementias.

8.3.2.1.4. Imaging Genetics Center (IGC), University of Southern California (USC), CA, USA

Marco Lorenzi is currently collaborator with the IGC for the investigation of the very complex relationship between brain atrophy and genetics in Alzheimer's disease, in particular for demonstrating the effectiveness of multivariate statistical models in providing a meaningful description of the relationship between genotype and brain phenotype.

8.3.2.1.5. Other International Hospitals

Collaborations with several other European hospitals have been established through the European projects VP2HF and MD PAEDIGREE.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Research Stays Abroad

In the context of the Associated team GeomStats, part of the Inria International Lab Inria@SiliconValley, Nina Miolane spent 3 months (April to June 2016) at the Stanford Statistics Department:

<p align="center" style="color:red">ATHENA Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Inria SAM Action Transverse

Participants: Paul Görlach, Evelyne Hubert [Aromath project team], Théodore Papadopoulo, Rachid Deriche.

Finding biomarkers of abnormalities of the white matter is one important problem in dMRI processing. As these biomarkers need to be independent of the orientation of the head, they are functions of the rotational invariants of the shapes that characterize the diffusion probabilities in the white matter. While the situation is well understood for second order tensors, these are not powerful enough to represent crossings in the white matter. Acquisitions made with the HARDI scheme allow for a richer description of probabilities, which have been modelled in the literature team as (positive) ternary quartics (tensors of order 4). But invariants of these quartics are not well known. For a long period, only six (out of 12 in theory) were known. Previous work in the ATHENA team developed some new strategies to compute more invariants. But these were ever non-polynomial and had some stability problems [99]. Another strategy [85] was leading to polynomial and stable invariants, but the approach was generating a number of invariants (more than 12) for which it was impossible to extract an irreducible family. The goal of this "Transverse action" was to join forces with the team AROMATH and leverage the methods they developed [87], [88], [86] to have a better insight in this problem of rotational invariants of ternary quartics.

9.1.2. Inria SAM Action Marquante

Participants: Demian Wassermann, Maureen Clerc, Théodore Papadopoulo, Amandine Audino.

Duration: *october 2016 to January 2018*

Elucidating the structure-function relationship of the brain is one of the main open question in neuroscience. The capabilities of diffusion MRI-based techniques to quantify the connectivity strength between brain areas, namely structural connectivity (SC), in combination with modalities such as electro encephalography (EEG) to quantify brain function have enabled advances in this field. However, the actual relationship between these SC measures and measures of information transport between neuronal patches is still far from being determined.

In this project, we will address this problem by establishing a relationship between diffusion MRI (dMRI) SC measures and electrical conductivity on the human brain cortex. We will exploit the Athena's competences in dMRI (Deriche-Wassermann) and EEG (Clerc-Papadopoulo) and our collaboration with the neurosurgical service at CHU Nice (Fontaine-Almairac). In successfully addressing this problem, we will set the bases to solve the current open problem of non-invasively measuring cortico-cortical (CC) connectivity in the human brain. This will boost the understanding of cognitive function as well as neurosurgical planning for the treatment of pathologies such as drug-resistant epilepsy and resection of glioblastomas.

9.2. National Initiatives

9.2.1. Inria Project Lab

9.2.1.1. IPL BCI-LIFT
Participants: Maureen Clerc, Théodore Papadopoulo, Nathanaël Foy, Nathalie Gayraud, Federica Turi.

Duration: *January 2015 to December 2018*

The Inria Project-Lab BCI-LIFT is an Inria-funded reasearch consortium to foster collaborative research on Brain-Computer Interfaces on the topic of Learning, Interaction, Feedback and Training. It is coordinated by Maureen Clerc. Its members are from 6 Inria teams: Athena, Camin, Hybrid, Mjolnir, Neurosys, Potioc, and from Dycog team from CRNL Lyon, and University of Rouen. For more information, refer to the BCI-LIFT website.

9.2.2. ANR

9.2.2.1. ANR MRSEI LEMONS
Participants: Maureen Clerc, Théodore Papadopoulo.

Duration:*october 2015 to april 2017* The ANR MRSEI LEMONS aims to consolidate a European Network by organizing meetings and visits, in order to submit a proposal for a MSCA-ITN. The European consortium is led by Inria (coordinator Maureen Clerc).

9.2.2.2. ANR MOSIFAH
Participants: Rachid Deriche, Rutger Fick, Demian Wassermann, Maureen Clerc, Théodore Papadopoulo.

Duration: *October 2013 to September 2017*

This ANR project is about multimodal and multiscale modelling and simulation of the fiber architecture of the human heart. It started on October 2013 and involves three partners: Creatis Team, INSA, Lyon (I. Magnin, Y. Zhu); TIMC-IMAG, CNRS, Grenoble (Y. Uson) and the ATHENA project team.

It consists in modelling and simulating the ex vivo and in vivo 3D fiber architectures at various scales using multiphysical data from different imaging modalities working at different spatial resolutions. To this end, the myocardium of the human heart will be imaged using respectively Polarized Light Imaging (PLI) and dMRI.

Appropriate diffusion models will be explored including second and fourth order DTI models as well as HARDI models such as the single shell Q-Ball Imaging (QBI). These various types of images will be processed within the right Riemannian mathematical framework to provide tensor as well as Ensemble Average Propagator (EAP) and Orientation Distribution Function (ODF) fields. Virtual cardiac fiber structure (VCFS) will then be modelled using myocardial fiber information derived from each of these imaging modalities. Finally, diffusion behavior of water molecules in these VCFSs will be simulated by means of quantum spin theory, which allows computing ex vivo and in vivo virtual diffusion magnetic resonance (MR) images at various scales ranging from a few microns to a few millimeters. From the obtained virtual diffusion MR images, multiscale and probabilistic atlas describing the 3D fiber architecture of the heart ex vivo and in vivo will be constructed. Meanwhile, the simulation involving a large number of water molecules, grid computing will be used to cope with huge computation resource requirement.

We expect to construct a complete database containing a very wide range of simulated (noise and artifact-free) diffusion images that can be used as benchmarks or ground-truth for evaluating or validating diffusion image processing algorithms and create new virtual fiber models allowing mimicking and better understanding the heart muscle structures. Ultimately, the proposed research can open a completely novel way to approach the whole field of heart diseases including the fundamental understanding of heart physiology and pathology, and new diagnosis, monitoring and treatment of patients.

9.2.2.3. ANR VIBRATIONS
Participants: Théodore Papadopoulo, Maureen Clerc, Rachid Deriche, Demian Wassermann.

Duration: *February 2014 to January 2018*

Computational modeling, under the form of a "virtual brain" is a powerful tool to investigate the impact of different configurations of the sources on the measures, in a well-controlled environment.

The VIBRATIONS project proposes to simulate in a biologically realistic way MEG and EEG fields produced by different configurations of brain sources, which will differ in terms of spatial and dynamic characteristics. The research hypothesis is that computational and biophysical models can bring crucial information to clinically interpret the signals measured by MEG and EEG. In particular, they can help to efficiently address some complementary questions faced by epileptologists when analyzing electrophysiological data.

The project follows a three-fold strategy:

- construct virtual brain models with both dynamic aspects (reproducing both hyperexcitability and hypersynchronisation alterations observed in the epileptic brain) and a realistic geometry based on actual tractography measures performed in patients
- explore the parameter space though large-scale simulations of source configurations, using parallel computing implemented on a computer cluster.
- confront the results of these simulations to simultaneous recordings of EEG, MEG and intracerebral EEG (stereotactic EEG, SEEG). The models will be tuned on SEEG signals, and tested versus the surface signals in order to validate the ability of the models to represent real MEG and EEG signals.

The project constitutes a translational effort from theoretical neuroscience and mathematics towards clinical investigation. A first output of the project will be a database of simulations, which will permit in a given situation to assess the number of configurations that could have given rise to the observed signals in EEG, MEG and SEEG. A second – and major - output of the project will be to give the clinician access to a software platform which will allow for testing possible configurations of hyperexcitable regions in a user-friendly way. Moreover, representative examples will be made available to the community through a website, which will permit its use in future studies aimed at confronting the results of different signal processing methods on the same 'ground truth' data.

9.2.3. ADT

9.2.3.1. ADT BOLIS
Participants: Nicolas Schnitzler, Théodore Papadopoulo, Juliette Leblond [APICS project-team], Jean-Paul Marmorat [CMA Ecole des Mines Paritech].

Duration: *December 2014 to December 2016*

ADT BOLIS aims to:

- build a sofware platform dedicated to inverse source localisation, building upon the elements of software found in FindSources3D. The platform will be modular, ergonomic, accessible and interactive. It will offer a detailed visualisation of the processing steps and the results. The goal is to provide a convenient graphical interface and a tool that can be easily distributed and used by professionals (target audience: clinicians and researchers).
- Upgrade medInria to use the latest libraries versions involved (this most notably encompasses VTK 6, Qt 5, and DTK 1.0). Then, these new versions will be used to implement a composer (a graphical tool to chain various actions in medInria) and to develop python scripting (for chaining actions and for adding non-regression testing).

9.2.3.2. ADT OpenViBE-X
Participants: Théodore Papadopoulo, Maureen Clerc, Nathanaël Foy.

Duration: *October 2014 to October 2016*

The OpenViBE-X ADT addresses the OpenViBE Brain Computer Interfaces (BCI) platform, in order to:

1. make BCI easier to apprehend by end-users
2. enrich the interaction with multimodal biosignals (eye gaze, heart-rate)
3. implement methods for auto-calibration and online adaptation of the classification
4. provide support, maintenance and dissemination for this software.

The OpenViBE platform is a central element to BCI research at Inria, and in the international community.

9.2.4. Other Funding Programs

9.2.4.1. Big Brain Theory: MAXIM'S
Participants: Demian Wassermann, Alexandra Petiet [ICM, CENIR, Paris], Stéphane Lehericy [ICM, CENIR, Paris], Julien Valette [Institut d'Imagerie Biomédicale, CEA, France], Virginie Callot [Center for Magnetic Resonance in Biology and Medicine - UMR 7339,Center for Magnetic Resonance in Biology and Medicine - UMR 7339].

Shedding light on the specificity of microstructural MRI biomarkers of axonal and myelin integrity using multi-modal imaging in rodents and quantitative histological correlations.

Magnetic Resonance Imaging (MRI) biomarkers (BMs) of axonal and myelin integrity suffer from lack of specificity at the microstructural level, which hinders our understanding of disease mechanisms. A better knowledge of the role of the white matter (WM) microstructure in normal and abnormal function relies on the development of MRI metrics that can provide (i) increased specificity to distinct attributes of WM such as local fiber architecture, axon morphology, myelin content, and (ii) specific markers of axonal vs. myelin pathologies. Advanced diffusion-weighted (DW) imaging techniques based on biophysical models of cerebral tissues and cellular compartments can extract for example mean axonal diameters or cellular geometry. In addition, diffusion-weighted spectroscopy (DWS) offers new insights into the diffusion properties of intracellular metabolites. More specifically, probing metabolite diffusion at different time scales allows assessing fiber diameter and length, and the specific compartmentalization of different metabolites in different cell types allows differentiating between astrocytic and neuronal microstructural parameters. Although very promising, these novel techniques still need extensive histological validation.

We propose to develop these two cutting-edge MRI techniques – DW-MRI and DWS, at 11.7T to investigate axonopathy and myelinopathy in well-established mouse models with a single lesion type, and to validate these new microstructural BMs with multivariate quantitative histological analyses.

Duration: *March 2016 to March 2019*

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERC AdG CoBCoM

Program: H2020-EU.1.1. (ERC-ADG-2015 - ERC Advanced Grant)

Project acronym: CoBCoM - **ID:** 694665

Project title: *Computational Brain Connectivity Mapping*

Start date: 2016-09-01, End date: 2021-08-31

P.I : R. Deriche

Partners: ATHENA project-team

Abstract:

One third of the burden of all the diseases in Europe is due to problems caused by diseases affecting brain. Although exceptional progress has been obtained for exploring it during the past decades, **the brain is still terra-incognita** and calls for specific research efforts to better understand its architecture and functioning.

CoBCoM is our response to this great challenge of modern science with the overall goal to **develop a joint Dynamical Structural-Functional Brain Connectivity Network** (DSF-BCN) solidly grounded on advanced and integrated methods for diffusion Magnetic Resonance Imaging (dMRI) and Electro & Magneto-Encephalography (EEG & MEG).

To take up this grand challenge and achieve new frontiers for brain connectivity mapping, we will develop a new generation of computational models and methods for identifying and characterizing the structural and functional connectivities that will be at the heart of the DSF-BCN. Our strategy is to break with the tradition to incrementally and separately contributing to structure or function and develop **a global approach involving strong interactions between structural and functional connectivities.** To solve the limited view of the brain provided just by one imaging modality, our models will be developed under a rigorous computational framework integrating complementary non invasive imaging modalities: dMRI, EEG and MEG.

COBCOM will push far forward the state-of-the-art in these modalities, developing **innovative models and ground-breaking processing tools** to provide in-fine a joint DSF-BCN solidly grounded on a detailed mapping of the brain connectivity, both in space and time.

Capitalizing on the strengths of dMRI, MEG & EEG methodologies and building on the **bio-physical and mathematical foundations** of our new generation of computational models, COBCOM will be applied to high-impact diseases, and its **ground-breaking comput ational nature and added clini cal value** will open new perspectives in neuroimaging.

9.3.1.2. *ChildBrain ETN*

ATHENA is an Associated Partner in this European Training Network: the team will participate in training workshops and receive PhD students in secondments.

Program: European Training Network

Project acronym: ChildBrain

Project title: Advancing brain research in children's developmental neurocognitive disorders

Duration: March 2015 to March 2019

Coordinator: Prof. Paavo Leppänen, University of Jyváskylä, Finland

Other partners: University of Leuven (Belgium), University of Münster (Germany), Rabboud University (The Netherlands), Aston University (United Kingdom), IcoMetrix (Belgium), Elekta (Finland), BESA (Germany)

Abstract: The purpose of the ChildBrain ETN is to train young scientists, i.e. Early Stage Researchers (ESRs), to utilise evidence-based neuroscientific knowledge for helping children, especially those at high risk for dropout due to neurocognitive disorders, to meet future educational and societal demands.

9.4. International Initiatives

9.4.1. *Inria Associate Teams Not Involved in an Inria International Labs*

9.4.1.1. *LargeBrainNets*

Title: Characterizing Large-scale Brain Networks Using Novel Computational Methods for dMRI and fMRI-based Connectivity

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Stanford Cognitive and Systems Neuroscience Laboratory - Vinod Menon

Start year: Jan. 2016

Partners: ATHENA project-team,

See also: http://www-sop.inria.fr/members/Demian.Wassermann/large-brain-nets.html

In the past two decades, brain imaging of neurotypical individuals and clinical populations has primarily focused on localization of function and structures in the brain, revealing activation in specific brain regions during performance of cognitive tasks through modalities such as functional MRI. In parallel, technologies to identify white matter structures have been developed using diffusion MRI. More recently, interest has shifted towards developing a deeper understanding of the brain's intrinsic architecture and its influence on cognitive and affective information processing. Using for this resting state fMRI and diffusion MRI to build the functional and structural networks of the human brain.

The human brain is a complex patchwork of interconnected regions, and graph-theoretical approaches have become increasingly useful for understanding how functionally connected systems engender, and constrain, cognitive functions. The functional nodes of the human brain and their

structural inter-connectivity, collectively the "connectome", are, however, poorly understood. Critically, there is a dearth of computational methods for reliably identifying functional nodes of the brain and their structural inter-connectivity in vivo, despite an abundance of high-quality data from the Human Connectome Project (HCP). Devising and validating methods for investigating the human connectome has therefore taken added significance.

The first major goal of this project is to develop and validate appropriate sophisticated computational and mathematical tools for identifying functional nodes at the whole-brain level and measuring structural and functional connectivity between them, using state-of-the-art human brain imaging techniques and open-source HCP data. To this end, we will first develop and validate novel computational tools for (1) identifying stable functional nodes of the human brain using resting-state functional MRI and (2) measuring structural connectivity between functional nodes of the brain using multi-shell high-angular diffusion MRI. Due to the complementarity of the two imaging techniques fMRI and dMRI, our novel computational methods methods, the synergy between the two laboratories of this associate team will allow us to reveal in unprecedented detail the structural and functional connectivity of the human brain.

The second major goal of this project is to use our newly developed computational tools to characterize normal structural and functional brain networks in neurotypical adults.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- SCIL Laboratory, Sherbrooke University, CA (Maxime Descoteaux)
- CMRR, University of Minnesota, USA (Christophe Lenglet)
- Verona University, It (Gloria Menegaz)
- Department of CISE, the University of Florida, Gainesville, USA (Baba C. Vemuri)
- Centre for Medical Image Computing (CMIC), Dept. Computer Science, UCL, UK (D. Alexander)
- SBIA, University of Pennsylvania Medical School, USA (R. Verma).
- University Houari Boumedienne (USTHB, Algiers) (L. Boumghar) and University of Boumerdes, (D. Cherifi), Algeria.
- BESA company on EEG/MEG modeling.
- CRM, Centre de Recherche Mathématiques, Montréal, Canada.

9.4.3. Participation in Other International Programs

9.4.3.1. Program: Collaborative Research in Computational Neuroscience (NSF – ANR)

Project acronym: NEUROREF

Project title: *Building MRI Reference Atlases to Analyze Brain Trauma and Post- Traumatic Stress*

Start date: 2016-10-01, End date: 2019-12-31

P.I : D. Wassermann (Athena) – S. Bouix (Harvard Medcical School)

Partners: ATHENA project-team,

International Partner (Institution - Laboratory - Researcher):

Harvard Medical School (United States) - Psychiatry and Neuroimaging Lab - Sylvain Bouix

Abstract:

While mild traumatic brain injury (mTBI) has become the focus of many neuroimaging studies, the understanding of mTBI, particularly in patients who evince no radiological evidence of injury and yet experience clinical and cognitive symptoms, has remained a complex challenge. Sophisticated imaging tools are needed to delineate the kind of subtle brain injury that is extant in these patients, as existing tools are often ill-suited for the diagnosis of mTBI. For example, conventional magnetic resonance imaging (MRI) studies have focused on seeking a spatially consistent pattern of abnormal signal using statistical analyses that compare average differences between groups, i.e., separating mTBI from healthy controls. While these methods are successful in many diseases, they are not as useful in mTBI, where brain injuries are spatially heterogeneous. The goal of this proposal is to develop a robust framework to perform subject-specific neuroimaging analyses of Diffusion MRI (dMRI), as this modality has shown excellent sensitivity to brain injuries and can locate subtle brain abnormalities that are not detected using routine clinical neuroradiological readings. New algorithms will be developed to create Individualized Brain Abnormality (IBA) maps that will have a number of clinical and research applications. In this proposal, this technology will be used to analyze a previously acquired dataset from the INTRuST Clinical Consortium, a multi-center effort to study subjects with Post- Traumatic Stress Disorder (PTSD) and mTBI. Neuroimaging abnormality measures will be linked to clinical and neuropsychological assessments. This technique will allow us to tease apart neuroimaging differences between PTSD and mTBI and to establish baseline relationships between neuroimaging markers, and clinical and cognitive measures. Upon completion of this project, a set of tools, which have the potential to establish radiological evidence of brain injury in mTBI, will have been designed and evaluated, thereby enhancing both the diagnosis and monitoring of progression/recovery of injury, as well assessing the efficacy of therapies on the injured brain.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Sadegh Masjoodi (PhD Student, Tehran University of Medical Sciences, Iran) visited ATHENA from April 2nd, 2016 to Sept, 10, 2016
- Lorenza Brusini (PhD Student, Univ. of Verona, Italy), visited ATHENA from Jan. 2016 until Apr 2016.
- Maria Carla Piastra (PhD Student, Univ. Clinic of Münster, Germany), visited ATHENA from Jul 2016 until Aug 2016.
- Mouloud Kachouane (PhD Student, Univ. USTHB, Alger) visited ATHENA from Nov. 2015 until Aug 2016.
- Thinhinane Megherbi (PhD Student, Univ. USTHB, Alger) visited ATHENA from Jan. 2016 until Feb. 2016.
- Vinod Menon (Stanford Medical School) visited ATHENA during June 2016
- John Kolchaka (Stanford Medical School) visited ATHENA during June 2016

9.5.1.1. Internships

Graeme Baker

        Date: May 2016 – Sept 2016

        Queen's University,

        Supervisor: Rachid Deriche

Nahuel Lascano

        Date: Jun 2016 – Sept 2016

        University of Buenos Aires,

Supervisor: Demian Wassermann

Leonel Exequiel Gomez

Date: Jun 2016 – Sept 2016

University of Buenos Aires,

Supervisor: Demian Wassermann

Paul Gorlach

Date: Jul 2016 – Dec. 2016

University of Buenos Aires,

Supervisor: Theo Papadopoulo and Evelyne Hubert

<p style="text-align:center;color:red;font-weight:bold;">BEAGLE Project-Team</p>

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Labex Ecofect IntraCellXevo. Participants: E Tannier, in collaboration with T Henry, Insem Lyon. This projects mixes an experimental evolution of *Franscicella tumarensis* in the cytosol and a bioinformatics analysis of the adaptive mutations. There is one publication associated with this project [19]. It has been funded by ANR and Investissements d'Avenir up to 120keuros.

7.2. National Initiatives

7.2.1. ANR

- Ancestrome (2012-2017): phylogenetic reconstruction of ancestral "-omes", a five-year project, call "Bioinformatics" of the "Investissements d'avenir". Supervisor: V Daubin (CNRS, LBBE, Lyon) ; with Institut Pasteur, ENS Paris, ISEM (Univ Montpellier 2) Participant: E Tannier.
- Aucomsi (2013-2016) (Models of the vocal tract to study auditory circuits): a 4-year project funded by a grant from the ANR-NSF-NIH Call for French-US Projects in Computational Neuroscience. With F. Theunissen, UC Berkeley, CA, USA. Supervisor: H. Soula (for France) and F. Theunissen (for US). Participants: H. Soula, M. Fernandez.
- Dopaciumcity (2014-2017): Dopamine modulation of calcium influx underlying synaptic plasticity, a 4-year project funded by a grant from the ANR-NSF-NIH Call for French-US Projects in Computational Neuroscience. With L. Venance, College de France, CIRB, CNRS/UMR 7241 - INSERM U1050, Paris, France and K Blackwell, Krasnow Institute of Advanced Studies, George Mason University, Fairfax, VA, USA. Supervisor: L Venance (for France) and K.L. Blackwell (for US). Participants: H Berry, I Prokin, A Foncelle
- Dallish (2016-2020): Data Assimilation and Lattice LIght SHeet imaging for endocytosis/exocytosis pathway modeling in the whole cell, Call AAPG ANR 2016. With C. Kervrann (Inria Rennes), J. Salamero (Institute Curie, Paris), B. Laroche (INRA, Jouy-en-Josas). Participants: H. Berry.

7.2.2. Inria

- ADT Phylophile. Participants: E Tannier, in collaboration with D Parsons, Inria, V Daubin, B Boussau, CNRS, Université de Lyon 1. This project aims at producing an easy to use software integrating modern algorithmic methods to build gene trees. It has been funded by Inria by a 24 month software engineer.
- ADT Aevol. Participants: C Kinbbe, G Beslon, V Liard, J Rouzaud-Cornabas, D Parsons. This project aims at speeding and scaling and maintaining the code for our most complex software, aevol. It has been funded by Inria by a 24 month software engineer.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. EvoEvo

Title: Evolution of Evolution

Programm: FP7

Duration: November 2013 - October 2016

Coordinator: Inria

Partners:

> Instituto de Biología Molecular y Celular de Plantas, Agencia Estatal Consejo Superior de Investigaciones Cientificas (Spain)
>
> LIRIS, Institut National des Sciences Appliquees de Lyon (France)
>
> LIRIS, Universite Lyon 1 Claude Bernard (France)
>
> LAPM, Universite Joseph Fourier Grenoble 1 (France)
>
> Bioinformatics and Theoretical Biology, Universiteit Utrecht (Netherlands)
>
> Computer science department, University of York (United Kingdom)

Inria contact: Guillaume Beslon

Evolution is the major source of complexity on Earth, at the origin of all the species we can observe, interact with or breed. On a smaller scale, evolution is at the heart of the adaptation process for many species, in particular micro-organisms (e.g. bacteria, viruses...). Microbial evolution results in the emergence of the species itself, and it also contributes to the organisms' adaptation to perturbations or environmental changes. These organisms are not only organised by evolution, they are also organised to evolve. The EvoEvo project will develop new evolutionary approaches in information science and will produce algorithms based on the latest understanding of molecular and evolutionary biology. Our ultimate goal is to address open-ended problems, where the specifications are either unknown or too complicated to express, and to produce software able to operate in unpredictable, varying conditions. We will start from experimental observations of micro-organism evolution, and abstract this to reproduce EvoEvo, in biological models, in computational models, and in application software. Our aim is to observe EvoEvo in action, to model EvoEvo, to understand EvoEvo and, ultimately, to implement and exploit EvoEvo in software and computational systems. The EvoEvo project will have impact in ICT, through the development of new technologies. It will also have impact in biology and public health, by providing a better understanding of micro-organism adaptation (such as the emergence of new pathogens or the development of antibiotic resistances).

7.3.1.2. Neuron-Astro-Nets

Title: Neuron-Astro-Nets

Programm: FP7 Marie-Curie International Outgoing Fellowship (IOF)

Duration: 2013-2017

Partners: Inria Grenoble-Rhone-Alpes; Dept Statistics and Neurobiology, University of Chicago, USA (N. Brunel)

Inria contact: H. Berry

This project aims at developing a new model of synaptic plasticity that takes into account astrocyte signaling, its extension to astrocytes-synapse biochemical interactions in ensembles of synapses enwrapped by the same astrocyte and, eventually, to the firing of a single neuron or networks. The project funds Maurizio De Pittá's postdoc for 4 years (June 2013- May 2017). M. De Pittá´ spent two years in N. Brunel's group in Chicago (06/2014-05/2016) then one year back in Beagle in Lyon (06/2016-05/2017).

7.4. International Initiatives

- The Beagle team is part of the LIA (Laboratoire International Associé) EvoAct (Evolution in action with living and artificial organisms). EvoAct is a joint laboratory gathering researchers from Dominique Schneider's team (UJF, LAPM, UMR CNRS 5163, France), Richard Lenski's team (Michigan State University, Beacon center, US) and the Beagle team.

BIGS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

- *PEPS AMIES* (2016), Apprentissage supervisé pour l'aide au diagnostic, Collaboration Institut Elie Cartan avec la StartUp SD Innovation Frouard. Participants: A. Gégout-Petit, P. Vallois

- *Popart (2016-2017)* In the framework of collaboration with A. Deveau of Inra Nancy, A. Gégout-Petit and A. Muller-Gueudin are included in the Inra "Microbial Ecosystems & Metaomics, Call 2016" Project "Popart"for "Regulation of the Poplar microbiome by its host: is the immune system involved ? ". The aim is to develop methodology for the inference of regulation network betwen micro-organisms around Poplar. The specificity of the data is the inflation of zeros that has to be taken into account.

- *Intérêt des antiangiogènes dans la potentialisation des thérapies par rayonnement dans le cas des glioblastomes* (2016). Funding organism: Ligue contre le Cancer (CCIR-GE). Leader: N. Thomas (CRAN, U. Lorraine). Participants : C. Lacaux and A. Muller-Gueudin

- (2014-16), A library of Near-InfraRed absorbing photosensitizers: tailoring and assessing photo-physical and synergetic photodynamic properties, Funding organism: PHC Bosphore - Campus France, Leader: M. Barberi-Heyob (CRAN), Thierry Bastogne

- GDR 3475 Analyse Multifractale, Funding organism: CNRS, Leader: S. Jaffard (Université Paris-Est), Céline Lacaux

- GDR 3477 Géométrie stochastic, Funding organism: CNRS, Leader: P. Calka (Université Rouen), Céline Lacaux

- FHU CARTAGE (Fédération Hospitalo Universitaire Cardial and ARTerial AGEing ; leader : Pr Athanase BENETOS), Jean-Marie Monnez

- RHU Fight HF (Fighting Heart Failure ; leader : Pr Patrick ROSSIGNOL), located at the University Hospital of Nancy, Jean-Marie Monnez

- Project "Handle your heart", team responsible for the creation of a drug prescription support software for the treatment of heart failure, head: Jean-Marie Monnez

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

- Photobrain project. AGuIX theranostic nanoparticles for vascular-targeted interstitial photodynamic therapy of brain tumors, project **EuroNanoMed II**, resp.: M. Barberi-Heyob, (2015-2017), participant: T. Bastogne.

- NanoBit Project. Nanoscintillator-Porphyrin Complexes for Bimodal RadioPhotoDynamic Therapy, project **EuroNanoMed II**, resp.: P. Juzenas, (2016-2018), participant: T. Bastogne.

<p style="text-align:center">**BIOCORE Project-Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. National programmes

- **ANR-Purple Sun:** The objective of this project (ANR-13-BIME-004) is to study and optimize a new concept consisting in coupling the production of microalgae with photovoltaic panels. The main idea is to derive the excess of light energy to PV electricity production, in order to reduce the phenomena of photoinhibition and overwarming both reducing microalgal productivity.

- **ANR-Facteur 4:** The objective of this project to produce non OGM strain of microalgae with enhanced performance. BIOCORE is involved in the directed selection of microalgae with interesting properties from an industrial point of view. The theory of competition is used to give a competitive advantage to some species. This competitive advantage can be provided by an online closed loop controller.

- **ANR-Phycover:** The overall objective of the PHYCOVER project is to identify a modular wastewater treatment process for the production of biogas. The method combines three modules. First, a high-rate algal pond is dedicated to the treatment of municipal wastewater. Then, an anaerobic digester capable of co- digesting biomass products (and others organic matter resources) to significantly reduce biological and chemical contaminants while producing a sustainable energy as biogas is analysed. A final module transforms the residual carbon, nitrogen and phosphorus into high-value microalgae dedicated to aquaculture and green chemistry.

- **ITE-OPALE:** The goal of the Institut de la Transition Énergétique - OPALE project is to increase the lipid content of microalgae by specific selection pressure. The project relies on the strain already selected during the facteur 4 project, whose productivity was 4 times higher than the wild type. We expect to still increase strain performances up to 10 times the productivity of the wild type.

- **ANR-FunFit:** The objective of this project (2013-2017) is to develop a trait-based approach linking individual fitness of fungal plant pathogens to ecological strategies. The idea is to derive eco-epidemiological strategies from fitness optimization in colonized environments and during colonization, as well as understanding the coexistence of sibling species. This project is co-coordinated by F. Grognard.

- **ANR-TripTic:** The objective of this project (2014-2018) is to document the biological diversity in the genus of the minute wasps *Trichogramma*, and to study the behavioral and populational traits relevant to their use in biological control programs.

- **ANR-GESTER:** "Management of crop resistances to diseases in agricultural landscapes as a response to new constraints on pesticide use", ANR Agrobiosphère, 2011–2016. This project aims at producing allocation scenarios of resistant varieties at the scale of cultivated landscapes, that will allow to limit disease development while ensuring sustainable efficiency of genetic resistances. BIOCORE participates in this project via MaIAGE, INRA Jouy-en-Josas.

- **ANR-MIHMES:** "Multi-scale modelling, from animal Intra-Host to Metapopulation, of mechanisms of pathogen spread to Evaluate control Strategies", ANR – Investissement d'avenir, action Bioinformatique (ANR-10-BINF-07) & Fond Européen de Développement Régional des Pays-de-la-Loire (FEDER), 2012–2017. This project aims at producing scientific knowledge and methods for the management of endemic infectious animal diseases and veterinary public health risks. BIOCORE participates in this project via MaIAGE, INRA Jouy-en-Josas. This project supports Natacha Go's postdoctoral position.

- **ANR-ICycle:** This project (2016-2020) aims at understanding the communication pathways between the cell division cycle and the circadian clock, using mathematical modeling and control theory to construct and implement two coupled synthetic biological oscillators. Project coordinated by M. Chaves.

- **RESET:** The objective of this project is to control the growth of *E. coli* cells in a precise way, by arresting and restarting the gene expression machinery of the bacteria in an efficient manner directed at improving product yield and productivity. RESET is an "Investissements d'Avenir" project in Bioinformatics (managed by ANR) and it is coordinated by H. de Jong (Ibis, Inria)

- **SIGNALIFE:** Biocore is part of this Labex (scientific cluster of excellence) whose objective is to build a network for innovation on Signal Transduction Pathways in life Sciences, and is hosted by the University of Nice Sophia Antipolis.

- **UMT FIORIMED:** FioriMed is a Mixed Technology Unit created in January 2015 to strengthen the production and dissemination of innovation to the benefit of ornamental horticulture. Horticultural greenhouses are seen as a "laboratory" for the actual implementation of agroecology concepts with the possibility of generic outcomes being transfered to other production systems. The main partners of UMT FioriMed are ASTREDHOR (National Institute of Horticulture) and the ISA Joint Research Unit of INRA-CNRS-Univ. Nice.

9.1.2. Inria funding

- **Inria Project Lab, Algae** *in silico***:** The Algae in silico Inria Project Lab, funded by Inria and coordinated by O. Bernard, focuses on the expertise and knowledge of biologists, applied mathematician and computer scientists to propose an innovative numerical model of microalgal culturing devices. The latest developments in metabolic modelling, hydrodynamic modelling and process control are joined to propose a new generation of advanced simulators in a realistic outdoor environment. The project gathers 5 Inria project teams and 3 external teams.

9.1.3. INRA funding

- **Take Control:** This project, "Deployment strategies of plant quantitative resistance to take control of plant pathogen evolution," is funded by the PRESUME call of the SMAcH INRA metaprogram (Sustainable Management of Crop Health). BIOCORE is a partner together with INRA PACA (Sophia Antipolis and Avignon) and INRA Toulouse (2013-2016). This project provides the major part of the funding for the experiments held for Elsa Rousseau's thesis.

- **K-Masstec:** "Knowledge-driven design of management strategies for stem canker specific resistance genes", INRA Metaprogramme SMaCH, PRESUME action, 2013–2016. The project aims at developing efficient strategies for the deployment of genetic resistance in the field, based on knowledge issued from the understanding of the molecular interaction between distinct avirulence genes, and mainly the discovery of non-conventional gene-for-gene interactions.

9.1.4. Networks

- **GDR Invasions Biologiques:** The objectives of this GDR are to encourage multidisciplinary research approaches on invasion biology. It has five different thematic axes: 1) invasion biology scenarios, 2) biological invasions and ecosystem functioning, 3) environmental impact of invasive species, 4) modeling biological invasions, 5) socio-economics of invasion biology. L. Mailleret is a member of the scientific comittee of the GDR .

- **ModStatSAP:** The objective of this INRA network is to federate researchers in applied mathematics and statistics and to promote mathematical and statistical modelling studies in crop and animal health. S. Touzeau is a member of the scientific committee.

- **Seminar:** BIOCORE organizes a regular seminar "Modeling and control of ecosystems" at the station zoologique of Villefranche-sur-Mer, at INRA-ISA or at Inria.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

SysBioDRez: Marie Curie International Incoming Fellowship FP7 (EC-PEOPLE) is a multidisciplinary CNRS-Inria project for the collaboration of Jeremie Roux (researcher) with both Paul Hofman (scientist in charge) and Jean-Luc Gouzé (partner lab), with the objective of linking in vitro quantitative dynamics to primary tumor samples profiling in order to determine the resistance probability of a specific combination of anti-cancer drugs in lung cancer, using computational methods (see [91]).

9.2.2. Collaborations with Major European Organizations

Imperial college, Department of Chemical engineering (UK),
Modelling and optimization of microalgal based processes.
Imperial College, Centre for Synthetic Biology and Innovation, Dept. of Bioengineering (UK):
Study of metabolic/genetic models
University of Aveiro, Portugal
Interconnected boolean networks
Roslin Institute, Edinburgh, UK
Epidemiology
University of Padova, Italy.
Modelling and control of microalgal production at industrial scale.

9.3. International Initiatives

9.3.1. Inria International Labs

Inria Chile
Associate Team involved in the International Lab:

9.3.1.1. GREENCORE

Title: Modelling and control for energy producing bioprocesses
International Partners (Institution - Laboratory - Researcher):

CIRIC (Chile) - Mélaine Gautier
PUCV (Chile) - Escuela de Ingenieria Bioquimica (EIB) - Gonzalo Ruiz Filippi
UTFSM (Chile) - Departamento de Matematica - Eduardo Cerpa
UFRO (Chile) - Chemical Engineering Department - David Jeison

Start year: 2014
See also: https://team.inria.fr/eagreencore/

The worldwide increasing energy needs together with the ongoing demand for CO2 neutral fuels represent a renewed strong driving force for the production of energy derived from biological resources. In this scenario, the culture of oleaginous microalgae for biofuel and the anaerobic digestion to turn wastes into methane may offer an appealing solution. The main objective of our proposal is to join our expertise and tools, regarding these bioprocesses, in order to implement models and control strategies aiming to manage and finally optimize these key bioprocesses of industrial importance. By joining our expertise and experimental set-up, we want to demonstrate that closed loop control laws can significantly increase the productivity, ensure the bioprocess stability and decrease the environmental footprint of these systems. This project gathers experts in control theory and optimization (BIOCORE, UTFSM) together with experts in bioprocesses (PUCV and UFRO) and software development (CIRIC).

9.3.1.2. Other IIL projects

BIOCORE is involved in the Bionature project from Inria Chile CIRIC (the Communication and Information Research and Innovation Center), in collaboration with four Chilean universities (Universidad de Chile, Universidad Tecnica Federico Santa Maria, Pontificia Universidad Catolica de Valparaiso, and Universidad de la Frontera). The Bionature project is devoted to natural resources management and the modeling and control of bioprocesses.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Univ. Ben Gurion : Microalgal Biotechnology Lab (IL), Member of the ESSEM COST Action ES1408 European network for algal-bioproducts (EUALGAE). Modelling of photosynthesis.

Universidad de la Frontera (CL), Modelling of CO_2 transfer in a microalgal absorption column.

GRIMCAPE, Université de Douala, Cameroon. Epidemiology.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Claude Aflalo (Ben Gurion University of the Neguev, Israel), 1 week;
- Eduardo Sontag (Rutgers University);
- Laurent Tournier (Inra Jouy-en-Josas), 1 week;
- Bapan Ghosh (National Institute of Technology Meghalaya, India), 1 month.

9.5. Project-team seminar

BIOCORE organized a 4-day seminar in September in La Colle-sur-Loup. On this occasion, every member of the project-team presented his/her recent results and brainstorming sessions were organized. Jacques-Alexandre Sepulchre (INLN, Univ. Nice) was invited as a guest speaker.

<h1 style="text-align:center; color:red;">BIOVISION Team</h1>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. Trajectory

Title: Encoding and predicting motion trajectories in early visual networks

Programm: ANR

Duration: October 2015 - September 2020

Coordinator: Invibe Team, Institut des Neurosciences de la Timone, Frédéric Chavane,

Partners:

AMU INT Aix-Marseille, Université Institut de Neurosciences de la Timone

INSERM IDV INSERM Institut de la Vision

USM UV U Santa Maria & U Valparaiso

Inria contact: Bruno Cessac

Global motion processing is a major computational task of biological visual systems. When an object moves across the visual field, the sequence of visited positions is strongly correlated in space and time, forming a trajectory. These correlated images generate a sequence of local activation of the feed-forward stream. Local properties such as position, direction and orientation can be extracted at each time step by a feed-forward cascade of linear filters and static non-linearities. However such local, piecewise, analysis ignores the recent history of motion and faces several difficulties, such as systematic delays, ambiguous information processing (e.g., aperture and correspondence problems) high sensitivity to noise and segmentation problems when several objects are present. Indeed, two main aspects of visual processing have been largely ignored by the dominant, classical feed-forward scheme. First, natural inputs are often ambiguous, dynamic and non-stationary as, e.g., objects moving along complex trajectories. To process them, the visual system must segment them from the scene, estimate their position and direction over time and predict their future location and velocity. Second, each of these processing steps, from the retina to the highest cortical areas, is implemented by an intricate interplay of feed-forward, feedback and horizontal interactions. Thus, at each stage, a moving object will not only be processed locally, but also generate a lateral propagation of information. Despite decades of motion processing research, it is still unclear how the early visual system processes motion trajectories. We, among others, have proposed that anisotropic diffusion of motion information in retinotopic maps can contribute resolving many of these difficulties. Under this perspective, motion integration, anticipation and prediction would be jointly achieved through the interactions between feed-forward, lateral and feedback propagations within a common spatial reference frame, the retinotopic maps. Addressing this question is particularly challenging, as it requires to probe these sequences of events at multiple scales (from individual cells to large networks) and multiple stages (retina, primary visual cortex (V1)). "TRAJECTORY" proposes such an integrated approach. Using state-of-the-art micro- and mesoscopic recording techniques combined with modeling approaches, we aim at dissecting, for the first time, the population responses at two key stages of visual motion encoding: the retina and V1. Preliminary experiments and previous computational studies demonstrate the feasibility of our work. We plan three coordinated physiology and modeling work-packages aimed to explore two crucial early visual stages in order to answer the following questions: How is a translating bar represented and encoded within a hierarchy of visual networks and for which condition does it elicit

anticipatory responses? How is visual processing shaped by the recent history of motion along a more or less predictable trajectory? How much processing happens in V1 as opposed to simply reflecting transformations occurring already in the retina? The project is timely because partners master new tools such as multi-electrode arrays and voltage-sensitive dye imaging for investigating the dynamics of neuronal populations covering a large segment of the motion trajectory, both in retina and V1. Second, it is strategic: motion trajectories are a fundamental aspect of visual processing that is also a technological obstacle in computer vision and neuroprostheses design. Third, this project is unique by proposing to jointly investigate retinal and V1 levels within a single experimental and theoretical framework. Lastly, it is mature being grounded on (i) preliminary data paving the way of the three different aims and (ii) a history of strong interactions between the different groups that have decided to join their efforts.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. RENVISION

Title: Retina-inspired ENcoding for advanced VISION tasks

Programm: FP7

Duration: March 2013 - February 2016

Coordinator: Instituto Italiano di Tecnologia_Pattern Analysis and Computer vision) Vittorio Murino

Partners:

PAVIS,NET3 Fondazione Istituto Italiano di Tecnologia (Italy)

Institute for Adaptive and Neural Computation, The University of Edinburgh (UK)

Institute of Neuroscience, University of Newcastle Upon Tyne (UK)

Inria contact: Bruno Cessac

The retina is a sophisticated distributed processing unit of the central nervous system encoding visual stimuli in a highly parallel, adaptive and computationally efficient way. Recent studies show that rather than being a simple spatiotemporal filter that encodes visual information, the retina performs sophisticated non-linear computations extracting specific spatio-temporal stimulus features in a highly selective manner (e.g. motion selectivity). Understanding the neurobiological principles beyond retinal functionality is essential to develop successful artificial computer vision architectures. RENVISION's goal is, therefore, twofold: i) to achieve a comprehensive understanding of how the retina encodes visual information through the different cellular layers; ii) to use such insights to develop a retina-inspired computational approach to high-level computer vision tasks. To this aim, exploiting the recent advances in high-resolution light microscopy 3D imaging and high-density multielectrode array technologies, RENVISION will be in an unprecedented position to investigate pan-retinal signal processing at high spatio-temporal resolution, integrating these two technologies in a novel experimental setup. This will allow for simultaneous recording from the entire population of ganglion cells and functional imaging of inner retinal layers at near-cellular resolution, combined with 3D structural imaging of the whole inner retina. The combined analysis of these complex datasets will require the development of novel multimodal analysis methods. Resting on these neuroscientific and computational grounds, RENVISION will generate new knowledge on retinal processing. It will provide advanced pattern recognition and machine learning technologies to ICTs by shedding a new light on how the output of retinal processing (natural or modelled) allows solving complex vision tasks such as automated scene categorization and human action recognition.

7.3. International Initiatives

7.3.1. Informal International Partners

- Maria-Jose Escobar, University Santa-Maria, Valparaiso;
- Adrian Palacios, Centro de Neurociencia, Valparaiso

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

- Marco Benzi (grant: Stage Master Transverse Biovision–GraphDeco), Retina-inspired tone mapping. Supervisors: Pierre Kornprobst and Adrien Rousseau (GraphDeco), in collaboration with Maria-Jose Escobar (Universidad Técnica Federico Santa María, Valparaíso, Chile)
- Alberto Patino (grant: CONACYT), Studying image transforms at neuronal level and in Virtual Reality. Supervisors: Pierre Kornprobst (Biovision) and Fabio Solari (University of Genoa, Italy)

<p align="center" style="color:red">BONSAI Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR ASTER: ASTER is a national project that aims at developing algorithms and software for analyzing third-generation sequencing data, and more specifically RNA sequencing. BONSAI is the principal investigator in this ANR. Other partners are Erable (LBBE in Lyon) and two sequencing and analysis platforms that have been very active in the MinION Access Program (Genoscope and Institut Pasteur de Lille).

- PIA France Génomique: National funding from "Investissements d'Avenir" (call *Infrastructures en Biologie-Santé*). France Génomique is a shared infrastructure, whose goal is to support sequencing, genotyping and associated computational analysis, and increases French capacities in genome and bioinformatics data analysis. It gathers 9 sequencing and 8 bioinformatics platforms. Within this consortium, we are responsible for the workpackage devoted to the computational analysis of sRNA-seq data, in coordination with the bioinformatics platform of Génopole Toulouse-Midi-Pyrénées.

9.1.2. ADT

- ADT Vidjil (2015–2017): The purpose of this ADT is to strengthen Vidjil development and to ensure a better diffusion of the software by easing its installation, administration and usability. This will enable the software to be well suited for a daily clinical use. The software is already used in test on our own web server (more than 5,000 samples processed by now). Vidjil is now used in a routine practice by three French hospitals and one German hospital. By the end of the ADT, we expect this number to increase and the software to be directly installed inside some hospitals.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

International ANR RNAlands (2014-2017): National funding from the French Agency Research (call *International call*). Our objective is the fast and efficient sampling of structures in RNA Folding Landscapes. The project gathers three partners: Amib from Inria Saclay, the Theoretical Biochemistry Group from Universität Wien and BONSAI.

Interreg Va (France-Wallonie-Vlaanderen) : Portfolio "SmartBioControl", including 5 constitutive projects and 25 partners working together towards sustainable agriculture.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. CG-ALCODE

Title: Comparative Genomics for the analysis of gene structure evolution: ALternative CODing in Eukaryote genes through alternative splicing, transcription, and translation.

International Partner (Institution - Laboratory - Researcher):

Université du Québec À Montréal (Canada) - Laboratoire de combinatoire et d'informatique mathématique (LaCIM) - Anne Bergeron

From 2014 to 2017

The aim of this Associated Team is the development of comparative genomics models and methods for the analysis of eukaryote genes structure evolution. Our goal is to answer very important questions arising from recent discoveries on the major role played by alternative transcription, splicing, and translation, in the functional diversification of eukaryote genes. Two working meeting took place in 2016. S. Blanquart and J.-S. Varré met A. Bergeron and K. Swenson in Montpellier, from 13th to 15th of April. J.-S. Varré and K. Swenson met A. Bergeron in Montréal, from 8th to 19th of November.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

- *Astrid Lindgrens Hospital, Stockholm University:* Collaboration with Anna Nilsson and Shanie Saghafian-Hedengren on RNA sequencing of stromal cells.
- *Childhood Leukaemia Investigation Prague (CLIP), Department of Pediatric Hematology/Oncology, 2nd Faculty of Medicine, Charles University, Prague, Czech Republic:* Collaboration with Michaela Kotrová and Eva Fronkova on leukemia diagnosis and follow-up.
- *CWI Amsterdam:* Collaboration with Alexander Schoenhuth and Jasmijn Baaijens on succinct data structures and algorithms for the assembly of viral quasispecies.
- *Department of Statitics, North Carolina State University:* Collaboration with Donald E. K. Martin on spaced seeds coverage.
- *Département des Sciences de la Vie, Faculté des Sciences de Liège:* Collaboration with Denis Beaurain on nonribosomal peptides.
- *Gembloux Agro-Bio Tech, Université de Liège:* Collaboration with Philippe Jacques on nonribosomal peptides.
- *Institut für Biophysik und physikalische Biochemie, University of Regensburg:* Collaboration with Rainer Merkl on ancestral sequence inference and synthesis.
- *Institute of Biosciences and Bioresources, Bari:* Collaboration with Nunzia Scotti on the assembly of plant mitochondrial genomes.
- *Makova lab, The Pennsylvania State University:* Collaboration with Kateryna Makova and Samarth Rangavittal on the assembly of the gorilla Y chromosome, and visualisation of assembly graphs.
- *Medvedev lab, The Pennsylvania State University:* Collaboration with Paul Medvedev on algorithms for constructing de Bruijn graphs.
- *Novo Nordisk Foundation Center for Biosustainability, Technical University of Denmark:* Collaboration with Tilmann Weber on nonribosomal peptides.
- *Proteome Informatics Group, Swiss Institute of Bioinformatics:* Collaboration with Frédérique Lisacek on nonribosomal peptides.
- *School of Social and Community Medicine, University of Bristol:* Collaboration with Marc Duez, John Moppett and Stephanie Wakeman on leukemia diagnosis follow-up.
- *Theoretical Biochemistry Group, Universität Wien:* Collaboration with Andrea Tanzer and Ronny Lorenz on RNA folding and RNA kinetics.

9.3.3. Participation in Other International Programs

- Participation in the EuroClonality-NGS consortium. This consortium aims at standardizing the study of immune repertoire, clonality and minimal residual disease in leukemia at the european level. We are part of the bioinformatics workgroup led by Nikos Darzentas (CEITEC, Brno, Czech Republic).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Dr. Alexander Schoenhuth (group leader, *CWI Amsterdam*) and Jasmijn Baaijens (PhD student, *CWI Amsterdam*).

CAMIN Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- LABEX NUMEV (postdoc):

  Participants: Mitsuhiro Hayashibe, Denis Mottet (EUROMOV).

  A 1-year postdoc was funded by the NUMEV Labex on "Control of Arm Synergies After a Stroke (CASAS)".

- LABEX NUMEV (PhD grants co-fundings): Participants: Christine Azevedo, David Andreu, Benoit Sijobert.
  Participants: Sofiane Ramdani, François Bonnetblanc, Anthony Boyer.

9.2. National Initiatives

- BCI-LIFT: an Inria Project-Lab Participants : Mitsuhiro Hayashibe, Saugat Bhattacharyya.

  BCI-LIFT is a large-scale 4-year research initiative (2015-2018) which aim is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. We work on BCI-FES study for promoting motor learning.

- ADT PersoBalance2

  Participants : Mitsuhiro Hayashibe, Philippe Fraisse.

  A half-year engineer was funded by Inria ADT on "Personalized Balance Assessment in Home Rehabilitation, version2 (PersoBalance2)".

9.2.1. Excellence intitiative, PSPC

- Project INTENSE 2012-2018
- Leader: LIVANOVA
- Partners: LTSI, INRA Rennes, CEA LETI, HEGP, CHU Rennes, MXM-Axonic, 3D+
- the aim of the project is to treat severe obesity and cardiac failure through Vagus Nerve Stimulation (VNS). Our contirubution concerned the development of innovative hardware and software architecture to allow for selective stimulation. We developed the models that were used to optimize the settings of the stimulators taking into account the geometry of the 12-pole neural electrode. The selectivity and the efficacy of the stimulation were also improved through the study of original stiumulus waveforms. As a whole the idea was to further enhance the therapy while limiting the side effects that VNS my induce.
- the cardiac application stops end of august due to internal decisions at LIVANOVA but the obesity application continues to be investigated.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: FP7

Project acronym: EPIONE

Project title: Natural sensory feedback for phantom limb pain modulation and therapy

Duration: 2013-2017

Coordinator: AAU (Aalborg, Denmark)

Other partners: Ecole polytechnique fédérale de Lausanne (EPFL), IUPUI (Indianapolis, USA), Lund University (LUNDS UNIVERSITET), MXM (Vallauris, France), Novosense AB (NS), IMTEK (Freiburg, Germany), UAB (Barcelona, Spain), Aalborg Hospital, Universita Cattolica del Sacro Cuore (UCSC), Centre hospitalier Universitaire Vaudois (CHUV)

Abstract: http://project-epione.eu/. The aim of the project is to treat phantom limb pain. CAMIN is only involved in the invasive approach using intrafascicular electrodes. We developed certified software with EPFL and AAU, co-supervised animal tests and data processing with UAB, provide support to clinical trials with IMTEK and UCSC and developped a new stimulator with MXM.

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. NEUROPHYS4NEUROREHAB

Title: Development of neurophysiological test setup for customizing and monitoring patient-specific non-invasive electrical stimulation-facilitated neurorehabilitation.

International Partners (Institution - Laboratory - Researcher):

IITH (India) - Centre for VLSI and Embedded Systems Technology - Shubhajit Roy Chowdhury

IIT Gandhinagar (India) - Department of Electrical Engineering- Uttama Lahiri

Start year: 2014

See also: https://team.inria.fr/nphys4nrehab/

Stroke presents with heterogeneous patient-specific impairments in motor, sensory, tone, visual, perceptual, cognition, aphasia, apraxia, coordination, and equilibrium where the functional limitations following stroke are varied, including gait dysfunction, fall risk, limited activities of daily living, difficulties in swallowing, reduced upper extremity function, altered communication, besides others. These heterogeneous patient-specific impairments make planning of the neurorehabilitation therapy challenging. Here, it may be important to stratify the stroke survivors for restorative neurorehabilitation based on the prognosis and the ability of the stroke survivor to undergo therapy depending on their cardiovascular and neuromuscular capacity besides psychological factors such as motivation where the therapy needs to be tailored to individual health condition. The WHO International Classification of Functioning (ICF) model recommends intervention at multiple levels (e.g., impairment, activity, participation) where environment and personal factors can play an important role in resource-limited India. In fact, deconditioned chronic stroke survivor will need to recondition their cardiovascular endurance, metabolic fitness, and muscle conditions with a gradual increase in the intensity (number of hours per day) and frequency (number of days per week) of therapy, providing a higher level as they improve their function. Towards that overarching goal in a low-resource setting, we propose development of neurophysiological screening and monitoring tools using low-cost sensors.

9.4.1.2. CACAO

Title: Lower limb electrical stimulation for function restoration

International Partner (Institution - Laboratory - Researcher):

UNB (Brazil) - NTAAI - FACHIN-MARTINS Emerson

UNB (Brazil) - LARA - Padilha-Bo Antonio

Start year: 2016

See also: https://team.inria.fr/cacao/

Electrical stimulation (ES) can activate paralyzed muscles to support rehabilitation. ES applied to fully or partially paralyzed muscles artificially induces muscle contraction substituting or completing the normal volitional control. In CACAO team we will join our efforts and specific expertise to develop approaches of lower limb function restoration in spinal cord injured individuals. Two main applications will be addressed: 1) Functional Electrical Stimulation (FES) to assist SCI individuals to perform pivot transfers and 2) FES-assisted cycling (we already jointly prepared and participated to CYBATHLON'16). We aim at proposing solutions that can have an effect on patients' quality of life, thus our choices intend to be realistic form a practical point of view. We will take care in evaluating both functional and psychological effects of our solutions and to constrain technical choices to be acceptable by final user. CACAO project will be a good opportunity to combine "bioengineer" (DEMAR) and "physiology/rehabilitation" (NTAAI) visions and knowledges towards solutions for clinical applications.

9.5. International Research Visitors

9.5.1. *Visits to International Teams*

9.5.1.1. France-Stanford program

The Executive Committee of the France-Stanford Center for Interdisciplinary Studies supported our collaboration (§7.1.1) with Prof. Jessica Rose (Department of Orthopaedic Surgery, Stanford University). As part of the collaboration, Professor Rose presented a keynote lecture on Artificial Walking Technologies for Neuromuscular stimulation-assisted Gait for children with cerebral palsy at the International Functional Electrical Stimulation Society (IFESS) conference hosted by CAMIN. In July, a Benoît Sijobert spent 2 weeks in July 2016 to setup the experiment and Christine Azevedo Coste 1 week to run experiments.

9.5.1.2. Asgard program

From may 5 to may 13, François Bonnetblanc visited The Endestad Brain Imaging Group, the Institute of Basic Medical Sciences, Akershus universitetssykehus HF, Sunnaas Sykehus HF, UiO Department of Psychology, and the Norwegian School of Sport Sciences in Norway thanks to the Asgard programme. (http://www.france. no/if/oslo/cooperation/sciences/programmes-sciences/asgard/)

A shared project about the closed-loop stimulation of urinal control of pigs has been proposed with the Institute of Basic Medical Sciences in the framework of Aurora (followup of Adgard).

9.5.1.3. Research Stays Abroad

Christine Azevedo Coste spent 2,5 months (November 2015-February 2016) at Brasilia University as an invited researcher in collaboration within Emerson FACHIN-MARTINS responsible of the NTAAI (Nucléo de Tecnologia Assistiva, Acessibilidade e Inovacão) initiative.
Brazilian program: Science without borders (Ciencías sem fronteiras) CAPES. She spent 10 days in May 2016 together with Charles FATTAL to perform experiments.

Mitsuhiro Hayashibe was invited to participate to JSPS Program: Program for Advancing Strategic International Networks to Accelerate the Circulation of Talented Researchers. (PI Prof. Hitoshi Hirata, Dep. of Med. Nagoya Univ.)(Feb. 2016)

Mitsuhiro Hayashibe was visiting Researcher at EPFL, BIOROB supported by Swiss National Science Foundation (Sep.-Oct. 2016)

<p style="text-align:center">**CAPSID Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. PEPS

Participants: Marie-Dominique Devignes [contact person], Bernard Maigret, David Ritchie.

The team is involved in the inter-disciplinary "MODEL-ICE" project led by Nicolas Soler (DynAMic lab, UMR 1128, INRA / Univ. Lorraine). The aim is to investigate protein-protein interactions required for initiating the transfer of an ICE (Integrated Conjugative Element) from one bacterial cell to another one.

8.2. National Initiatives

8.2.1. FEDER

8.2.1.1. LBS

Participant: Marie-Dominique Devignes [contact person].

The project "LBS" (Le Bois Santé) is a consortium funded by the European Regional Development Fund (FEDER) and the French "Fonds Unique Interministériel" (FUI). The project is coordinated by Harmonic Pharma SAS. The aim of LBS is to exploit wood products in the pharmaceutical and nutrition domains. Our contribution has been in data management and knowledge discovery for new therapeutic applications.

8.2.2. ANR

8.2.2.1. Fight-HF

Participants: Marie-Dominique Devignes [contact person], Bernard Maigret, Sabeur Aridhi, David Ritchie.

This "Investissements d'Avenirs" project aims to discover novel mechanisms for heart failure and to propose decision support for precision medicine. The project has been granted € 9M, and involves many participants from Nancy University Hospital's Federation "CARTAGE" (http://www.fhu-cartage.com/). In collaboration with the Orpailleur Team, Marie-Dominique Devignes is coordinating a work-package on network-based science and drug discovery for this project.

8.2.2.2. IFB

Participants: Marie-Dominique Devignes [contact person], Sabeur Aridhi, Isaure Chauvot de Beauchêne, David Ritchie.

The Capsid team is a research node of the IFB (Institut Français de Bioinformatique), the French national network of bioinformatics platforms (http://www.france-bioinformatique.fr). The principal aim is to make bioinformatics skills and resources more accessible to French biology laboratories.

8.2.2.3. PEPSI

Participants: David Ritchie [contact person], Marie-Dominique Devignes.

The PEPSI ("Polynomial Expansions of Protein Structures and Interactions") project is a collaboration with Sergei Grudinin at Inria Grenoble – Rône Alpes (project Nano-D) and Valentin Gordeliy at the Institut de Biologie Structurale (IBS) in Grenoble. This project funded by the ANR "Modèles Numériques" program involves developing computational protein modeling and docking techniques and using them to help solve the structures of large molecular systems experimentally.

8.3. International Initiatives

8.3.1. Participation in Other International Programs

Participant: Bernard Maigret; Project: *Characterization, expression and molecular modeling of TRR1 and ALS3 proteins of Candida spp., as a strategy to obtain new drugs with action on yeasts involved in nosocomial infections;* Partner: State University of Maringá, Brasil; Funding: CNPq.

Participant: Bernard Maigret; Project: *Fusarium graminearum target selection;* Partner: Embrapa Recursos Geneticos e Biotecnologia, Brasil; Funding: CNPq.

Participant: Bernard Maigret; Project: *The thermal shock HSP90 protein as a target for new drugs against paracoccidioidomicose;* Partner: Brasília University, Brasil; Funding: CNPq.

Participant: Bernard Maigret; Project: *Protein-protein interactions for the development of new drugs;* Partner: Federal University of Goias, Brasil. Funding: Chamada MCTI/CNPq/FNDCT.

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

Gabin Personeni visited the Biomedical Informatics Research Laboratory of Prof. Michel Dumontier at Stanford University for 3 months (Nov 2015 – Feb 2016).
Seyed Ziaeddin Alborzi visited the UniProt development team of Maria Martin at the European Bioinformatics Institute (EBI), Hinxton UK, for 3 months (Oct – Dec 2016) in partial fulfilment of the requirements for a European PhD.

CARMEN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. IHU LIRYC

Our work is partially funded by the LIRYC project (ANR 10-IAHU 04).

- Until November 2016 the salary of M. Potse was funded by LIRYC.

8.2. National Initiatives

8.2.1. ANR HR-CEM

The project "High Resolution Cardiac Electrophysiology Models: HR-CEM" within the ANR call *Modèles Numériques* started in November 2013 and will last until November 2017.

It is an international project that involves three partners: Inria (coordinator), IHU LIRYC, and UMI-CRM in Montréal (Canada). The project has external collaborators in Univ. Bordeaux and Univ. Pau.

Based on these collaborations and new developments in structural and functional imaging of the heart available at LIRYC, we plan to reconsider the concepts behind the models in order to improve the accuracy and efficiency of simulations. Cardiac simulation software and high-resolution numerical models will be derived from experimental data from animal models. Validation will be performed by comparing of simulation output with experimentally recorded functional data. The validated numerical models will be made available to the community of researchers who take advantage of in-silico cardiac simulation and, hopefully, become references. In particular we shall provide the first exhaustive model of an animal heart including the four chambers coupled through the special conduction network, with highly detailed microstructure of both the atria and the ventricles. Such a model embedded in high-performance computational software will provide stronger medical foundations for in-silico experimentation, and elucidate mechanisms of cardiac arrhythmias.

8.2.2. ANR Labcom CardioXcomp

We are participant in the ANR Labcom project between Inria and the company Notocord (www.notocord.com). In this project, we propose a mathematical approach for the analysis of drug effects on the electrical activity of human induced pluripotent stem cell-derived cardiomyocytes (hiPSC-CMs) based on multi-electrode array (MEA) experiments. Our goal is to produce an *in-silico* tool able to simulate drug actions in MEA/hiPSC-CM assays. The mathematical model takes into account the geometry of the MEA and the electrode properties. The electrical activity of the stem cells at the ion-channel level is governed by a system of ordinary differential equations (ODEs). The ODEs are coupled to the bidomain equations, describing the propagation of the electrical wave in the stem cells preparation. The field potential (FP) measured by the MEA is modeled by the extra-cellular potential of the bidomain equations. First, we propose a strategy allowing us to generate a field potential in good agreement with the experimental data. We show that we are able to reproduce realistic field potentials by introducing different scenarios of heterogeneity in the action potential. This heterogeneity reflects the differentiation atria/ventricles and the age of the cells. Second, we introduce a drug/ion channels interaction based on a pore block model. We conduct different simulations for five drugs (mexiletine, dofetilide, bepridil, ivabradine and BayK). We compare the simulation results with the field potential collected from experimental measurements. Different biomarkers computed on the FP are considered, including depolarization amplitude, repolarization delay, repolarization amplitude and depolarization-repolarization segment. The simulation results show that the model reflect properly the main effects of these drugs on the FP.

8.2.3. REO

The CARMEN team is a partner with the REO team at Inria Paris Rocquencourt and the Notocord company in the CardioXcomp project.

8.2.4. MedicActiv

The CARMEN team cooperates in interaction with the MedicActiV project.

8.2.5. GENCI

GENCI (*grand équipement national de calcul intensif*) is the agency that grants access to all national high-performance resources for scientific purposes in France. GENCI projects have to be renewed yearly. Our project renewal *Interaction between tissue structure and ion-channel function in cardiac arrhythmia*, submitted in October 2015, has been granted 9.4 million core-hours on the three major systems Curie, Occigen, and Turing. This compute time, to be used in the calendar year 2016, is primarily destined for our research into the interaction between ionic and structural heart disease in atrial fibrillation, Brugada syndrome, and early repolarisation syndrome [51]. A renewal request has been submitted in October 2016 and was granted with 9.8 million core-hours.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

The Carmen team is a core member of two H2020 proposals that are to be submitted in March 2017.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. EPICARD

Title: inversE Problems In CARDiac electrophysiology

International Partner (Institution - Laboratory - Researcher):

ENIT (Tunisia) – Department of Intelligence Science and Technology - Nabil Gmati

Start year: 2015

See also: https://team.inria.fr/carmen/epicard/

Improving the information that we can extract from electrical signals measured on patients with heart diseases is a major priority for the IHU LIRYC. We would like to non-invasively construct the electrical potential on the heart surface only from measurements of the potential on the the chest of the patient. It is known that algorithms that have been used in the literature for solving this electrocardiography imaging (ECGI) problem, including those used in commercial medical devices, have several limitations. This problem could be mathematically seen as a boundary data completion problem for elliptic equations. Many studies have been carried out in order to solve this Cauchy problem, but have never been used for solving the ECGI problem. The goal of this Inria International Lab (IIL) is to develop an experimental platform allowing to test various methods and compare their performance on real life experimental data.

We describe here two projects that have been performed in the context of this IIL.

8.4.1.1.1. Mathematical analysis of the parameter estimation problem

N. Zemzemi, J. Lassoued, and M. Mahjoub worked on the mathematical analysis of a parameter identification problem in cardiac electrophysiology modeling. The work was based on a monodomain reaction-diffusion model of the heart. The purpose was to prove the stability of the identification of the parameter τ_{in}, which is the parameter that multiplies the cubic term in the reaction term. The proof of the result is based on a new Carleman-type estimate for both the PDE and ODE problems. As a consequence of the stability result they proved the uniqueness of the parameter τ_{in} giving some observations of both state variables at a given time t_0 in the whole domain and the PDE variable in a non empty open subset w_0 of the domain.

8.4.1.1.2. Uncertainty quantification in the electrocardiography problem

N. Zemzemi worked with N. Fikal, R. Aboulaich and EL.M. El Guarmah on uncertainty quantification in electrocardiography imaging. The purpose of this work was to study the influence of errors and uncertainties of the imput data, like the conductivity, on the electrocardiographic imaging (ECGI) solution. They propose a new stochastic optimal control formulation to calculate the distribution of the electric potentiel on the heart from the measurement on the body surface. The discretization was done using a stochastic Galerkin method allowing to separate random and deterministic variables. The problem was discretized, in spatial part, using the finite element method and the polynomial chaos expansion in the stochastic part of the problem. The problem was solved using a conjugate gradient method where the gradient of the cost function was computed with an adjoint technique. The efficiency of this approach to solve the inverse problem and the usability to quantify the effect of conductivity uncertainties in the torso were demonstrated through numerical simulations on a 2D analytical geometry and on a 2D cross section of a real torso.

8.4.1.2. Informal International Partners

M. Potse works with the group of Prof. U. Schotten at Maastricht University (The Netherlands) and the Center for Computational Medicine in Cardiology at the *Università della Svizzera italiana* (Lugano, Switzerland) on simulation studies of atrial fibrillation [20]. The Maastricht group was partially funded by the FP7 project EUTRAF and our simulations were supported by GENCI (section 8.2.5).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Professor Y. Bourgault (University of Ottawa) visited the team from 12 to 26 March.

Professor A. Fraguela Collar, from the *Benemerita Universidad Autonoma de Puebla-Mexico* visited us in July 2016.

8.5.2. Visits to International Teams

8.5.2.1. Other international activities

N. Zemzemi gave a course in the CIMPA research school: "Modelling and simulating the electrical activity of the heart Direct and Inverse problems."

N. Zemzemi organized a mini-symposium intitled "Imaging and inverse modeling" in PICOF 2016: https://picof.sciencesconf.org/resource/page/id/4#. From 01/06/2016 to 03/06/2016. Autrans, France.

CASTOR Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

- ANEMOS : ANR-11-MONU-002

  ANEMOS : Advanced Numeric for Elms : Models and Optimized Strategies associates JAD Laboratory/Inria (Nice, Manager), IRFM-CEA (Cadarache), Maison de la Simulation (Saclay) and Inria EPI Bacchus (Bordeaux). Final report, oral talk and poster to the "Journées des Rencontres Numériques de l'ANR" (16-17 nov. 2016), http://www.rencontres-numerique-anr.fr/.

6.1.2. Inria Project Lab: FRATRES (Fusion Reactors Research and Simulation)

- Participants : Inria project-teams : CASTOR, IPSO, TONUS,
- Partners : IRFM-CEA, Max Planck Institute-IPP Garching, LJLL-Jussieu, IMT-Toulouse

Controlled nuclear fusion can be considered as an example of grand challenge in many fields of computational sciences from physical modelling, mathematical and numerical analysis to algorithmics and software development and several Inria teams and their partners are developing mathematical and numerical tools in these areas.

Since january 2015, H. Guillard is coordinating the Inria Project Lab FRATRES (https://team.inria.fr/ipl-fratres/) to organize these developments on a collaborative basis in order to overcome the current limitations of today numerical methodologies. The ambition is to prepare the next generation of numerical modelling methodologies able to use in an optimal way the processing capabilities of modern massively parallel architectures. This objective requires close collaboration between a) applied mathematicians and physicists that develop and study mathematical models of PDE; b) numerical analysts developing approximation schemes; c) specialists of algorithmic proposing solvers and libraries using the many levels of parallelism offered by the modern architecture and d) computer scientists. This Inria Project Lab will contribute in close connection with National and European initiatives devoted to nuclear Fusion to the improvement and design of numerical simulation technologies applied to plasma physics and in particular to the ITER project for magnetic confinement fusion.

Contact : Hervé Guillard

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

6.2.1.1. EuroFusion Consortium

CASTOR participates to the following EuroFusion consortium projects :

- CfP-WP14-ER-01/Swiss Confederation-01. École Polytechnique Fédérale de Lausanne (PI: Paolo Ricci) "Synergetic numerical-experimental approach to fundamental aspects of turbulent transport in the tokamak edge"
- CfP-WP14-ER-01/CEA-01. CEA (PI: Matthias Hoelzl IPP) "JOREK, BOUT++ non-linear MHD modelling of MHD instabilities and their control in existing tokamaks and ITER"
- EUROfusion WPCD (Working Package Code Development)
    - ACT1: Extended equilibrium and stability chain (participation)
    - ACT2: Free boundary equilibrium and control (participation and coordination)

6.2.1.2. EoCoE

The team also participates in the EoCoE European project. Grant Agreement number: 676629 — EoCoE — H2020-EINFRA-2014-2015/H2020-EINFRA-2015-1.

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Commissariat à l'Energie Atomique et Aux Energies Alternatives (France)

Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)

Consiglio Nazionale Delle Ricerche (Italy)

The Cyprus Institute (Cyprus)

Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Forschungszentrum Julich (Germany)

Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany)

University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

The aim of the present proposal is to establish an Energy Oriented Centre of Excellence for computing applications. EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

6.3. International Initiatives

6.3.1. Inria Associate Teams Not Involved in an Inria International Labs

6.3.1.1. AMOSS

Title: Advanced modelling on Shear Shallow Flows for Curved Topography : water and granular flows.

International Partner (Institution - Laboratory - Researcher):

   NCKU (Taiwan) - Yih-Chin Tai

Start year: 2014

Our objective here is to generalize the promising modelling strategy proposed by S. Gavrilyuk (2012-2013) to genuinely 3D shear flows and also take into account the curvature effects related to topography. Special care will be exercised to ensure that the numerical methodology can take full advantage of massively parallel computational platforms and serve as a practical engineering tool. Cross validations will be achieved by experiments and numerical simulations with applications to landslides.

Closing workshop of the associated team, 7-10 nov. 2016 - Tainan (Taïwan)

6.3.2. Inria International Partners

6.3.2.1. Informal International Partners

The team collaborates with TUC (Technical University of Crete, Prof. Argyris Delis) on the subject of shallow water models. Part of this collaboration is common with the works done in the framework of the AMOSS associate team.

CLIME Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

- The ANR project Estimair aims at quantifying the uncertainties of air quality simulations at urban scale. The propagation of uncertainties requires the use of model reduction and emulation. A key uncertainty source lies in the traffic emissions, which are generated using a dynamic traffic assignment model. Ensembles of traffic assignments are calibrated and used in the uncertainty quantification. Estimair is led by Clime.

- The IPSL project "AVES" (Ensemble Variational Assimilation applied to a shallow-water model) aims at estimating the quality of an ensemble produced by a variational ensemble algorithm applied on a shallow-water numerical model. A focus is made on the bayesian properties of the ensemble, i.e. its capacity to sample the a-posteriori probability law of the model state.

- Two new ANR projects have been accepted in 2016 and will begin in January 2017.
  FireCaster aims at fire forecasting and risk mitigation.
  Cense aims at the estimation of urban noise, using numerical simulation and a dense monitoring network.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Program: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

   CEA, Commissariat à l'Énergie Atomique et aux Énergies Alternatives (France)

   Forschungszentrum Julich (Germany)

   Max Planck Gesellschaft (Germany)

   ENEA, Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)

   CERFACS, European Centre for Research and Advanced Training in Scientific Computing (France)

   Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

   Universita Degli Studi di Trento (Italy)

   Fraunhofer Gesellschaft (Germany)

   University of Bath (United Kingdom)

   CYL, The Cyprus Institute (Cyprus)

   CNR, National Research Council of Italy (Italy)

   Université Libre de Bruxelles (Belgium)

   BSC, Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Inria contact: Michel Kern (Serena team)

The aim of the projevt is to establish an Energy Oriented Centre of Excellence for computing applications (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

9.2.1.2. *Env&You 2016*

Title: Env&You

Program: EIT Digital

Duration: January 2016 - December 2016

Coordinator: Inria (MiMove)

Partners and subgrantees:

> Inria
>
> NUMTECH
>
> Cap Digital
>
> Forum Virium (Finland)
>
> TheCivicEngine (United States)
>
> Ambientic

Inria contact: Valérie Issarny (Mimove project-team)

Env&You aims at delivering the whole picture of urban pollution, from the individual exposure to neighborhood-by-neighborhood and day-to-day variation, to citizens and governments, informing their decisions for healthy urban living. There is a clear, and probably increasing, desire from the citizens to better know their individual exposure to pollution. Partial solutions exist to the exposure data problem but each focuses on one or another domain of information—crowdsourcing exposure, translating governmental open data to usable consumer information, harnessing social media information, harnessing biometrics—what is unique about Env&You is that it will assimilate a multi-dimensional picture of exposure and provide the integrated information to citizen, government, and business use.

9.3. International Initiatives

9.3.1. *Inria International Partners*

9.3.1.1. *Informal International Partners*

Partner: Marine Hydrophysical Institute, Ukraine.

The collaboration concerns the study of the Black Sea surface circulation and the issue of image assimilation in forecasting models.

Partner: IBM Research, Dublin, Ireland

The collaboration addresses the assimilation of classical observations as well as images, with application to geophysics. New assimilation methods are developed, mainly based on minimax filtering.

<div align="center" style="color:red">**COFFEE Project-Team**</div>

8. Partnerships and Cooperations

8.1. Regional Initiatives

The team is involved in the recently granted project UCA-JEDI.

8.2. National Initiatives

8.2.1. ANR

The ANR-project Monumentalg, led by M. Ribot, is devoted to the modeling and simulation of biological damage on monuments and algae proliferation.

Coffee is among the partners of the project CHARMS, with a funding starting in 2016; the project is devoted to the modeling of reservoirs in complex hydrothermal networks.

8.2.2. National and European networks

- GdR MANU.

  The research group MANU has activities centered around scientific computing, design of new numerical schemes and mathematical modelling (upscaling, homogenization, sensitivity studies, inverse problems,...). Its goal is to coordinate research in this area, as well as to promote the emergence of focused groups around specific projects

- S. Junca is involved in the GdR-e "Wave Propagation in Complex Media for Quantitative and non Destructive Evaluation".

8.3. International Initiatives

8.3.1. Declared Inria International Partners

Team COKLYCO

Title: Modeling, analysis and simulation of kinetic and fluid models for MEMS

International Partner (Institution - Laboratory - Researcher):

Kyoto (Japan) - Department of Mechanical Engineering and Science (ME) - Aoki Kazuo

Start year: 2014 End year: 2016.

See also: https://team.inria.fr/coffee/?page_id=323

We wish to elaborate and analyse new models of microscopic and macroscopic type for Micro-Electro-Mechanical Systems (MEMS). The tiny scales of such technical devices induce new and challenging difficulties. A specific attention will be paid to the treatment of coupling conditions from moving boundaries, and to the multi-scale character of the problem. The project is based on a strong interplay between mathematical analysis, experiments and numerical simulations, made possible by the composition of the team.

8.3.2. Informal International Partners

Quite recently, S. Junca has started a collaboration with Mathias Legrand, from the Mechanical Engineering department at Mc Gill, Montréal with the supervision of the internship of a master student (S. Heng, 6 months, June-Nov. 2013). Furthermore, S. Junca is an active member of the European network "Wave propagation in complex media for quantitative and non destructive evaluation" [0]

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[0] http://www.gdre-us.cnrs-mrs.fr/spip.php?rubrique8

S. Krell has a collaboration with Martin Gander (University of Geneva, Switzerland) on domain decomposition methods, adapted to DDFV discretizations.

M. Ribot started a collaboration with Roberto Natalini a couple of years ago. Connections with experts in Firenze was the starting point of the research on biofilm formation and algae proliferation. M. Ribot and R. Natalini have also worked on new well-balanced strategy — the so-called AHO schemes — in order to preserve equilibria and to capture correctly large time solutions for complex PDEs system, without knowing explicitly the equilibrium solution. They have co-advised 2 PhD thesis.

Finally, we have many international collaborations, with variable peaks of activity, in our research networks: A. Vasseur (U. T. Austin), P.E. Jabin (Univ. Maryland), J.-A. Carrillo (Imperial College London), S. Jin (U. W. Madison and Jiao Tong Univ.), R. Aavatsmark (Univ. of Bergen), etc.

M. Ribot spent a semester, funded by CNRS at ICL, UK.

8.4. International Research Visitors

Kazuo Aoki, from Taiwan, Satushi Taguchi, Takeru Yano, Shingo Kosuge from Kyoto and Osaka University.

<p align="center">**DRACULA Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

In the context of the chair of applied mathematics "OQUAIDO", driven by Olivier Roustand (Mines de St Etienne), Celine Vial is the scientific responsible of a contract with the BRGM (Orléans) 2016-2018: "Study of a submergence problem: identify the critical offshore conditions for coastal flooding".

8.2. National Initiatives

8.2.1. ANR

Collaboration in other projects

- ANR RPIB PrediVac "Innovative modeling tools for the prediction of CD8 T cell based vaccine efficacy", 2013-2016 (jeune): http://www.agence-nationale-recherche.fr/?Projet=ANR-12-RPIB-0011. Partners: U1111 Inserm (J. Marvel, coordinator), Dracula, Altrabio (small company), The Cosmo Company (small company). Members are Fabien Crauste and Olivier Gandrillon.

- Thomas Lepoutre is a member of the ANR KIBORD (head L. Desvillettes) dedicated to "kinetic and related models in biology". 2014-2017: https://www.ljll.math.upmc.fr/kibord/.

- Thomas Lepoutre is a member of the ERC MESOPROBIO (head V. Calvez) dedicated to "Mesoscopic models for propagation in biology". 2015-2020: https://erc.europa.eu/projects-and-results/erc-funded-projects/mesoprobio.

- Olivier Gandrillon participates in the ANR (Investissement d'Avenir) Iceberg (head Gregory Batt (Inria)) "From population models to model populations: single cell observation, modeling, and control of gene expression". 2011-2017: https://contraintes.inria.fr/~batt/iceberg/home.html.

- Celine Vial participates in the ANR PEPITO (head M. Henner) dedicated to "Design of Experiment for the Industry of transportation and Optimization". 2014-2018: http://www.agence-nationale-recherche.fr/?Project=ANR-14-CE23-0011.

8.2.2. Other projects

- Inria ADT : SiMuScale "Simulations Multi-Échelles de Populations Cellulaires", 2014-2016.
  Participants: Samuel Bernard [Coordinator], Fabien Crauste, Olivier Gandrillon, David Parsons.

- Association France Alzheimer Sciences Médicales 2014-2015 : PAMELA "Prion et Alzheimer : Modélisation et Expérimentation d'une Liaison Agressive", 2014-2015. Partners: UR0892 VIM (Virologie et Immunologie Moléculaires), INRA Domaine de Vilvert, Jouy-en-Josas.
  Participants: Mostafa Adimy, Samuel Bernard, Thomas Lepoutre, Laurent Pujo-Menjouet [Coordinator], Léon Tine.

8.3. International Initiatives

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. Modelling leukemia

Title: Modeling quiescence and drug resistance in Chronic Myeloid Leukemia

International Partner (Institution - Laboratory - Researcher):

University of Maryland (United States) - Center for Scientific Computation and Mathematical Modeling (CSCAMM) - Levy Doron

Start year: 2013

See also: http://dracula.univ-lyon1.fr/modelling_leukemia.php

Leukemia is the most famous disease of the blood cell formation process (hematopoiesis). Chronic myeloid leukemia results in a uncontrolled proliferation of abnormal blood cells. As the hematopoiesis involves stem cells (not accessible to observations), mathematical modeling is here a great tool to test hypothesis. We will join the expertise of Inria team DRACULA specialized on the modeling of blood cell formation and the Center for Scientific Computation and Applied Mathematical Modeling (CSCAMM, University of Maryland, College Park). The theoretical and modeling experience of team DRACULA and the numerical expertise combined with the links with experimentalists of members of CSCAMM will allow us to study deeply evolution of leukemia. We will especially focus on the behavior of leukemic stem cells and their possibility of becoming quiescent (dormant). Then we will study (using the knowledge obtained on leukemic stem cells) the phenomenon of drug resistance and its propagation over time and finally the mechanisms of multidrug resistance.

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

Mostafa Adimy has been invited for three months (September-December) to "Fundação Getulio Vargas (FGV)" of Rio de Janeiro. He gave a course of 45 hours to students of Master of the School of Applied Mathematics (EMAp): "Reaction-diffusion and age-structured equations with application to biological populations". A collaboration has been started with FGV on mathematical modeling of human transmissible diseases.

<p style="text-align:center;color:red;font-weight:bold;">DYLISS Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Regional initiative: the Ecosyst project

Participants: Damien Eveillard, Marie Chevallier, Clémence Frioux, Anne Siegel, Camille Trottier.

EcoSyst is a Biogenouest inter-regional federating project (Brittany â Pays de la Loire) aiming at the emergence of Systems Ecology at the level of western regions. Drawing on the strengths and skills involved, EcoSyst targets the incubation of new ideas and new projects at disciplinary interfaces. Thanks to this community project, we want to develop the skills of Ecology, Environment, Modeling, Bioinformatics and Systems Biology and their application to organisms and ecosystems of interest in agronomy, sea and health. EcoSyst includes also the identification of the major issues and concerns, the fundamental and essential methods and the very real needs of the community (training, tools, ...); this in order to consider the construction of a community platform (or an offer of service within an existing platform) on complex systems modeling, meeting expectations of the community as fully as possible.

8.1.2. Regional partnership with computer science laboratories in Nantes

Participants: Anne Siegel, Jérémie Bourdon, Damien Eveillard, François Coste, Jacques Nicolas.

Methodologies are developed in close collaboration with university of Nantes (LINA) and Ecole centrale Nantes (IRCCyN). This is acted through the Biotempo and Idealg ANR projects and co-development of common software toolboxes within the Renabi-GO platform support. C. Trottier is a co-supervised bioianalysis and software development engineer within the Idealg project. M. Chevallier is a co-supervised development and animation engineer within the regional initiative "Ecosyst". In addition, the former Ph-D student V. Picard and the ongoing Ph-D student J. Laniau are also co-supervised with members of the LINA laboratory.

8.1.3. Regional partnership in Marine Biology

Participants: Catherine Belleannée, Jérémie Bourdon, Jean Coquet, François Coste, Damien Eveillard, Olivier Dameron, Clémence Frioux, Jeanne Got, Julie Laniau, Jacques Nicolas, Camille Trottier, Anne Siegel.

A strong application domain of the Dyliss project is marine Biology. This application domain is co-developed with the station biologique de Roscoff and their three UMR and involves several contracts. The IDEALG consortium is a long term project (10 years, ANR Investissement avenir) aiming at the development of macro-algae biotechnology. Among the research activities, we are particularly interested in the analysis and reconstruction of metabolism and the characterization of key enzymes. Other research contracts concern the modeling of the initiation of sea-urchin translation (former PEPS program Quantoursin, Ligue contre le cancer and ANR Biotempo), the analysis of extremophile archebacteria genomes and their PPI networks (former ANR MODULOME and PhD thesis of P.-F. Pluchon) and the identification of key actors implied in competition for light in the ocean (PELICAN ANR project). In addition, the team participates to a collaboration program (Inria Project Lab) with the Biocore and Ange teams, together with Ifremer-Nantes, focused on the understanding on micro-algae (Ph-D thesis of J. Laniau).

8.1.4. Regional partnership in agriculture and bio-medical domains

Participants: Aymeric Antoine-Lorquin, Catherine Belleannée, François Coste, Jean Coquet, Olivier Dameron, Victorien Delannée, Aurélie Evrard, François Moreews, Jacques Nicolas, Anne Siegel, Nathalie Théret, Denis Tagu, Pierre Vignet.

We have a strong and long term collaboration with biologists of INRA in Rennes : PEGASE and IGEPP units. F. Morrews is a permanent engineer from PEGASE center hosted in the team to develop methods for integrative biology applied to species of interest in agriculture. D. Tagu is a research director at INRA who spends 20% of his time in the team to develop collaborative projects. This partnership is supported by the co-supervision of one post-doctoral student and the co-supervision of several PhD students. The Ph-D thesis of V. Wucher was supported by collaborations with the IGEPP laboratory. The former post-doc of Ch. Bettembourg strengthened these collaborations. This collaboration was also reinforced by collaboration within ANR contracts (MirNadapt, FatInteger). Lately, A. Evrard joined the team at mid-part of her time in collaboration with Agrocampus Ouest and INRA to apply the semantic web to technologies developed within the mirnAdapt framework to new agriculture applications (Brassicae).

We also have a strong and long term collaboration in the bio-medical domain, namely with the IRSET laboratory at Univ. Rennes 1/Irset. N. Théret, research director at INSERM, is hosted in the team to strenghen our collaborative projects. Our collaborations are acted by the co-supervised Ph-D theses of V. Delannée (Metagenotox project, funded by Anses) and J. Coquet. This partnership was reinforced in the former years by the ANR contract Biotempo ended at the end of 2014. In 2015, the project of combining semantic web technologies and bi-clustering classification based on formal concept analysis was applied to systems biology within the PEPS CONFOCAL project. This scientific project has been recently pushed forward in the recent TGFSYSBio project funded by Plan Cancer on the modelling of the microenvironment of TGFbeta signaling network (P. Vignet has been recruited on this contract at the end of 2016).

8.2. National Initiatives

8.2.1. Long-term contracts

8.2.1.1. "Omics"-Line of the Chilean CIRIC-Inria Center
Participants: Meziane Aite, Jérémie Bourdon, François Coste, Marie Chevallier, Damien Eveillard, Clémence Frioux, Jacques Nicolas, Anne Siegel.

We have a cooperation with Univ. of Chile (MATHomics, A. Maass) on methods for the identification of biomarkers and software for biochip design, supported by a national Inria initiative. It aims at combining automatic reasoning on biological sequences and networks with probabilistic approaches to manage, explore and integrate large sets of heterogeneous omics data into networks of interactions allowing to produce biomarkers, with a main application to biomining bacteria. The program is co-funded by Inria and CORFO-chile from 2012 to 2022. In this context, IntegrativeBioChile is an Associate Team between Dyliss and the Laboratory of Bioinformatics and Mathematics of the Genome hosted at Univ. of Chile funded from 2011 to 2016.

8.2.1.2. ANR Idealg
Participants: Jérémie Bourdon, Marie Chevallier, François Coste, Damien Eveillard, Clémence Frioux, Jeanne Got, Jacques Nicolas, Anne Siegel.

IDEALG is one of the five laureates from the national call 2010 for Biotechnology and Bioresource and will run until 2020. It gathers 18 different partners from the academic field (CNRS, IFREMER, UEB, UBO, UBS, ENSCR, University of Nantes, INRA, AgroCampus), the industrial field (C-WEED, Bezhin Rosko, Aleor, France Haliotis, DuPont) as well as a technical center specialized in seaweeds (CEVA) in order to foster biotechnology applications within the seaweed field. It is organized in ten workpackages. We are participating in the tasks related to the establishment of a virtual platform for integrating omics studies on seaweed) and the integrative analysis of seaweed metabolism, in cooperation with SBR Roscoff. Major objectives are the building of brown algae metabolic maps, flux analysis and the selection extraction of important parameters for the production of targeted compounds. We will also contribute to the prediction of specific enzymes (sulfatases) [More details].

8.2.2. Programs funded by research institutions

8.2.2.1. PEPS PEPS: a platform for supporting studies in pharmaco-epidemiology using medico-administrative databases
Participants: Olivier Dameron, Yann Rivault.

As a partner of the PEPS platform, IRISA develops generic methods supporting efficient and semantically-rich queries for pharmaco-epidemiology studies on medico-administrative databases. The leader is Thomas Guyet (IRISA team Lacodam). We showed that Semantic Web technologies are technically suited for representing patients' data from medico-administrative databases as RDF and querying them using SPARQL. We also demonstrated that this approach is relevant as it supports the combination of patients' data with hierarchical knowledge in order to address the problem of reconciling precise patients data with more general query criteria [33], [31], [30]. This work is mostly conducted by Yann Rivault, whose PhD thesis is supervized by Olivier Dameron and Nolwenn LeMeur (Ecole des Hautes Etudes en Santé Publique).

8.2.2.2. Cancer Plan: TGFSYSBIO
Participants: Nathalie Théret, Jacques Nicolas, Olivier Dameron, Anne Siegel, Jean Coquet.

The TGFSYSBIO project aims to develop the first model of extracellular and intracellular TGF-beta system that might permit to analyze the behaviors of TGF-beta activity during the course of liver tumor progression and to identify new biomarkers and potential therapeutic targets. Based on collaboration with Jerome Feret from ENS, Paris,we will combine a rule-based model (Kappa language) to describe extracellular TGF-beta activation and large-scale state-transition based (Cadbiom formalism) model for TGF-beta-dependent intracellular signaling pathways. The multi-scale integrated model will be enriched with a large-scale analysis of liver tissues using shotgun proteomics to characterize protein networks from tumor microenvironment whose remodeling is responsible for extracellular activation of TGF-beta. The trajectories and upstream regulators of the final model will be analyzed with symbolic model checking techniques and abstract interpretation combined with causality analysis. Candidates will be classified with semantic-based approaches and symbolic bi-clustering technics. The project is funded by the national program "Plan Cancer - Systems biology" from 2015 to 2018.

8.2.2.3. ANR Samosa
Participants: Damien Eveillard, Jeanne Got, Anne Siegel.

Oceans are particularly affected by global change, which can cause e.g. increases in average sea temperature and in UV radiation fluxes onto ocean surface or a shrinkage of nutrient-rich areas. This raises the question of the capacity of marine photosynthetic microorganisms to cope with these environmental changes both at short term (physiological plasticity) and long term (e.g. gene alterations or acquisitions causing changes in fitness in a specific niche). Synechococcus cyanobacteria are among the most pertinent biological models to tackle this question, because of their ubiquity and wide abundance in the field, which allows them to be studied at all levels of organization from genes to the global ocean.

The SAMOSA project is funded by ANR from 2014 to 2018, coordinated by F. Gaczarek at the Station Biologique de Roscoff/UPMC/CNRS. The goal of the project is to develop a systems biology approach to characterize and model the main acclimation (i.e., physiological) and adaptation (i.e. evolutionary) mechanisms involved in the differential responses of Synechococcus clades/ecotypes to environmental fluctuations, with the goal to better predict their respective adaptability, and hence dynamics and distribution, in the context of global change. For this purpose, following intensive omics experimental protocol driven by our colleagues from − Station Biologique de Roscoff −, we aim at constructing a gene network model sufficiently flexible to allow the integration of transcriptomic and physiological data.

8.2.2.4. ADT Complex-biomarkers and ADT Proof of concept
Participants: Jeanne Got, Marie Chevallier, Meziane Aite, Anne Siegel.

This project started in Oct. 2014 and aims at designing a working environment based on workflows to assist molecular biologists to integrate large-scale omics data on non-classical species. The main goal of the workflows will be to facilitate the identification of set of regulators involved in the response of a species when challenged by an environmental stress. Applications target extremophile biotechnologies (biomining) and marine biology (micro-algae).

8.2.2.5. ANSES Mecagenotox

Participants: Victorien Delannée, Anne Siegel, Nathalie Théret.

The objective of Mecagenotox project is to characterize and model the human liver ability to bioactivate environmental contaminants during liver chronic diseases in order to assess individual susceptibility. Indeed, liver pathologies which result in the development of fibrosis are associated with a severe dysfunction of liver functions that may lead to increased susceptibility against contaminants. In this project funded by ANSES and coordinated by S. Langouet at IRSET/inserm (Univ. Rennes 1), we will combine cell biology approaches, biochemistry, biophysics, analytical chemistry and bioinformatics to 1) understand how the tension forces induced by the development of liver fibrosis alter the susceptibility of hepatocytes to certain genotoxic chemicals (especially Heterocyclic Aromatic Amines) and 2) model the behavior of xenobiotic metabolism during the liver fibrosis. Our main goal is to identify "sensitive" biomolecules in the network and to understand more comprehensively bioactivation of environmental contaminants involved in the onset of hepatocellular carcinoma.

8.2.2.6. PEPS CONFOCAL

Participants: Olivier Dameron, Jean Coquet, Nathalie Théret, Jacques Nicolas, Anne Siegel, Pierre Vignet.

PEPS CONFOCAL aims at developing new bioinformatics methods for analyzing heterogeneous *omics data and for filtering them according to domain knowledge. The current approaches are facing four main limitations: (1) classic biclustering methods do not support partial overlap of clusters, which is too restrictive considering some genes' pleiotropic nature, (2) they assume that the items to analyze (the genes, the molecules, the signaling pathways...) are independent, (3) they tend to generate numerous clusters leaving to the experts the task of identifying the relevant ones, and (4) they are sensitive to noisy or incomplete data. We investigate the extension of Formal Concept Analysis (FCA) with symbolic knowledge from ontologies in order to process large and complex sets of associations between genes, signaling pathways and the molecules involved in these pathways. Future applications cover the discrete model analysis in molecular biology. CONFOCAL initiated a collaboration with Amedeo Napoli (LORIA Nancy) and Elisabeth Remy (Mathematics Institute Luminy, "Mathematical Methods for Genomics" team).

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Partner: Aachen university (Germany)
Title: Modeling the logical response of a signalling network with constraints-programming.

Partner: Potsdam university (Germany)
Title: Constraint-based programming for the modeling and study of biological networks.

8.4. International Initiatives

8.4.1. Inria International Labs

The Dyliss team is strongly involved in the Inria CIRIC center, and the research line "Omics integrative center". The associated team "IntegrativeBioChile", the post-doc of S. Thiele (2012) and the co-supervision of A. Aravena (2010-2013) contributed to reinforce the complementarity of both Chilean and French teams. In 2013, a workshop was organized in Chile to develop new French-Chilean collaborations within the framework of the CIRIC center. In 2014, Marie Chevallier and Meziane Aite joined the team as engineers to improve softwares resulting from collaborations. Maria-Paz Cortes visited the team during 6 monthes in the framework of her ph-D thesis.

Inria Chile
Associate Team involved in the International Lab:

8.4.1.1. BIOINTEGRATIVECHILE

Title: Integrative Biology in Extreme Environments

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Center for Mathematical Modeling (CMM) - Maass Alejandro

Start year: 2014

See also: http://www.irisa.fr/dyliss/public/EA/index.html

The project is in the area of bioinformatics, with a special focus on bacteria living in extreme environments, more precisely on microorganisms involved in bio-remediation or bio-production processes. We are particularly interested in bioprocesses such as copper extraction, salmon lethality, metal-resistance, all having an economical interest in Chile. Since the last decade, huge databases of microbial genomic sequences, together with multi-scale and large-scale cellular observations (genomics, transcriptomics, proteomics, metabolomics) have been produced. Each one can be viewed as a different scale of a biological process, either in time or space, but ultimately are related through networks of biological interactions that control the behavior of the system The reconstruction, analysis and modeling of such networks using all levels of information are biologically, mathematically and computationally challenging. Applied on microorganisms living in extreme environments, this question is even more challenging since relatively few knowledge is publicly available on the species, requiring to develop methods which are robust to uncertainty. We are developing methods to integrate and manage heterogeneous omics and uncertain data. This in the purpose of extracting suitable biomarkers from this multi-level information. This question will be addressed by coupling probabilistic and static dynamical systems methods with recent and efficient paradigms of constraint programming (Answer Set Programming).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- **Argentina**. Fundation Leloir, Buenos Aeres [S. Videla]
- **Chile**. Centro de Modelimiento Matematico, Santiago [A. Maass, N. Loiraâ , M. Latorre, M.-P. Cortes]
- **Niger**. University of Maradi [O. Abdou-Arbi]
- **Germany**. Max Planck Institute for Biophysical Chemistry [C. Galiez]

8.5.2. Research stays abroad

- **Germany**. University of Kaiserslautern [A. Antoine-Lorquin, 2 months]
- **Germany**. University of Potsdam [C. Frioux, 2 months]
- **Japan**. National Institute of Informatics in Tokyo [J.Coquet, 3 months]

8.5.3. Visits to International Teams

- **Chile**. Centro de Modelimiento Matematico, Santiago de Chile [J. Bourdon, M. Aite, F. Coste, A. Siegel]
- **Germany**. Frei Berlin University [A. Siegel]
- **Poland**. Wroclaw University of Science and Technology [F. Coste]
- **Netherland**. Utrecht University [F. Coste]

ERABLE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. ICEbErg

- Title: Integrating Co-phylogeny in the analysis of Ecological nEtworks
- Coordinator: B. Sinaimeri and S. Dray
- ERABLE participant(s): B. Sinaimeri
- Type: Inter-departmental project funded by the LBBE (Sept 2016 - Sept 2017)
- Web page: Not available

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. ABS4NGS

- Title: Solutions Algorithmiques, Bioinformatiques et Logicielles pour le Séquençage Haut Débit
- Coordinator: E. Barillot
- ERABLE participant(s): V. Lacroix
- Type: ANR (2012-2016)
- Web page: https://sites.google.com/site/abs4ngs/

7.2.1.2. Colib'read

- Title: Methods for efficient detection and visualization of biological information from non assembled NGS data
- Coordinator: P. Peterlongo
- ERABLE participant(s): V. Lacroix, L. I. S. de Lima, A. Julien-Laferrière, H. Lopez-Maestre, C. Marchet, G. Sacomoto, M.-F. Sagot, B. Sinaimeri
- Type: ANR (2013-2016)
- Web page: http://colibread.inria.fr/

7.2.1.3. ExHyb

- Title: Exploring genomic stability in hybrids
- Coordinator: C. Vieira
- ERABLE participant(s): C. Vieira
- Type: ANR (2014-2018)
- Web page: Not available

7.2.1.4. GraphEn

- Title: Enumération dans les graphes et les hypergraphes : algorithmes et complexité
- Coordinator: D. Kratsch
- ERABLE participant(s): A. Mary
- Type: ANR (2015-2019)
- Web page: http://graphen.isima.fr/

7.2.1.5. IMetSym

- Title: Immune and Metabolic Control in Intracellular Symbiosis of Insects
- Coordinator: A Heddi
- ERABLE participant(s): H. Charles, S. Colella
- Type: ANR Blanc (2014-2017)
- Web page: Not available

7.2.2. Others

Notice that were included here national projects of our members from Italy when these have no other partners than researchers from the same country.

7.4. International Initiatives

7.4.1. Inria International Labs

ERABLE participates in a project within the Inria-Chile CIRIC (Communication and Information Research and Innovation Center) titled "Omics Integrative Sciences". The main objectives of the project are the development and implementation of mathematical and computational methods and the associated computational platforms for the exploration and integration of large sets of heterogeneous omics data and their application to the production of biomarkers and bioidentification systems for important Chilean productive sectors. The project started in 2011 and is coordinated in Chile by Alejandro Maass, Mathomics, University of Chile, Santiago. It is in the context of this project that we are currently hosting Alex di Genova in ERABLE as a PhD sandwich student (for 18 to 24 months). Alex is co-supervised by Alejandro Maass and by Eric Goles from the University Adolfo Ibañez, Santiago, Chile.

7.4.2. Inria Associate Teams Not Involved in an Inria International Labs

ALEGRIA

- Title: ALgorithms for ExplorinG the inteRactions Involving Apicomplexa and kinetoplastida
- Duration: 2015 - 2017
- Coordinator: On the Brazilian side, Andréa Rodrigues Ávila; on the French side, Marie-France Sagot
- ERABLE participant(s): M. Ferrarini, L. Ishi Soares de Lima, A. Mary, H. T. Pusa, M.-F. Sagot, M. Wannagat
- Web page: http://team.inria.fr/erable/en/alegria/

7.4.3. Participation in other International Programs

ERABLE is coordinator of a CNRS-UCBL-Inria Laboratoire International Associé (LIA) with the Laboratório Nacional de Computação Científica (LNCC), Petrópolis, Brazil. The LIA has for acronym LIRIO ("Laboratoire International de Recherche en bIOinformatique") and is coordinated by Ana Tereza Vasconcelos from the LNCC and Marie-France Sagot from BAOBAB-ERABLE. The LIA was created in January 2012 for 4 years, renewable once. A web page for the LIA LIRIO is available at this address: http://team.inria.fr/erable/en/cnrs-lia-laboratoire-international-associe-lirio/.

ERABLE coordinates another project with Brazil. This is a CAPES-COFECUB project titled: "Multidisciplinary Approach to the Study of the Biodiversity, Interactions and Metabolism of the Microbial Ecosystem of Swines", and its acronym MICO. The coordinators are M.-F. Sagot (France) and A. T. Vasconcelos (LNCC, Brazil) with also the participation of Arnaldo Zaha (Federal University of Rio Grande do Sul, Brazil). The project started in 2013 for 2 years, and was renewed for 2 more years starting from 2015. The main objective of this project is to experimentally and mathematically explore the biodiversity of the bacterial organisms living in the respiratory tract of swines, many of which are pathogenic. This project is strongly linked to the LIA LIRIO. More information on it may be found at this address: http://team.inria.fr/erable/en/cnrs-lia-laboratoire-international-associe-lirio/associated-projects/#CAPES-COFECUB_Microbial_Ecosystem_of_Swines.

ERABLE has a Stic AmSud project that started in 2016 for 2 years. The title of the project is "Methodological Approaches Investigated as Accurately as possible for applications to biology", and its acronym MAIA. This project involves the following partners: (France) Marie-France Sagot, ERABLE Team, Inria; (Brazil) Roberto Marcondes César Jr, Instituto de Matemática e Estatística, Universidade de São Paulo; and Paulo Vieira Milreu, TecSinapse; (Chile) Vicente Acuña, Centro de Modelamiento Matemático, Santiago; and Gonzalo Ruz, University Adolfo Ibañez, Santiago. One of them, TecSinapse, is an industrial partner. MAIA has two main goals: one methodological that aims to explore how accurately hard problems can be solved theoretically by different approaches – exact, approximate, randomised, heuristic – and combinations thereof, and a second that aims to better understand the extent and the role of interspecific interactions in all main life processes by using the methodological insights gained in the first goal and the algorithms developed as a consequence. A preliminary web page for MAIA is available at this address: http://team.inria.fr/erable/en/projects/maia/.

Finally, we would like to mention the participation of one member of ERABLE (Alain Viari) in the Breast Cancer French Working Group of the International Cancer Genome Consortium (ICGC, https://icgc.org) led by the Institut National du Cancer (INCa, http://www.e-cancer.fr/Professionnels-de-la-recherche/Innovations/Les-progres-de-la-genomique/ICGC-France). This project was initiated by Pr. Gilles Thomas who passed away in 2014. Alain took the head of the bioinformatics platform located at the Centre Léon Bérard. The project aims at the genomic characterisation of 75 HER2-amplified breast cancers by using high-throughput sequencing (whole genome of paired tumour/normal samples and RNAseq of tumour samples). One of the scientific goals is to decipher whether the HER2/ERBB2 amplification is a driver or a passenger event in the course of tumour development.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

In 2016, ERABLE greeted the following International scientists:

- In France: Katharina Huber and Vincent Moulton (University of Warwick, UK), Giuseppe Italiano (Tor Vergata University of Rome, Italy, various visits), Ana Rute Neves and Thomas Janzen (ChR Hansen, Oslo, Danemark), two members of the LIA LIRIO (Arnaldo Zaha from the Federal University of Rio Grande do Sul, and Ana Tereza Vasconcelos from the LNCC, both in Brazil), Susana Vinga and various members of her team (IDMEC-IST Portugal), Tiziana Calamoneri (Sapienza University of Rome).
- In Italy: Costas Iliopoulos and Solon Pissis (King's College, London, UK).

7.5.2. Internships

In 2016, ERABLE greeted the following internship students:

- In France: Audric Cologne, Master 2 (6 months); Irene Ziska, Master Free University Berlin (2 months), Louis Duchemin Master 1 (5 months).

7.5.3. Visits to International Teams

7.5.3.1. Visits

In 2016, members of ERABLE visited the following International teams:

- In France: Giuseppe Italiano (Tor Vergata University of Rome), visit to members of the LIA LIRIO at the LNCC in Brazil, visit to the Department of Computer Science of the University of São Paulo and to members of the TecSinapse company in Brazil, Tiziana Calamoneri (La Sapienza University of Rome), Susana Vinga and members of her team (IDMEC-IST Portugal), Rafaelle Giancarlo (Palermo University, Italy).
- In Italy: Costas Iliopoulos (King's College, London, UK), Luís Russo (INESC-IST, Lisbon, Portugal), Paola Bonizzoni (Milan-Bicocca, Italy), Rafaelle Giancarlo (Palermo University, Italy).

7.5.3.2. Research stays abroad

Gunnar Klau spent 9 months starting from November 2015 at the Center for Computational Molecular Biology at Brown University, USA, visiting notably Benjamin Raphael, Director of the Center.

FLUMINANCE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Comins'lab: SEACS : Stochastic modEl-dAta-Coupled representationS for the analysis, simulation and reconstruction of upper ocean dynamics

Participant: Etienne Mémin.

duration 48 months. The SEACS project whose acronym stands for: "Stochastic modEl-dAta-Coupled representationS for the analysis, simulation and reconstruction of upper ocean dynamics" is a Joint Research Initiative between the three Britanny clusters of excellence of the "Laboratoires d'Excellence" program: Cominlabs, Lebesgue and LabexMer centered on numerical sciences, mathemathics and oceanography respectively. Within this project we aim at studying the potential of large-scale oceanic dynamics modeling under uncertainty for ensemble forecasting and satellite image data assimilation.

8.1.2. ANR JCJC GERONIMO : Advanced GEophysical Reduced-Order Model construction from IMage Observations

Participant: Cédric Herzet.

duration 48 months. The GERONIMO project which started in March 2014 aims at devising new efficient and effective techniques for the design of geophysical reduced-order models from image data. The project both arises from the crucial need of accurate low-order descriptions of highly-complex geophysical phenomena and the recent numerical revolution which has supplied the geophysical scientists with an unprecedented volume of image data. The project is placed at the intersection of several fields of expertise (Bayesian inference, matrix factorization, sparse representations, etc.) which will be combined to handle the uncertainties associated to image measurements and to characterize the accurate reduced dynamical systems.

8.1.3. ANR BECOSE : Beyond Compressive Sensing: Sparse approximation algorithms for ill-conditioned inverse problems.

Participants: Dominique Heitz, Cédric Herzet.

duration 48 months. The BECOSE project aims to extend the scope of sparsity techniques much beyond the academic setting of random and well-conditioned dictionaries. In particular, one goal of the project is to step back from the popular L1-convexification of the sparse representation problem and consider more involved nonconvex formulations, both from a methodological and theoretical point of view. The algorithms will be assessed in the context of tomographic Particle Image Velocimetry (PIV), a rapidly growing imaging technique in fluid mechanics that will have strong impact in several industrial sectors including environment, automotive and aeronautical industries. The consortium gathers the Fluminance and Panama Inria research teams, the Research Center for Automatic Control of Nancy (CRAN), The Research Institute of Communication and Cybernetics of Nantes (IRCCyN), and ONERA, the French Aerospace Lab.

8.1.4. ANR-MN: H2MNO4 project

Participants: Yvan Crenner, Benjamin Delfino, Jean-Raynald de Dreuzy, Jocelyne Erhel, Lionel Lenôtre.

Contract with ANR, program Modèles Numériques
Duration: four years from November 2012.
Title: Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology.
Coordination: Jocelyne Erhel and Géraldine Pichot, with Fabienne Cuyollaa.
Partners: Geosciences Rennes, University of Poitiers, University of Lyon 1, Andra, Itasca.
International collaborations: University of San Diego (USA), UPC, Barcelona (Spain)

Web page: http://h2mno4.inria.fr/
Abstract: The project H2MNO4 develops numerical models for reactive transport in heterogeneous media. It defines six mathematical and computational challenges and three applications for environmental problems with societal impact. We presented a poster at the ANR-day (rencontre du numérique, Parius, Nov. 2016)

8.1.5. INSU-LEFE: Toward new methods for the estimation of sub-meso scale oceanic streams

Participant: Cédric Herzet.

duration 36 months. This project tackles the problem of deriving a precise submesoscale characterization of ocean currents from satellite data. The targeted methodologies should in particular enable the exploitation of data of different nature (for example sea surface temperature or height) and/or resolutions. This 36-month project benefits from a collaboration with the Laboratoire de Météorologie Dynamique, Ecole Normale Supérieure, Paris.

8.1.6. INSU-LEFE: MODELER

Participant: Etienne Mémin.

duration 24 months. This project with MeteoFrance aims at exploring error modeling and stochastic parameterization in geophysical flow dynamics. The theory explored in this context should enable the construction of unified image data assimilation strategies.

8.1.7. Inria Project Lab: C2S@EXA project

Participants: Yvan Crenner, Jocelyne Erhel.

Title: C2S@EXA - Computer and Computational Scienecs at Exascale
Duration: from January 2012 until April 2017
Coordination: S. Lanteri, Nachos team.
Partners: Inria teams working on HPC; external partners: ANDRA and CEA.
Webpage: http://www-sop.inria.fr/c2s_at_exa/
Abstract: The C2S@Exa Inria Project Lab is concerned with the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. The team participated in several workshops.

8.1.8. GENCI: project on advanced linear solvers

Participants: Yvan Crenner, Jocelyne Erhel, David Imberti.

Title: Numerical models for hydrogeology
Duration: 2016
Coordination: J. Erhel
Webpage: http://www.genci.fr/
Abstract: To run large scale simulations, we defined a project, based on the platform H2OLab and on a new GMRES solver. We obtained and used computing time on machines located at GENCI supercomputing centers.

8.1.9. GDR MANU

Participants: Benjamin Delfino, Jocelyne Erhel.

Title: Mathematics for Nuclear industry
Duration: From 2016 to 2019
Coordination: C. Cancès
Webpage: http://gdr-manu.math.cnrs.fr/
Abstract: The working group MANU is a follow-up to the group MOMAS. It covers many subjects related to mathematical modeling and numerical simulations for problems arising from nuclear industry and nuclear waste disposal. The team participated in the conference JEMP2016.

8.2. European Initiatives

8.2.1. EXA2CT

Participants: Jocelyne Erhel, David Imberti.

Title: EXascale Algorithms and Advanced Computational Techniques

Programm: FP7

Duration: September 2013 - August 2016

Coordinator: S. Ashby, IMEC, Belgium

Partners:

Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

Interuniversitair Micro-Electronica Centrum Vzw (Belgium)

Intel Corporations (France)

Numerical Algorithms Group Ltd (United Kingdom)

Systems Solutions for Research (Germany)

Universiteit Antwerpen (Belgium)

Universita della Svizzera italiana (Switzerland)

Universite de Versailles Saint-Quentin-En-Yvelines. (France)

Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)

Inria contact: Luc Giraud

Abstract: Numerical simulation is a crucial part of science and industry in Europe. The advancement of simulation as a discipline relies on increasingly compute intensive models that require more computational resources to run. This is the driver for the evolution to exascale. The EXA2CT project brings together experts at the cutting edge of the development of solvers, related algorithmic techniques, and HPC software architects for programming models and communication.

8.2.2. EOCOE project

Participant: Jocelyne Erhel.

Program: EINFRA-5-2015

Project acronym: EoCoE

Project title: Energy oriented Center of Excellence for computer applications

Duration: 36 months

Coordinator: CEA

Other partners: organisme, labo (pays) : 12 other partners

Abstract: the EoCoE objectives aims at firstly, to design, test and spread new methodological and organisational paradigms (Objectives 1, 3, and 4) driven by the users communities and, secondly, to contribute to mathematical and computer sciences challenges on the whole HPC tool chain (Objective 2).

8.3. International Initiatives

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. LFD-FLU

Title: Large-scale Fluid Dynamics analysis from FLow Uncertainty

International Partner (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (Argentina) - Department of Computer Science and Electrical Engineering - Guillermo Artana

Start year: 2016

See also: http://www.irisa.fr/prive/memin/LFD-FLU/

The first objective of this associate team is primarily concerned with the establishment of efficient fluid flow image data analysis procedures. This concerns for instance data assimilation issues to reconstruct meaningful numerical representation of experimental fluid flows for analysis purpose. The second objective focuses on the incorporation of uncertainties in the flow dynamical evolution models

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Imperial College (London, UK) We have initiated a collaboration with the Department of Aeronautics within the PhD thesis of Pranav Chandramoulli

Chico California State University (USA), We have pursue our collaboration with the group of Shane Mayor on the GPU implementation of wavelet based motion estimator for Lidar data. This code is developped in coproperty between Inria and Chico.

College of Control Science & Engineering of Zhejiang University We have initiated a collaboration with Prof. Chao Xu on the study of fluid motion estimator.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- 2 month sojourn of Gisela Charo (PhD student University of Buenos Aires) to work with Etienne Mémin and Valentin Resseguier within the associate team LFD
- 2 weeks visit of Alejandro Gronskis (Researcher Conicet Argentina) to work with Dominique Heitz, Etienne Mémin and Pranav Chandramouli within the associate team LFD
- Sojourn of 9 month of Shengze Cai PhD student in the College of Control Science & Engineering, Zhejiang University to work with Etienne Mémin
- 2 weeks visit of Prof. Luigi Berselli (U. Pisa) to work with Roger Lewandowski.

<p style="text-align:center;color:red;">**GALEN Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- Program: ANR Blanc International

    Project acronym: ADAMANTIUS

    Project title: Automatic Detection And characterization of residual Masses in pAtients with lymphomas through fusioN of whole-body diffusion-weighTed mrI on 3T and 18F-flUorodeoxyglucoSe pet/ct

    Duration: 9/2012-8/2015

    Coordinator: CHU Henri Mondor - FR

- Program: ANR JCJC

    Project acronym: HICORE

    Project title: HIerarchical COmpositional REpresentations for Computer Vision

    Duration: 10/2010-9/2014

    Coordinator: ECP - FR

- Program: ANR JCJC

    Project acronym: LearnCost

    Project title: Learning Model Constraints for Structured Prediction

    Duration: 2014-2018

    Coordinator: Inria Saclay - FR

- Program: ITMOs Cancer & Technologies pour la santé d'Aviesan / INCa

    Project acronym: CURATOR

    Project title: Slice-to-Image Deformable Registration towards Image-based Surgery Navigation & Guidance

    Duration: 12/2013-11/2015

    Coordinator: ECP - FR

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. I-SUPPORT

Title: ICT-Supported Bath Robots

Programm: FP7

Duration: March 2015 - March 2018

Coordinator: Robotnik Automation S.L.L.

Partners:

Bethanien Krankenhaus - Geriatrisches Zentrum - Gemeinnutzige GMBH (Germany)

Fondazione Santa Lucia (Italy)

Institute of Communication and Computer Systems (Greece)

Karlsruher Institut für Technologie (Germany)

Theofanis Alexandridis Kai Sia Ee (OMEGATECH) (Greece)

Robotnik Automation Sll (Spain)

Scuola Superiore di Studi Universitari E di Perfezionamento Sant'Anna (Italy)

Frankfurt University of Applied Sciences (Germany)

Inria contact: Iasonas Kokkinos

The I-SUPPORT project envisions the development and integration of an innovative, modular, ICT-supported service robotics system that supports and enhances older adults' motion and force abilities and assists them in successfully, safely and independently completing the entire sequence of bathing tasks, such as properly washing their back, their upper parts, their lower limbs, their buttocks and groin, and to effectively use the towel for drying purposes. Advanced modules of cognition, sensing, context awareness and actuation will be developed and seamlessly integrated into the service robotics system to enable the robotic bathing system to adapt to the frail elderly population' capabilities and the frail elderly to interact in a master-slave mode, thus, performing bathing activities in an intuitive and safe way. Adaptation and integration of state-of-the-art, cost-effective, soft-robotic manipulators will provide the hardware constituents, which, together with advanced human-robot force/compliance control that will be developed within the proposed project, will form the basis for a safe physical human-robot interaction that complies with the most up-to-date safety standards. Human behavioural, sociological, safety, ethical and acceptability aspects, as well as financial factors related to the proposed service robotic infrastructure will be thoroughly investigated and evaluated so that the I-SUPPORT end result is a close-to-market prototype, applicable to realistic living settings.

8.2.1.2. MOBOT

Title: Intelligent Active MObility Aid RoBOT integrating Multimodal Communication

Programm: FP7

Duration: February 2013 - January 2016

Coordinator: Technische Universität München

Partners:

Bartlomiej Marcin Stanczyk (Poland)

Athena Research and Innovation Center in Information Communication & Knowledge Technologies (Greece)

Bethanien Krankenhaus - Geriatrisches Zentrum - Gemeinnutzige (Germany)

Diaplasis Rehabilitation Center (Greece)

Ecole Centrale des Arts et Manufactures (France)

Technische Universitaet Muenchen (Germany)

Ruprecht-Karls-Universitaet Heidelberg (Germany)

Inria contact: Iasonas Kokkinos

Mobility disabilities are prevalent in our ageing society and impede activities important for the independent living of elderly people and their quality of life. The MOBOT project aims at supporting mobility and thus enforcing fitness and vitality by developing intelligent active mobility assistance robots for indoor environments that provide user-centred, context-adaptive and natural support. Our driving concept envisions cognitive robotic assistants that act (a) proactively by realizing an autonomous and context-specific monitoring of human activities and by subsequently reasoning on meaningful user behavioural patterns, as well as (b) adaptively and interactively, by analysing multi-sensory and physiological signals related to gait and postural stability, and by performing adaptive compliance control for optimal physical support and active fall prevention. Towards these targets, a multimodal action recognition system will be developed to monitor, analyse and predict user actions with a high level of accuracy and detail. The main thrust of our approach will be the

enhancement of computer vision techniques with modalities such as range sensor images, haptic information as well as command-level speech and gesture recognition. Data-driven multimodal human behaviour analysis will be conducted and behavioural patterns will be extracted. Findings will be imported into a multimodal human-robot communication system, involving both verbal and nonverbal communication and will be conceptually and systemically synthesised into mobility assistance models taking into consideration safety critical requirements. All these modules will be incorporated in a behaviour-based and context-aware robot control framework. Direct involvement of end-user groups will ensure that actual user needs are addressed. Finally, user trials will be conducted to evaluate and benchmark the overall system and to demonstrate the vital role of MOBOT technologies for Europe's service robotics.

8.2.1.3. RECONFIG

Type: FP7

Defi: Cognitive Systems and Robotics

Instrument: Specific Targeted Research Project

Objectif: Cognitive Systems and Robotics

Duration: February 2013 - January 2016

Coordinator: Dimos Dimarogonas

Partner: KTH (SE)

Inria contact: Iasonas Kokkinos

The RECONFIG project aims at exploiting recent developments in vision, robotics, and control to tackle coordination in heterogeneous multi-robot systems. Such systems hold promise for achieving robustness by leveraging upon the complementary capabilities of different agents and efficiency by allowing sub-tasks to be completed by the most suitable agent. A key challenge is that agent composition in current multi-robot systems needs to be constant and pre-defined. Moreover, the coordination of heterogeneous multi-agent systems has not been considered in manipulative scenarios. We propose a reconfigurable and adaptive decentralized coordination framework for heterogeneous multiple & multi-DOF robot systems. Agent coordination is held via two types of information exchange: (i) at an implicit level, e.g., when robots are in contact with each other and can sense the contact, and (ii) at an explicit level, using symbols grounded to each embodiment, e.g, when one robot notifies one other about the existence of an object of interest in its vicinity.

8.2.1.4. Strategie

Title: Statistically Efficient Structured Prediction for Computer Vision and Medical Imaging

Programm: FP7

Duration: January 2014 - December 2017

Coordinator: Inria

Inria contact: Matthew Blaschko

'Inference in medical imaging is an important step for disease diagnosis, tissue segmentation, alignment with an anatomical atlas, and a wide range of other applications. However, imperfections in imaging sensors, physical limitations of imaging technologies, and variation in the human population mean that statistical methods are essential for high performance. Statistical learning makes use of human provided ground truth to enable computers to automatically make predictions on future examples without human intervention. At the heart of statistical learning methods is risk minimization - the minimization of the expected loss on a previously unseen image. Textbook methods in statistical learning are not generally designed to minimize the expected loss for loss functions appropriate to medical imaging, which may be asymmetric and non-modular. Furthermore, these methods often do not have the capacity to model interdependencies in the prediction space, such as those arising from spatial priors, and constraints arising from the volumetric layout of human anatomy. We aim to develop new statistical learning methods that have these capabilities,

to develop efficient learning algorithms, to apply them to a key task in medical imaging (tumor segmentation), and to prove their convergence to optimal predictors. To achieve this, we will leverage the structured prediction framework, which has shown impressive empirical results on a wide range of learning tasks. While theoretical results giving learning rates are available for some algorithms, necessary and sufficient conditions for consistency are not known for structured prediction. We will consequently address this issue, which is of key importance for algorithms that will be applied to life critical applications, e.g. segmentation of brain tumors that will subsequently be targeted by radiation therapy or removed by surgery. Project components will address both theoretical and practical issues.'

8.2.2. Collaborations with Major European Organizations

8.2.2.1. CT dose and IQ optimization

Title: Development of a system helping in optimizing and tailoring computed tomography protocols

Program: Collaboration et encadrement de these CIFRE

Partners: GE Medical Systems, Université Paris-Est Créteil Val de Marne

Duration: December 2014 - November 2017

The purpose of the PhD is to create a method of CT dose and IQ optimization taking into account clinical indication, patient's characteristics and previous exams. The method will consist (i) in linking a clinical indication to IQ defined by quantitative physical metrics and (ii) in quantifying the patient's morphology from the analysis of local scans.

8.2.2.2. Imaging biomarkers in ILD

Title: Développement d' outils de Quantification en Imagerie dans les maladies respiratoires chroniques fibrosantes et obstructives

Program: Fondation de Coopération Scientifique

Partners: GE Medical Systems SCS

Duration: April 2016 - March 2019

We aim to test two different approaches for the development of new imaging biomarkers in interstitial lung disease (scleroderma): assessment of the regional lung elasticity through deformable registration and tissue characterization by textural analysis. We will also study structural changes in obstructive lung disease (cystic fibrosis) in order to develop new imaging biomarkers based on elastic registration, histogram and textural analysis.

8.2.2.3. SuBSAmPLE

Title: Identification and prediction of salient brain states through probabilistic structure learning towards fusion of imaging and genomic date

Partners: Fondation de Coopération Scientifique Digiteo

Duration: January 2012 - December 2016 (extended by 1 year)

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- UCL – Collaboration with Professor Arthur Gretton. Topic: non-parametric hypothesis testing
- University of Toronto – Collaboration with Professors Raquel Urtasun and Richard Zemel. Topic: Representation of Scene Graphs for Image Retrieval and Visual Question Answering
- MILA, Universite de Montreal - Collaboration with Kyle Kastner from the lab of Professor Yoshua Bengio. Topic: Efficient Inference of Graph Structures using Deep Learning

- Sup'Com Tunis – Collaborative research with Amel Benazza-Benhayia. Collaboration Topic: Multispectral imaging

- University of Patras, Greece – Collaborative research with V. Megalooikonomou. Collaboration Topic: Biosignal analysis.

- University of Oxford – Collaborative research with Andrea Vedaldi. Collaboration Topic: Deep Learning for Texture Recognition.

- Google Research – Collaborative research with George Papandreou. Collaboration Topic: Deep Learning for Semantic Segmentation.

- Universitad Polytecnical de Catalunia – Collaborative research with Francesc Moreno. Collaboration Topic: Deep Learning for Image Descriptors.

- Ecole Polytechnique Federale de Lausanne (EPFL) – Collaborative research with Eduard Trulls. Collaboration Topic: Deep Learning for Image Descriptors.

- University of California at Los Angeles – Collaborative research with Alan Yuille. Collaboration Topic: Deep Learning for Semantic Segmentation.

- University of Massachusetts at Amherst – Collaborative research with Subhransu Maji. Collaboration Topic: Deep Learning for Texture Recognition.

- Ryerson University – Collaborative research with Kostas Derpanis. Collaboration Topic: Deep Learning for Learning Segmentation.

- University of Pennsylvania - Collaborative research with Aristeidis Sotiras. Collaboration Topic: Higher Order Graphs in biomedical image analysis.

GENSCALE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Rennes Hospital, Hematology service, Genetic service
Participants: Patrick Durand, Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo, Guillaume Rizk.

The collaboration with the Hematology service and with the Genetic service of the Rennes hospital aims to set up advanced bioinformatics pipelines for cancer diagnosis. More precisely, we are in the process of setting up and evaluating a new method of predictions of small cancer-related mutations (such as SNPs and small insertions/deletions) from raw DNA sequencing data. The method relies on the use of k-mers and clustering of reads to call for mutations. Current prototype relies on Python programming language just for the purpose of evaluating the prediction quality of the software. However, final software is expected to use GATB library to highly increase the performance of the new tool.

9.1.2. Partnership with INRA in Rennes
Participants: Cervin Guyomar, Dominique Lavenier, Fabrice Legeai, Claire Lemaitre, Sébastien Letort, Pierre Peterlongo.

The GenScale team has a strong and long term collaboration with biologists of INRA in Rennes: IGEPP and PEGASE units. This partnership concerns both service and research activities and is acted by the hosting of one INRA engineer (F. Legeai) and one PhD student (C. Guyomar).

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. Project ADA-SPODO: Genetic variation of Spodoptera Frugiperda
Participants: Claire Lemaitre, Fabrice Legeai, Anaïs Gouin, Dominique Lavenier, Pierre Peterlongo.

Coordinator: E. D'Alençon (Inra, Montpellier)
Duration: 45 months (Oct. 2012 – May 2016)
Partners: DGIMI Inra Montpellier, CBGP Inra Montpellier, URGI Inra Versailles, Genscale Inria/IRISA Rennes.

The ADA-SPODO project aims at identifying all sources of genetic variation between two strains of an insect pest: Lepidoptera Spodoptera Frugiperda in order to correlate them with host-plant adaptation and speciation. GenScale's task is to develop new efficient methods to compare complete genomes along with their postgenomic and regulatory data.

9.2.1.2. Project COLIB'READ: Advanced algorithms for NGS data
Participants: Pierre Peterlongo, Antoine Limasset, Camille Marchet, Claire Lemaitre, Dominique Lavenier, Fabrice Legeai, Guillaume Rizk, Chloé Riou.

Coordinator: P. Peterlongo (Inria, GenScale, Rennes)
Duration: 45 months (Mar. 2013 – Dec. 2016)
Partners: LIRMM Montpellier, Erable Inria Lyon, Genscale Inria/IRISA Rennes.

The main goal of the Colib'Read project is to design new algorithms dedicated to the extraction of biological knowledge from raw data produced by High Throughput Sequencers (HTS). The project proposes an original way of extracting information from such data. The goal is to avoid the assembly step that often leads to a significant loss of information, or generates chimerical results due to complex heuristics. Instead, the strategy proposes a set of innovative approaches that bypass the assembly phase, and that do not require the availability of a reference genome. https://colibread.inria.fr/

9.2.1.3. Project HydroGen: Metagenomic applied to ocean life study
Participants: Dominique Lavenier, Pierre Peterlongo, Claire Lemaitre, Guillaume Rizk, Gaëtan Benoit.

Coordinator: P. Peterlongo (Inria/Irisa, GenScale, Rennes)
Duration: 42 months (Nov. 2014 – Apr. 2018)
Partners: CEA (GenosScope, Evry), INRA (AgroParisTech, Paris – MIG, Jouy-en-Jossas).

The HydroGen project aims to design new statistical and computational tools to measure and analyze biodiversity through comparative metagenomic approaches. The support application is the study of ocean biodiversity based on the analysis of seawater samples available from the Tara Oceans expedition.

9.2.1.4. Project SpeCrep: speciation processes in butterflies
Participants: Dominique Lavenier, Pierre Peterlongo, Claire Lemaitre, Fabrice Legeai.

Coordinator: M. Elias (Museum National d'Histoire Naturelle, Institut de Systematique et d'Evolution de la Biodiversite, Paris)
Duration: 48 months (Jan. 2015 – Dec. 2018)
Partners: MNHN (Paris), INRA (Versailles-Grignon), Genscale Inria/IRISA Rennes.

The SpeCrep project aims at better understanding the speciation processes, in particular by comparing natural replicates from several butterfly species in a suture zone system. GenScale's task is to develop new efficient methods for the assembly of reference genomes and the evaluation of the genetic diversity in several butterfly populations.

9.2.2. PIA: Programme Investissement d'Avenir

9.2.2.1. RAPSODYN: Optimization of the rapeseed oil content under low nitrogen
Participants: Dominique Lavenier, Claire Lemaitre, Sebastien Letort, Pierre Peterlongo.

Coordinator: N. Nesi (Inra, IGEPP, Rennes)
The objective of the Rapsodyn project is the optimization of the rapeseed oil content and yield under low nitrogen input. GenScale is involved in the bioinformatics work package to elaborate advanced tools dedicated to polymorphism and application to the rapeseed plant.

9.2.2.2. France Génomique: Bio-informatics and Genomic Analysis
Participants: Laurent Bouri, Dominique Lavenier.

Coordinator: J. Weissenbach (Genoscope, Evry)
France Génomique gathers resources from the main French platforms in genomic and bio-informatics. It offers to the scientific community an access to these resources, a high level of expertise and the possibilities to participate in ambitious national and international projects. The GenScale team is involved in the work package "assembly" to provide expertise and to design new assembly tools for the 3rd generation sequencing.

9.2.3. Programs from research institutions

9.2.3.1. Inria ADT DiagCancer
Participants: Dominique Lavenier, Patrick Durand.

Since October 1st, 2016, Genscale has started a one-year Inria ADT called DiagCancer. It aims at: (1) including the DiscoSnp++ tool within the current data production pipeline at Pontchaillou Hospital (Rennes), (2) providing a new prediction tool applied to the calling of cancer related mutations from DNA sequencing data and (3) creating new analysis tools to facilitate the interpretation of results by end-users (biologists, doctors). The project is done in close collaboration with Haematology Service, CHU Pontchaillou, Rennes.

9.3. International Initiatives

9.3.1. Informal International Partners

- Free University of Brussels, Belgium: Genome assembly [P. Perterlongo, R. Andonov]
- IMECC, UNICAMP, Campinas, Brazil: Distance geometry problem [A. Mucherino]
- Los Alamos National Laboratory (LANL), Los Alamos: Graph structure, Parallelism, GPU [R. Andonov, D. Lavenier, G. Rizk]

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Visit of prof. Tomi Klein from Bar Ilan University (Israel). One week, december 2016. Collaboration for the application of approximate hash function to the TGS data analysis [P. Peterlongo]
- Visit of Hristo Djidjev from Los Alamos National Laboratory, June 2016. Graph algorithms for scaffolding problem, professeur invité, University of Rennnes 1, [R. Andonov]
- Visit of Guillaume Chapuis from Los Alamos National Laboratory, June 2016. Parallelism, GPU. [R. Andonov, D. Lavenier]

9.4.2. Internships

- Samyadeep Basu, BITS Pilani, India, May - July 2016. Development of a web server for assembling bacteria genomes [D. Lavenier, P. Durand, C. Deltel]

9.4.3. Visits to International Teams

9.4.3.1. Research Stays Abroad

- Visit of Guillaume Rizk to Los Alamos National Laboratory, USA, August - September 2016 (2 months). Efficient combinatorial optimization using quantum computing.

<p style="text-align: center; color: red;">**IBIS Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

Project name	RNAfluo: Quantification d'ARN régulateurs in vivo
Coordinators	S. Lacour
IBIS participants	S. Lacour
Type	AGIR program, Université Grenoble Alpes

8.2. National Initiatives

Project name	AlgeaInSilico: Prédire et optimiser la productivité des microalgues en fonction de leur milieu de croissance
Coordinator	O. Bernard
IBIS participants	H. de Jong, N. Giordano
Type	Inria Project Lab (2015-2019)
Web page	https://project.inria.fr/iplalgaeinsilico/

Project name	RESET – Arrest and restart of the gene expression machinery in bacteria: from mathematical models to biotechnological applications
Coordinator	H. de Jong
IBIS participants	C. Boyat, E. Cinquemani, J. Geiselmann, H. de Jong, S. Lacour, L. Lancelot, Y. Markowicz, C. Pinel, D. Ropers
Type	Bioinformatics call, Investissements d'Avenir program (2012-2017)
Web page	https://project.inria.fr/reset/

Project name	MEMIP – Modèles à effets mixtes de processus intracellulaires : méthodes, outils et applications
Coordinator	G. Batt
IBIS participants	E. Cinquemani, D. Ropers
Type	ANR project (2016-2020)

Project name	ENZINVIVO – Détermination in vivo des paramètres enzymatiques dans une voie métabolique synthétique
Coordinator	G. Truan
IBIS participants	J. Geiselmann, H. de Jong
Type	ANR project (2016-2020)

Project name	Analyse intégrative de la coordination entre stabilité des ARNm et physiologie cellulaire chez Escherichia coli
Coordinators	D. Ropers, M. Cocaign-Bousquet (Inra, LISBP)
IBIS participants	T. Etienne, D. Ropers
Type	Contrat Jeune Scientifique Inra-Inria (2016-2019)

Project name	A web application for the analysis of time-series fluorescent reporter gene data
Coordinator	H. de Jong
IBIS participants	E. Cinquemani, J. Geiselmann, Y. Martin, M. Page, D. Ropers, V. Zulkower (University of Edinburgh)
Type	IFB call for development of innovative bioinformatics services for life sciences (2016-2017)

Project name	FluoBacTracker – Adaptation et valorisation scientifique du logiciel FluoBacTracker
Coordinator	H. de Jong, H. Berry
IBIS participants	C. Dutrieux, H. de Jong, J. Geiselmann
Type	Inria Hub (2016-2017)

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Laboratoire d'Automatique at Ecole Polytechnique Fédérale de Lausanne (Switzerland), Giancarlo Ferrari-Trecate

Control theory and systems identification with applications to systems biology

Automatic Control Lab at ETH Zürich (Switzerland), John Lygeros

Control theory and systems identification with applications to systems biology

Computational Microbiology research group, Institute of Food Research, Norwich (United Kingdom), Aline Métris and József Baranyi

Mathematical modelling of survival and growth of bacteria

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Invited researcher	Alberto Soria-Lopéz (Centro de Investigación y de Estudios Avanzados (Cinestav) of Instituto Politécnico Nacional (IPN), Mexico)
Subject	Development of an automatically-controlled system of multiplexed mini-bioreactors

Invited researcher	Aline Métris (Institute of Food Research (IFR), Norwich, UK)
Subject	Comparative analysis of metabolic networks of Escherichia coli and Salmonella

<p style="text-align: center; color: red;">**LEMON Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **Cart'Eaux** project (European Regional Development Fund (ERDF)): in partnership with colleagues of LIRMM and HSM (Montpellier) and with Berger-Levrault company, Carole DELENNE and Benjamin COMMANDRE are developing a methodology that will collect and merge multi-sources data in the aim of mapping urban drainage networks for hydraulic modeling purpose. This chain of treatment includes: i) detection of manhole covers from remote sensing data (aerial images, numerical elevation models...), 2) development of an algorithm to retrieve the network from the detected points and other information such as roads or topography, 3) data manning to extract useful characteristics for the hydraulic model, from various databases available or from documents automatically gathered from the web. A confidence index will be given to each characteristic assessed and a sensitivity analysis will enable the software to propose a hydraulic model together with an associated uncertainty.

- The GeRIMU project (Gestion du Risque d'Inondation en Milieu Urbain) counts 3 partners: Cerec Ingénierie, HSM and Predict Services. In this porject, the upscaled shallow water model with porosity SW2D developed at HSM is embedded in a software chain that will allow fast uran flood computations from forecasted precisiptation fields. The project is funded under the Feder scheme. It has earned a distinction from the local Scientific Advisory Committee ("Coup de coeur du COSTI").

9.2. National Initiatives

9.2.1. ANR

Fabien MARCHE is member of the ANR project BonD (PI Sylvie Benzoni), 2013-2017

Fabien MARCHE is member of the ANR project ACHYLLES (PI Rodolphe Turpault), 2014-2017

Fabien CAMPILLO is member of the ANR project Slofadybio, 2015-2016

Antoine ROUSSEAU is member of the ANR project ANSWER (PI Céline Casenave), 2016-2019

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Vincent GUINOT was the main investigator of an International Training Network (ITN) proposal in 2016. The proposal was not accepted and will be submitted again in 2017, accounting for the remarks made by the reviewers.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. Inria Chile

Antoine ROUSSEAU spent 9 months at Inria Chile from January to October 2016.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

In 2015, the *Marine Energies Research International Center* (MERIC) was launched in Chile by CORFO. Antoine ROUSSEAU will be the scientific coordinator for Inria, and several members of LEMON, CARDAMOM and TOSCA research teams will be involved in this 8 years project driven by DCNS. Antoine ROUSSEAU and Fabien MARCHE are involved in the research line *advanced modeling for marine energy*.

9.4.2.2. Informal International Partners

Vincent GUINOT collaborates with B.F. Sanders (Irvine University, Californie, USA)

Carole DELENNE and Vincent GUINOT collaborates with S. Soares-Frazao (Unité de Génie Civil, Université catholique de Louvain, Belgium)

Antoine ROUSSEAU continues to collaborate with H. Ramirez (CMM, Santiago) and P. Gajardo (UTFSM, Valparaiso) after the end of the Inria associated team Dymecos (2015).

9.5. International Research Visitors

9.5.1. Research Stays Abroad

Antoine ROUSSEAU spent 9 months at Inria Chile from January to October 2016. He co-advised 2 master students and 1 research engineer in the framework of the MERIC project in Chile. Antoine ROUSSEAU also participated to the Tsunamilab project between Inria Chile and CIGIDEN.

<div align="center">

LIFEWARE Project-Team

</div>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

- ANR-MOST BIOPSY (2016-2020) on "Biochemical Programming System", coordinated by F. Molina (CNRS, Sys2diag, Montpellier) and J.H. Jiang (National Taiwan University), with F. Fages.
- ANR MEMIP (2016-2020) on "Mixed-Effects Models of Intracellular Processes", coordinated by G. Batt, with P. Hersen, (CNRS/Paris7), E. Cinquemani (Inria EPI IBIS) and M. Lavielle (Inria/CNRS/Polytechnique, EPI XPOP).
- ANR COGEX (2016-2019) on "Computer Aided Control of Gene Expression" coordinated by P. Hersen (MSC lab, CNRS/Paris7), with G. Batt and G. Truan (LISBP, CNRS/INSA).
- ANR Blanc HYCLOCK (2014-2018) on "Hybrid modeling of time for Circadian Clock Biology and Chronopharmacology", coordinated by F. Delaunay (CNRS, Nice), with F. Lévi (INSERM Paris-Sud), G. Bernot (CNRS I3S, Nice), O. Roux (Ecole Centrale Nantes), F. Fages and S. Soliman.
- ANR Blanc STOCH-MC (2014-2018) on "Stochastic Models: Scalable Model Checking", coordinated by Blaise Genest (Inria Rennes), with Grégory Batt, Wieslaw Zielonka (LIAFA), and Hugo Gimbert (LaBRI).
- ANR Investissement Avenir ICEBERG project (2011-2016) "From population models to model populations", coordinated by Grégory Batt, with Pascal Hersen (MSC lab, Paris Diderot Univ./CNRS), Reiner Veitia (Institut Jacques Monod, Paris Diderot Univ./CNRS), Olivier Gandrillon (BM2A lab, Lyon Univ./CNRS), Cédric Lhoussaine (LIFL/CNRS), and Jean Krivine (PPS lab, Paris Diderot Univ./CNRS).

8.1.2. GENCI Contract

- GENCI (2009-2016) attribution of 300000 computation hours per year on the Jade cluster of 10000 cores of GENCI at CINES, Montpellier. Used for our hardest parameter search problems in BIOCHAM-parallel.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

In the context of the PhD thesis of Virgile Andréani, we initiated a collaboration with the lab of Lingchong You in the Biomedical Engineering department of Duke University (NC, USA).

8.2.2. Participation in Other International Programs

- French-German PROCOPE (2015-2017) grant on "Réduction de modèle et analyse de grands réseaux biochimiques par des méthodes stoechiométriques et tropicales", coord. Prof. Andreas Weber, University of Bonn, Germany, and Prof. Ovidiu Radulescu, Univ. Montpellier, France.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Our group received for a sabbatical stay of six months

- Prof. David Rosenblueth, University of Mexico, Mexico.

We also received for short visits:

- Prof. Mark Chaplain, University of St-Andrews, UK,
- Prof. Attila Attila Csikász-Nagy, King's College London,
- Dr. Jakob Ruess, IST Austria,
- Dr. Amaury Pouly, Univ. Oxford, UK,
- Dr. Christoph Zechner, ETH Zurich,
- Prof. Natalio Krasnogor, Newcastle University, UK,

8.3.1.1. Research Stays Abroad

Virgile Andréani visited Lingchong You's lab (Duke U.) for two weeks in March 2016.

<p align="center">**M3DISIM Project-Team**</p>

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. VP2HF

Title: Computer model derived indices for optimal patient-specific treatment selection and planning in Heart Failure

Programm: FP7

Duration: October 2013 - March 2017

Coordinator: King's College London (UK)

See also: http://vp2hf.eu/

Inria contact: Dominique Chapelle

Abstract: Heart failure (HF) is one of the major health issues in Europe affecting 6 million patients and growing substantially because of the ageing population and improving survival following myocardial infarction. The poor short to medium term prognosis of these patients means that treatments such as cardiac re-synchronisation therapy and mitral valve repair can have substantial impact. However, these therapies are ineffective in up to 50% of the treated patients and involve significant morbidity and substantial cost. The primary aim of VP2HF is to bring together image and data processing tools with statistical and integrated biophysical models mainly developed in previous VPH projects, into a single clinical workflow to improve therapy selection and treatment optimisation in HF.

<p style="text-align:center;color:red;font-weight:bold;">MAGIQUE-3D Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Partnership with I2M in Bordeaux supported by Conseil Régional d'Aquitaine

> title: Imaging complex materials.
>
> Coordinator: Hélène Barucq
>
> Other partners: I2M CNRS Université Bordeaux I

The detection, localization and monitoring of the defect evolution in composite materials, concrete and more generally heterogeneous materials is a challenging problem for Aeronautics and energy production. It is already possible to localize defects in homogeneous materials by using methods based on ultrasonic inspection and sometimes, they are usable in particular heterogeneous materials, most of the time in 2D. Classical methods rely on the correspondence between the distance and the propagation time of the wave traveling between the defect and the receivers. In complex media, such a correspondence may be lapsed, for instance when the velocity depends on the frequency (dispersion) or of the propagation direction (anisotropy). The defect signature can also be embedded in the acoustic field sent by the structure (multiple reflections). The complexity of the propagation in heterogeneous materials makes then difficult the accurate localization of the defect, in particular in 3D.

Topological imaging techniques can be applied to heterogeneous media. They can find the positions of defects from two simulations performed in a safe experimental medium. They have been developed at I2M laboratory to carry on 2D single/multi mode inspection in isotropic and anisotropic waveguides. They have also been applied to a highly reflecting medium observed with a single sensor. The objective of this work is to extend the technique to 3D problems. In particular, we are going to handle detection in composite plates and in highly heterogeneous media including a collection of small scatterers.

This project is supported by the Conseil Régional d'Aquitaine, for a duration of 2 years.

8.2. National Initiatives

8.2.1. Depth Imaging Partnership

Magique-3D maintains active collaborations with Total. In the context of Depth Imaging, Magique-3D coordinates research activities dealing with the development of high-performance numerical methods for solving wave equations in complex media. This project has involved 2 other Inria Team-Projects (Hiepacs and Nachos) which have complementary skills in mathematics, computing and in geophysics. DIP is fully funded by Total by the way of an outline agreement with Inria .

In 2014, the second phase of DIP has begun. Lionel Boillot has been hired as engineer to work on the DIP platform. 4 PhD students have defended their PhD in 2015 and they have now post-doctoral researchers in Europe. DIP is currently employing 2 PhD students and one post-doctoral researcher.

8.2.2. ANR Num4Sun

The ANR has launched a specific program for supporting and promoting applications to European or more generally International projects. Magique-3D has been selected in 2016 after proposing a project to be applied as a FET project on the occasion of a call that will open in 2017 April. This project will gather researchers of the MPS (https://www.mps.mpg.de/en), of the BSC (https://www.bsc.es/), of the BCAM (http://www.bcamath.org/en/), of Heriot-Watt University (https://www.hw.ac.uk/) and Inria teams.
A kick-off meeting has been held in November in Strasbourg. The second one will be held in Paris in March 2017. The project is funded for 18 months starting from August 2016. The funding amounts 30000€.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. GEAGAM

Title: Geophysical Exploration using Advanced GAlerkin Methods

Program: H2020

Duration: January 2015 - December 2017

Coordinator: Universidad Del Pais Vasco (EHU UPV)

Partners:

Bcam - Basque Center for Applied Mathematics Asociacion (Spain)

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Total S.A. (France)

Universidad Del Pais Vasco Ehu Upv (Spain)

Pontificia Universidad Catolica de Valparaiso (Chile)

Universidad de Chile (Chile)

Universidad Tecnica Federico Santa Maria (Chile)

University of Texas at Austin (USA)

Inria contact: Hélène BARUCQ

The main objective of this Marie Curie RISE action is to improve and exchange interdisciplinary knowledge on applied mathematics, high performance computing, and geophysics to be able to better simulate and understand the materials composing the Earth's subsurface. This is essential for a variety of applications such as $CO2$ storage, hydrocarbon extraction, mining, and geothermal energy production, among others. All these problems have in common the need to obtain an accurate characterization of the Earth's subsurface, and to achieve this goal, several complementary areas will be studied, including the mathematical foundations of various high-order Galerkin multiphysics simulation methods, the efficient computer implementation of these methods in large parallel machines and GPUs, and some crucial geophysical aspects such as the design of measurement acquisition systems in different scenarios. Results will be widely disseminated through publications, workshops, post-graduate courses to train new researchers, a dedicated webpage, and visits to companies working in the area. In that way, we will perform an important role in technology transfer between the most advanced numerical methods and mathematics of the moment and the area of applied geophysics.

8.3.1.2. HPC4E

Title: HPC for Energy

Program: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partners:

Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)

Iberdrola Renovables Energia (Spain)

Repsol (Spain)

Lancaster University (United Kingdom)

Total S.A. (France)

Fundação Coordenação de Projetos, Pesquisas e Estudos Tecnològicos, (Brazil)

National Laboratory for Scientific Computation, (Brazil)

Instituto Tecnològico de Aeronàutica, (Brazil)

Petrobras, (Brazil)

Universidade Federal do Rio Grande do Sul, (Brazil)

Universidade Federal de Pernambuco, (Brazil)

Inria contact: Stéphane Lanteri

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO_2 emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

8.4.1.1.1. MAGIC2

Title: Advance Modeling in Geophysics

International Partner (Institution - Laboratory - Researcher):

California State University at Northridge (United States) - Department of Mathematics - Djellouli Rabia

The Associated Team MAGIC was created in January 2006 and renewed in January 2009. At the end of the program in December 2011, the two partners, MAGIQUE-3D and the California State University at Northridge (CSUN) decided to continue their collaboration and obtained the "Inria International Partner" label in 2013.

See also: https://project.inria.fr/magic/

The ultimate objective of this research collaboration is to develop efficient solution methodologies for solving inverse problems arising in various applications such as geophysical exploration, underwater acoustics, and electromagnetics. To this end, the research program will be based upon the following three pillars that are the key ingredients for successfully solving inverse obstacle problems. 1) The design of efficient methods for solving high-frequency wave problems. 2) The sensitivity analysis of the scattered field to the shape and parameters of heterogeneities/scatterers. 3) The construction of higher-order Absorbing Boundary Conditions.

In the framework of Magic2, Rabia Djellouli (CSUN) visited Magique 3D in December 2016

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Antoine Chaigne (University of Music and Performing Arts Vienna) visited Magique 3D in November 2016.
- Rabia Djellouli (CSUN) visited Magique 3D in December 2016.

8.5.2. Visits to International Teams

8.5.2.1. Research Stays Abroad

- In the framework of the European project Geagam, Aralar Erdozain and Victor Péron visited Ignacio Muga, PUCV, Chile, in January and November 2016.
- In the framework of the European project Geagam, Florian Faucher and Ha Pham visited Henri Calandra, Total Houston, USA, in October 2016.

MAMBA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR Blanc 2014-2018 "Kibord"

This project gathers several members of the MAMBA team together with the ENS Cachan and Université Paris-Dauphine on the mathematical study of PDE models with application to biology.

8.1.1.2. ANR 2014-2017 IFLOW

Eric Vibert, Hopital Paul Brousse (coordinator). Partners: Inria REO, Hopital Toulouse, Dirk Drasdo. Objectives are simulation of liver perfusion after partial hepatectomy (PHx) with and without therapeutic manipulations to improve patients survival after PHx.

8.1.1.3. ANR iLITE 2016 - 2020

Jean-Charles Duclos-Vallée, Paul Brousse Hospital, Villejuif. Partners are several departments in Paul Brousse Hospital, ENS Cachan, University of Compiègne and several companies all over France, and REO team, Inria Paris. The pursued objective is the bioengineering design of an artifical liver intended for liver replacement.

8.1.2. ITMO Cancer

8.1.2.1. ITMO Cancer 2014 - 2016, INVADE.

Emmanuel Barillot, Institut Curie (coordinator). Partners: Groups from Institut Curie, Dirk Drasdo. Objective is a model for a better understanding of breast cancer invasion.

8.1.2.2. ITMO Cancer 2016 THE call

See above "Highlights of the year"

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. ERC Starting Grant SKIPPER[AD], 2012-2017, Principal Investigator: Marie Doumic.

This grant allowed to fund Sarah Eugène's and Mathieu Mézache's Ph.Ds, as well as to develop new collaborations as with Wei-Feng Xue in Canterbury, Piotr Gwiazda in Poland, Teresa Teixeira and Zhou Xu in IBCP.

8.3. International Initiatives

8.3.1. Participation in Other International Programs

8.3.1.1. International Initiatives

CAPES-COFECUB Modelling innovative control methods for dengue fever

- Brazilian part headed by Claudio Struchiner
- French part headed by Benoît Perthame

MOSTICAW MOdelling the Spread and (opTImal) Control of Arboviroses by Wolbachia
International Partners (Institution - Laboratory - Researcher):

- Universidad de Buenos Aires (Argentina) - Hernán G. Solari
- Universidad de Chile (Chile) - Carlos Conca

- Universidade Federal Fluminense (Brazil) - Max Souza
- Universidad Tecnica Federico Santa Maria (Chile) - Pablo Aguirre
- EMAp (Brazil) - Pierre-Alexandre Bliman
- CIRAD (France) - Yves Dumont
- Duration: 2016 - 2017
- Start year: 2016
- The spread of certain strains of the intracellular parasitic bacterium Wolbachia in populations of mosquitoes Aedes aegypti drastically reduces their competence as vector of dengue and other severe mosquito-borne viral diseases known as arboviral infections. In absence of vaccine, or of preventive or curative treatment, the release of mosquitoes infected by the bacterium has been recently considered a promising tool to control these diseases, and experimental introductions in wild populations are currently under way in Brazil and Colombia. A key question about this method concerns the effective strategies of release of the infected mosquitoes in the field that can be applied with limited cost to reach the desired state of complete exclusion of Wolbachia-free mosquitoes. The mathematical study of central topics is the core of this project. The scientific questions to be addressed during this project are related to the study of the dynamic and control of the key invasion mechanism on finite-dimensional compartments.
- Pierre-Alexandre Bliman is International and Brazilian coordinator of the STIC AmSud project *MOdeling the Spread and (opTImal) Control of Arboviroses by Wolbachia* (MOSTICAW), 2016-2017. Partners: UBA (Argentina); FGV, Fiocruz, UFF (Brazil); UC, UTFSM (Chile), Universidad de Quindio, Universidad Autónoma de Occidente (Colombia), EPI MAMBA, INRA-Montpellier, CIRAD-Montpellier(France); UNA (Paraguay); Universidad Nacional Mayor de San Marcos (Peru).
- Pierre-Alexandre Bliman is also French coordinator of the ECOS-NORD project *New methods for the control of epidemics of dengue and arboviroses*, 2017-2019. Partner: Universidad del Valle, Cali, Colombia.

LiSym Liver Systems Medicine, BMBF funded project.

- Duration: 2016 - 2020
- Start year: 2016
- LiSym addresses liver diseases and regeneration, namely, steatosis, fibrosis and cirrhoses, and acutisation of chronic liver disease. It is composed of three subprojects and three junior research groups. Dirk Drasdo is co-coordinator of one of these three projects and participates in one of the others. He is also member of the leadership board.

8.4. International Research Visitors

8.4.1. Internships

- Andreas Buttenschoen (PhD student of Thomas Hillen, Univ. Edmonton, Alberta, Canada) has been welcomed in the MAMBA team, under Dirk Drasdo's supervision, for a 6-month internship within the framework of the Inria-MITACS programme. Program of the stay: Training on agent-based modeling of growth and cell migration; training on the software tool TiSim.
- Shalla Hanson (Duke University, Durham, NC) has been welcomed in the MAMBA team for a 6-month internship within the framework of the Chateaubriand programme. She is since October 2015 in a PhD thesis in co-tutela under the supervision of Michael Reed (Duke) and Jean Clairambault (MAMBA & UPMC).

8.4.2. Visits to International Teams

8.4.2.1. Sabbatical programme

BLIMAN Pierre-Alexandre

> Date: Jun 2014 - Jul 2016
>
> Escola de Matemática Aplicada
>
> Institution: Fundação Getulio Vargas, Rio de Janeiro, Brazil
>
> Chargé de mission at Direction des Partenariats Européens et Internationaux (DPEI), Inria

DOUMIC-JAUFFRET Marie

> Date: Jun 2016 - Jul 2017
>
> Institution: Wolfgang Pauli Institute, University of Vienna (Austria)
>
> Sabbatical

8.4.2.2. Research Stays Abroad

STRUGAREK Martin

> Date: Oct 2016
>
> Institution: Fundação Oswaldo Cruz, Rio de Janeiro
>
> Programme CAPES-COFECUB "Modelling innovative control methods for dengue fever"

VAUCHELET Nicolas

> Date: Jan-Feb 2016
>
> Institution: IMPA, Rio de Janeiro
>
> Teaching collaboration between IMPA, Rio and UPMC, Paris

MATHNEURO Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

Olivier Faugeras is a member of the scientific committee of the "Axe Interdisciplinaire de Recherche de l'Université de Nice Sophia Antipolis" entitled "Modélisation Théorique et Computationnelle en Neurosciences et Sciences Cognitives".

6.2. National Initiatives

6.2.1. ANR

6.2.1.1. SloFaDyBio

Title: a network for Slow-Fast Dynamics in the Biosciences

Programm: ANR "amorçage"

Duration: January 2015 - January 2017 (extension up to January 2018)

Coordinator: Inria

PI: Mathieu Desroches

Partners:
see the webpage of the project.

The SloFaDyBio project targets to gather European researchers from about 10 cost countries in order to build up a network project on "Multi-Scale Dynamics in Neuroscience" and to submit within two years a large-scale proposal to a European funding agency such as COST. The initial fund provided by the ANR is used to meet regularly over this period and write a complete proposal. We now have an operational team and we are in the process of writing a full proposal which will be submitted at the next COST call, that is, at the end of September 2017.

6.3. European Initiatives

6.3.1. FP7 & H2020 Projects

6.3.1.1. HBP

Title: The Human Brain Project

Programm: FP7

Duration: October 2013 - March 2016 (first part) and then : April 2016 - March 2018 (second part)

Coordinator: EPFL

Partners:
see the webpage of the project.

Inria contact: Olivier Faugeras (first part) and then : Romain Veltz (second part)

Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases.

This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics, Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity.

A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

6.4. International Research Visitors

6.4.1. *Visits of International Scientists*

Invitation of Martin Wechselberger, University of Sydney (Australia), June 2016

Invitation of Daniele Avitabile, University of Nottingham (UK), June 2016

Invitation of James MacLaurin, University of Sydney (Australia), December 2016

Invitation of Tim O'Leary, University of Cambridge (UK), December 2016

Invitation of Antonio Teruel, University of the Balearic Islands (Spain), December 2016

6.4.1.1. *Internships*

Cantin Baron (collaboration with H. Marie at IPMC, Feb-June 2016)

Raphaël Fourquet (collaboration with H. Marie at IPMC, Feb-June 2016)

6.4.2. *Visits to International Teams*

Visit of Mathieu Desroches to Daniele Avitabile (University of Nottingham, UK) in April 2016

Visit of Romain Veltz to Cian O'Donnell (University of Bristol, UK) in April 2016

Visit of Mathieu Desroches to Martin Wechselberger (University of Sydney, Australia) in August 2016

Visit of Mathieu Desroches to Vivien Kirk (University of Auckland, New Zealand) in September 2016

Visit of Mathieu Desroches to Daniele Avitabile (University of Nottingham, UK) in April 2016

Visit of Mathieu Desroches to Serafim Rodrigues (Plymouth University, UK) in October 2016

<p style="text-align:center;color:red;font-weight:bold;">MIMESIS Team</p>

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Institut Hospitalo-Universitaire de Strasbourg

Our team has been selected to be part of the IHU of Strasbourg. This institute is a very strong innovative project of research dedicated to future surgery of the abdomen. It is dedicated to minimally invasive surgery, guided by image and simulation. Based on interdisciplinary expertise of academic partners and strong industry partnerships, the IHU aims at involving several specialized groups for doing research and developments towards hybrid surgery (gesture of the surgeon and simulation-based guidance). The MIMESIS team is an important part of the project. Since September 2011, we develop numerous experimental activities in close collaboration with clinicians.

7.1.2. Other research teams

At the regional level, the MIMESIS team also collaborates with:

Inria Magrit team: we closely collaborate with the Magrit team on the use of augmented reality in surgical procedures, through the PhD thesis of Jaime Garcia Guevara and the postdoctoral position of Nazim Haouchine. This collaboratin leads to many publications [14].

ICube *Automatique Vision et Robotique* (AVR) team: we are currently working with the medical robotics team on percutaneous procedures, in particular robotized needle insertion (with Prof. Bernard Bayle), and needle tracking in medical images (with Elodie Breton). We are also collaborating with Jonathan Vappou on elastography.

ICube *Informatique Géométrique et Graphqiue* (IGG) team: the Mimesis team joined the IGG team and develops collaboration in the domain of dynamic topologies, mainly through the use of the CGoGN framework. CGoGN is a C++ library for the manipulation of meshes. It implements combinatorial maps and their multiresolution extensions and has been used in various high level application like the simulation of crowds of autonomous agents and the simulation of cuts, tears and fractures in the context of surgical simulations.

Nouvel Hopital Civil, Strasbourg: since 2014 we have been working with Prof. David Gaucher, an ophthalmologist surgeon, expert in retina surgery. This led to the submission of the ANR project RESET which started in March 2015. We also collaborate with Prof. Patrick Pessaux, a surgeon who helps us in the context of the SOFA-OR project.

7.1.3. ADT: Aide au Développement Technologique

The MIMESIS receives support for the development of the SOFA framework through two ADT:

SofaOR (Jan 2015-Dec 2016): The objective of this ADT was twofold: first, we aimed at achieving a level of quality and robustness compatible with IEC 62304 for the core of SOFA and a reduced set of components. This does not include the certification of the code itself, but rather the implementation of a comprehensive development process that will enable the certification by companies wishing to integrate this code into their systems. The second objective was to add new features specific to the needs of using intra-operative guiding tools: interoperability with equipment from the operating room, acquisition and real-time processing of full HD video streams, data assimilation and predictive filters, path planning, visualization for augmented reality, or user interfaces dedicated to the operating room.

DynMesh (Sep 2015-Aug 2017): The objectives of this ADT was the coupling of SOFA, the physical simulation platform supported by Inria, and CGoGN, the mesh management library developed within the ICube lab at Strasbourg. The goal is to extend the physical engine SOFA with the topological kernel of CGoGN that supports a wide variety of mesh and many local remeshing operations. The coupling of both software libraries will provide users of physical engines with new tools for the development of simulations involving topological changes like cutting, fracturing, adaptation of the resolution or improving contact management or collision detection. The impacts are numerous and will be operated directly within the MIMESIS Team, with our partners or through the establishment of new collaborations.

7.2. National Initiatives

7.2.1. ANR

MIMESIS participates to the following ANR project:

RESET: This project started in March 2015 and will end in May 2017. Its objective is to develop a high-fidelity training system for retinal surgery. Retina surgery is an increasingly performed procedure for the treatment of a wide spectrum of retinal pathologies. Yet, as most micro-surgical techniques, it requires long training periods before being mastered. This simulator is built upon our scientific expertise in the field of real-time simulation, and our success story for technology transfer in the field of cataract surgery simulation (MSICS simulation developed for the HelpMeSee foundation).

Coordinator: MIMESIS

Partners: the InSimo company, the AVR team of the ICube lab.

7.2.2. National Collaborations

At the national level, the MIMESIS team collaborates with:

The LML laboratory *(Laboratoire de Mécanique de Lille)*: a French research laboratory (UMR CNRS 8107) part of the Carnot institute ARTS. With more than two hundred researchers, LML focuses on the following research areas: mechanical reliability and Tribology, fluid mechanics, civil engineering and soil mechanics.

The TIMC laboratory *(Techniques de l'Ingénierie Médicale et de la Complexité)* **in Grenoble**: this large research group has a strong background in computer-aided surgery, medical imaging, registration, statistical and bio-mechanical modeling. We have regular interactions with various members of this group. We are collaborating with Yohan Payan (DR CNRS) on the modeling and simulation of the brain shift. A common PhD thesis started on that topic in late 2014. Other areas of interest are in the field of advanced soft tissue modeling and computer aided surgery,

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

MIMESIS participates to the following European project:

Program: FP7

Project acronym: **RASimAs**

Project title: Regional Anaesthesia Simulator and Assistant

Duration: Nov 2013 - Nov 2016

Coordinator: Department of Medical Informatics, Uniklinik RWTH Aachen (Germany)

Other partners: we collaborate, among others, with: the University Hospital Aachen, RWTH Aachen, Bangor University, University College Cork, Universidad Rey Juan Carlos, Foundation for Research and Technology Hellas, Zilinska univerzita v Ziline, Katholieke Universiteit Leuven and the Stiftelsen Sintef.

Abstract: The goal of this project was to increase the application, the effectiveness and the success rates of regional anaesthesia and furthermore the diffusion of the method into a broader clinical use through the development of clinical tools to train new anaesthesiologists and assist them during the operation. The project combine two independent but complementary systems: one system is for training and the other one is for operational guidance. The training system consists in one medical simulator recreating RA operation for the anaesthesiologist in a virtual reality environment. The trainee is able to practise virtually the operation on various patient anatomies. The guidance system consists in assisting anaesthesiologists during the practise of RA by providing enhanced feedback on image interpretation and patient-specific anatomy. These two prototypes have been evaluated through a multi-centre clinical trial in Germany, Belgium and Ireland.

7.4. International Initiatives

The MIMESIS team has collaboration with the following international partners:

- **Team Legato, University of Luxembourg**: since last year we have active collaborations with Prof. Stéphane Bordas on real-time soft tissue cutting simulation. This has already led to a journal article [19] and the co-supervision of a post-doctoral fellow ;

- **Humanoid and Intelligence Systems Lab, Karlsruhe Institute of Technology**: we started a collaboration with Stefanie Speidel and Stefan Suwelack on the topics of real-time soft tissue modeling and laparoscopic augmented reality.

- **SINTEF, Norway**: we are currently collaborating with SINTEF in the context of the European project RASimAs, and also on other aspects, such as the creation of anatomically correct and accurate datasets from patient-specific data. We are also discussing future collaborations in the context of hepatic surgery simulation and augmented reality (we have jointly written a H2020 proposal on this topic).

- **Faculty of Informatics, Masaryk University, Czech Republic**: We began collaborations with Professor Ludek Matyska on biomedical simulations. The PhD thesis of Lukas Rucka on the Validation and verification of soft tissue models; takes place in this context.

<p style="text-align:center; color:red">MNEMOSYNE Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. PsyPhINe: Cogito Ergo Es

Participant: Nicolas Rougier.

Project gathering researchers from: MSH Lorraine (USR3261), InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Loria (UMR7503) & Mnemosyne.

PsyPhiNe is a pluridisciplinary and exploratory project between philosophers, psychologists, neuroscientists and computer scientists. The goal of the project is to explore cognition and behavior from different perspectives. The project aims to explore the idea of assignments of intelligence or intentionality, assuming that our intersubjectivity and our natural tendency to anthropomorphize play a central role: we project onto others parts of our own cognition. To test these hypotheses, we ran a series of experiments with human subject confronted to a motorized lamp that can or cannot interact with them while they're doing a specific task. Early results (analysis not yet finished) tend to show that people have a tendency to over-interpret any kind of behavior as intentional and meaningful. We also organized our second national conference in Nancy gathering speakers from philosophy, robotics, art and psychology and hired a new post-doc to work on the new experimental setup (http://poincare.univ-lorraine.fr/fr/manifestations/psyphine-2016)

9.1.2. Project of the Aquitaine Regional Council: Decision making, from motor primitives to action

Participants: Nicolas Rougier, Meropi Topalidou.

This project has ended with the PhD defense of Meropi Topalidou on October 10th, 2016. Using a computational model, we investigated the classic hypothesis of habits formation and expression in the basal ganglia and proposed a new hypothesis concerning the respective role for both the basal ganglia and the cortex. Inspired by previous theoretical and experimental works [47], we designed a computational model of the basal ganglia- thalamus-cortex system that uses segregated loops (motor, cognitive and associative) and makes the hypothesis that basal ganglia are only necessary for the acquisition of habits while the expression of such habits can be mediated through the cortex. This work leads to several publications including an important article in "Movement disorders" [7] explaining some counter-intuitive clinical observations. Furthermore, the early work during the first year of the PhD led N.Rougier to create the ReScience journal.

9.1.3. Collaboration with the Neurocentre Magendie on parameter optimization: Neurobees

Participant: André Garenne.

The development of computational models of neurons and networks typically involves tuning the numerical parameters to fit experimental results. Parameter tuning can sometimes be manually completed, it is more convenient to use automated optimization algorithms at least for two reasons: (i) to apply an homogeneous processing to all the calculation and parameter space exploration which alleviates operator influence and (ii) to avoid a tedious and uncertain result from human operators when the dimensionality increases. A multi-agent algorithm in line with ABC (Artificial Bee Colony) paradigm has been applied to new benchmark tests in order to ensure its robustness and better performances, especially when compared to evolutionary and swarm algorithms and this has recently been confirmed, thanks to the local Plafrim computation facilities.

9.2. National Initiatives

9.2.1. FUI Sumatra

Participants: Frédéric Alexandre, Thalita Firmo Drumond, Xavier Hinaut, Randa Kassab, Nicolas Rougier, Thierry Viéville.

This FUI project, supported by the Aerospace Valley Innovation Pole, gathers two industrial groups (Safran Helicopter and SPIE), three research labs and four SME. Its goal is to provide contextualized information to maintenance operators by the online analysis of the operating scene. We are concerned in this project with the analysis of visual scenes, in industrial contexts, and the extraction of visual primitives, categories and pertinent features, best decribing the scenes, with biologically inspired neuronal models.

Firstly, this is an opportunity for us to revisit the principles of deep network architectures by adapting principles that we will elaborate from the context of the hierarchical architecture of the temporal visual cortex. Secondly, we intend to exploit and adapt our model of hippocampus to extract more heterogenous features. This project is an excellent opportunity to associate and combine our models and also to evaluate the robustness of our models in real-world applications.

9.2.2. ANR MACAQUE40

Participant: Nicolas Rougier.

Most of the theoretical models in economics proposed so far to describe money emergence are based on three intangible assumptions: the omniscience of economic agents, an infinite time and an extremely large number of agents (not bounded). The goal of this interdisciplinary study is to investigate the condition of apparition of a monetary economy in a more ecological framework provided with the assumption that the market is made up of a finite number of agents having a bounded rationality and facing a time constraint.

In this study, we propose a generic model and environment of monetary prospecting. Our first objective is to artificially identify structural (trading organisation, agents specialisation) and cognitive conditions (learning skills, memory and strategic anticipation abilities, tradeoff exploration/exploitation) that allowed money emergence. This will provide relevant environmental constraints that we will use during our manipulations in the laboratory. The agents that will be involved in these manipulations will be of two types: non-human primates (rhesus macaques) and humans.

9.2.3. Project Motus of the ANSES

Participant: André Garenne.

The MOTUS project (MOdulaTion dU Signal RF et effets sur le cerveau : approche in vivo et in vitro) is financed by the ANSES (the french national agency for health security). This 3 years project is studying the effects of GSM-RF on living matter and especially neuronal activity and development. Our main involvement concerns electrophysiological data and spike trains analysis as well as the development of pharmacological protocols to test GSM-RF effects hypotheses.

9.2.4. Project Mimacore of the CNRS Challenge Imag'In

Participants: Frédéric Alexandre, Nicolas Rougier.

Better understanding the resting states (regional interactions and corresponding functional networks in the brain when the subject is at rest) is of central interest for a systemic approach of brain understanding. As we think that this domain is not mature enough for a direct functional modeling approach, we try to get familiar with it, through this imaging study. In this exploratory study funded by the CNRS, we are associated with three teams in neuroscience developing three imaging techniques (MRS, MRI, Clarity), to explore resting states in rodents and learn more about their genesis.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. Braincraft

> Title: Braincraft
>
> International Partner (Institution - Laboratory - Researcher):

University of Colorado, Boulder (United States) - Computational Cognitive Neuroscience - Randall O'Reilly

Start year: 2015

We develop with this team a computationally-based understanding of the neural circuits involved in decision making, namely basal ganglia and prefrontal cortex. More precisely, we want to understand what are the processes by which animals and humans select their actions based on their motivations and on the consequences of past actions. This is a fundamental question in neurosciences, with implications to ethology, psychology, economics, sociology and computer science. Through a unique combination of expertise in cognitive psychology, neurosciences and computer science, this associate team will foster a collaboration for developing a computationally-based understanding of the neural circuits involved in decision making, namely basal ganglia and prefrontal cortex. One of the key question is to know the overall contribution of these structures and their function in the decision process.

9.3.2. Participation in Other International Programs

9.3.2.1. Project LingoRob with Germany

LingoRob - Learning Language in Developmental Robots - is a project of the Programme Hubert Curien PHC Procope with Germany (University of Hamburg). The scientific objective of the collaboration is to better understand the mechanisms underlying language acquisition and enable more natural interaction between humans and robots in different languages, while modelling how the brain processes sentences and integrates semantic information of scenes. Models developed in both labs involve artificial neural networks, and in particular Echo State Networks (ESN), also known as pertaining to the Reservoir Computing framework. These neural models allow insights on high-level processes of the human brain, and at the same time are well suited as robot control platform, because they can be trained and executed online with low computational resources. The collaborators will also combine Deep Learning networks to the reservoir models already used in order to benefit from their very good feature extraction abilities.

9.3.2.2. Project BGaL with India

In the 3-years project "Basal Ganglia at Large (BGaL)", funded by the CNRS and the CEFIPRA, we collaborate with the computer science department of IIIT Hyderabad and the biomedical department of IIT Madras, for the design of models of basal ganglia and for their implementation at large scale as well as for their relation with other brain structures. This year we have developed a model of a dopaminergic region, VTA, central for reinforcement learning in the basal ganglia.

9.3.2.3. Project ECOS-Sud with Chile

In the 3-years project "A network for computational neuroscience, from vision to robotics", funded by ECOS-Sud and Conicyt, we collaborate with University Santa Maria and University of Valparaiso in Chile, and also with another Inria EPI, NeuroMathComp. The goal of the project is to rely on our experience of previous collaborations with these teams, to develop original tools and experimental frameworks to open our scientific domains of investigation to new fields of valorization, including medical (neurodegeneration) and technological aspects (robotics). This year, in addition to the visits of a Professor and a PhD student, we have written a chapter book that will be published next year and have prepared together a summer school to be held in Chile in january 2017 (http://www.laconeu.cl/).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Prof. Palacios Adrian

Date: Sep 2016

Institution: Univ. Valparaiso (Chile)

Ravello Cesar (PhD student)

Date: Nov 2016

Institution: Univ. Valparaiso (Chile)

Prof O'Reilly Randall

Date: June 2016

Institution: U. Colorado Boulder (USA)

Mollick Jessica (PhD student)

Date: Jul 2016 - Aug 2016

Institution: U. Colorado Boulder (USA)

9.4.1.1. Internships

Kaushik Pramod

Date: June 2016 - Dec 2016

Institution: IIIT Hyderabad (India)

Sabyasachi Shivkumar

Date: June 2016 - July 2016

Institution: IIIT Madras (India)

<div align="center">**MONC Project-Team**</div>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *Plan Cancer*

8.1.1.1. NUMEP

Plan Cancer NUMEP: 2016–2019. Numerics for Clinical Electroporation Funding: 460 kE Partners: Inria Team MONC, Institut de Pharmacologie de Toulouse, CHU J. Verdier de Bondy Duration: Octobre 2016—Septembre 2019 Project leader: C. Poignard Co-PI: M-P. Rols (IPBS), O. Séror (CHU J. Verdier)

8.1.1.2. Dynamo

Plan Cancer DYNAMO: 2015–2018. Dynamical Models for Tissue Electroporation Funding: 370 kE Partners: Laboratoire Ampère, Lab. Vectorology and Anticancerous Therapies (IGR), Inria Team MONC Duration: Octobre 2015—Septembre 2018 Project leader: R. Scorretti (Laboratoire Ampère) Co-PI: L.M. Mir (IGR), C. Poignard (Inria Team MONC)

8.1.1.3. Moglimaging

- Project acronym - Moglimaging: Modeling of Glioblastoma treatment-induced resistance and heterogeneity by multi-modal imaging.
- Partners -
- Duration - from Nov. 2016 to Nov 2019.
- Coordinator - E. Cohen-Jonathan Moyal, Institut Universitaire du Cancer Toulouse / Local coordinator - O. Saut.
- Team participants - S. Benzekry, A. Collin, C. Poignard, O. Saut.

8.1.1.4. MIMOSA

- Project acronym - Plan Cancer MIMOSA (Physique, Mathématiques et Sciences de l'ingénieur appliqués au Cancer)
- Partner - Laboratory of Biology, Bordeaux University
- Duration - from 2014 to 2017
- Coordinator - Th. Colin
- Team participants - S. Benzekry, Th. Colin, C. Poignard, O. Saut
- Title - Mathematical modeling for exploration of the impact of mechanical constraints on tumor growth

8.1.2. *A*Midex MARS*

- Project acronym - A*Midex MARS
- Partner - Service d'Oncologie Multidisciplinaire & Innovations Thérapeutiques, Hopitaux de Marseille
- Duration - from 2014 to 2016
- Coordinator - F. Barlesi
- Team participant - S. Benzekry
- Title - Modeling Anticancer Research & Simulation

8.1.3. *PEPS CNRS*

- PEPS CNRS "Jeune chercheur" Acronym: Metamat Partners: J. Ebos, Roswell Park Cancer Institute, Buffalo, USA Duration: October - November 2016 PI: S. Benzekry

8.1.4. Competitivity Clusters

- Labex TRAIL (http://trail.labex.u-bordeaux.fr): MOD Project Consolidation. 1 2-years post-doc position (100k€), led by A. Collin, 1 PhD funding (100k€) led by O. Saut.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

- LEA EBAM on electroporation http://lea-ebam.cnrs.fr,
- JSPS Core-to-Core "Establishing Network in Mathematical Medicine" granted by Japan, led by T. Suzuki, Osaka University, (local PI: C. Poignard).

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Clair Poignard and the team had visits from the following scientists:

- T. Suzuki, Osaka University, Japan,
- R. Natalini, IAC, Rome (PhD co-supervision of M. Deville)
- F. Gibou, UCSB, Santa Barbara (Numerical methods for cell aggregate electroporation).
- Rouzimaimati Makemuti (Associate professor at Xingiang University, China);

Thierry Colin and Olivier Saut had the pleasure to welcome Hassan Fathallah-Shaykh (neuro-oncologist, Univ. Alabama at Birmingham) for two weeks to work on ours models for glioblastoma.

<p style="text-align:center;color:red;font-weight:bold;">MORPHEME Project-Team</p>

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. LABEX SIGNALIFE

The MORPHEME team is member of the SIGNALIFE Laboratory of Excellence.

Florence Besse and Xavier Descombes are members of the Scientific Committee.

Florence Besse and Xavier Descombes participated in the selection committee for LabeX PhD program students.

7.2. National Initiatives

7.2.1. ANR RNAGRIMP

Participants: Florence Besse [PI], Xavier Descombes, Eric Debreuve, Djampa Kozlowski, Nicolas Cedilnik.

Here, we propose to study the molecular bases underlying the assembly and regulation of RNA granules, using the highly conserved IMP-containing granules as a paradigm. Specifically, we propose to perform an unbiased genome-wide RNAi screen on Drosophila cultured cells to identify mutant conditions in which the organization and/or distribution of IMP-containing granules is altered. To quantitatively and statistically analyze mutant conditions, and to define precise and coherent classes of mutants, we will combine high throughput microscopy with the development of a computational pipeline optimized for automatic analysis and classification of images. The function of positive hits isolated in the screen will then be validated in vivo in Drosophila neurons using fly genetics and imaging techniques, and characterized at the molecular and cellular levels using biochemical assays, in vitro phase transition experiments and live-imaging. Finally, the functional conservation of identified regulators will be tested in zebrafish embryos combining gene inactivation and live-imaging techniques. This integrative study will provide the first comprehensive analysis of the functional network that regulates the properties of the conserved IMP RNA granules. Our characterization of the identified regulators in vivo in neuronal cells will be of particular significance in the light of recent evidence linking the progression of several degenerative human diseases to the accumulation of non-functional RNA/protein aggregates.

This 4-years project started january, 2016 and is leaded by F. Besse (iBV, Nice). Participants are iBV, institut de biologie Paris Seine (IBPS, Paris), and Morpheme.

7.2.2. ANR HMOVE

Participants: Xavier Descombes, Eric Debreuve.

Among the signaling molecules involved in animal morphogenesis are the Hedgehog (Hh) family proteins which act at distance to direct cell fate decisions in invertebrate and vertebrate tissues. To study the underlying process we will develop accurate tracking algorithm to compare trajectories of different Hh pools transportation in live animals. This will allow us to analyze the contribution of the different carriers in the establishment of the Hh gradient. Moreover, we will develop new methods to modify the spatio-temporal and dynamical properties of the extra-cellular Hh gradient and separate the contribution of the apical versus basal Hh pools. We will complete this study with a genome-wide screen to identify genes and related cellular processes responsible for Hh release. The particular interest of this collaboration lies in the combination of development of tracking algorithm to analyze Hh distribution and trajectories with extremely powerful genetics, ease of in vivo manipulation and lack of genetic redundancy of Drosophila.

This 4-years project started january, 2016 and is leaded by P. Thérond (iBV, Nice). Participants are iBV and Morpheme.

7.2.3. *ANR DIG-EM*

Participants: Grégoire Malandain, Xavier Descombes, Gaël Michelin.

Morphogenesis controls the proper spatial organization of the various cell types. While the comparatively simple process of patterning and cell differentiation has received considerable attention, the genetic and evolutionary drivers of morphogenesis are much less understood. In particular, we very poorly understand why some morphogenetic processes evolve very rapidly, while others show remarkable evolutionary stability.

This research program aims at developing a high-throughput computational framework to analyze and formalize high-throughput 4D imaging data, in order to quantify and formally represent with cellular resolution the average development of an organism and its variations within and between species. In addition to its biological interest, a major output of the project will thus be the development of robust general computational methods for the analysis, visualization and representation of massive high-throughput light-sheet data sets.

This 4-years project started october the 1st, 2014 and is leaded by P. Lemaire (CRBM, Montpellier). Participants are the CRBM, and two Inria project-team, Morpheme and Virtual Plants.

7.2.4. *ANR PhaseQuant*

Participants: Grégoire Malandain, Eric Debreuve.

The PhaseQuantHD project aims at developing a high-content imaging system using quadriwave lateral shearing interferometry as a quantitative phase imaging modality. Automated analysis methods will be developed and optimized for this modality. Finally an open biological study question will be treated with the system.

This 3-years project started october the 1st, 2014 and is leaded by B. Wattelier (Phasics, Palaiseau). Participants are Phasics, and three academic teams TIRO (UNS/CEA/CAL), Nice, Mediacoding (I3S, Sophia-Antipolis), and Morpheme.

7.2.5. *Inria Large-scale initiative Morphogenetics*

Participants: Grégoire Malandain, Xavier Descombes, Gaël Michelin.

This action gathers the expertise of three Inria research teams (Virtual Plants, Morpheme, and Evasion) and other groups (RDP (ENS-CNRS–INRA, Lyon), RFD (CEA-INRA-CNRS, Grenoble)) and aimed at understanding how shape and architecture in plants are controlled by genes during development. To do so, we will study the spatio-temporal relationship between genetic regulation and plant shape utilizing recently developed imaging techniques together with molecular genetics and computational modeling. Rather than concentrating on the molecular networks, the project will study plant development across scales. In this context we will focus on the Arabidopsis flower, currently one of the best-characterized plant systems.

7.2.6. *Octopus Project*

Participant: Eric Debreuve.

The Octopus project deals with automatic classification of images of zooplankton. It is conducted in collaboration with the Laboratoire d'Océanographie de Villefranche-sur-mer (LOV) et l'ENSTA Paris. The kickoff meeting took place in May 2015 and a 3-day *brainstorming* meeting on Deep Learning took place in December 2015. Participants are I3S (Frédéric Precioso and Mélanie Ducoffe), LOV (Marc Picheral and Jean-Olivier Irisson), and ENSTA Paris (Antoine Manzanera).

7.3. European Initiatives

7.3.1. Collaborations in European Programs, Except FP7 & H2020

- COST Action (The COST Program is supported by the EU Framework Program H2020). We are part of a consortium of teams which submitted in December a COST Action proposal on machine learning and intelligent systems for the marine and aquatic sciences.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

Mohammed Lamine Benomar, PhD, Université Abou Bekr Belkaid Tlemcen, Algérie, from October 2016 until April 2017.

Hibetallah Ouazaa, PhD, National Engineering School of Tunis, from May 2016 until Jun 2016

<h2 style="text-align:center; color:red">MYCENAE Project-Team</h2>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Jonathan Touboul is member of the Kibord (KInetic models in Biology Or Related Domains) project obtained in 2014.

He is also PI of the projects "Mathematical modeling of synaptic plasticity" (with Laurent Venance, CIRB) funded as an interdisciplinary structuring project of INSB (Institut des Sciences Biologiques in CNRS) and "Altering Fear Memory" (with Sidney Wiener, CIRB and Karim Benchenane, ESPCI) funded by the PSL Labex MemoLife.

8.1.2. National Networks

- GdR REPRO (F. Clément is member of the direction board)
- MIA REM network: Réduction de modèles (PI Béatrice Laroche, INRA Jouy)

8.1.3. National Collaborations

- Center for Interdisciplinary Research in Biology (CIRB), Collège de France (Alain Prochiantz, Marie Manceau, Laurent Venance)
- UMR Physiologie de la Reproduction et des Comportements, INRA Centre- Val de Loire (Bios and Bingo teams)
- Université Pierre & Marie Curie (UPMC)
    - Jacques-Louis Lions Laboratory, Pierre & Marie Curie University (Jean-Pierre Françoise, Marie Postel)
    - Developmental Biology Laboratory, Institut de Biologie Paris Seine (IBPS), Pierre & Marie Curie University (Alice Karam, Sylvie Schneider Maunoury), in the framework of the NeuroMathMod, Sorbonne-Universités Émergence call
- Jacques Monod Institute (IJM)
    - Computational Biology and Biomathematics (Khashayar Pakdaman)
    - Génétique et développement du cortex cérébral (Alessandra Pierani)
- Centre de Recherche en Mathématiques de la Décision (CEREMADE), Paris Dauphine University (Stéphane Mischler)
- Unité de Neurosciences, Information & Complexité (UNIC), CNRS Gif-sur-Yvette (Alain Destexhe)

8.2. International Research Visitors

8.2.1. Visits to International Teams

Jonathan Touboul has visited Simon Levin in Princeton University (December 15-26)

<div align="center">

NEUROSYS Project-Team

</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

In the *Contrat de Projet État Région (CPER) IT2MP* 2015-2020 on *Technological innovations, modeling and Personalized Medicine*, we are contributing on platform SCIARAT (*cognitive stimulation, Ambient Intelligence, Robotic assistance" and Telemedicine*). Contact in Neurosys is Laurent Bougrain.

9.2. National Initiatives

PEPS JCJC INS2I 2016 Modeling and simulation of the oscillatory activity of the memory system during sleep and under general anesthesia (L. Buhry, L. Bougrain).

In order to better understand the mechanisms of amnesia under anesthesia, we propose, on the one hand, to carry out a comparative study, to model and simulate the hippocampal oscillatory activity under general anesthesia and during sleep (tasks 1 and 2). Deep SEEG recordings in epileptic patients during seizures will serve as a reference for modeling and simulation. On the other hand, on the basis of data recorded during sleep, we wish (tasks 3 and 4) to analyze and model the interactions between two structures involved in memory, the hippocampus and the prefrontal cortex, and (tasks 5) propose an automated method to reveal markers of the hippocampal activity characteristics of the sleep stages making use of sole surface recordings. *As it is widely acknowledged that the consolidation of memory occurs mostly during the deep sleep stages, this should make it possible to distinguish the parts of the signal corresponding to periods of consolidation and to propose, through mathematical modeling and simulation, mechanisms explaining the effects of amnesia, or even the absence of memory formation under general anesthesia.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The *ITN*-project *Neural Engineering Transformative Technologies (NETT)*[0] (2012-2016) is a Europe-wide consortium of 18 universities, research institutes and private companies which together hosts 17 PhD students and 3 postdoctoral researchers over the past 4 years. Neural Engineering brings together engineering, physics, neuroscience and mathematics to design and develop brain-computer interface systems, cognitive computers and neural prosthetics. Contact is L. Bougrain.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

+ We have an ongoing collaboration with Prof. Motoharu Yoshida at the Ruhr University Bochum, Germany, aiming to study the role of persistent firing neurons in memory and more specifically in neural network synchronization. M. Yoshida provides us with biological data that we combine with simulations to test hypotheses on memory formation (L. Buhry).

+ We also collaborate with Prof. LieJune Shiau (University of Houston, Texas, USA) on more theoretical approaches concerning the role of intrinsic neuronal dynamics in network synchronization and brain oscillations (L. Buhry).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Prof. LieJune Shiau, University of Houston, June 2016. (collab. with L. Buhry)

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[0]http://www.neural-engineering.eu/

<p style="text-align:center; color:red;">**NUMED Project-Team**</p>

7. Partnerships and Cooperations

7.1. European Initiatives

Vincent Calvez is the main investigator of an ERC.

7.1.1. FP7 & H2020 Projects

7.1.1.1. DDMoRE

Programm: FP7

Duration: February 2011 - January 2016

Coordinator: Pfizer

Inria contact: Marc Lavielle

7.2. International Research Visitors

7.2.1. *Visits of International Scientists*

Toan Nguyen (Penn State University) has visited Numed in june 2016.

<p align="center">**PARIETAL Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *CoSmic project*

Participants: Philippe Ciuciu [Correspondant], Carole Lazarus, Loubna El Gueddari.

This is a collaborative project with Jean-Luc Stark, (CEA) funded by the CEA program drf-impulsion.

Compressed Sensing is a recent theory in maths that allows the perfect recovery of signals or images from compressive acquisition scenarios. This approach has been popularized in MRI over the last decade as well as in astrophysics (noticeably in radio-astronomy). So far, both of these fields have developed skills in CS separately. The aim of the COSMIC project is to foster collaborations between CEA experts in MRI (Inria-CEA Parietal team within NeuroSpin) and in astrophysics (CosmoStat lab within the Astrophysics Department). These interactions will allow us to share different expertise in order to improve image quality, either in MRI or in radio-astronomy (thanks to the interferometry principle). In this field, given the data delivered by radio-telescopet he goal will consist of extracting high temporal resolution information in order to study fast transient events.

8.1.2. *BrainAMP project*

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Andre Monteiro Manoel.

This is a collaborative project with Lenka Zdeborová, Theoretical Physics Institute (CEA) funded by the CEA program drf-impulsion.

In many scientific fields, the data acquisition devices have benefited of hardware improvement to increase the resolution of the observed phenomena, leading to ever larger datasets. While the dimensionality has increased, the number of samples available is often limited, due to physical or financial limits. This is a problem when these data are processed with estimators that have a large sample complexity, such as multivariate statistical models. In that case it is very useful to rely on structured priors, so that the results reflect the state of knowledge on the phenomena of interest. The study of the human brain activity through high-field MRI belongs among these problems, with up to 10^6 features, yet a set of observations limited by cost and participant comfort.

We are missing fast estimators for multivariate models with structured priors, that furthermore provide statistical control on the solution. Approximate message passing methods are designed to work optimally with low-sample-complexity, they accommodate rather generic class of priors and come with an estimation of statistical significance. They are therefore well suited for our purposes.

We want to join forces to design a new generation of inverse problem solvers that can take into account the complex structure of brain images and provide guarantees in the low-sample-complexity regime. To this end, we will first adapt AMP to the brain mapping setting, using first standard sparsity priors (e.g. Gauss-Bernoulli) on the model. We will then consider more complex structured priors that control the variation of the learned image patterns in space. Crucial gains are expected from the use of the EM algorithm for parameter setting, that comes naturally with AMP. We will also examine the estimators provided by AMP for statistical significance. BrainAMP will design a reference inference toolbox released as a generic open source library. We expect a 3- to 10-fold improvement in CPU time, that will benefit to large-scale brain mapping investigations.

8.1.3. *iConnectom project*

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Elvis Dohmatob.

This is a Digiteo project (2014-2017).

Mapping brain functional connectivity from functional Magnetic Resonance Imaging (MRI) data has become a very active field of research. However, analysis tools are limited and many important tasks, such as the empirical definition of brain networks, remain difficult due to the lack of a good framework for the statistical modeling of these networks. We propose to develop population models of anatomical and functional connectivity data to improve the alignment of subjects brain structures of interest while inferring an average template of these structures. Based on this essential contribution, we will design new statistical inference procedures to compare the functional connections between conditions or populations and improve the sensitivity of connectivity analysis performed on noisy data. Finally, we will test and validate the methods on multiple datasets and distribute them to the brain imaging community.

8.1.4. MetaCog project

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Jérome Dockès.

This is a Digicosme project (2016-2019) and a collaboration with Fabian Suchanek (Telecom Paritech).

Understanding how cognition emerges from the billions of neurons that constitute the human brain is a major open problem in science that could bridge natural science –biology– to humanities –psychology. Psychology studies performed on humans with functional Magnetic Resonance Imaging (fMRI) can be used to probe the full repertoire of high-level cognitive functions. While analyzing the resulting image data for a given experiment is a relatively well-mastered process, the challenges in comparing data across multiple datasets poses serious limitation to the field. Indeed, such comparisons require to pool together brain images acquired under different settings and assess the effect of different *experimental conditions* that correspond to psychological effects studied by neuroscientists.

Such meta-analyses are now becoming possible thanks to the development of public data resources –OpenfMRI http://openfmri.org and NeuroVault http://neurovault.org. As many others, researchers of the Parietal team understand these data sources well and contribute to them. However, in such open-ended context, the description of experiments in terms of cognitive concepts is very difficult: there is no universal definition of cognitive terms that could be employed consistently by neuroscientists. Hence meta-analytic studies loose power and specificity. On the other hand, http://brainspell.org provide a set of curated annotation, albeit on much less data, that can serve as a seed or a ground truth to define a consensual ontology of cognitive concepts. Relating these terms to brain activity poses another challenge, of statistical nature, as brain patterns form high-dimensional data in perspective with the scarcity and the noise of the data.

The purpose of this project is to learn a semantic structure in cognitive terms from their occurrence in brain activations. This structure will simplify massive multi-label statistical-learning problems that arise in brain mapping by providing compact representations of cognitive concepts while capturing the imprecision on the definition these concepts.

8.1.5. CDS2

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Guillaume Lemaitre.

CDS2 is an "Strategic research initiatice" of the Paris Saclay University Idex http://datascience-paris-saclay.fr. Although it groups together many partners of the Paris Saclay ecosystem, Parietal has been deeply involved in the project. It currently funds a post-doc for Guillume Lemaitre.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. MultiFracs project

Participants: Philippe Ciuciu [Correspondant], Daria La Rocca.

The scale-free concept formalizes the intuition that, in many systems, the analysis of temporal dynamics cannot be grounded on specific and characteristic time scales. The scale-free paradigm has permitted the relevant analysis of numerous applications, very different in nature, ranging from natural phenomena (hydrodynamic turbulence, geophysics, body rhythms, brain activity,...) to human activities (Internet traffic, population, finance, art,...).

Yet, most successes of scale-free analysis were obtained in contexts where data are univariate, homogeneous along time (a single stationary time series), and well-characterized by simple-shape local singularities. For such situations, scale-free dynamics translate into global or local power laws, which significantly eases practical analyses. Numerous recent real-world applications (macroscopic spontaneous brain dynamics, the central application in this project, being one paradigm example), however, naturally entail large multivariate data (many signals), whose properties vary along time (non-stationarity) and across components (non-homogeneity), with potentially complex temporal dynamics, thus intricate local singular behaviors.

These three issues call into question the intuitive and founding identification of scale-free to power laws, and thus make uneasy multivariate scale-free and multifractal analyses, precluding the use of univariate methodologies. This explains why the concept of scale-free dynamics is barely used and with limited successes in such settings and highlights the overriding need for a systematic methodological study of multivariate scale-free and multifractal dynamics. The Core Theme of MULTIFRACS consists in laying the theoretical foundations of a practical robust statistical signal processing framework for multivariate non homogeneous scale-free and multifractal analyses, suited to varied types of rich singularities, as well as in performing accurate analyses of scale-free dynamics in spontaneous and task-related macroscopic brain activity, to assess their natures, functional roles and relevance, and their relations to behavioral performance in a timing estimation task using multimodal functional imaging techniques.

This overarching objective is organized into 4 Challenges:

1. Multivariate scale-free and multifractal analysis,
2. Second generation of local singularity indices,
3. Scale-free dynamics, non-stationarity and non-homogeneity,
4. Multivariate scale-free temporal dynamics analysis in macroscopic brain activity.

8.2.1.2. BrainPedia project

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux.

BrainPedia is an ANR JCJC (2011-2015) which addresses the following question: Neuroimaging produces huge amounts of complex data that are used to better understand the relations between brain structure and function. While the acquisition and analysis of this data is getting standardized in some aspects, the neuroimaging community is still largely missing appropriate tools to store and organize the knowledge related to the data. Taking advantage of common coordinate systems to represent the results of group studies, coordinate-based meta-analysis approaches associated with repositories of neuroimaging publications provide a crude solution to this problem, that does not yield reliable outputs and looses most of the data-related information. In this project, we propose to tackle the problem in a statistically rigorous framework, thus providing usable information to drive neuroscientific knowledge and questions.

8.2.1.3. Niconnect project

Participants: Bertrand Thirion, Gaël Varoquaux [Correspondant], Alexandre Abraham, Kamalaker Reddy Dadi, Darya Chyzhyk, Mehdi Rahim.

- **Context:** The NiConnect project (2012-2016) arises from an increasing need of medical imaging tools to diagnose efficiently brain pathologies, such as neuro-degenerative and psychiatric diseases or lesions related to stroke. Brain imaging provides a non-invasive and widespread probe of various features of brain organization, that are then used to make an accurate diagnosis, assess brain rehabilitation, or make a prognostic on the chance of recovery of a patient. Among different measures extracted from brain imaging, functional connectivity is particularly attractive, as it readily probes the integrity of brain networks, considered as providing the most complete view on brain functional organization.

- **Challenges:** To turn methods research into popular tool widely usable by non specialists, the NiConnect project puts specific emphasis on producing high-quality open-source software. NiConnect addresses the many data analysis tasks that extract relevant information from resting-state fMRI datasets. Specifically, the scientific difficulties are *i)* conducting proper validation of the models and tools, and *ii)* providing statistically controlled information to neuroscientists or medical doctors. More importantly, these procedures should be robust enough to perform analysis on limited quality data, as acquiring data on diseased populations is challenging and artifacts can hardly be controlled in clinical settings.

- **Outcome of the project:** In the scope of computer science and statistics, NiConnect pushes forward algorithms and statistical models for brain functional connectivity. In particular, we are investigating structured and multi-task graphical models to learn high-dimensional multi-subject brain connectivity models, as well as spatially-informed sparse decompositions for segmenting structures from brain imaging. With regards to neuroimaging methods development, NiConnect provides systematic comparisons and evaluations of connectivity biomarkers and a software library embedding best-performing state-of-the-art approaches. Finally, with regards to medical applications, the NiConnect project also plays a support role in on going medical studies and clinical trials on neurodegenerative diseases.

- **Consortium**
    - Parietal Inria research team: applied mathematics and computer science to model the brain from MRI
    - LIF INSERM research team: medical image data analysis and modeling for clinical applications
    - CATI center: medical image processing center for large scale brain imaging studies
    - Henri-Mondor hospital neurosurgery and neuroradiology: clinical teams conducting research on treatments for neurodegenerative diseases, in particular Huntington and Parkinson diseases
    - Logilab: consulting in scientific computing

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. HBP

Title: The Human Brain Project

Programm: FP7

Duration: October 2013 - September 2016

Coordinator: EPFL

Partners: 100 across Europe

Inria contact: Olivier Faugeras

Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases. This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics,

Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity. A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: Marie Curie

Project acronym: Neuroimaging Power

Project title: Effect size and power for neuroimaging.

Duration: mois année début - mois année fin

Coordinator: Inria

Other partners: Univ. Stanford, USA

Abstract: There is an increasing concern about statistical power in neuroscience research. Critically, an underpowered study has poor predictive power. Findings from a low-power study are unlikely to be reproducible, and thus a power analysis is a critical component of any paper. This project aims to promote and facilitate the use of power analyses.A key component of a power analysis is the specification of an effect size. However, in neuroimaging, there is no standardised way to communicate effect sizes, which makes the choice of an appropriate effect size a formidable task. The best way today to perform a power analysis is by collecting a pilot data set, a very expensive practice. To eliminate the need for pilot data, we will develop a standardised measure of effect size taking into account the spatial variance and the uncertainty of the measurements. Communicating effect sizes in new publications will facilitate the use of power analyses.To further alleviate the need for pilot data, we will provide a library of effect sizes for different tasks and contrasts, using open data projects in neuroimaging. We will integrate our effect size estimator in open repositories NeuroVault and OpenfMRI. Consequently, these effect sizes can then serve as a proxy for a pilot study, and as such, a huge cost in the design of an experiment is eliminated.A new experiment will not be identical to the open data and as such the hypothesised parameters might not be fully accurate. To address this issue, we present a flexible framework to analyse data mid-way without harming the control of the type I error rate. Such a procedure will allow re-evaluating halfway an experiment whether it is useful to continue a study, and how many more subjects are needed for statistically sound inferences.To make our methods maximally available, we will write a software suite including all these methods in different programming platforms and we will provide a GUI to further increase the use of power analyses.

8.4. International Initiatives

8.4.1. MetaMRI

Title: Machine learning for meta-analysis of functional neuroimaging data

International Partner (Institution - Laboratory - Researcher):

    Stanford (United States) - Department of Psychology - Russ Poldrack

Start year: 2015

See also: https://team.inria.fr/metamri

Neuroimaging produces huge amounts of complex data that are used to better understand the relations between brain structure and function. Observing that the neuroimaging community is still largely missing appropriate tools to store and organize the knowledge related to the data, Parietal team and Poldrack's lab, have decided to join forces to set up a framework for functional brain image meta-analysis, i.e. a framework in which several datasets can be jointly analyzed in order to accumulate information on the functional specialization of brain regions. MetaMRI will build upon Poldrack's lab expertise in handling, sharing and analyzing multi-protocol data and Parietal's recent developments of machine learning libraries to develop a new generation of meta-analytic tools.

<p style="text-align:center">**PLEIADE Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANTICOR – Biocontamination in aircraft reservoirs

ANTICOR is an industrial-academic research and development working group coordinated by Dassault Aviation, investigating the causes of microbial contamination in aircraft reservoirs and aimed at developing mitigating procedures and equipment. Previous results have shown that this contamination forms biofilms at the fuel-water interface and is comprised of complex communities of hundreds of bacterial and fungal species. PLEIADE is particularly interested in measuring and modeling these communities, especially as concerns understanding how they change based on environmental conditions and on reservoir geometry.

8.1.2. CAER – Alternative Fuels for Aeronautics

CAER is a 6 M-Euro contract with the Civil Aviation Directorate (Direction Générale de l'Aviation Civile, DGAC), coordinated by the French Petroleum Institute (Institut français de pétrole-énergies nouvelles, IFPEN) on behalf of a large consortium of industrial (EADS, Dassault, Snecma, Turbomeca, Airbus, Air France, Total) and academic (CNRS, INRA, Inria) partners to explore different technologies for alternative fuels for aviation. PLEIADE's role concerns the genomics of highly-performant oleaginous microorganisms.

8.2. International Initiatives

8.2.1. Supervised clustering

One way to build an inventory in a community on a molecular basis is to map unknown reads onto a taxonomically annotated reference database. We (AF, PC, JMF, FS) have developed a cooperation with UMR Carrtel (A. Bouchez, F. Rimet) and SLU at Uppsala (Sweden, M. Kahlert) for industrializing molecular based inventories from data production (NGS facilities, PGTB, Pierroton) to data analysis. Molecular based inventories of about 200 samples have been done, for diatoms Mayotte rivers, and the same number for diatoms in Fennoscandian rivers. The method has been published in [13]. As far as those tools and metagenomics are concerned, a complementary partnership has been established with UMR BioGER (V. Laval) on metabarcoding of fungal communities.

8.2.2. Metagenomics for zoonoses

In the framework of CEBA Cluster of Excellence (Centre d'Etude de la Biodiversité Amazonienne), Pleiade team has been successful in an application for being part of a so called long term strategic project (2017-2019) called microbiome, chaired by Institut Pasteur in Cayenne and UMR MIVEGEC (CNRS-IRD) at Montpellier. The role of the team is twofold: (i) develop methods for metabarcoding of viral and bacterial communities in some hosts (bats, birds, ...) and (ii) run some data analysis for scaling up from microbiomes to landscape ecology, having in mind the dilution effect, i.e. pristine forest offer a better protection against disease spread than disturbed ones. The project starts on January 1, 2017.

8.2.3. Historical biogeography of plant families

In the framework of CEBA too, AF and David Sherman have worked in providing some tools for mapping paleoclimatic conditions on the Earth over geological times, elaborating on datasets of paleoclimates produced by running General Circulation Models (work done by UMR LSCE, Orsay, in a previous ANR project lead by AF). These maps will be part of a collaboration established with The Royal Botanical Gardens at Kew (UK) and several Brasilian Universities in a join project on historical biogeography of Myrtaceae, a large family of trees and shrubs, well developed in the Neotropoics. A. Franc has been visiting E. Lucas, at Kew Botanical gardens, in March 2016 for setting up a cooperation. A first workshop has been organized by F. Salgeiro and AF at Rio in May 2016. The next one will be held in August 2017, organized by E. Lucas and coll. An an open access paper on historical biogeography of the genus Quercus, in collaboration with University of Padova and Museum of Natural History of Stockholm, is [11].

8.2.4. *Informal International Partners*

PLEIADE collaborates with Rodrigo Assar of the Universidad Andrès Bello, and Nicolás Loira and Alessandro Maass of the Center for Genomic Regulation, in Santiago de Chile (Chile). Our focus is inference of metabolic and regulatory models by comparative genomics, and their description using stochastic transition systems.

REO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Project "EXIFSI"
Participants: Faisal Amlani, Miguel Ángel Fernández Varela [Principal Investigator], Axel Fourmont, Mikel Landajuela Larma, Marina Vidrascu.

Period: 2012-2016
The aim of this project, coordinated by Miguel Ángel Fernández Varela, is to study mathematically and numerically new numerical methods for incompressible fluid-structure interaction.

9.1.1.2. ANR LabCom "CARDIOXCOMP"
Participants: Muriel Boulakia, Damiano Lombardi, Jean-Frédéric Gerbeau [Principal Investigator], Fabien Raphel, Eliott Tixier.

Period: 2013-2016.
This project, coordinated by Jean-Frédéric Gerbeau, is carried out in the framework of a joint laboratory ("LabCom" call of ANR) with the software company NOTOCORD. The focus is the mathematical modeling of a device measuring the electrical activity of cardiomyocytes. The overall objective of CardioXcomp is to enrich NOTOCORD's software with modeling and simulation solutions and provide to safety pharmacology research a completely new set incorporating state of the art signal processing and numerical simulation.

9.1.1.3. ANR Project "iFLOW"
Participants: Chloé Audebert, Jean-Frédéric Gerbeau, Irene Vignon-Clementel [co-Principal Investigator].

Period: 2013-2017.
This ANR-TecSan, co-managed by Eric Vibert (Paul Brousse Hospital) and Irene Vignon-Clementel, aims at developing an Intraoperative Fluorescent Liver Optimization Workflow to better understand the relationship between architecture, perfusion and function in hepatectomy.

Other partners: DHU Hepatinov - Hôpital Paul Brousse, Inria Mamba, Fluoptics, IfADo, MID.

9.1.1.4. ANR Project "IFSMACS"
Participants: Muriel Boulakia, Céline Grandmont [local coordinator].

Period: 2015-2019.
The objective of this project, coordinated by Takéo Takahashi (Inria Nancy Grand-Est), is the mathematical analysis of systems involving structures immersed in a fluid. This includes the asymptotic analysis, the study of the controllability and stabilization of fluid-structure interaction systems, the understanding of the motion of self-propelled structures and the analysis and development of numerical methods to simulate fluid-structure systems.

9.1.1.5. Participation to other ANR projects

- Laurent Boudin is a member of the ANR Blanc project Kibord on kinetic models in biology and related domains

- Laurent Boudin is a member of the ANR TecSan Oxhelease

- Céline Grandmont is a member of the ANR TecSan Oxhelease

- Marina Vidrascu is a member of the ANR ARAMIS

- Irene Vignon-Clementel is a member of the project iLite (09/16-), RHU-santé grant, a large French hospital-medical research consortium that aims at developing innovations for liver and tissue engineering (Inria PI: Dirk Drasdo).

9.1.2. Inria initiatives

9.1.2.1. ADT Project "MENAMES"
   Participants: Miguel Ángel Fernández Varela [Principal Investigator], Axel Fourmont, Marina Vidrascu.

   Period: 2014-2016
   The aim of this project, coordinated by Miguel Ángel Fernández Varela, is to implement in the FELiScE library the shell elements included in the shelddon and Modulef libraries.

9.1.2.2. ADT Project "PARASOL"
   Participants: Miguel Ángel Fernández Varela [Principal Investigator], Axel Fourmont, Marina Vidrascu.

   Period: 2016-2017
   The aim of this project, coordinated by Miguel Ángel Fernández Varela, is to implement in the FELiScE library several balancing domain decomposition methods (BDD) for solid-mechanics.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. REVAMMAD

   Title: "Retinal Vascular Modeling, Measurement and Diagnosis"

   Programm: FP7

   Duration: April 2013 - March 2017

   Coordinator: University of Lincoln

   Partners: See the web site http://revammad.blogs.lincoln.ac.uk/partners/

   Inria contact: J.-F. Gerbeau

   REVAMMAD is a European Union project aimed at combatting some of the EU's most prevalent chronic medical conditions using retinal imaging. The project aims to train a new generation of interdisciplinary scientists for the academic, clinical and industrial sectors, and to trigger a new wave of biomedical interventions. The role of REO team within this consortium is to propose a mathematical model and a simulation tool for the retina hemodynamics. See http://revammad.blogs.lincoln.ac.uk for more details.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

9.2.2.1. SimInhale COST
   Participant: Irene Vignon-Clementel.

   Action MP1404, a pan-European network of experts in the field of inhaled medicine

9.3. International Initiatives

9.3.1. Trans-Atlantic Network of Excellence for Cardiovascular Research

Participants: Jean-Frédéric Gerbeau, Sanjay Pant, Irene Vignon-Clementel [correspondant].

Period: 2010-2016

This network, funded by the Leducq foundation, is working on the multi-scale modeling of single ventricle hearts for clinical decision support.

Other partners: see http://modelingventricle.clemson.edu/home.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Visiting Professor: Rodolfo Araya, University of Concepcion (Chile), from Apr 2016 to Jul 2016
- Visiting PhD student: Michele Annese, Universita degli Studi di Brescia (Italy), from Mar to Jul 2016
- Visiting PhD student: Stefano Zonca, Politecnico di Milano (Italy), from Oct to Sep 2016

SERENA Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

GT Elfic (Labex DigiCosme, 2014–2016): "Formal proof for finite element programs", with TOCCATA (Inria Saclay - Île-de-France), CEA LIST, LIPN (Université de Paris 13), and LMAC (Université de Technologie de Compiègne).

8.2. National Initiatives

8.2.1. ANR

ANR DEDALES: "Algebraic and geometric domain decomposition for subsurface flow". The project aims at developing high performance software for the simulation of two phase flow in porous media. It specifically targets parallel computers where each node is itself composed of a large number of processing cores, such as are found in new generation many-core architectures. The project had its intermediate review in December 2016, and received excellent marks from the expert panel.

The partners are HIEPACS, Laboratoire Analyse, Géométrie et Application, University Paris 13, Maison de la Simulation, and ANDRA. SERENA representants are M. Kern (grant leader) and M. Vohralík, period 2014–2017.

ANR GEOPOR: "Geometrical approach for porous media flows: theory and numerics". A new approach to numerical methods for multiphase simulations based on the concept of gradient flows is investigated. With Laboratoire Jacques-Louis Lions, University Pierre and Marie Curie. SERENA representant is M. Vohralík, period 2013–2017.

ANR H2MNO4: "Original optimized object-oriented numerical model for heterogeneous hydrogeology". The project H2MNO4 develops numerical models for reactive transport in heterogeneous media. The objective is to design both Eulerian and Lagrangian models. Three applications are concerned: freshwater supply, remediation of mine drainage, and waste geological disposal. The project relies on a consortium of six partners, involving four public research laboratories (Inria, Geosciences Rennes, University of Lyon 1, University of Poitiers, Pprime Institute), one public institution (ANDRA), and one enterprise (ITASCA). International collaborations are pursued with University of San Diego (USA) and UPC (Spain). SERENA representant is G. Pichot, period 2012–2016.

ANR HHOMM: "Hybrid high-order methods on polyhedral meshes", Theoretical foundations and applications (up to software development) for the recently-devised Hybrid high-order methods. Coordinated by D. Di Pietro, University of Montpellier. SERENA representant is A. Ern, period 2015–2019.

C2S@Exa: "Computer and Computational Sciences at Exascale". This is an Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This project supported in particular the Ph.D. of N. Birgle in the framework of the Inria–ANDRA collaboration.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

ERC GATIPOR: "Guaranteed fully adaptive algorithms with tailored inexact solvers for complex porous media flows". The subject of this project are new approaches to porous media multiphase flows: inexact Newton-multigrid solvers, local stopping criteria, adaptivity, and a posteriori error control. The goal is to guarantee the overall simulation error and to speed-up importantly the present-day simulations. SERENA representant is M. Vohralík (grant leader), period 2015–2020.

EoCoE: "Energy Oriented Center of Excellence" This project is coordinated by Maison de la Simulation and gathers 23 partners from 13 countries to use the tremendous potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable low carbon energy supply using HPC (High Performance Computing). SERENA representant M. Kern, period 2015–2018.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

8.3.2.1. ITEA 3

Program: ITEA 3

Project acronym: OPENCPS

Project title: Open cyber-physical system model-driven certified development

Duration: Dec 2015–Dec 2018

Coordinator: Magnus Eek

Other partners: AB SKF, CEA, ELTE-Soft Kft., ESI Group, EDF, Wqua Simulation AB, Ericsson, IncQuery Labs Kft., KTH, Linköping University, RTE, SICS, SIREHNA, Saab AB, Sherpa Engineering, Siemens Industrial Torbumachinery AB, VTT Technical Research Center of Finland Ltd.

Abstract: Cyber-physical systems put increasing demands on reliability, usability, and flexibility while, at the same time, lead time and cost efficiency are essential for industry competitiveness. Tools and environments for model-based development of cyber-physical systems are becoming increasingly complex and critical for the industry: tool interoperability, vendor lock-ins, and tool life-cycle support are some of the challenges. The project focuses on interoperability between the standards Modelica/UML/FMI, improved execution speed of (co-)simulation, and certified code generation.

8.3.2.2. ERC CZ

Program: Research, Development and Innovation Council of the Czech Republic

Project acronym: MoRe

Project title: Implicitly constituted material models: from theory through model reduction to efficient numerical methods

Duration: September 2012 – September 2017

Coordinator: Josef MÁLEK, Charles University in Prague. SERENA representant is M. Vohralík.

Other partners: Institute of Mathematics, Czech Academy of Sciences; University of Oxford

Abstract: A multidisciplinary project on nonlinear Navier–Stokes flows with implicit constitutive laws. It focuses on development of accurate, efficient, and robust numerical methods for simulations of the new class of implicit models.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

H. Ben Ameur, Professor at IPEST and member of ENIT-Lamsin, Tunis, Tunisia, November 1–15, 2016.

G. Hammond, Applied Systems Analysis and Research Sandia National Laboratories, USA, April 18, 2016.

M. Köppel, Ph.D. student, University of Stuttgart, Germany, October 1–December 31, 2016.

Z. Strakoš, Professor at the Charles University in Prague, April, 17–21, 2016.

<p style="text-align:center;color:red;">SERPICO Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

ENSAI-CREST: Statistical methods and models for image registration, Vincent Briane PhD thesis is co-funded by Inria and ENSAI-CREST and co-supervised by Myriam Vimond (ENSAI-CREST).

Région Bretagne: Identification, localization and enumeration of ribosomes within a tomogram by combining state-of-the-art denoising methods and object descriptor-based recognition (CATLAS, see Section 8.2.1).

BioGenOuest: Collaboration with S. Prigent (engineer) in charge of the organization of image processing services for Biogenouest bio-imaging facilities.

IGDR: Collaboration with J. Pecreaux, Y. Le Cunff (co-supervision of A.G. Caranfil's PhD thesis).

9.2. National Initiatives

9.2.1. *France-BioImaging project*

Participants: Charles Kervrann, Patrick Bouthemy, Thierry Pécot, Emmanuel Moebel, Ancageorgiana Caranfil.

The goal of the project is to build a distributed coordinated French infrastructure for photonic and electronic cellular bioimaging dedicated to innovation, training and technology transfer. High-computing capacities are needed to exhaustively analyse image flows. We address the following problems: i/ exhaustive analysis of bioimaging data sets; ii/ deciphering of key steps of biological mechanisms at organ, tissular, cellular and molecular levels through the systematic use of time-lapse 3D microscopy and image processing methods; iii/ storage and indexing of extracted and associated data and metadata through an intelligent data management system. SERPICO is co-head of the IPDM (Image Processing and Data Management) node of the FBI network composed of 6 nodes.

Funding: Investissement d'Avenir - Infrastructures Nationales en Biologie et Santé ANR (2011-2016).

Partners: CNRS, Institut Jacques Monod, Institut Pasteur, Institut Curie, ENS Ulm, Ecole Polytechnique, INRA, INSERM.

9.2.2. *ANR DALLISH project (2016-2020): Data Assimilation and Lattice LIght SHeet imaging for endocytosis/exocytosis pathway modeling in the whole cell*

Participants: Charles Kervrann, Patrick Bouthemy, Vincent Briane, Ancageorgiana Caranfil.

The Lattice Light Sheet Microscopy (LLS-M) represents at present the novel generation of 3D fluorescence microscopes dedicated to single cell analysis, generating extraordinarily high resolved and sharp, but huge 3D images and videos: one single live cell experiment in one single condition, imaging two molecular markers of the endocytosis pathway and using cutting-edge LLS-M can result into up to one Terabyte of data, at the spatial resolution of 100-200 nanometers in 3D. In such a situation, it is found the usual conventional image reconstruction algorithms and image analysis methods developed for 3D fluorescence microscopy are likely to fail to process a deluge of voxels generated by LLS-M instruments. The goal of the project is then to develop new paradigms and computational strategies for image reconstruction and 3D molecule tracking/motion estimation. Furthermore, establishing correspondences between the image-based measurements and features (e.g., motion vectors, trajectories), stochastic motion models and the underlying biological and biophysical information remains a challenging task.

The impact of the project will be three-fold. First, our new image processing paradigms and improved algorithms (allowing faster, more resolved and more accurate results) will have direct benefits in modern bioimaging. Second, the methods and algorithms will apply to decipher molecular mechanisms of protein transports, here focused on endocytosis/exocytosis. Finally, in a larger perspective, the quantitative description of protein transport will be a prerequisite for understanding the functioning of a cell in normal and pathological situations, as default in protein transport appeared over the years, as a major contributory factor to a number of diseases, including cancer, viral infection and neurodegenerative diseases.

Funding: ANR - Agence Nationale de la Recherche

Partners: Inria (SERPICO, BEAGLE, Fluminance), INRA MaIAGE Unit Jouy-en-Josas, Institut Curie (UMR CNRS 144 & U1143 Inserm UMR 3666) Paris

9.3. European Initiatives

9.3.1. Major European Organizations with which the Team have followed Collaborations

ESFRI Euro-BioImaging initiative: SERPICO participates in the ESFRI Euro-BioImaging project, one of the four new biomedical science projects in the roadmap of the European Strategic Forum on Research Infrastructures (ESFRI). The mission of Euro-BioImaging is to provide access, service and training to state-of-the-art imaging technologies and foster the cooperation and networking at the national and European level including multidisciplinary scientists, industry, regional, national and European authorities. SERPICO also participates to the French counterpart, the so-called "France-BioImaging" (FBI) network which gathers several outstanding cellular imaging centers (microscopy, spectroscopy, probe engineering and signal processing) as described in Section 9.2.1 .

9.4. International Initiatives

9.4.1. Informal International Partners

Collaboration with Max-Planck Institute, Martinsried (Germany), Dr. Julio Ortiz: Detection and segmentation of macromolecules in cryo electron tomography (project in progress with Emmanuel Moebel and Charles Kervrann).

Collaboration with Aalborg University (Denmark), Prof. Rasmus Waagepetersen : Estimating equations for inhomogeneous determinantal point processes (project in progress with Frédéric Lavancier).

Collaboration with EPFL (M. Unser's Team, Switzerland). D. Fortun: optical flow computing (project in progress with Charles Kervrann).

9.4.2. CytoDI Inria Associated-Team

Title: Quantitative Imaging of Cytoskeleton Dynamics in 3D

International Partner:

University of Texas, SouthWestern Medical Center, Dallas (United States) - Gaudenz Danuser

Start year: 2016

See also: http://serpico.rennes.inria.fr/doku.php?id=research:cytodi

The main scientific goal of the Associated-Team is the spatiotemporal characterization and comparison of cytoskeleton networks involved in cell migration and observed through live cell imaging in three dimensions (3D). Those networks include the cytoskeleton, i.e., microtubules (MT), intermediate filaments (IF), dynamically resolvable by Bessel Beam Light Sheet fluorescent microscopy. The goal will be achieved through the design of local and global descriptors of the spatial conformation and deformation of the cytoskeleton. Subsequently, general metrics to compare and classify the MT and IF networks will be investigated. This study will be carried out on oncogenically transformed lung cancer epithelial cells.

The first meeting took place in Dallas in May 2016 as originally scheduled, to discuss and update current research direction and discuss scientific progress.

9.5. International Research Visitors

9.5.1. Visits to International Teams

Visit of 3 months of Juan Manuel Perez Rua in the Philip Torr's team (University of Oxford, UK).
Visit of 1 one week of Vincent Briane to the ESGI (European Study Group in Industry) in Dublin (Ireland, July 2016).

Visit of 1 one week of Vincent Briane to the University of Limerick (K. Burke's team) (Ireland, November 2016).

<p style="text-align:center">**SISTM Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

The team have strong links with :

Université de Bordeaux

ISPED (Institut de Santé Publique et du Développement)

Bordeaux CHU ("Centre Hospitalier Universitaire").

Limoges CHU ("Centre Hospitalier Universitaire").

Research teams of the research center INSERM U1219 : "Injury Epidemiology, Transport, Occupation" (IETO), Biostatistics, "Pharmacoepidemiology and population impact of drugs", "Multimorbidity and public health in patients with HIV or Hepatitis" (MORPH3Eus) and "Maladies infectieuses dans les pays à ressources limitées" (IDLIC).

Institut Bergonié, Univ Bordeaux through the EUCLID platform

Inria Project-team MONC and CQFD

9.2. National Initiatives

9.2.1. *Labex Vaccine Research Institute (VRI)*

There are strong collaborations with immunologists involved in the Labex Vaccine Research Institute (VRI) as Rodolphe Thiébaut is leading the Biostatistics/Bioinformatics division.

9.2.2. *Expert Appraisals*

Rodolphe Thiébaut is an expert for INCA (Institut National du Cancer) for the PHRC (Programme hospitalier de recherche Clinique en cancérologie) and for the PRME (Programme de recherche médico-économique en cancérologie).

Mélanie Prague is an expert for ANRS (France Recherche Nord&Sud Sida-HIV Hépatites) in the CSS 3 (Recherches cliniques et physiopathologiques dans l'infection à VIH).

Rodolphe Thiébaut is a member of the Membre du CNU 46.04 (Biostatistiques, informatique médicale et technologies de communication).

Laura Richert is an expert for the PHRC (Programme hospitalier de recherche Clinique).

Laura Richert is a member of F-CRIN Steering Committee.

Marta Avalos is an expert for L'ASNM (Agence nationale de sécurité du médicament et des produits de santé)

9.2.3. *Various Partnership*

The project team members are involved in:

Convention between the "Fédération francaise de natation" and Inria (18950 euros) for the R&D project "Quels schémas de périodisation pour la préparation des Jeux Olympiques à Rio ?" (Marta Avalos).

DRUGS-SAFE platform funded by ANSM (Marta Avalos).

F-CRIN (French clinical research infrastructure network) was initiated in 2012 by ANR under a PIA founding (Programme des Investissements d'avenir) named "INBS/Infrastructures nationales en biologie et en santé". (Laura Richert)

The project team members also collaborate with:

I-REIVAC is the French vaccine research network. This network is part of the Consortium de Recherche en Vaccinologie (CoReVac) created by the Institut de Microbiologie et des Maladies Infectieuses (IMMI). (Laura Richert)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The member of SISTM Team are involved in EHVA (European HIV Vaccine Alliance):

Program: Most information about this program can be found at http://www.ehv-a.eu/.

Coordinator: Rodolphe Thiébaut is Work Package leader of the WP10 "Data Integration".

Other partners: The EHVA encompasses 39 partners, each with the expertise to promote a comprehensive approach to the development of an effective HIV vaccine. The international alliance, which includes academic and industrial research partners from all over Europe, as well as sub-Saharan Africa and North America, will work to discover and progress novel vaccine candidates through the clinic.

Abstract: With 37 million people living with HIV worldwide, and over 2 million new infections diagnosed each year, an effective vaccine is regarded as the most potent public health strategy for addressing the pandemic. Despite the many advances in the understanding, treatment and prevention of HIV made over the past 30 years, the development of broadly-effective HIV vaccine has remained unachievable. EHVA plans to develop and implement:

- Discovery Platform with the goal of generating novel vaccine candidates inducing potent neutralizing and non-neutralizing antibody responses and T-cell responses
- Immune Profiling Platform with the goal of ranking novel and existing (benchmark) vaccine candidates on the basis of the immune profile
- Data Management/Integration/Down-Selection Platform, with the goal of providing statistical tools for the analysis and interpretation of complex data and algorithms for the efficient selection of vaccines
- Clinical Trials Platform with the goal of accelerating the clinical development of novel vaccines and the early prediction of vaccine failure.

The member of SISTM Team and particularly Laura Richert are also involved in other H2020 projects such as SenseCog, Medit'aging and Orthunion.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: The EBOVAC2 project is one of 8 projects funded under IMI Ebola+ programme that was launched in response to the Ebola virus disease outbreak. The project aims to assess the safety and efficacy of a novel prime boost preventive vaccine regimen against Ebola Virus Disease (EVD).

Project acronym: EBOVAC2

Project title: EBOVAC2

Coordinator: Rodolphe Thiébaut

Other partners: Inserm (France), Labex VRI (France), Janssen Pharmaceutical Companies of Johnson & Johnson, London School of Hygiene & Tropical Medicine (United Kingdom), The Chancellor, Masters and Scholars of the University of Oxford (United Kingdom), Le Centre Muraz (Burknia Faso), Inserm Transfert (France)

Abstract: Given the urgent need for an preventive Ebola vaccine strategy in the context of the current epidemic, the clinical development plan follows an expedited scheme, aiming at starting a Phase 2B large scale safety and immunogenicity study as soon as possible while assuring the safety of the trial participants.

- Phase 1 trials to assess the safety and immunogenicity data of the candidate prime-boost regimen in healthy volunteers are ongoing in the UK, the US and Kenya and Uganda. A further study site has been approved to start in Tanzania. Both prime-boost combinations (Ad26.ZEBOV prime + MVA-BN-Filo boost; and MVA-BN-Filo prime + Ad26.ZEBOV boost) administered at different intervals are being tested in these trials.

- Phase 2 trials (this project) are planned to start as soon as the post-prime safety and immunogenicity data from the UK Phase I are available. Phase 2 trials will be conducted in healthy volunteers in Europe (France and UK) and non-epidemic African countries (to be determined). HIV positive adults will also be vaccinated in African countries. The rationale for inclusion of European volunteers in Phase 2, in addition to the trials in Africa, is to allow for higher sensitivity in safety signal detection in populations with low incidence of febrile illnesses, to generate negative control specimens for assay development, to allow for inclusion of health care workers or military personnel that may be deployed to Ebola-endemic regions.

9.3.3. Collaborations with Major European Organizations

University of Oxford;

London School of Hygiene and Tropical Medicine;

University Hospital Hamburg;

Heinrich Pette Institute for Experimental Virology, Hambourg;

MRC, University College London

9.4. International Initiatives

Scharp, Seattle;

Fred Hutchinson Cancer center, Seattle;

Baylor Institute;

NIH for the Prevac trial;

NGO Alima for the Prevac trial;

Several African clinical sites for Ebovac2 and Prevac trials.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Cristian Meza, Associate Professor of the Universidad de Valparaiso (Chili), member of the research center CIMFAV : http://cmeza.cimfav.cl/ collaborates on the project entitled "Longitudinal high-dimensional data" (septembre)

David Conesa, Associate Professor of the Universidad de Valencia (Espagne), member of the research group GEEITEMA : http://www.geeitema.org/conesa/ collaborates on the project entitled "Bayesian predictive methods with application to the home and leisure injuries in France study MAVIE" (septembre)

Sam Doerken, PhD student of the University of Freiburg (Allemagne), member of the Institute for Medical Biometry and Statistics : http://portal.uni-freiburg.de/imbi/employees/persons/doerken collaborates on the project entitled "Penalization regression methods for sparse exposures with application to pharmacoepidemiology" (septembre - octobre)

Jessica Gronsbell, PhD student of the Harvard T.H. Chan School of Public Health, came as a visiting scholar on a subject of "analysis of high dimensional genetic data" (May).

9.5.2. Visits to International Teams

Marta Avalos will be a research visitor at CSIRO's Data61 in Canberra, Australia from Dec. 2016 until June 2017. Collaboration with Cheng Soon Ong http://www.ong-home.my/

Marta Avalos (in April and october) visited David Conesa through the Erasmus+ program Universidad de Valencia (Espagne).

Perrine Soret (from 26/12/15 to 28/01/16) visited Cristian Meza and Karine Bertin (Inria Chili) at CIMFAV (Centre for Research and Modeling of Random Phenomena, Valparaíso), Univ Valparaiso, Chili, concerning the project "New challenges in mixed-effects models".

Laura Richtert spent 6 months as visiting researcher at Heinrich Pette Institut for experimental virology, department virus immunology (Pr M. Altfeld), Hamburg Germany in 2016

Boris Hejblum is a Visiting Scientist appointment at Harvard University (not paid), Department of Biostatistics

<p style="text-align:center; color:red;">**STEEP Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

The design of our LUTI model of Grenoble based on TRANUS platform takes place in the framework of a tight collaboration with the AURG, the Urban Planning Agency of the Grenoble area.

9.2. National Initiatives

9.2.1. ANR

CITiES (*Calibrage et valIdation de modèles Transport - usagE des Sols*)
Program: "*Modèles Numériques*" 2012, ANR
Duration: 2013 – 2016
Coordinator: Emmanuel Prados (STEEP)
Other partners: LET, IDDRI, IRTES-SET ("Systemes and Transports" lab of Univ. of Tech. of Belfort-Montbéliard), IFSTTAR-DEST Paris (formerly INRETS), LVMT ("*Laboratoire Ville Mobilité Transport*", Marne la Vallée), VINCI (Pirandello Ingenierie, Paris), IAU Île-De-France (Urban Agency of Paris), AURG (Urban Agency of Grenoble), MOISE (Inria project-team)
Abstract: Calibration and validation of transport and land use models.

9.2.2. FRB (*Fondation pour la Recherche sur la Biodiversité*)

ESNET (Futures of ecosystem services networks for the Grenoble region)
Program: "Modeling and Scenarios of Biodiversity" flagship program, Fondation pour la Recherche sur la Biodiversité (FRB). This project is funded by ONEMA (*Office National de l'Eau et des Milieux Aquatiques*).
Duration: 2013 – 2016
Coordinator: Sandra Lavorel (LECA)
Other partners: EDDEN (UPMF/CNRS), IRSTEA Grenoble (formerly CEMAGREF), PACTE (UJF/CNRS), ERIC (Lyon 2/CNRS)
Abstract: This project explores alternative futures of ecosystem services under combined scenarios of land-use and climate change for the Grenoble urban area in the French Alps. In this project, STEEP works in particular on the modeling of the land use and land cover changes, and to a smaller extent on the interaction of these changes with some specific services.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

9.3.1.1. Internships

- Songyou Peng (summer internship, MSc student in the ViBOT Erasmus Mundus program).

TAPDANCE Team

5. Partnerships and Cooperations

5.1. International Research Visitors

5.1.1. Visits of International Scientists

Prof. David Doty from UC Davis, California, was hosted for 1 week in 2016.

5.1.2. Visits to International Teams

Woods visited Caltech for several weeks in 2016.

Woods visited Dagstuhl 3-8 July 2016 for Caltech for several weeks in 2016. Dagstuhl Seminar 16271 Algorithmic Foundations of Programmable Matter. Collaborative work with workshop attendees. Invited talk.

<h2 style="color:red; text-align:center;">TONUS Team</h2>

8. Partnerships and Cooperations

8.1. Regional Initiatives

The thesis of Pierre Gerhard devoted to numerical simulation of room acoustics is supported by the Alsace region. It is a joint project with CEREMA (*Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement*) in Strasbourg.

8.2. National Initiatives

8.2.1. ANR

ANR project PEPPSI (models for edge plasma physic in Tokamak) in *Programme Blanc* SIMI 9, started in 2013. Participants, G. Manfredi (coordinator), S. Hirstoaga, D. Coulette.
Participants: Giovanni Manfredi [coordinator], Sever Adrian Hirstoaga.

8.2.2. IPL FRATRES

The TONUS project belongs to the IPL FRATRES (models and numerical methods for Tokamak). The annual meeting has been organized in Strasbourg by Emmanuel Franck and Philippe Helluy.

8.2.3. IPL C2S@exa

The TONUS and HIEPACS projects have obtained the financial support for the PhD thesis of Nicolas Bouzat thanks to the IPL C2S@exa (computational sciences at exascale). Nicolas Bouzat works at CEA Cadarache and is supervised locally by Guillaume Latu; the PhD advisors are Michel Mehrenberger and Jean Roman.

8.2.4. Competitivity clusters

GENCI projet : "*Simulation numérique des plasmas par des méthodes semi-lagrangiennes et PIC adaptées*". 450 000 scalar computing hours on CURIE_standard (January 2016-January 2017); coordinator: Michel Mehrenberger
Participants: Sever Adrian Hirstoaga, Guillaume Latu, Michel Mehrenberger, Thi Nhung Pham, Christophe Steiner, Yann Barzamian.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. EUROfusion 2015-2017

Eurofusion Enabling Research Project ER15-IPP01 (1/2015-12/2017) "Verification and development of new algorithms for gyrokinetic codes" (Principal Investigator: Eric Sonnendrücker, Max-Planck Institute for Plasma Physics, Garching).
Participants: Philippe Helluy, Sever Adrian Hirstoaga, Michel Mehrenberger.

Eurofusion Enabling Research Project ER15-IPP05 (1/2015-12/2017) "Global non-linear MHD modeling in toroidal geometry of disruptions, edge localized modes, and techniques for their mitigation and suppression" (Principal Investigator: Matthias Hoelzl, Max-Planck Institute for Plasma Physics, Garching).
Participant: Emmanuel Franck.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

Michel Mehrenberger collaborates with Bedros Afeyan (Pleasanton, USA) on KEEN wave simulations.

Emmanuel Franck collaborates with E. Sonnendruecker (IPP Garching) and S. Serra Capizzano (University of Como, Italy) on preconditioning for IGA methods.

8.4.2. Participation In other International Programs

Participants: Conrad Hillairet, David Coulette, Emmanuel Franck, Philippe Helluy [local coordinator].

ANR/SPPEXA "EXAMAG" is a joint French-German-Japanese project. Its goal is to develop efficient parallel MHD solvers for future exascale architectures. With our partners, we plan to apply highly parallelized and hybrid solvers for plasma physics. One of our objectives is to develop Lattice-Boltzmann MHD solvers based on high-order implicit Discontinous Galerkin methods, using SCHNAPS and runtime systems such as StarPU.

<h1 style="color:red; text-align:center;">VIRTUAL PLANTS Project-Team</h1>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *New pearl*

Participants: Sixtine Passot, Yann Guédon, Soazig Guyomarc'h [Montpellier University, DIADE], Laurent Laplaze [IRD, DIADE].

Funding: Labex Agro (Contractor for Virtual Plants: CIRAD, from 2014 to 2017)

Pearl millet is an orphan crop regarding research effort despite its key role for food safety in Sub-Saharan Africa. The objective of the New Pearl project is to develop basic biological knowledges concerning Pearl millet development and genetic diversity. We are more specifically involved in the study of the root system development and the genetic diversity on the basis of root phenotypic traits.

8.1.2. *MecaFruit3D*

Participants: Mik Cieslak, Frédéric Boudon, Christophe Godin, Nadia Bertin [PSH, Avignon].

Funding: Labex Agro (Contractor for Virtual Plants: INRA, from 2013 to 2016)

The fruit cuticle plays a major role in fruit development and shelf-life. It is involved in water losses, cracking, and protection against stress, and thus it may have major economic impacts. Objectives of the project are to better understand the multiple roles of the fruit cuticle in the control of fleshy fruit growth and quality.

The multicellular model for fruit growth that we develop (see section 6.3.2) will be used to study qualitatively the impact of the cuticle mechanical properties.

Partners: PSH, INRA, Avignon; LCVN, IES, Université Sud de France, Montpellier.

8.1.3. *Integrated model of plant organ growth*

Participants: Yann Guédon, Christine Granier [INRA, LEPSE], Garance Koch [INRA, LEPSE], Nadia Bertin [INRA, PSH], Valentina Baldazzi [INRA, PSH].

Funding: Labex Agro (Contractor for Virtual Plants: CIRAD. From 2015 to 2018)

The objective of this project is to develop a generic model which will predict interactions among the main processes controlling the development of source and sink organs in tomato, i.e. cell division, cell expansion and endoreduplication in relation to carbon and water fluxes under fluctuating environment. To achieve this objective we will i) capitalize on expertise, multi-scale phenotyping tools and genetic resources already compiled on the fruit model tomato and the model plant *Arabidopsis thaliana*; ii) perform new experiments to collect phenotyping data currently missing in this field, especially concerning the early phase of fruit and leaf development in tomato and the interactions between genes and environment; iii) develop a process-based model of organ growth which will integrate knowledge collected at the different scales.

Partners: PSH, INRA, Avignon; LEPSE, INRA, Montpellier, Biologie du fruit et Pathologie INRA, Bordeaux;

8.2. National Initiatives

8.2.1. *HydroRoot*

Participants: Mikaël Lucas [IRD], Christophe Pradal, Christophe Godin, Yann Boursiac [BPMP], Christophe Maurel [BPMP].

Funding: ANR (Contractor for Virtual Plants: Cirad, From 2012 to 2016)

The HydroRoot project proposes a unique combination of approaches in the model plant Arabidopsis thaliana to enhance our fundamental knowledge of root water transport. Accurate biophysical measurements and mathematical modeling are used, in support of reverse and quantitative genetics approaches, to produce an integrated view of root hydraulics. The HydroRoot project will address as yet unknown facets of root water transport. It will lead to an integrated view of root hydraulics that considers both tissue hydraulics and root architecture and explains how these components are controlled at the molecular level by physiological and/or environmental cues. Because of its strong physiological and genetic background, this research may also directly impact on breeding programs, for production of crops with optimised water usage and stress responses.

8.2.2. *Phenome*

Participants: Christian Fournier, Christophe Pradal, Yann Guédon, Sarah Cohen-Boulakia, Simon Artzet, Jerome Chopard, Patrick Valduriez.

Funding: ANR-Investissement d'avenir (Contractor for Virtual Plants: INRA, From 2015 to 2018)
The goal of Phenome is to provide France with an up-to-date, versatile, high- throughput infrastructure and suite of methods allowing characterisation of panels of genotypes of different species under climate change scenarios. We are involved in the methodological part of the project, that aims at developping a software framework dedicated to the analysis of high throughput phenotyping data and models. It will based on the OpenAlea platform that provides methods and softwares for the modelling of plants, together with a user-friendly interface for the design and execution of scientific workflows. We also develop the InfraPhenoGrid infrastructure that allows high throughput computation and recording of provenance during the execution of Workflows.

8.2.3. *DigEM*

Participants: Christophe Godin, Grégoire Malandain, Patrick Lemaire.

Funding: ANR (Contractor for Virtual Plants: Inria, From 2015 to 2019)
In this project, we will use advanced ligh-sheet imaging of live embryos to quantitatively describe embryonic morphogenesis in ascidians, a class of animals that undergo very rapid genomic divergence, yet show an extraordinary stasis of embryonic morphologies, based on invariant early cell lineages shared by all studied species. The global aims of the proposal, which will bridge micro- and macroevolutionary scales of analysis, are: i) to provide a global systems-level description at cellular resolution of an animal embryonic program; ii) to use this description to characterize intra-specific and inter-specific patterns of morphogenetic variations; iii) to analyze possible molecular mechanisms explaining the unusual robustness of this program to environmental and genetic perturbations. To achieve these aims, we will combine advanced live light-sheet microscopy, computational biology, functional gene assays and evolutionary approaches.

8.2.4. *Leaf Serration*

Participants: Christophe Godin, Eugenio Azpeitia.

Funding: ANR (Contractor for Virtual Plants: Inria, From 2014 to 2019)
Leaf growth and development result from the coordination in time and space of cellular divisions and cellular expansion, and expansion of certain plant cells reaches up to one thousand times their size when living the meristem. Transcription factors belonging to the CUP-SHAPED COTYLEDON (CUC) genes and homeodomain genes of the KNOTTED-LIKE (KNOXI) family were shown to be essential for the control of leaf size and shape. In addition, the phytohormone auxin is a critical regulator of growth and development, involved in the regulation and coordination of cell division and cell expansion. The mechanisms of auxin signalling are based on a complex set of co-receptors exhibiting high to low affinity for auxin and an even more complex modular network of transcriptional repressors and activators tightly controlling the expression of a large set of genes.

The SERRATIONS project is based on recent data relative to key transcription factors regulating leaf morphogenesis and advanced knowledge on the generic signalling mechanisms of the phytohormone auxin that plays a critical role in the control and coordination of cellular responses sustaining leaf size and shape. The goal of the project is to identify auxin signalling modules involved in leaf morphogenesis and to integrate these data in mathematical modelling to provide new insights into complex regulatory networks acting on leaf morphogenesis and to further test model-derived hypotheses.

8.2.5. *Other national grants*

8.2.5.1. *SCOOP*
Participants: Pierre Fernique, Yann Guédon, Christophe Pradal, Christophe Godin, Frédéric Boudon, Jean-Baptiste Durand.

Funding: Inria ADT (Contractors for Virtual Plants: Inria from 2014 to 2016)
The goal of this project is to improve the software quality and the dissemination of Vplants components for plant phenotyping. Virtual Plants team has played a pioneering role in the development of methods for analyzing plant development that take account of the complexity of plant architecture. Numerous software components has been developed for more than 20 years and a profound re- engineering is now necessary to facilitate the collaborations with biologist and agronomists of CIRAD, INRA and IRD and to help the dissemination of ours methods in the scientific community.

8.2.5.2. *Morphogenetics*
Participants: Christophe Godin, Frédéric Boudon, Olivier Ali, Jean Phillipe Bernard, Hadrien Oliveri, Christophe Pradal, Guillaume Cerutti, Grégoire Malandain, François Faure, Jan Traas, François Parcy, Arezki Boudaoud, Teva Vernoux.

Funding: Inria Project Lab (From 2013 to 2017)
Morphogenetics is an Inria transversal project gathering 3 Inria teams and two Inra teams. It aimed at understanding how flower shape and architecture are controlled by genes during development. Using quantitative live-imaging analysis at cellular resolution we will determine how specific gene functions affect both growth patterns and the expression of other key regulators. The results generated from these experiments will be integrated in a specially designed database (3D Atlas) and used as direct input to new predictive computational models for morphogenesis and gene regulation. Model predictions will then be further tested through subsequent rounds of experimental perturbation and analysis. A particular emphasis will be put on the modeling of mechanics in tissues for which different approaches will be developed.

Partners: RDP ENS-Lyon; Imagine Inria Team (Grenoble); Morpheme Inria Team (Sophia-Antipolis), UMR PCV (Grenoble).

8.2.5.3. *Rose*
Participants: Christophe Godin, Frédéric Boudon.

Funding: INRA - PhD project (From 2016 to 2019)
In this project we want to quantify and understand how sugars interfere with hormonal signals (auxin, cytokinins) to regulate lateral bud outgrowth of aerial stems of roses. Experiments will be made on Rose stems to test different levels of sugar conditions and hormonal concentrations on bud outgrowth. An extension of the recently published hormonal model of apical dominance will be made to take into account the role of carbon as a signaling molecule.

Partners: UMR SAGAH, Angers

8.2.5.4. *ReProVirtuFlow*
Participants: Christophe Pradal, Sarah Cohen-Boulakia, Jerome Chopard.

In the life science domain, scientists are facing the deluge and the size of available data, the composition of a myriad of existing tools, and the complexity of computational experiment. In this context, reproducing an experiment is particularly difficult, as evidenced by numerous recent studies. The aim of this GDR CNRS project is to make a complete review of existing approaches in this field, considering in priority as elements of solution: (i) scientific worklfows, (ii) data provenance, and (iii) virtual machines. This project brings together experts in data bases, algorithms and virtual environments, working in the domain of life science.

Funding: GDR - CNRS

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

8.3.1.1. Hook
Participants: Christophe Godin, Olivier Ali.

A new collaboration started with the University of Umeä (Sweden) on the modeling of the apical hook in the hypocotyl of *Arabidopsis thaliana*. The question we want to answer is what regulates the opening dynamics of the apical hook at the tip of the hypocotyl and how. For this, a multidisciplinary approach, combining 3D laser imaging, molecular biology, genetics and modeling will be developed by the partners.

Partners: University of Umeä, RDP ENS-Lyon.

8.4. International Initiatives

8.4.1. ANR-DFG

8.4.1.1. AlternApp
Participants: Yann Guédon, Maryam Aliee.

Funding: ANR-DFG (Contractor for Virtual Plants: INRA, From 2015 to 2019)
The aim of the AlternApp project is to investigate functional hypotheses on the genetic and environmental control of floral induction in apple tree progenies. Two segregating populations will be studied in two different environmental conditions for floral induction and bearing behavior, in order to identify genomic regions associated with regular phenotypes. The specific contribution of the team will be to develop statistical methods to quantify phenotype and genotype, as well as years and climatic effects on alternation. Transcriptome of varieties contrasted in their bearing behavior and artificially set into high or low cropping conditions will be explored by New Generation Sequencing Technology (NGS) to identify new candidate genes and allelic variations of interest. By this project, new results are expected on floral induction in apple tree in relation to their alternate bearing behavior and more applied results linked to the discovery of allelic variation in key genes that could be used in breeding programs.

Partners: AFEF INRA team (Montpellier), PIAF INRA team (Clermont-Ferrand), JKI (Dresden, Germany), UHOH (Hohenheim, Germany), Foundation E. Mach (San Michele all'Adige, Italy)

8.4.2. Inria International Partners

8.4.2.1. BioSensors
Participants: Guillaume Cerutti, Sophie Ribes, Frédéric Boudon, Christophe Godin, Teva Vernoux [ENS-Lyon], Géraldine Brunoud [ENS-Lyon], Carlos Galvan-Ampudia [ENS-Lyon].

Funding: Human Frontiers - HFSP (From 2014 to 2017)

We propose to elucidate the basis for positional information by hormones during plant morphogenesis. While it is known that cell fate decisions require simultaneous input from multiple hormones, to-date a precise understanding of how these signals are coordinated and act together to drive morphogenesis does not exist. Our limited mechanistic understanding is largely due to the difficulty to quantify the distribution of these small molecules in space and time. To explore this fundamental question, we will exploit recent advances in synthetic biology to engineer an RNA-based biosensor platform applicable to a broad range of small molecules and in particular to hormones. Using live-imaging technologies, we will use the sensors to obtain quantitative dynamic 3D maps of hormone distributions and relate these maps to the spatio-temporal distribution of cell identities, both during normal morphogenesis and upon perturbations of hormone levels. This analysis will be done on the shoot apical meristem, one of the bestcharacterized developmental systems in higher plants. In this context, mathematical approaches will be essential to analyze and establish a predictive model for how multiple hormones influence cell fate in a spatio-temporal manner.

8.4.2.2. Informal International Partners

An important collaboration with the CIRAD research unit HortSys at the Reunion island and in particular Frédéric Normand, Yann Guédon, Pierre Fernique and Christophe Pradal has been established for several years. The topic of the collaboration is the study of the phenology of mango tree. This is a tripartite collaboration that also involves Pierre-Eric Lauri of the System research unit (INRA, Montpellier).

We have for several years a strong partnership with Ted de Jong group at UC Davis concerning the influence of various agronomic practices (water stress, pruning) on fruit tree branching and production. This is a tripartite collaboration that also involves Evelyne Costes of the AGAP/AFEF team.

A collaboration in plant phenotyping with the CSIRO and the INRA/Lepse team has been established for several years. The topic of the collaboration is to develop a full pipeline using OpenAlea 2.0 on plant phenotyping platforms. This is a joint collaboration with UMR LEPSE in Montpellier (François Tardieu).

A collaboration started in the last two years with the group of Henrik Jönsson of the Sainsbury Lab, Cambridge, UK. The collaboration is related to several modeling projects in the context of shoot apical and flower meristems development, with a particular focus on the use of quantitative 3D reconstructions of meristem structures. Yassin Refahi from the Sainsbury Lab is regularly paying visits to Montpellier. The Virtual Plants team is also regularly invited to Cambridge.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Julia Pulwicki from the University of Calgary, Canada, spent 10 days at our lab in May to study the opportunity to define a post-doctoral project for her and to set up the basis of a joint scientific project. This project has lead us to submit to the Inria post-doctoral programme a project on that was accepted. Julia arrived for a 12 month post-doctoral project in November.

In this study, we want to formalize the analogy between the development of shapes in biology and the feedback between mass and space curvature in general relativity. Our aim is to propose a quantitative approach of such a vision by developing a mathematical and computational framework combining formalisms from non-euclidean geometry developed in general relativity and models of signal propagation and gene regulation in plant tissues.

8.5.1.1. Research Stays Abroad

In the context of the project on mango modelling and the PhD of S. Persello, F. Boudon is currently positioned in the Reunion island in the Hortsys unit for one year. He develops there a project on Mango modelling in collaboration with F. Normand.

<h1 style="text-align:center; color:red">VISAGES Project-Team</h1>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Biogenouest

The VisAGeS team and the Neurinfo platform integrated the Biogenouest "Groupement d'Intérêt Scientifique (GIS)" in 2012. Biogenouest is a Western France life science and environment core facility network. Research programmes are undertaken in the fields of Marine biology, Agriculture/Food-processing, Human health, and Bioinformatics. Set up in keeping with the inter-regional principle of complementarity, Biogenouest coordinates over twenty technological core facilities in both the Brittany and Pays de la Loire regions.

9.1.2. Projet Fondation de France: PERINE

Participants: Élise Bannier, Isabelle Corouge, Olivier Commowick, Jean-Christophe Ferré, Christian Barillot.

This study evaluates the effect of prenatal exposure to neurotoxicants on the developing brain. Following previous studies in the PELAGIE cohort this MRI study involves ASL, Diffusion and working memory as well as motor inhibition BOLD fMRI together with neuropsychological tests in children. Inclusions have started in November 2014 and lasted for 2 years. The MRI acquisitions of the PERINE projects have all been performed and 101 children included. A post-doc will start in April 2017 to process the diffusion MRI and ASL data of this project.

9.1.3. Fondation de l'Avenir - Stroke, rehabilitation and fMRI

Participants: Élise Bannier, Isabelle Bonan, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot, Jean-Yves Gauvrit.

duration: 12 months from November 2012. Project extended in 2015.
A complementary funding (20 000€) was obtained to support a new research project on rehabilitation of stroke patients. The fMRI tasks were setup and validated on healthy controls (paper ready for submission). The project was extended in 2014 to recruit more patients.

9.1.4. Projet Fondation de France: EPMR-MA

Participants: Pierre-Yves Jonin, Élise Bannier, Christian Barillot, Isabelle Corouge, Quentin Duché, Jean-Christophe Ferré.

This project evaluates memory effects in healthy adults and in patients presenting cognitive impairments using BOLD fMRI and diffusion MRI. A pilot study has been completed in 2015 in order to optimize the experimental design. The inclusions of patients started in 2016 and are ongoing. A Post Doc was recruited to work on fMRI and DTI processing.

9.1.5. Allocation d'Installation Scientifique – Rennes Métropole

Participant: Emmanuel Caruyer.

Diffusion MRI has been a tremendous tool for the diagnosis of a number of brain pathologies such as abnormal development, neuro-degenerative or inflammatory disorders or brain tumors. Typical resolution in diffusion MRI is about 2mm – this suggests that in white matter, any volume element may contain millions of axons. Although currently we can characterize molecular diffusion, recent developments in diffusion MRI have shown the possibility to quantify more specifically some physical tissue parameters in white matter, such as axonal density and diameter: this means that we can retrieve information from a much smaller scale than the typical imaging resolution.

Acquisition time for this kind of measurements remains long and largely incompatible with in vivo application in humans. This projects aims at developing novel signal processing and acquisition methods for the reconstruction of microstructural informations in a reasonable acquisition time. We will study how sparse representations can be applied to the diffusion signal, in order to enable microstructure information reconstruction. In conjunction with this, we will develop acquisition sequences adapted to these sparse represnetations, in order to reconstruct the diffusion signal from fewer measurements, using results from the compressive sensing theory.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR "MAIA", 2015 generic projects program

Participants: Maia Proisy, Pierre Maurel, Antoine Legouhy, Olivier Commowick, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot.

Each year in France, 55 000 children are born prematurely, i.e., before the 37th week of gestation. Long-term studies of the outcome of prematurely born infants have clearly documented that the majority of such infants may have significant motor, cognitive, and behavioral deficits.

However, there is a limited understanding of the nature of the cerebral abnormality underlying these adverse neurologic outcomes. In this context, the emergence of new modalities of 3D functional MRI, e.g., Arterial Spin Labeling (ASL), or optical imaging technologies, e.g., Near InfraRed Spectroscopy (NIRS), brings new perspectives for extracting cognitive information, via metabolic activity measures. Other classical technics devoted to cerebral signal measurement, such as ElectroEncephaloGraphy (EEG), provide cognitive information at the cortical level. Each of these various non-invasive imaging technologies brings substantial and specific information for the understanding of newborn brain development.

This project aims at developing innovative approaches for multi-image / multi-signal analysis, in order to improve neurodevelopment understanding methods. From a fundamental point of view, mathematics and computer science have to be considered in association with imaging physics and medicine, to deal with open issues of signal and image analysis from heterogeneous data (image, signal), considered in the multiphysics contexts related to data acquisition (magnetic, optic, electric signals) and biophysics modeling of the newborn brain. A sustained synergy between all these scientific domains is then necessary.

Finally, the sine qua non condition to reach a better understanding of the coupled morphological- cognitive development of premature newborns, is the development of effective software tools, and their distribution to the whole medical community. The very target of this project will be the design of such software tools for medical image / signal analysis, actually operational in clinical routine, and freely available. Academic researchers and industrial partners will work in close collaboration to reach that ambitious goal.

9.2.2. Competitivity Clusters

9.2.2.1. The HEMISFER Project

Participants: Élise Bannier, Jean-Marie Batail, Isabelle Bonan, Isabelle Corouge, Jean-Christophe Ferré, Jean-Yves Gauvrit, Pierre Maurel, Lorraine Perronnet, Christian Barillot.

The HEMISFER project ("Hybrid Eeg-MrI and Simultaneous neuro-FEedback for brain Rehabilitation") will be conducted at Inria Rennes with the support of the Cluster of Excellence "CominLabs" [0]. The goal of HEMISFER is to make full use of the neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. We propose to combine advanced instrumental devices (Hybrid EEG and MRI platforms), with new man-machine interface paradigms (Brain computer interface and serious gaming) and new computational models (source separation, sparse representations and machine

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[0]https://iww.inria.fr/cominlabs-newsletter/april-2013-four-projects-selected/#hemisfer

learning) to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major neurological and psychiatric disorders of the developmental and the aging brain (stroke, attention-deficit disorder, language disorders, treatment-resistant mood disorders, ...). This project will be conducted with the HYBRID and PANAMA Teams from Inria Rennes, the EA 4712 team from University of Rennes I and the ATHENA team from Inria Sophia-Antipolis. This work will benefit from the research 3T MRI and MRI-compatible EEG systems provided by the NeurInfo in-vivo neuroimaging platform on which these new research protocols will be set up. A budget of 500keuros will be provided by the CominLabs cluster in the next 3 years to support this project (through experimental designs, PhDs, Post-docs and Expert Engineers).

9.2.2.2. France Life Imaging (FLI)
Participants: Christian Barillot, Olivier Commowick, Michael Kain, Florent Leray, Julien Louis, Aneta Morawin, Mathieu Simon, Yao Chi.

France Life Imaging (FLI) is a proposed large-scale research infrastructure project aimed at establishing a coordinated and harmonized network of biomedical imaging in France. This project was recently selected by the call "Investissements d'Avenir - Infrastructure en Biologie et Santé". One node of this project is the node Information Analysis and Management (IAM), a transversal node build by a consortium of teams that will contribute to the construction of a network for data storage and information processing. Instead of building yet other dedicated facilities, the IAM node will use already existing data storage and information processing facilities (LaTIM Brest; CREATIS Lyon; CIC-IT Nancy; VisAGeS U746 Inria Rennes; CATI CEA Saclay; LSIIT/ICube Strasbourg) that will increase their capacities for the FLI infrastructure. Inter-connections and access to services will be achieved through a dedicated software platform that will be developed based on the expertise gained through successful existing developments. The IAM node has several goals. It aims first at building a versatile facility for data management that will inter-connect the data production sites and data processing for which state-of-the-art solutions, hardware and software, will be available to infrastructure users. Modular solutions are preferred to accommodate the large variety of modalities acquisitions, scientific problems, data size, and adapted for future challenges. Second, it aims at offering the latest development that will be made available to image processing research teams. The team VisAGeS fulfills multiple roles in this nation-wide project. Christian Barillot is the chair of the node IAM, Olivier Commowick is participating in the working group workflow and image processing and Michael Kain the technical manager. Apart from the team members, software solutions like medInria and Shanoir will be part of the final software platform.

9.2.2.3. OFSEP
Participants: Justine Guillaumont, Élise Bannier, Christian Barillot, Olivier Commowick, Gilles Edan, Jean-Christophe Ferré, Michael Kain, Inès Fakhfakh.

The French Observatory of Multiple Sclerosis (OFSEP) is one of 10 projects selected in January 2011 in response to the call for proposal in the "Investissements d'Avenir - Cohorts 2010" program launched by the French Government. It allows support from the National Agency for Research (ANR) of approximately € 10 million for 10 years. It is coordinated by the Department of Neurology at the Neurological Hospital Pierre Wertheimer in Lyon (Professor Christian Confavreux), and it is supported by the EDMUS Foundation against multiple sclerosis, the University Claude Bernard Lyon 1 and the Hospices Civils de Lyon. OFSEP is based on a network of neurologists and radiologists distributed throughout the French territory and linked to 61 centers. OFSEP national cohort includes more than 50,000 people with Multiple Sclerosis, approximately half of the patients residing in France. The generalization of longitudinal monitoring and systematic association of clinical data and neuroimaging data is one of the objectives of OFSEP in order to improve the quality, efficiency and safety of care and promote clinical, basic and translational research in MS. For the concern of data management, the Shanoir platform of Inria has been retained to manage the imaging data of the National OFSEP cohort in multiple sclerosis.

9.2.2.4. PHRC EMISEP: Evaluation of early spinal cord injury and late physical disability in Relapsing Remitting Multiple Sclerosis
Participants: Élise Bannier, Christian Barillot, Emmanuel Caruyer, Benoit Combès, Olivier Commowick, Gilles Edan, Jean-Christophe Ferré, Anne Kerbrat, Haykel Snoussi.

Multiple Sclerosis (MS) is the most frequent acquired neurological disease affecting young adults (1/1000 inhabitants in France) and leading to impairment. Early and well adapted treatment is essential in patients presenting aggressive forms of MS. This PHRC project focusses on physical impairment and especially on the ability to walk. Several studies, whether epidemiolgic or based on brain MRI, have shown that several factors were likely to announce aggressive development of the disease, such as age, number of focal lesions on baseline MRI, clinical activity. However, these factors only partially explain physical impairment progression, preventing their use at the individual level. Spinal cord is often affected in MS, as demonstrated in postmortem or imaging studies. Yet, early radiological depiction of spinal cord lesions is not always correlated with clinical symptoms. Preliminary data, on reduced number of patients, and only investigating the cervical spinal cord have shown that diffuse spinal cord injury, observed via diffusion or magnetisation transfer imaging, would be correlated with physical impairment as evaluated by the EDSS score. Besides, the role of early spinal cord affection (first two years) in the evolution of physical impairment remains unknown.

In this project, we propose to address these different issues and perform a longitudinal study on Relapsing Remitting Multiple Sclerosis (RRMS) patients, recruited in the first year of the disease. Our goal is to show that diffuse and focal lesions detected spinal cord MRI in the first 2 years can be used to predict disease evolution and physical impairment at 5 years. Twelve centers are involved in the study to include 80 patients.

To date, 65 of the 80 subjects have been included. H. Snoussi is working in the scope of his PhD thesis on diffusion imaging in the spinal cord and has dedicated his first year to literature review and definition of methodological aspects to tackle starting with distortion correction. B. Combès started as a post doc in November 2016 to process the EMISEP imaging data, starting with morphological data processing (registration, segmentation) and magnetization transfer data processing.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. EuroBioimaging

Type: CAPACITIES

Challenge: Provide access and training in imaging technologies, and share the best practice and image data in order to make Euro-BioImaging an engine that will drive European innovation in imaging research and technologies

Instrument: Combination of COLLABORATIVE PROJECTS and COORDINATION and SUPPORT ACTIONS

Objective: Euro-BioImaging is a large-scale pan-European research infrastructure project on the

European Strategy Forum on Research Infrastructures (ESFRI) Roadmap.

Duration: December 2010 - 2016

Coordinators: Jan Ellenberg (EMBL) and Oliver Speck (University of Magdeburg)

Partner: EMBL (Germany); Erasmus Medical Center (Netherlands) for WG11

Inria contact: C. Kervrann, Christian Barillot

Abstract: Euro-BioImaging is a pan-European infrastructure project whose mission is to build a distributed imaging infrastructure across Europe that will provide open access to innovative biological and medical imaging technologies for European researchers. The project is funded by the EU and currently the consortium is finalizing the basic principles for the operation of future Euro-BioImaging organisation.

Euro-BioImaging will be governed by representatives of the European countries that will join Euro-BioImaging (Euro-BioImaging member states).

The infrastructure established by Euro-BioImaging will consist of a set of geographically distributed but strongly interlinked imaging facilities (Euro-BioImaging Nodes), which will be selected among the leading European imaging facilities based on an independent evaluation process.

Inria and the VisAGeS team is involved through the FLI national infrastructure and contributes to the WG11 Working Group on Data Storage and Analysis. This WG performs a series of tasks to define a European Biomedical Imaging Data Storage and Analysis infrastructure plan for the construction phase.

9.3.1.2. H2020 OpenAire-Connect

Program: E-INFRA

Topic: EINFRA-22-2016

Type of Action: RIA

Project acronym: OpenAIRE-Connect

Project title: OpenAIRE - CONNECTing scientific results in support of Open Science

Acceptation date: 01/09/2016

Open Science is around the corner. Scientists and organizations see it as a way to speed up, improve quality and reward, while policy makers see it as a means to optimize cost of science and leverage innovation. Open Science is an emerging vision, a way of thinking, whose challenges always gaze beyond its actual achievements. De facto, today's scientific communication ecosystem lacks tools and practices to allow researchers to fully embrace Open Science. OpenAIREConnect aims to provide technological and social bridges, and deliver services enabling uniform exchange of research artefacts (literature, data, and methods), with semantic links between them, across research communities and content providers in scientific communication. It will introduce and implement the concept of Open Science as a Service (OSaaS) on top of the existing OpenAIRE infrastructure, delivering out-of-the-box, on-demand deployable tools. OpenAIRE-Connect will adopt an end-user driven approach (via the involvement of 5 prominent research communities), and enrich the portfolio of OpenAIRE infrastructure production services with a Research Community Dashboard Service and a Catch-All Notification Broker Service. The first will offer publishing, interlinking, packaging functionalities to enable them to share and re-use their research artifacts (introducing methods, e.g. data,software, protocols). This effort, supported by the harvesting and mining "intelligence" of the OpenAIRE infrastructure, will provide communities with the content and tools they need to effectively evaluate and reproduce science. OpenAIRE-Connect will combine dissemination and training with OpenAIRE's powerful NOAD network engaging research communities and content providers in adopting such services. These combined actions will bring immediate and long-term benefits to scholarly communication stakeholders by affecting the way research results are disseminated, exchanged, evaluated, and re-used.

In this project VisAGeS is acting, through CNRS, as the French coordinator to develop the link with the Neuroimaging research community. This will be performed in the context of the FLI-IAM national infrastructure

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. Kic-EIT-eHealth

Program: KIC-EIT: European Institute of Innovation and Technology

Project acronym: e-Health

Project title: Innovation for healthy living and active ageing

Acceptation date: 01/12/2014

website: http://eithealth.eu/about-us/

EIT Health aims to promote entrepreneurship and develop innovations in healthy living and active ageing, providing Europe with new opportunities and resources. EIT Health will enable citizens to lead healthier and more productive lives by delivering products, services and concepts that will improve quality of life and contribute to the sustainability of healthcare across Europe. EIT Health is a strong, diverse and balanced partnership of best-in-class organisations in education, research,

technology, business creation and corporate and social innovation. EIT Health intends to foster cooperation and unlock Europe's innovation and growth potential – developing and retaining the best talents, creating high-quality jobs and boosting the global competitiveness of European industry. VisAGeS is involved in this project through the Inserm and Inria institutions. Christian Barillot is representing Inria as one expert in the dedicated WG "Healthy Brain". VisAGeS is also concerned by the WG "big data".

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. BARBANT

Title: Boston and Rennes, a Brain image Analysis Team

International Partner (Institution - Laboratory - Researcher):

Harvard University (United States) - Mathematics Department - Simon K. Warfield

Start year: 2015

See also: https://team.inria.fr/barbant/

BARBANT is an Inria associate team shared between Inria VisAGeS research team and the Computational Radiology Laboratory at the Boston Children's hospital (Harvard Medical School). This associate team aims at better understanding the behavior of normal and pathological Central Nervous System (CNS) organs and systems. Pathologies of particular interest to us are multiple sclerosis, psychiatric, and pediatric diseases such as pediatric multiple sclerosis or tuberous sclerosis. A major challenge is to characterize the future course of the pathological processes in each patient as early as possible in order to predict the progression of the disease and/or adverse neurological outcomes, and to develop better techniques for both monitoring response to therapy and for altering therapy (duration, dose and nature) in response to patient-specific changes in imaging characteristics. At term, this project will allow to introduce objective figures to correlate qualitative and quantitative phenotypic markers coming from the clinic and image analysis, mostly at the early stage of the pathologies. This will allow for the selection or adaptation of the treatment for patients at an early stage of the disease.

9.4.1.2. Informal International Partners

- Collaboration with Sherbrooke University (Sherbrooke, Canada): From Jun to Aug 2016, Michael Paquette, PhD student from Sherbrooke supervised by Maxime Descoteaux, visited the VisAGeS team to collaborate with Emmanuel Caruyer on the development on new analysis techniques for the structural brain connectome. This visit was funded by a MITACS/Inria scholarship.

- Collaboration with LTS5, EPFL (Lausanne, Switzerland) and Computer Science department, University of Verona (Verona, Italy): Alessandro Daducci, Gabriel Girard and Jean-Philippe Thiran visited the VisAGeS team for a 2 days workshop on the development of novel validation methods for the human brain connectome using software generated phantoms.

- Collaboration with the Mathematics department, Politecnico di Milano (Italy): Olivier Commowick and Christian Barillot visited the department for the annual meeting of the Italian statistical society and collaborated with Aymeric Stamm and Simone Vantini.

- Collaboration with the Microstructure Imaging Group, UCL (London, UK): Christian Barillot, Emmanuel Caruyer, Olivier Commowick and Sudhanya Chatterjee visited the group of Daniel Alexander for a workshop on "MRI based Virtual Histology: Meeting Tomorrow's Healthcare Challenges Today"

- visit of Tobias Kober and Bénédicte Maréchal from the ACIT Siemens research group in Lausanne [0] to discuss potential collaborations on the MP2Rage sequence and other brain MR imaging topics

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[0] http://w1.siemens.ch/home/ch/de/healthcare/produkte/ACIT/Pages/AClT.aspx

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Simon Warfield and Benoit Scherrer, Harvard University, visited the VisAGeS team for the annual seminar on Jun 9-10 2016.

- From Jun to Aug 2016, Michael Paquette, PhD student from Sherbrooke supervised by Maxime Descoteaux, visited the VisAGeS team to collaborate with Emmanuel Caruyer on the development on new analysis techniques for the structural brain connectome. This visit was funded by a MI-TACS/Inria scholarship.

- Alessandro Daducci, Gabriel Girard and Jean-Philippe Thiran visited the VisAGeS team for a 2 days workshop on the development of novel validation methods for the human brain connectome using software generated phantoms.

9.5.2. Visits to International Teams

- Sudhanya Chatterjee visited the Computational Radiology Lab, Boston Children's Hospital, Harvard University for 3 weeks in Oct-Nov 2016. This stay was funded by the international program of University of Rennes 1. Christian Barillot, Emmanuel Caruyer and Olivier Commowick visited the same lab for a 3 days workshop in the context of the Associate Team.

- Christian Barillot, Emmanuel Caruyer, Olivier Commowick and Sudhanya Chatterjee visited the Microstructure Imaging Group, UCL (London, UK) of Daniel Alexander for a workshop on "MRI based Virtual Histology: Meeting Tomorrow's Healthcare Challenges Today"

- Olivier Commowick and Christian Barillot visited the Mathematics department, Politecnico di Milano (Italy) for the annual meeting of the Italian statistical society and collaborated with Aymeric Stamm and Simone Vantini.

XPOP Team

9. Partnerships and Cooperations

9.1. European Initiatives

9.1.1. FP7 & H2020 Projects

The Drug Disease Model Resources (DDMoRe) consortium will build and maintain a universally applicable, open source, model-based framework, intended as the gold standard for future collaborative drug and disease modeling and simulation.

The DDMoRe project is supported by the Innovative Medicines Initiative (IMI), a large-scale public-private partnership between the European Union and the pharmaceutical industry association EFPIA.

Marc Lavielle was leader of WP6: "New tools for Model Based Drug Development".

DDMoRe website: http://www.ddmore.eu

Duration: 2010 - 2016

Project members: Uppsala Universitet, Sweden; University of Navarra, Spain; Universiteit Leiden, Netherlands; Université Paris Diderot, France; Universita degli Studi di Pavia, Italy; UCB Pharma , Belgium; Simcyp, UK; Pfizer, UK; Optimata , Israel; Novo Nordisk , Denmark; Novartis, Switzerland; Merck Serono, Switzerland; Takeda, Switzerland; Mango Business Solutions , UK; Lixoft, France; Interface Europe, Belgium; Institut de Recherches Internationales Servier, France; Inria, France; GlaxoSmithKline Research and Development, UK; Freie Universitat Berlin, Germany; F. Hoffmann - La Roche , Switzerland; EMBL - European Bioinformatics Institute, UK; Eli Lilly , UK; Cyprotex Discovery, UK; Consiglio Nazionale delle Ricerche, Italy; AstraZeneca, Sweden.

9.2. International Initiatives

9.2.1. Informal International Partners

Marc Lavielle is Adjunct Professor at the Faculty of Pharmacy of Florida University.

Marc Lavielle is Adjunct Professor at the Faculty of Pharmacy of Buffalo University.

Julie Josse collaborates with Susan Holmes, Stanford University.

Eric Moulines regularly collaborates with Sean P. Meyn, University of Florida.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Ricardo Rios, Universidad Central de Venezuela, Caracas: September 2016.

<p style="text-align:center; color:red; font-weight:bold">ALPINES Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. Medimax

ANR-MN (Modèles Numériques) October 2013 - September 2017

The main goal is the methodological and numerical development of a new robust inversion tool, associated with the numerical solution of the electromagnetic forward problem, including the benchmarking of different other existing approaches (Time Reverse Absorbing Condition, Method of Small-Volume Expansions, Level Set Method). This project involves the development of a general parallel open source simulation code, based on the high-level integrated development environment of FreeFem++, for modeling an electromagnetic direct problem, the scattering of arbitrary electromagnetic waves in highly heterogeneous media, over a wide frequency range in the microwave domain. The first applications considered here will be medical applications: microwave tomographic images of brain stroke, brain injuries, from both synthetic and experimental data in collaboration with EMTensor GmbH, Vienna (Austria), an Electromagnetic Medical Imaging company.

9.1.1.2. ANR Cine-Para

October 2015 - September 2019, Laura Grigori is Principal Coordinator for Inria Paris. Funding for Inria Paris is 145 Keuros. The funding for Inria is to combine Krylov subspace methods with parallel in time methods. Partners: University Pierre and Marie Curie, J. L. Lions Laboratory (PI Y. Maday), CEA, Paris Dauphine University, Paris 13 University.

9.1.1.3. Non-local DD

ANR appel à projet générique October 2015 - September 2020

This project in scientific computing aims at developing new domain decomposition methods for massively parallel simulation of electromagnetic waves in harmonic regime. The specificity of the approach that we propose lies in the use of integral operators not only for solutions local to each subdomain, but for coupling subdomains as well. The novelty of this project consists, on the one hand, in exploiting multi-trace formalism for domain decomposition and, on the other hand, considering optimized Schwarz methods relying on Robin type transmission conditions involving quasi-local integral operators.

9.1.1.4. Soilμ-3D

ANR appel à projet générique October 2015 - September 2020

In spite of decades of work on the modeling of greenhouse gas emission such as CO_2 and N_2O and on the feedback effects of temperature and water content on soil carbon and nitrogen transformations, there is no agreement on how these processes should be described, and models are widely conflicting in their predictions. Models need improvements to obtain more accurate and robust predictions), especially in the context of climate change, which will affect soil moisture regime.

The goal of this new project is now to go further using the models developed in MEPSOM to upscale heterogeneities identified at the scale of microbial habitats and to produce macroscopic factors for biogeochemical models running at the field scale.

To achieve this aim, it will be necessary to work at different scales: the micro-scale of pores (μm) where the microbial habitats are localized, the meso-scale of cores at which laboratory measurements on CO2 and N2O fluxes can be performed, and the macro-scale of the soil profile at which outputs are expected to predict greenhouse gas emission. The aims of the project are to (i) develop new descriptors of the micro-scale 3D soil architecture that explain the fluxes measured at the macro-scale, (ii) Improve the performance of our 3D pore scale models to simulate both micro-and meso- scales at the same time. Upscaling methods like "homogeneization" would help to simulate centimeter samples which cannot be achieved now. The reduction of the computational time used to solve the diffusion equations and increase the number of computational units, (iii) develop new macro-functions describing the soil micro-heterogeneity and integrate these features into the field scale models.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. NLAFET

Title: Parallel Numerical Linear Algebra for Future Extreme-Scale Systems

Programm: H2020

Duration: November 2015 - November 2018

Coordinator: UMEÅUniversitet

Partners:

Science and Technology Facilities Council (United Kingdom)

Computer Science Department, UmeåUniversitet (Sweden)

Mathematics Department, The University of Manchester (United Kingdom)

Inria contact: Laura Grigori

The NLAFET proposal is a direct response to the demands for new mathematical and algorithmic approaches for applications on extreme scale systems, as identified in the FETHPC work programme and call. This project will enable a radical improvement in the performance and scalability of a wide range of real-world applications relying on linear algebra software, by developing novel architecture-aware algorithms and software libraries, and the supporting runtime capabilities to achieve scalable performance and resilience on heterogeneous architectures. The focus is on a critical set of fundamental linear algebra operations including direct and iterative solvers for dense and sparse linear systems of equations and eigenvalue problems. Achieving this requires a co-design effort due to the characteristics and overwhelming complexity and immense scale of such systems. Recognized experts in algorithm design and theory, parallelism, and auto-tuning will work together to explore and negotiate the necessary tradeoffs. The main research objectives are: (i) development of novel algorithms that expose as much parallelism as possible, exploit heterogeneity, avoid communication bottlenecks, respond to escalating fault rates, and help meet emerging power constraints; (ii) exploration of advanced scheduling strategies and runtime systems focusing on the extreme scale and strong scalability in multi/many-core and hybrid environments; (iii) design and evaluation of novel strategies and software support for both offline and online auto-tuning. The validation and dissemination of results will be done by integrating new software solutions into challenging scientific applications in materials science, power systems, study of energy solutions, and data analysis in astrophysics. The deliverables also include a sustainable set of methods and tools for cross-cutting issues such as scheduling, auto-tuning, and algorithm-based fault tolerance packaged into open-source library modules.

9.2.1.2. EXA2CT

Title: EXascale Algorithms and Advanced Computational Techniques

Programm: FP7

Duration: September 2013 - August 2016

Coordinator: IMEC

Partners:

        Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

        Interuniversitair Micro-Electronica Centrum Vzw (Belgium)

        Intel Corporations (France)

        Numerical Algorithms Group Ltd (United Kingdom)

        T-Systems Solutions for Research (Germany)

        Universiteit Antwerpen (Belgium)

        Universita della Svizzera italiana (Switzerland)

        Université de Versailles Saint-Quentin-En-Yvelines. (France)

        Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)

Inria contact: Luc Giraud

Numerical simulation is a crucial part of science and industry in Europe. The advancement of simulation as a discipline relies on increasingly compute intensive models that require more computational resources to run. This is the driver for the evolution to exascale. Due to limits in the increase in single processor performance, exascale machines will rely on massive parallelism on and off chip, with a complex hierarchy of resources. The large number of components and the machine complexity introduce severe problems for reliability and programmability. The former of these will require novel fault-aware algorithms and support software. In addition, the scale of the numerical models exacerbates the difficulties by making the use of more complex simulation algorithms necessary, for numerical stability reasons. A key example of this is increased reliance on solvers. Such solvers require global communication, which impacts scalability, and are often used with preconditioners, increasing complexity again. Unless there is a major rethink of the design of solver algorithms, their components and software structure, a large class of important numerical simulations will not scale beyond petascale. This in turn will hold back the development of European science and industry which will fail to reap the benefits from exascale. The EXA2CT project brings together experts at the cutting edge of the development of solvers, related algorithmic techniques, and HPC software architects for programming models and communication. It will take a revolutionary approach to exascale solvers and programming models, rather than the incremental approach of other projects. We will produce modular open source proto-applications that demonstrate the algorithms and programming techniques developed in the project, to help boot-strap the creation of genuine exascale codes.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- J. Demmel, UC Berkeley, USA
- R. Hipmair, ETH Zurich
- M. Grote (Université de Bâle, Suisse)
- F. Assous (Israel)

9.4. International Research Visitors

9.4.1. Visits to International Teams

9.4.1.1. Research Stays Abroad

- Laura Grigori has spent 5 months at UC Berkeley, from January 2016 to May 2016, as a visiting Professor/Researcher.

ASAP Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR project SocioPlug

Participants: Davide Frey, Anne-Marie Kermarrec, Pierre-Louis Roman, Francois Taiani.

SocioPlug is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, and LIRIS (INSA Lyon and Univ. Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more of less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

8.1.2. DeSceNt CominLabs

Participants: Resmi Ariyattu Chandrasekharannair, Davide Frey, Michel Raynal, Francois Taiani.

The DeSceNt project aims to ease the writing of distributed programs on a federation of plug computers. Plug computers are a new generation of low-cost computers, such as Raspberry pi (25$), VIA- APC (49$), and ZERO Devices Z802 (75$), which offer a cheap and readily available infrastructure to deploy domestic on-line software. Plug computers open the opportunity for everyone to create cheap nano-clusters of domestic servers, host data and services and federate these resources with their friends, colleagues, and families based on social links. More particularly we will seek in this project to develop novel decentralized protocols than can encapsulate the notion of privacy-preserving federation in plug-based infrastructures. The vision is to use these protocols to provide a programming toolkit that can support the convergent data types being developed by our partner GDD (Gestion de Données Distribuées) at Univ. Nantes.

8.1.3. ANR Blanc project Displexity

Participants: George Giakkoupis, Anne-Marie Kermarrec, Michel Raynal.

The Displexity project started in 2011. The aim of this ANR project that also involves researchers from Paris and Bordeaux is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing. One difficulty to be faced by DISPLEXITY is to reconcile two non necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues on distributed algorithms.

8.1.4. ANR project PAMELA

Participants: Davide Frey, George Giakkoupis, Francois Taiani.

PAMELA is a collaborative ANR project involving ASAP, Inria Lille, UMPC, Mediego and Snips. The project aims at developing machine learning theories and algorithms in order to learn local and personalized models from data distributed over networked infrastructures. This project seeks to provide first answers to modern information systems built by interconnecting many personal devices holding private user data in the search of personalized suggestions and recommendations. More precisely, we will focus on learning in a collaborative way with the help of neighbors in a network. We aim to lay the first blocks of a scientific foundation for these new types of systems, in effect moving from graphs of data to graphs of data and learned models. We argue that this shift is necessary in order to address the new constraints arising from the decentralization of information that is inherent to the emergence of big data. We will in particular focus on the question of learning under communication and privacy constraints. A significant asset of the project is the quality of its industrial partners, SNIPS and MEDIEGO, who bring in their expertise in privacy protection and distributed computing as well as use cases and datasets. They will contribute to translate this fundamental research effort into concrete outcomes by developing personalized and privacy-aware assistants able to provide contextualized recommendations on small devices and smartphones.

8.1.5. ANR project OBrowser

Participants: David Bromberg, Davide Frey, Francois Taiani.

OBrowser is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, the Bretagne Sud. University, and Orange. The project emerges from the vision of designing and deploying distributed application on millions of machines using web-enabled technologies without relying on a cloud or a central authority. OBrowser proposes to build collaborative applications through a decentralized execution environment composed of users' browsers that autonomously manages issues such as communication, naming, heterogeneity, and scalability. The introduction of browser-to-browser communication with WebRTC's Datachannel has made these scenarios closer, but today only experts can afford to tackle the technical challenges associated with large-scale browser-based deployments such as decentralized instant-messaging (Firechat) and Infrastructure-less Mission Critical Push To Talk. O'Browser aims to solve these challenges by means of a novel programming framework.

8.1.6. ANR project DESCARTES

Participants: George Giakkoupis, Michel Raynal, Francois Taiani.

DESCARTES is a collaborative ANR project involving ASAP, Labri (U. Bordeaux), Lafia (U. Paris Diderot), Vérimag (Grenoble), LIF (Marseilles), and LINA (Nantes). Despite the practical interests of reusable frameworks for implementing specific distributed services, many of these frameworks still lack solid theoretical bases, and only provide partial solutions for a narrow range of services. In this project, we argue that this is mainly due to the lack of a generic framework that is able to unify the large body of fundamental knowledge on distributed computation that has been acquired over the last 40 years. The DESCARTES project aims at bridging this gap, by developing a systematic model of distributed computation that organizes the functionalities of a distributed computing system into reusable modular constructs assembled via well-defined mechanisms that maintain sound theoretical guarantees on the resulting system. DESCARTES arises from the strong belief that distributed computing is now mature enough to resolve the tension between the social needs for distributed computing systems, and the lack of a fundamentally sound and systematic way to realize these systems.

8.1.7. ANR-ERC Tremplin project NDFUSION

Participant: George Giakkoupis.

NDFUSION is an 18-month ANR project awarded to the PI to support his preparation for his upcoming ERC grant application. The idea of intervening in a network diffusion process to enhance or retard its spread has been studied in various contexts, e.g., to increase the spread or speed of diffusion by choosing an appropriate set of seed nodes (a standard goal in viral marketing by word-of-mouth), or achieve the opposite effect either by choosing a small set of nodes to remove (a goal in immunization against diseases), or by seeding a competing diffusion (e.g., to limit the spread of misinformation in a social network). The aim of this project is to consolidate existing work under a single, comprehensive framework, and using this framework to develop

new, efficient algorithms for optimizing (maximizing or minimizing) the spread of diffusion processes. Novel aspects of the project involve issues of scalability, multiple concurrent diffusions, and the use of multistage online strategies to optimize diffusions. Results from this project are likely to be relevant to many different disciplines, from network optimization in computing to disease containment in medicine.

8.2. International Initiatives

8.2.1. Inria International Labs

Anne-Marie Kermarrec has been scientific collaborator at EPFL, Lausanne, since Feb 2014.

Anne-Marie Kermarrec has been the scientific coordinator of the EPFL/Inria International Lab since Feb 2015.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Antonio Carzaniga, Università della Svizzera italiana (USI), Apr 29.

Evangelos Bampas, Aix-Marseille Université, Mar 23.

Fábio Moreira Costa, Institute of Informatics, Federal University of Goiás, Goiânia-GO, Brazil, Sep 12–16.

Ricardo Couto Antunes da Rocha, Department of Computer Science, Federal University of Goiás, Catalão-GO, Brazil, Sep 12–16.

Rachid Guerraoui, EPFL, Switzerland, invited Professor at Univ. Rennes I / ISTIC, since September 2016.

Arvid Bosk, KTH Royal Institute of Technology, guest PhD Student, from Dec 2016.

8.3.1.1. Internships

Florestan De Moor, Collaborative Filtering Under a Sybil Attack, Univ. Rennes I, May to Jul 2016, supervised by Davide Frey.

Julien Lepiller, Private Decentralized Aggregation, Inria, Feb to Jun 2016, supervised by Davide Frey and Francois Taiani.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

David Bromberg visited UFG, Goiania, Brazil, from Jun to Jul 2016 (CONFAP CNRS project)

8.3.2.2. Internships

Pierre-Louis Roman did an internship at Vrije Universiteit Amsterdam, The Netherlands, from Jun to Aug 2016 under the supervision of Spyros Voulgaris, with a grant from Université Bretagne Loire.

Simon Bouget did an internship at Centre for Complex Systems and Big Data at University of Neuchatel, Switzerland, from May to Aug 2016, under the supervision of Etienne Rivière, with a grant from the "Outgoing Mobility for Doctoral Students" program of Rennes Métropole.

Stéphane Delbruel did an internship at Universita della Svizzera Italiana, Switzerland, from Jun to Jul 2016, under the supervision of Antonio Carzaniga.

ASCOLA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. RFI Atlanstic 2020

9.1.1.1. CoMe4ACloud
Participants: Thomas Ledoux [coordinator], Frederico Alvares, Zakarea Al Shara.

The high-level objective of the 1-year CoMe4ACloud (Constraints and Model Engineering for Autonomic Clouds) project is to provide an end-to-end solution for autonomic Cloud services. To that end, we rely on techniques of Constraint Programming so as a decision-making tool and Model-driven Engineering to ease the automatic generation of the so-called autonomic managers as well as their communication with the managed system.

CoMe4ACloud is an Atlanstic2020 funded project and supports a post-doc position. The project is led by Ascola research team and involves also AtlanModels and TASC, all of them from the LINA (Nantes Computer Science Laboratory) and situated at Ecole des Mines de Nantes. See https://come4acloud.github.io for more information.

9.1.2. Pays de la Loire

9.1.2.1. SyMeTRIC
Participant: Jean-Marc Menaud.

SyMeTRIC is a regional federated project in Systems Medicine funded by the Pays de la Loire region. Systems Medicine approaches can be compared to Systems Biology. They aim at integrating several information sources to design and validate bio-models and biomarkers to anticipate and enhance patients following (diagnosis, treatment response prediction, prognosis).

The long term goal of SyMeTRIC is to build a common Systems Medicine computing infrastructure to accelerate the discovery and validation of biomarkers in the fields of oncology, transplantation, and chronic cardiovascular diseases.

9.2. National Initiatives

9.2.1. CominLabs laboratory of excellence

9.2.1.1. EPOC
Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux, Md Sabbir Hasan, Yunbo Li.

The project EPOC (Energy Proportional and Opportunistic Computing system) is a project running for 4 years. Four other partners collaborate within the project that is coordinated by ASCOLA: Myriads team, and the three institutions ENIB, ENSTB and University of Nantes. In this project, the partners focus on energy-aware task execution from the hardware to application's components in the context of a *mono-site* data center (all resources are in the same physical location) which is connected to the *regular electric Grid and to renewable energy sources* (such as windmills or solar cells). Three major challenges are addressed in this context: Optimize the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services; Design a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed system; Investigate energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

One of the strengths of the project is to provide a systematic approach, and use a single model for the system (from hard to soft) by mixing constraint programming and behavioral models to manage energy consumption in data centers.

9.2.1.2. PrivGen

Participants: Fatima-Zahra Boujdad, Mario Südholt [coordinator].

PrivGen ("Privacy-preserving sharing and processing of genetic data") is a three-year project that has been started in Oct. 2016 and is conducted by three partners: a team of computer scientists from the LATIM Inserm institute in Brest mainly working on data watermarking techniques, a team of geneticians from an Inserm institute in Rennes working on the gathering and interpretation of genetic data, and the Ascola team. The project provides funding of 330 KEUR altogether with an Ascola share of 120 KEUR.

The project considers challenges related to the outsourcing of genetic data that is in the Cloud by different stakeholders (researchers, organizations, providers, etc.). It tackles several limitations of current security solutions in the cloud, notably the lack of support for different security and privacy properties at once and computations executed at different sites that are executed on behalf of multiple stakeholders.

The partners are working on three main challenges:

- Mechanisms for a continuous digital content protection
- Composition of security and privacy-protection mechanisms
- Distributed processing and sharing of genetic data

The Ascola team is mainly involved in providing solutions for the second and third challenges.

9.2.1.3. SecCloud

Participants: Jacques Noyé [coordinator], Florent Marchand de Kerchove de Denterghem, Mario Südholt.

The high-level objective of the 3-year SecCloud (Secure Scripting for the Cloud) project is to enhance the security of devices on which web applications can be downloaded, i.e. to enhance client-side security in the context of the Cloud. In order to do so, the project relies on a language-based approach, focusing on three related issues:

- The definition of security policies for web architectures, especially on the client-side.
- Formally-proven analyses of web programming languages.
- Multi-level enforcement mechanisms for the security policies (based on static and dynamic analysis encompassing application-level and system-level software).

ASCOLA members are mainly interested in JavaScript as a programming language as well as the use of aspects as a seamless path from the definition of security policies and their composition to their implementation.

This year, we have finalized our proposal of extensible JavaScript modules and applied it to extend in a modular way the full-blown JavaScript interpreter Narcissus with several dynamic analyses including information-flow analyses.

9.2.2. ANR

9.2.2.1. SONGS (ANR/INFRA)

Participants: Adrien Lebre [coordinator], Jonathan Pastor, Anthony Simonet.

The SONGS project (Simulation of Next Generation Systems) is an ANR/INFRA project running for 48 months (starting in January 2012 with an allocated budget of 1.8MEuro, 95KEuro for ASCOLA).

The consortium is composed of 11 academic partners from Nancy (AlGorille, coordinator), Grenoble (MESCAL), Villeurbanne (IN2P3 Computing Center, GRAAL/Avalon - LIP), Bordeaux (CEPAGE, HiePACS, RUNTIME), Strasbourg (ICPS - LSIIT), Nantes (ASCOLA), Nice (MASCOTTE, MODALIS).

The goal of the SONGS project (http://infra-songs.gforge.inria.fr) is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems.

9.2.3. FSN

9.2.3.1. OpenCloudware (FSN)

Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux.

The OpenCloudware project is coordinated by France Telecom, funded by the French Fonds National pour la Société Numérique (FSN, call Cloud n°1) and endorsed by competitiveness clusters Minalogic, Systematic and SCS. OpenCloudware is developed by a consortium of 18 partners bringing together industry and academic leaders, innovative technology start-ups and open source community expertise. The project started in 2012 for a duration of 42 months.

The OpenCloudware project aims at building an open software engineering platform, for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures. It will be available through a self-service portal. We target virtualized multi-tier applications such as JavaEE - OSGi. The results of OpenCloudware will contain a set of software components to manage the lifecycle of such applications, from modelling(Think), developing and building images (Build), to a multi-IaaS compliant PaaS platform (Run).

The ASCOLA project-team is mainly involved in the sub-projects "Think" (SLA model across Cloud layers) and "Run" (virtual machine manager for datacenters and placement constraints). The team has developed btrCloudStack, a private cloud based on the OpenSource CloudStack and integrating the work on placement rules and energy optimization. This software system has been extended this year.

9.2.3.2. Hosanna (FSN)

Participants: Jean-Marc Menaud [coordinator], Rémy Pottier.

The Hosanna project (aims to scientifically and technically addresses the problem of deploying applications on a distributed multi-cloud virtual infrastructure (private cloud, Amazon, OVH, CloudWatt, Numergy etc.). This recent need is an important topic issue highlighted by recent major Outages in 2013 by the biggest players in the cloud such as Amazon or Netflix. This project aims to provide services that allow users to deploy their cloud multi-tier applications on hybrid Clouds infrastructures without any separation between IaaS. The Ascola team is extending its optimization solution to address the task placement problem in a multi-cloud environment and will develop a case study on a secure distributed file system. The project started in 2015 for a duration of 2 years.

9.2.4. CPER

9.2.4.1. SeDuCe

Participants: Jean-Marc Menaud [coordinator], Adrien Lebre.

The SeDuCe project (Sustainable Data Centers: Bring Sun, Wind and Cloud Back Together), aims to design an experimental infrastructure dedicated to the study of data centers with low energy footprint. This innovative data center will be the first experimental data center in the world for studying the energy impact of cloud computing and the contribution of renewable energy (solar panels, wind turbines) as well on the scientific, technological, that economical. This project is integrated in the national context of grid computing (Grid'5000), and the Constellation project, which will be an inter-node (Pays de la Loire, Brittany). He also participated in the validation of scientific work in interdisciplinary axis STIC and energy efficiency of the laboratory of excellence COMIN Labs.

9.2.5. Inria Project Labs

9.2.5.1. DISCOVERY

Participants: Ronan Alexandre Rcherreau, Adrien Lebre [coordinator], Anthony Simonet, Mario Südholt.

To accommodate the ever-increasing demand for Utility Computing (UC) resources, while taking into account both energy and economical issues, the current trend consists in building larger and larger Data Centers in a few strategic locations. Although such an approach enables UC providers to cope with the actual demand while continuing to operate UC resources through centralized software system, it is far from delivering sustainable and efficient UC infrastructures for future needs.

The DISCOVERY initiative [36] aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet in order to deliver widely distributed platforms that can better match the geographical dispersal of users as well as the ever increasing demand. Critical to the emergence of such locality-based UC (also referred as Fog/Edge Computing) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote a new kind of Cloud Operting System (OS) that will enable the management of such a large-scale and widely distributed infrastructure in an unified and friendly manner.

The consortium is composed of experts in the following research areas: large-scale infrastructure management systems, networking and P2P algorithms. Moreover, two key network operators, namely Orange and RENATER, are involved in the project.

By deploying and using a Fog/Edge OS on backbones, our ultimate vision is to enable large parts of the Internet to be hosted and operated by its internal structure itself: a scalable set of resources delivered by any computing facilities forming the Internet, starting from the larger hubs operated by ISPs, governments and academic institutions, to any idle resources that may be provided by end users.

ASCOLA leads the DISCOVERY IPL and contributes mainly around two axes: VM life cycle management and security concerns.

9.2.6. InriaHub

9.2.6.1. MERCURY
Participants: Ronan-Alexandre Rcherrueau, Adrien Lebre [coordinator].

ASCOLA, in particular within the framework of the DISCOVERY initiative has been working on the massively distributed use case since 2013. With the development of several proof-of-concepts around OpenStack, the team has had the opportunity to start an InriaHub action. Named MERCURY, the goal of this action is twofold: (i) support the research development made within the context of DISCOVERY and (ii) favor the transfer toward the OpenStack community.
Further information available at: http://beyondtheClouds.github.io.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. CoqHoTT

> Title: Coq for Homotopy Type Theory
>
> Programm: H2020
>
> Type: ERC
>
> Duration: June 2015 - May 2020
>
> Coordinator: Inria
>
> Inria contact: Nicolas TABAREAU

Every year, software bugs cost hundreds of millions of euros to companies and administrations. Hence, software quality is a prevalent notion and interactive theorem provers based on type theory have shown their efficiency to prove correctness of important pieces of software like the C compiler of the CompCert project. One main interest of such theorem provers is the ability to extract directly the code from the proof. Unfortunately, their democratization suffers from a major drawback, the mismatch between equality in mathematics and in type theory. Thus, significant Coq developments have only been done by virtuosos playing with advanced concepts of computer science and mathematics. Recently, an extension of type theory with homotopical concepts such as univalence is gaining traction because it allows for the first time to marry together expected principles of equality. But the univalence principle has been treated so far as a new axiom which breaks one fundamental property of mechanized proofs: the ability to compute with programs that make use of this axiom. The main goal of the CoqHoTT project is to provide a new generation of proof assistants

with a computational version of univalence and use them as a base to implement effective logical model transformation so that the power of the internal logic of the proof assistant needed to prove the correctness of a program can be decided and changed at compile time—according to a trade-off between efficiency and logical expressivity. Our approach is based on a radically new compilation phase technique into a core type theory to modularize the difficulty of finding a decidable type checking algorithm for homotopy type theory. The impact of the CoqHoTT project will be very strong. Even if Coq is already a success, this project will promote it as a major proof assistant, for both computer scientists and mathematicians. CoqHoTT will become an essential tool for program certification and formalization of mathematics.

9.3.1.2. BigStorage

> Title: BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data
>
> Programm: H2020
>
> Duration: January 2015 - December 2018
>
> Coordinator: Universidad politecnica de Madrid
>
> Partners:
>
>> Storage Research Group, Barcelona Supercomputing Center - Centro Nacional de Super-computacion (Spain)
>>
>> Ca Technologies Development Spain (Spain)
>>
>> Commissariat A L Energie Atomique et Aux Energies Alternatives (France)
>>
>> Deutsches Klimarechenzentrum (Germany)
>>
>> ICS, Foundation for Research and Technology Hellas (Greece)
>>
>> Fujitsu Technology Solutions (Germany)
>>
>> Johannes Gutenberg Universitaet Mainz (Germany)
>>
>> Universidad Politecnica de Madrid (Spain)
>>
>> Seagate Systems Uk (United Kingdom)
>
> Inria contact: G. Antoniu & A. Lebre

The consortium of this European Training Network (ETN) 'BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data' will train future data scientists in order to enable them and us to apply holistic and interdisciplinary approaches for taking advantage of a data-overwhelmed world, which requires HPC and Cloud infrastructures with a redefinition of storage architectures underpinning them - focusing on meeting highly ambitious performance and energy usage objectives. There has been an explosion of digital data, which is changing our knowledge about the world. This huge data collection, which cannot be managed by current data management systems, is known as Big Data. Techniques to address it are gradually combining with what has been traditionally known as High Performance Computing. Therefore, this ETN will focus on the convergence of Big Data, HPC, and Cloud data storage, ist management and analysis. To gain value from Big Data it must be addressed from many different angles: (i) applications, which can exploit this data, (ii) middleware, operating in the cloud and HPC environments, and (iii) infrastructure, which provides the Storage, and Computing capable of handling it. Big Data can only be effectively exploited if techniques and algorithms are available, which help to understand its content, so that it can be processed by decision-making models. This is the main goal of Data Science. We claim that this ETN project will be the ideal means to educate new researchers on the different facets of Data Science (across storage hardware and software architectures, large-scale distributed systems, data management services, data analysis, machine learning, decision making). Such a multifaceted expertise is mandatory to enable researchers to propose appropriate answers to applications requirements, while leveraging advanced data storage solutions unifying cloud and HPC storage facilities.

<p style="text-align:center; color:red;">**AVALON Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. PIA

8.1.1.1. PIA ELCI, Environnement Logiciel pour le Calcul Intensif, 2014-2017
Participants: Hélène Coullon, Thierry Gautier, Laurent Lefevre, Christian Perez, Issam Rais, Jérôme Richard.

The ELCI PIA project is coordinated by BULL with several partners: CEA, Inria, SAFRAB, UVSQ.

This project aims to improve the support for numerical simulations and High Performance Computing (HPC) by providing a new generation software stack to control supercomputers, to improve numerical solvers, and pre- and post computing software, as well as programming and execution environment. It also aims to validate the relevance of these developments by demonstrating their capacity to deliver better scalability, resilience, modularity, abstraction, and interaction on some application use-cases. Avalon is involved in WP1 and WP3 ELCI Work Packages through the PhD of Issam Rais and the postdoc of Hélène Coullon. Laurent Lefevre is the Inria representative in the ELCI technical committee.

8.1.2. French National Research Agency Projects (ANR)

8.1.2.1. ANR INFRA MOEBUS, Multi-objective scheduling for large computing platforms, 4 years, ANR-13-INFR-000, 2013-2016
Participants: Laurent Lefevre, Salem Harrache, Olivier Mornard, Christian Perez, Frédéric Suter.

The ever growing evolution of computing platforms leads to a highly diversified and dynamic landscape. The most significant classes of parallel and distributed systems are supercomputers, grids, clouds and large hierarchical multi-core machines. They are all characterized by an increasing complexity for managing the jobs and the resources. Such complexity stems from the various hardware characteristics and from the applications characteristics. The MOEBUS project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments.

We propose to investigate new functionalities to add at low cost in actual large scale schedulers and programming standards, for a better use of the resources according to various objectives and criteria. We propose to revisit the principles of existing schedulers after studying the main factors impacted by job submissions. Then, we will propose novel efficient algorithms for optimizing the schedule for unconventional objectives like energy consumption and to design provable approximation multi-objective optimization algorithms for some relevant combinations of objectives. An important characteristic of the project is its right balance between theoretical analysis and practical implementation. The most promising ideas will lead to integration in reference systems such as SLURM and OAR as well as new features in programming standards implementations such as MPI or OpenMP.

8.1.2.2. ANR INFRA SONGS, Simulation Of Next Generation Systems, 4 years, ANR-12-INFRA-11, 2012-2016
Participant: Frédéric Suter.

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently manage such platforms still raises many challenges. As demonstrated by the USS SIMGRID project, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the SONGS project is to extend the applicability of the SIMGRID simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

8.1.3. Inria Large Scale Initiative

8.1.3.1. C2S@Exa, Computer and Computational Sciences at Exascale, 4 years, 2013-2017
Participants: Hélène Coullon, Laurent Lefevre, Christian Perez, Jérôme Richard, Thierry Gautier.

Since January 2013, the team is participating to the C2S@Exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.1.3.2. DISCOVERY, DIstributed and COoperative management of Virtual Environments autonomousLY, 4 years, 2015-2019
Participants: Jad Darrous, Gilles Fedak, Christian Perez.

To accommodate the ever-increasing demand for Utility Computing (UC) resources, while taking into account both energy and economical issues, the current trend consists in building larger and larger Data Centers in a few strategic locations. Although such an approach enables UC providers to cope with the actual demand while continuing to operate UC resources through centralized software system, it is far from delivering sustainable and efficient UC infrastructures for future needs.

The DISCOVERY initiative aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet in order to deliver widely distributed platforms that can better match the geographical dispersal of users as well as the ever increasing demand. Critical to the emergence of such locality-based UC (LUC) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote the LUC Operating System (OS), a unified system in charge of turning a complex, extremely large-scale and widely distributed infrastructure into a collection of abstracted computing resources which is efficient, reliable, secure and at the same time friendly to operate and use.

To achieve this, the consortium is composed of experts in research areas such as large-scale infrastructure management systems, network and P2P algorithms. Moreover two key network operators, namely Orange and RENATER, are involved in the project.

By deploying and using such a LUC Operating System on backbones, our ultimate vision is to make possible to host/operate a large part of the Internet by its internal structure itself: A scalable set of resources delivered by any computing facilities forming the Internet, starting from the larger hubs operated by ISPs, government and academic institutions, to any idle resources that may be provided by end-users.

8.1.3.3. HAC SPECIS, High-performance Application and Computers, Studying PErformance and Correctness In Simulation, 4 years, 2016-2020

Participants: Laurent Lefevre, Frédéric Suter.

Over the last decades, both hardware and software of modern computers have become increasingly complex. Multi-core architectures comprising several accelerators (GPUs or the Intel Xeon Phi) and interconnected by high-speed networks have become mainstream in HPC. Obtaining the maximum performance of such heterogeneous machines requires to break the traditional uniform programming paradigm. To scale, application developers have to make their code as adaptive as possible and to release synchronizations as much as possible. They also have to resort to sophisticated and dynamic data management, load balancing, and scheduling strategies. This evolution has several consequences:

First, this increasing complexity and the release of synchronizations are even more error-prone than before. The resulting bugs may almost never occur at small scale but systematically occur at large scale and in a non deterministic way, which makes them particularly difficult to identify and eliminate.

Second, the dozen of software stacks and their interactions have become so complex that predicting the performance (in terms of time, resource usage, and energy) of the system as a whole is extremely difficult. Understanding and configuring such systems therefore becomes a key challenge.

These two challenges related to correctness and performance can be answered by gathering the skills from experts of formal verification, performance evaluation and high performance computing. The goal of the HAC SPECIS Inria Project Laboratory is to answer the methodological needs raised by the recent evolution of HPC architectures by allowing application and runtime developers to study such systems both from the correctness and performance point of view.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. PaaSage

Participants: Pedro de Souza Bento Da Silva, Matthieu Imbert, Christian Perez.

Title: PaaSage: Model-based Cloud Platform Upperware

Type: Seventh Framework Programme

Instrument: Collaborative project

Duration: October 2012 - September 2016 (48 months)

Coordinator: Pierre Guisset (GEIE ERCIM)

Others partners: SINTEF, STFC, HLRS, University of Stuttgart, Inria, CETIC, FORTH, be.wan, EVRY, SysFera, Flexiant, Lufthansa Systems, AG GWDG, Automotive Simulation Center Stuttgart e.V.

See also: http://paasage.eu

Abstract: PaaSage will deliver an open and integrated platform, to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimization, and deployment of existing and new applications independently of the existing underlying Cloud infrastructures. Specifically it will deliver an IDE (Integrated Development Environment) incorporating modules for design time and execution time optimizations of applications specified in the CLOUD Modeling Language (CLOUD ML), execution-level mappers and interfaces and a metadata database.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

8.2.2.1. CHIST-ERA STAR

Participants: Radu Carpa, Marcos Dias de Assunção, Olivier Glück, Laurent Lefevre.

Title: SwiTching And tRansmission project

Type: CHIST-ERA (European Coordinated Research on Long-term Challenges in Information and Communication Sciences & Technologies ERA-Net)

Duration: 2013-2016

Coordinator: Jaafar Elmirghani (University of Leeds - UK)

Others partners: Inria ,University of Cambridge (UK), University of Leeds (UK), AGH University of Science and Technology Department of Telecommunications (Poland)

See also: http://www.chistera.eu/projects/star

Abstract: The Internet power consumption has continued to increase over the last decade as a result of a bandwidth growth of at least 50 to 100 times. Further bandwidth growth between 40% and 300% is predicted in the next 3 years as a result of the growing popularity of bandwidth intensive applications. Energy efficiency is therefore increasingly becoming a key priority for ICT organizations given the obvious ecological and economic drivers. In this project we adopt the GreenTouch energy saving target of a factor of a 100 for Core Switching and Routing and believe this ambitious target is achievable should the research in this proposal proven successful. A key observation in core networks is that most of the power is consumed in the IP layer while optical transmission and optical switching are power efficient in comparison, hence the inspiration for this project. Initial studies by the applicants show that physical topology choices in networks have the potential to significantly reduce the power consumption, however network optimization and the consideration of traffic and the opportunities afforded by large, low power photonic switch architectures will lead to further power savings. Networks are typically over provisioned at present to maintain quality of service. We will study optimum resource allocation to reduce the over-provisioning factor while maintaining the quality of service. Protection is currently provided in networks through the allocation of redundant paths and resources, and for full protection there is a protection route for every working route. Avalon is contributing to STAR in terms of software network protocols and services optimizations which will be combined with more efficient photonic switches in order to obtain a factor of 100 power saving in core networks. Avalon has put in place and deployed several experimental hardware (NetFPGA, low power processors, high performance servers) and software (SDN) platforms in order to validate the various energy efficient services.

8.2.2.2. COST IC1305 : Nesus

Participants: Marcos Dias de Assunção, Laurent Lefevre, Violaine Villebonnet.

Program: COST

Project acronym: IC1305

Project title: Network for Sustainable Ultrascale Computing (NESUS)

Duration: 2014-2019

Coordinator: Jesus Carretero (Univ. Madrid)

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. In Nesus, Laurent Lefevre is co-chairing the Working on Energy Efficiency (WG5).

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. Joint Laboratory for Extreme Scale Computing (JLESC) (2014-2018)

Participants: Hélène Coullon, Gilles Fedak, Thierry Gautier, Vincent Lanore, Christian Perez, Jérôme Richard.

Partners: NCSA (US), ANL (US), Inria (FR), Jülich Supercomputing Centre (DE), BSC (SP), Riken (JP).

The purpose of the Joint Laboratory for Extreme Scale Computing (JLESC) is to be an international, virtual organization whose goal is to enhance the ability of member organizations and investigators to make the bridge between Petascale and Extreme computing. The founding partners of the JLESC are Inria and UIUC. Further members are ANL, BSC, JSC and RIKEN-AICS.

JLESC involves computer scientists, engineers and scientists from other disciplines as well as from industry, to ensure that the research facilitated by the Laboratory addresses science and engineering's most critical needs and takes advantage of the continuing evolution of computing technologies.

8.3.1.2. Associate Team DALHIS – Data Analysis on Large-scale Heterogeneous Infrastructures for Science (2013-2018)

Participant: Frédéric Suter.

Partners: EPC Myriads (Rennes, Bretagne Atlantique), Avalon (Grenoble, Rhône-Alpes), Data Science and Technology Department (LBNL,USA).

The goal of the Inria-LBL collaboration is to create a collaborative distributed software ecosystem to manage data lifecycle and enable data analytics on distributed data sets and resources. Specifically, our goal is to build a dynamic software stack that is user-friendly, scalable, energy-efficient and fault tolerant. We plan to approach the problem from two dimensions: (i) Research to determine appropriate execution environments that allow users to seamlessly execute their end-to-end dynamic data analysis workflows in various resource environments and scales while meeting energy-efficiency, performance and fault tolerance goals; (ii) Engagement in deep partnerships with scientific teams and use a mix of user research with system software R&D to address specific challenges that these communities face, and inform future research directions from acquired experience.

8.3.1.3. Informal International Partners

- Université Gaston Berger, Saint Louis, Sénégal. Contact: Pr. Ousmane Thiaré.
- École Centrale Mahindra, Hyderabad, India. Contact: Dr. Arya Kumar Bhattacharya.
- Center for Computing and Networking, Chinese Academy of Sciences, Beijing, China. Pr. Haiwu He.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Alberto Cabrera, University of La Laguna, Spain, Jan 2016

Damian Fernandez Cerero, University of Sevilla, Spain, Sep 2016-Dec 2016

Pr. Haiwu He, Computer Network Information Center, Chinese Academy of Sciences, Beijing, China, Nov 2016-Jan 2017

Tchimou N'Takpé, Université Nangui Abrogoua, Côte d'Ivoire, Nov 2016-Dec 2016.

8.4.1.1. Internships

Daniel Ciugurean, University of Cluj, Romania, Jun-Sep 2016

Joel Faubert, University of Ottawa, Canada, May-Jul 2016

<div style="text-align:center">

CIDRE Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

- **Region Bretagne ARED Grant :** the PhD of Mourad Leslous on malicious codes in Android applications is supported by a grant from the Région Bretagne.

- **Labex COMINLAB contract (2012-2016): "SecCloud" - http://www.seccloud.cominlabs.ueb. eu/** Attacks targeting web browsers constitute a major threat. We tackled in the context of the SecCloud project attacks induced by client-side code execution (javascript, flash or html5). Existing security mechanisms such as os-level access control often are not sufficient to pre- vent client-side browser attacks as the web browser is granted the same privileges as the user. The idea is to monitor information flows within the web browser in order to enforce a security information flow policy. Such a policy should allow to define fine-grained in- formation flow rules between user data and distant web sites. We proposed a new secure information flow control model specifically designed for JavaScript. This study was conducted in cooperation with other Inria Teams (Ascola and Celtique). Deepak Subramanian is doing his PhD in the context of this project.

- **Labex COMINLAB contract (2013-2018): "DeSceNt" - http://www.descent.cominlabs.ueb.eu** In DeSceNt, we propose to investigate how decentralized home-based networks of plug computers can support personal clouds according to sound architectural principles, mechanisms, and program- ming abstractions. To fulfill this vision we see three core scientific challenges, which we think must be overcome. The first challenge, decentralized churn-poor design, arises from the nature of plug federations, which show much lower levels of churn than traditional peer-to-peer environments. The second challenge, quasi-causal consistency, is caused by the simultaneous needs to produce a highly scalable environment (potentially numbering millions of users), that also offers collaborative editing capabilities of mutable data-structures (to offer rich social interactions). The third and final chal- lenge, intuitive data structures for plug programming, arises from the need by programmers for intu- itive and readily reusable data-structures to rapidly construct rich and robust decentralized personal cloud applications. This study is conducted in cooperation with other teams (GDD Team (University of Nantes), Inria team ASAP)

- **Labex COMINLAB contract (2014-2017): "Kharon-Security" - http://kharon.gforge.inria.fr**

  Google Play offers more than 800'000 applications (apps), and this number increases every day. Google play users have performed more than 25 billion app downloads. These applications vary from games to music, video, books, tools, etc. Unfortunately, each of these application is an attack vector on Android. The number of malicious applications (pieces of malware) discovered during the first six months of 2013 exceeds the number of pieces of malware discovered during the 2010 to 2012 period, more than 700 thousand malicious and risky applications were found in the wild. In this context, we propose the Kharon-Security project to stem the progression of Android pieces of malware. We propose to combine static and dynamic monitoring to compute a behavioral signature of Android malware. Behavioral signatures are helpful to understand how malware infect the devices and how they spread information in the Android operating system. Static analysis is essential to understand which particular event or callback triggers malware payload.

  In the project we have already developed GroddDroid a tool dedicated to automatic identification and execution of suspicious code. We have also built a dataset of Android malware, it this dataset, all malware are entirely manually reverse and documented. We have also developed an analysis platform. This platform is currently under private deployment.

- **Labex COMINLAB contract (2015-2018): "HardBlare-Security" -** http://www.hardblare. cominlabs.ueb.eu/

The general context of the HardBlare project is to address Dynamic Information Flow Control that generally consists in attaching marks to denote the type of information that is saved or generated within the system. These marks are then propagated when the system evolves and information flow control is performed in order to guarantee a safe execution and storage within the system. Existing solutions imply a large overhead induced by the monitoring process. Some attempts rely on a hardware-software approach where DIFC operations are delegated to a coprocessor. Nevertheless, such approaches are based on modified processors. Beyond the fact hardware-assisted DIFC is hardly adopted, existing works do not take care of coprocessor security and multicore/multiprocessor embedded systems.

We plan to implement DIFC mechanisms on boards including a non-modified ARM processor and a FPGA such as those based on the Xilinx Zynq family. The HardBlare project is a multidisciplinary project between CentraleSupélec IETR SCEE research team, CentraleSupélec Inria CIDRE research team and UBS Lab-STICC laboratory. Mounir Nasr Allah is doing his PhD in the context of this project. The main objective of this PhD is to study how hybrid analysis could improve hardware assisted DIFC using static analysis performed at compile-time. Another objective is to manage labels for persistent memory (i.e., files) using a modified OS kernel.

9.2. National Initiatives

9.2.1. ANR

- **ANR INFRA Project: SOCIOPLUG (2013-2017) -** http://socioplug.univ-nantes.fr/index.php/ SocioPlug_Project

SocioPlug is a collaborative ANR project involving Inria (ASAP and CIDRE teams), the Nantes University, and LIRIS (INSA Lyon and Université Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more of less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

9.2.2. Inria Project Labs

- **CAPPRIS (2012-2016)**

CAPPRIS stands for "Collaborative Action on the Protection of Privacy Rights in the Information Society". The main objective of CAPPRIS is to tackle the privacy challenges raised by the most recent developments and usages of information technologies such as profiling, data mining, social networking, location-based services or pervasive computing by developing solutions to enhance the protection of privacy in the Information Society. To solve this generic objective, the project focuses in particular on the following fundamental issues:

  – The design of appropriate metrics to assess and quantify privacy, primarily by extending and integrating the various possible definitions existing for the generic privacy properties such as anonymity, pseudonymity, unlinkability and unobservability, as well as notions coming from information theory or databases such as the recent but promising concept of differential privacy;

– The definition and the understanding of the fundamental principles underlying "privacy by design", with the hope of deriving practical guidelines to implement notions such as data minimization, proportionality, purpose specification, usage limitation, data sovereignty and accountability directly in the formal specifications of our information systems;

– The integration between the legal and social dimensions, intensely necessary since the developed privacy concepts, although they may rely on computational techniques, must be in adequacy with the applicable law (even in its heterogeneous and dynamic nature). In particular, privacy-preserving technologies cannot be considered efficient as long as they are not properly understood, accepted and trusted by the general public, an outcome which cannot be achieved by the means of a mathematical proof.

Three major application domains have been identified as interesting experimentation fields for this work: online social networks, location-based services and electronic health record systems. Each of these three domains brings specific privacy-related issues. The aim of the collaboration is to apply the techniques developed to the application domains in a way that promotes the notion of privacy by design, instead of simply considering them as a form of privacy add-ons on the top of already existing technologies. CAPPRIS is a joint project between Inria, LAAS-CNRS, Université de Rennes I, Supélec, Université de Namur, Eurecom, and Université de Versailles.

In addition of the scientific advances in the field of privacy, members of CAPPRIS are actively involved in the animation and federation of the French community on privacy, through the APVP workshop but also interdisciplinary colloquiums.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The **PANOPTESEC** project (http://www.panoptesec.eu) started on the 1st of November 2013 and ended in 2016. It deals with the automated and assisted security management of IT and SCADA system. The main objective of PANOPTESEC is to provide an integrated solution that will allow to efficiently monitor SCADA systems, detect intrusions and react to them. To that end, it encompasses many of the research topics that are addressed by the CIDRE team: alerts aggregation and correlation, policy-aware intrusion detection, architecture-aware intrusion detection, automated trust management, trust-based automated reaction and visualization.

The CIDRE team is involved in the project on all of these aspects. The partners are:
- REHA (BE),
- Nokia-Lucent Bell Labs France (FR),
- Epistematica (IT),
- the University of Rome (IT),
- the University of Hamburg (GE),
- the Institut Mines-Telecom (FR),
- ACEA (IT),
- CentraleSupélec (FR).

This year, our work focused on design and implementation but also on the integration phase. Most of our work focused on WP5 and WP6, that deal with the IDS event correlation system and the visualization system.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Emmanuelle Anceaume is actively working with Leonardo Querzoni from the University La Sapienza, Italy, on data streams algorithms and engines. Their cooperation gave rise to two conference publications in 2016, one in Middelware [25] and the other one in Algotel [26].

Since several years, Michel Hurfin works with Professor Yun Wang (Southeast University, Nanjing, China). Their joint work focuses on convergence and synchronization problems in unreliable distributed systems prone to byzantine failures. In 2016, we investigate the iterative approximate byzantine consensus problem during a joint work with Chuanyou Li [22]. A visit of Professor Yun Wang in Rennes is planned next year.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Prof. Jean-Marc Robert from ETS (Ecole Supérieure de Technologie) of Montréal has made several short visits in the CIDRE research group in 2016.

<h2 style="text-align:center; color:red;">COAST Project-Team</h2>

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Region Lorraine TV Paint (2016–2017)

Participants: Claudia-Lavinia Ignat [contact], Gérald Oster, Quang Vinh Dang, Matthieu Nicolas.

Partners: TVPaint Development, Inria COAST project-team

Website: https://www.tvpaint.com/

This is a project in collaboration with TVPaint Development financed by Region Lorraine. The goal is to contribute to the creation of a collaborative system dedicated to animation movies, that allows to manipulate high quantities of digital artifacts in a collaborative way.

7.2. National Initiatives

7.2.1. OpenPaas NG (2015–2018)

Participants: Claudia-Lavinia Ignat, François Charoy [contact], Gérald Oster, Olivier Perrin, Jean-Philippe Eisenbarth, Phillippe Kalitine, Matthieu Nicolas, Mohammed Riyadh Abdmeziem, Kahina Bessai, Victorien Elvinger, Quentin Laporte Chabasse, Hoai Le Nguyen, Hoang Long Nguyen.

Partners: Linagora, XWiki SAS, Nexedi, COAST project-team (Université de Lorraine, LORIA), DaScim team (LIX).

Website: http://www.open-paas.org/

This project is financed by BpiFrance and involves French industrial leaders in open-source software development (Linagora, Nexedi, XWiki) and academic partners in collaborative work (COAST team) and recommender systems (DaScim team, LIX). The goal of the project is to develop next generation cloud enabled virtual desktop based on an Enterprise Social Network to provide advanced collaborative and recommendation services. COAST team is responsible of the work package dedicated to the design of the peer-to-peer collaborative middleware. In this context, we bring our expertise on data replication for collaborative data in peer-to-peer environments and on trust and access control and identity management in distributed collaborative information systems.

7.2.2. Inria ADT PLM (2014-2016)

Participants: Gérald Oster [contact], Matthieu Nicolas.

Partners: COAST project-team, MYRIADS project-team.

Website: https://github.com/BuggleInc/plm/

This work is performed jointly with Martin Quison (previously member of project-team VERIDIS, now Professor at ENS Rennes).

The Programmer's Learning Machine (PLM) is a software platform dedicated to computer programming education. This generic platform offers support to teachers for creating programming microworlds suitable to teaching courses. It features an integrated and graphical environment, providing a short feedback loop to students in order to improve the effectiveness of the autonomous learning process.

This project aims at establishing an experimental platform for studying the teaching of basic programming and a research instrument to design new collaborative learning environments.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. SyncFree (2013-2016)

Participants: Pascal Urso [contact], Jordi Martori Adrian.

Program: FP7-ICT-2013-10

Project acronym: SyncFree

Project title: Large-scale computation without synchronisation

Duration : October 2013 - September 2016

Coordinator: Marc Shapiro, Inria

Other Partners: REGAL project-team (Inria Paris - Rocquencourt / LIP6, coordinator), Basho Technologies Limited (United Kingdom), Trifork AS (Denmark), Rovio Entertaiment OY (Finland), Faculdade de Ciências e Tecnologia (Universidade Nova de Lisboa, Portugal), Université Catholique de Louvain (Belgium), Ko c University (Turkey), Technische Universität Kaiserslautern (Germany) and COAST project-team.

Large-scale on-line services including social networks and multiplayer games handle huge quantities of frequently changing shared data. Maintaining their consistency is relatively simple in a centralised cloud, but no longer possible due to increased scalability requirements. Instead, data must be replicated across several distributed data centres, requiring new principled approaches to consistency that have been explored by the SyncFree project. http://syncfree.lip6.fr/

7.4. International Initiatives

7.4.1. *Inria Associate Teams Not Involved in an Inria International Labs*

7.4.1.1. USCOAST2

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

Wright State University (United States) - Department of Psychology, Knoesis - Valerie Shalin

Start year: 2016

See also: http://uscoast.loria.fr

The proposed project addresses the perception of trust by users, the appropriateness of a trust-based security approach and the role of trust metrics in the management of distributed work. The main challenge of this project is how to measure trust based on user behaviour and to verify by means of experimental studies with users that the trust-based mechanism is acceptable by users. We plan to apply this trust-based mechanism for two types of applications. The first one is collaborative editing where user trust will be computed based on the quality of user contributions for a document or project. The second type of application is in the management of work over a large group of people in order to conduct efficient, high-yield, high-density real time crowdsourcing activities.

Partners of USCOAST2 project have complementary expertise. Coast provides expertise in collaborative methods, systems and related technologies. Coast will propose algorithms that track and manipulate trust metrics. Kno.e.sis provides expertise on the analysis of human work-related behavior, including methods of data collection and data analysis, as well as a theoretical foundation for the evaluation of human performance. Knoesis will analyse trust from a psychological phenomenon point of view.

7.5. International Research Visitors

7.5.1. Visits to International Teams

7.5.1.1. Research Stays Abroad

- Claudia-Lavinia Ignat visited the Department of Computer Science & Knoesis, Wright State University for 1 month in the period June–July 2016 in the context of the associated team USCOAST2
- Gérald Oster visited the Department of Computer Science & Knoesis, Wright State University for 1 month in the period June–July 2016 in the context of the associated team USCOAST2

COATI Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Blanc STINT, 2014-2017

Participants: Pierre Aboulker, Jean-Claude Bermond, David Coudert, Frédéric Havet, Luc Hogie, William Lochet, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

The STINT project (*STructures INTerdites*) is led by the MC2 group (LIP, ENS-Lyon) and involves the G-SCOP laboratory (Grenoble).

The aim of STINT is to answer the following fundamental question: *given a (possibly infinite) family ψ of graphs, what properties does a ψ-free graph have?* To this end, it will firstly establish bounds on some classical graph parameters (e.g., clique number, stability number, chromatic number) for ψ-free graphs. Then, it will design efficient algorithms to recognize ψ-free graphs and to determine or approximate some parameters for those graphs. These studies shall result in the development of new proof techniques.

(http://www.ens-lyon.fr/LIP/MC2/STINT/)

9.1.2. PEPS

9.1.2.1. PEPS MoMis SYSTEMIC, 2015 (extended in 2016)

Participant: Frédéric Giroire.

The SYSTEMIC project was led by COATI and involves the LAMA (Paris Est), GREDEG (Sophia Antipolis) and CREM (Rennes) laboratories.

The aim of SYSTEMIC was to bring together the expertises of researchers in economics, graph theory and financial mathematics to propose new models to evaluate the systemic risk of networks of financial institutions, and to propose new methods to mitigate the risk of contagions in such networks. The novelty of the project was in particular to consider strategies for a dynamic control of heterogeneous networks.

9.1.3. GDR Actions

9.1.3.1. Action ResCom, ongoing (since 2006)

Réseaux de communications, working group of GDR RSD, CNRS.

(http://rescom.asr.cnrs.fr/)

9.1.3.2. Action Graphes, ongoing (since 2006)

Action Graphes, working group of GDR IM, CNRS.

(http://gtgraphes.labri.fr/)

9.2. European Initiatives

9.2.1. Collaborations with Major European Organizations

AOR (Vassilis Zissimopoulos) : University of Athens, Department of Informatics and Telecommunications (Greece)

Combinatorial Optimization, Games and Applications (COGA), June 2015- September 2016

Participants : Jean-Claude Bermond, David Coudert, Frédéric Giroire, Nicolas Nisse, Stéphane Pérennes

9.3. International Initiatives

9.3.1. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

9.3.1.1. ALDYNET

Title: distributed ALgorithms for DYnamic NETworks

International Partner (Institution - Laboratory - Researcher):

Universidad Adolfo Ibañez (Chile) - Facultad de Ingeniería y Ciencias - Karol SUCHAN

Start year: 2016

See also: https://team.inria.fr/coati/projects/aldynet/

This associated team would be the natural continuation of the fruitful EA AlDyNet (2013-2015, https://team.inria.fr/coati/projects/aldynet/)

The main goal of this Associate Team is to design and implement practical algorithms for computing graph structural properties. We will then use these algorithms on a concrete case of study which concerns the transportation network of the Santiago agglomeration. We are both interested in theoretical results concerning the feasibility of computing graph properties, and by their practical implementation (using SageMath, www.sagemath.org/) for our application and their diffusion in the scientific community. There are three main objectives:

1) Design efficient algorithms to compute important graph properties (hyperbolicity, treelength, centrality, treewidth...) in real networks. We are not only interested by the worst-case time-complexity of these algorithms but by their performance in practice.

2) Implement and document our algorithms using the open-source framework SageMath. One advantage of using SageMath is that it has interfaces with other graph libraries (igraph, Boost...) and with Linear Programming solver (GLPK, Cplex...). Moreover, the success of SageMath (which has accumulated thousands of users over the last 10 years) will participate to the diffusion of our algorithms.

3) Apply our algorithms on the Santiago transportation network that have been collected by our Chilean partner during the last year of AlDyNet (2013-2015). Based on the results, propose tools for decision support in designing bus routes, timetables, etc. More precisely, we have collected information about the use of public transport (data of smart cards for automatic fare collection - BIP-, bus routes and bus schedules, etc.), urban infrastructure information, schools' addresses, and approximate locations where students live. We have started to clean and consolidate these data. We will then develop decision support tools, for example, for improving quality education accessibility.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Apart from formal collaboration COATI members maintain strong connections with the following international teams, with regular visits of both sides.

Univ. of Southern Denmark, Prof. Jorgen Bang Jensen

RWTH Aachen Univ., Lehrstuhl II für Mathematik, Germany, Prof. Arie M.C.A. Koster

Concordia Univ. - Montréal, Quebec, Canada, Prof. Brigitte Jaumard

9.3.3. Participation in Other International Programs

GAIATO : Graphs and Algorithms Applied to Telecommunications, International Cooperation FUNCAP/FAPs/Inria/INS2i-CNRS, no. INC-0083-00047.01.00/13, with Federal University of Ceará, Brasil, 2014-2016.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Daniela Aguirre Guerrero

Universitat de Girona, Girona, Spain, Visiting PhD Student, from Sep 2016 until Nov 2016.

Jean Francois Baffier

Japanese-French Laboratory for Informatics UMI 3527, Japan, Visiting Scientist, June 2016.

Jorgen Bang Jensen

University of Southern Denmark, Odensee, Denmark, Visiting Scientist, from June 2016 until Jul 2016.

Augustin Chaintreau

Columbia University, New York, US, Visiting Scientist, 19-21st January 2016.

Clément Charpentier

Université Joseph Fourier, Grenoble, France, Visiting Scientist, 21-26th February 2016.

Romuald Elie

Université Paris-Est Marne-la-Vallée, Visiting Scientist, October 24-November 2, 2016.

Takako Kodate

Tokyo Woman's Christian Univ., Japan, Visiting Scientist, Apr 2016.

Christian Konrad

Reykjavik University, Iceland, Visiting Scientist, February 28th to March 3rd, 2016.

Aurélie Lagoutte

Université de Princeton, USA, 9-11th March, 2016.

Zvi Lotker

Ben Gurion University of the Negev, Israel, 22-27th February, 2016.

Ana Karolinna Maia De Oliveira

Univ. Federal do Ceara, Fortaleza, Brazil, Visiting Scientist, Oct 2016.

Colin McDiarmid

University of Oxford, UK, Visiting Scientist, September 26-30th 2016.

Ioannis Milis

Athens University of Economics and Business, Athens, Greece, Visiting Scientist, Feb 2016.

Eduardo Moreno

Univ. Adolfo Ibanez, Santiago, Chile, Visiting Scientist, Sep 2016.

Julio Cesar Silva Araujo

Univ. Federal do Ceara, Fortaleza, Brazil, Visiting Scientist, Oct 2016.

Guillem Perarnau-Llobet

University of Birmingham, UK, Visiting Scientist, May 9-13rd 2016.

Jean-Sébastien Sereni

CNRS, France, 22-25th February.

Yllka Velaj

Gran Sasso Science Institute, L'Aquila, Italia, Visiting PhD Student, from Feb 2016 until Apr 2016.

Joseph Yu

University of the Fraser Valley, Abbotsford, Canada, Visiting Scientist, Apr 2016.

Vassilis Zissimopoulos

> National and Kapodistrian University of Athens, Athens, Greece, Visiting Scientist, Feb 2016.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Julien Bensmail

> LaBRI, University of Bordeaux, October 10-14, 2016;
>
> LIF, Aix-Marseille University, October 17-19, 2016.

Jean-Claude Bermond

> Department of Informatics and Telecommunications of the National and Kapodistrian University of Athens, Greece, June7-21, 2016.

David Coudert

> LIP6, UPMC, Paris, October 11-13, 2016;
>
> Univ. Adolfo Ibañez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AlDyNet, October 24-November 11, 2016.

Frédéric Giroire

> Orange Labs, Chatillon, May 17-20, 2016;
>
> Computer Science and Software Engineering department, Concordia University, Montréal, Canada, September 28-October 7, 2016.

Nicolas Huin

> Concordia University, Montreal, Canada, August 22-November 22, 2016.

William Lochet

> Université libre de Bruxelles, Belgique, June 20-25th, 2016.

Nicolas Nisse

> Univ. Federal do Ceará, Fortaleza, Brazil, April, 2016;
>
> LIF, Aix-Marseille University, July 18-22, 2016;
>
> Univ. Adolfo Ibañez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AlDyNet, October 24-November 11, 2016.

Bruce Reed

> National Institute of Informatics Tokyo Japan, June 1-28th 2016;
>
> Pacific Institute of Mathematical Sciences, June 28th-September 5th 2016;
>
> National Institute of Informatics Tokyo Japan, October 1st-December 31th 2016.

<p style="text-align:center">CTRL-A Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

The Labex Persyval-lab is a large regional initiative, supported by ANR, where we are contributing through two projects:

9.1.1. Equipe-action HPES

This project (2013-17) groups members from Inria, LIG, Gipsa-lab, TIMA and Gipsa-lab, around the topic of High-Performance Computing benefitting from technologies originally developed for Embedded Systems : https://persyval-lab.org/en/sites/hpes. Ctrl-A is directly involved in the co-advising of the PhD of Naweiluo Zhou, with J.F. Méhaut (LIG), on the topic of autonomic management of software transactional memory mechanisms : https://persyval-lab.org/en/research/phd/autonomic-thread-parallelism-and-mapping-control-software-transactional-memory.

9.1.2. Projet Exploratoire CASE

This project (2015-16) grouped members from Inria, LIG, Gipsa-lab and CEA LETI/DACLE and concerned the general topic of Control techniques for Autonomic Smart Environments, with a special emphasis on relating discrete and stochastic control models with middleware platforms applied to smart environments. It enables us to hire two Masters students for 2016.

9.2. National Initiatives

9.2.1. ANR

HPeC is an ANR project on Self-Adaptive, Energy Efficient High Performance Embedded Computing, with a UAV case study. The Coordinator is Lab-STICC / MOCS (Lorient / Brest), and the duration: 42 month from october 2015. Others Partners are: UBO, U. Clermont-Ferrand, InPixal.

In Ctrl-A, it is funding a PhD thesis or a post-doc position, to be hired in Grenoble and co-adivsed with Lorient. Another PhD based in Brest is co-advised by Stéphane Mocanu.

9.2.2. Informal National Partners

We have contacts with colleagues in France, in addition to the cooperation mentioned before, and with whom we are submitting collaboration projects, co-organizing events and workshops, etc. They feature : Avalon Inria team in Lyon (F. Desprez), LIP6 (J. Malenfant), Scales Inria team in Sophia-Antipolis (L. Henrio), LIRRM in Montpellier (A. Gamatié, K. Godary, D. Simon), IRISA/Inria Rennes (J. Buisson, J.L. Pazat, ...), Telecom Paris-Tech (A. Diaconescu, E. Najm), LAAS (Thierry Monteil), LURPA ENS Cachan (J.M. Faure, J.J. Lesage).

9.2.3. Informal National Industrial Partners

We have ongoing discussions with several industrial actors in our application domains, some of them in the framework of cooperation contracts, other more informal: Eolas/Business decision (G. Dulac), ST Microelectronics (V. Bertin), Schneider Electric (C. El-Kaed, P. Nappey, M. Pitel), Orange labs (J. Pulou, T. Coupaye, G. Privat).

9.3. International Initiatives

9.3.1. Inria International Labs

We participated to the 6th Workshop of the JLESC, with partners Inria, the University of Illinois, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and RIKEN AICS. We presented the potential of Autonomic Computing, examplified by our results from Section 7.2.3 , and had contacts with collaboration potentials.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

We have ongoing relations with international colleagues in the emerging community on our topic of control for computing e.g., in Sweden at Lund (K.E. Arzen, M. Maggio) and Linnaeus Universities (D. Weyns, N. Khakpour), in the Netherlands at CWI/leiden University (F. Arbab), in China at Heifei University (Xin An), in Italy at University Milano (C. Ghezzi, A. Leva), in the USA at Ann Arbor University (S. Lafortune) and UMass (P. Shenoy, E. Cecchet).

9.3.3. Participation in Other International Programs

Eric Rutten is a member of the IFAC Technical Committee 1.3 on Discrete Event and Hybrid Systems, for the 2011-2014 triennium, and for the 2014-2017 triennum http://tc.ifac-control.org/1/3 ; and of the IEEE Control Systems Society Discrete Event Systems Technical Committee http://discrete-event-systems.ieeecss.org.

DANTE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. Equipex FIT (Futur Internet of Things)
Participant: Éric Fleury [correspondant].

FIT is one of 52 winning projects in the Equipex research grant program. It will set up a competitive and innovative experimental facility that brings France to the forefront of Future Internet research. FIT benefits from 5.8Ã¢ÂÂ¬ÃÅ¡ million grant from the French government Running from 22.02.11 – 31.12.2019. The main ambition is to create a first-class facility to promote experimentally driven research and to facilitate the emergence of the Internet of the future.

9.1.1.2. ANR GRAPHSIP (Graph Signal Processing)
Participants: Paulo Gonçalves Andrade [correspondant], Éric Fleury, Thomas Begin, Sarra Ben Alaya, Hadrien Hours.

An increasing number of application areas require the processing of massive datasets. These data can often be represented by graphs in order to encode complex interactions. When data vectors are associated with graph vertices, a so-called graph signal is obtained. The processing of such graph signals includes several open challenges because of the nature of the involved information. Indeed graph theory and signal and image processing methodologies do not combine readily. In particular, such a combination requires new developments, allowing classical signal processing methods to work on irregular grids and non Euclidean spaces. Considering the significant success of classical signal processing tools, it appears essential to generalise their use to graph signals. The GRAPHSIP project aims at developing a set of advanced methods and algorithms for the processing of graph signals: multi-scale transforms and solutions of variational problems on graphs. The major outcomes of this project are expected to lead to significant breakthroughs for graph data processing. The project will also focus on two novel applications on instances of graph signals: brain networks and 3D colour point clouds. They will exemplify and illustrate the proposed methodological advances on emerging applications.

9.1.1.3. ANR INFRA DISCO (DIstributed SDN COntrollers for rich and elastic network services)
Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guérin Lassous, Huu Nghi Nguyen.

The DANTE team will explore the way SDN (Software Designed Network) can change network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. More specifically, the team will address the issues regarding the positioning of SDN controllers within the network, and the implementation of an admission control that can manage IP traffic prioritisation.

9.1.1.4. ANR REFLEXION (REsilient and FLEXible Infrastructure for Open Networking)
Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guérin Lassous, Guillaume Artero Gallardo, Zidong Su.

The DANTE team will work on the monitoring of NFV proposing passive and light-weight metrology tools. They will then investigate the modelling of low-level resources consumptions and finally propose methods to dynamically allocate these resources taking into account performance constraints.

9.1.1.5. ANR CONTINT CODDDE
Participants: Éric Fleury [correspondant], Christophe Crespelle, Márton Karsai, Hadrien Hours.

It is a collaborative project between the ComplexNetwork team at LIP6/UPMC; Linkfluence and Inria Dante. The CODDDE project aims at studying critical research issues in the field of real-world complex networks study:

- How do these networks evolve over time?
- How does information spread on these networks?
- How can we detect and predict anomalies in these networks?

In order to answer these questions, an essential feature of complex networks will be exploited: the existence of a community structure among nodes of these networks. Complex networks are indeed composed of densely connected groups of that are loosely connected between themselves.

The CODDE project will therefore propose new community detection algorithms to reflect complex networks evolution, in particular with regards to diffusion phenomena and anomaly detection.

These algorithms and methodology will be applied and validated on a real-world online social network consisting of more than 10 000 blogs and French media collected since 2009 on a daily basis (the dataset comprises all published articles and the links between these articles).

9.1.1.6. ANR SoSweet
Participants: Jean Pierre Chevrot, Éric Fleury, Márton Karsai [correspondant], Jean-Philippe Magué.

The SoSweet project focuses on the synchronic variation and the diachronic evolution of the variety of French used on Twitter. The recent rise of novel digital services opens up new areas of expression which support new linguistics behaviours. In particular, social medias such as Twitter provide channels of communication through which speakers/writers use their language in ways that differ from standard written and oral forms. The result is the emergence of new varieties of languages. The main goal of SoSweet is to provide a detailed account of the links between linguistic variation and social structure in Twitter, both synchronically and diachronically. Through this specific example, and aware of its bias, we aim at providing a more detailed understanding of the dynamic links between individuals, social structure and language variation and change.

9.1.1.7. ANR DylNet
Participants: Jean Pierre Chevrot, Éric Fleury [correspondant], Márton Karsai.

The DylNet project aims to observe and to characterise the relationships between childhood sociability and oral-language learning at kindergarten. With a view to this, it takes an multidisciplinary approach combining work on language acquisition, sociolinguistics, and network science. It will be implemented by following all the children (≈ 150) and teaching staff in one kindergarten over a 3-year period. The use of wireless proximity sensors will enable collection of social contacts throughout the study. The data on sociability will be linked to the results of language tests and recordings of verbal interactions used to follow the childrenâs progress on both a psycholinguistic level (lexicon, syntax, pragmatics) and a sociolinguistic level (features showing belonging to a social group). The aim is to better understand the mechanisms of adaptation and integration at work when young children first come into contact with the school context.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EMBERS

Title: Enabling a Mobility Back-End as a Robust Service

Programm: H2020

Duration: December 2015 - November 2018

Coordinator: UPMC

Partners:

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Technische Universitat Berlin (Germany)

Universite Pierre et Marie Curie - Paris 6 (France)

Ubiwhere Lda (Portugal)

Inria contact: Eric Fleury

EMBERS will bring to market a back-end for smart city mobility that is developed by a European small enterprise based upon its smart parking and smart traffic management products that two municipalities in Portugal currently deploy. The Mobility Back-end as a Service (MBaaS) replaces such all-in-one systems, in which a municipality purchases the full set of components from a single vendor. Instead, the city manager can purchase best-of-breed devices and apps developed by third parties, with the only constraint being that they interoperate with the back-end via a free, open, smart city mobility API. This domain-specific API lowers barriers to entry for app and device developers, making it easier for innovative SMEs to enter the market. Furthermore, the API is offered via a variety of generic interfaces, including oneM2M, ETSI M2M, OMA LWM2M, and FIWARE NGSI. EMBERS thus clears the way for developers and to municipalities that have adopted any one of these potential emerging machine-to-machine (M2M) communication standards. Beyond its primary goal of bringing the MBaaS to market, EMBERS will stimulate development of an entire ecosystem around the MBaaS smart city mobility API. Separating out the back-end from the other components will, however, require rigorous testing. EMBERS will experiment with the system on two testbeds that are part of the FIRE OneLab facility: the FUSECO Playground, for M2M communications, and FIT IoT-LAB, for wireless sensor devices. EMBERS will host a hackathon and an app challenge to bring in third party developers. The project will also include three demonstrators by third parties via an open call. These activities will contribute back to FIRE by demonstrating successful experimentation by SMEs developing close-to-market products. The project will also conduct real world pilots in two or more cities as a final step in bringing the MBaaS to market.

9.2.1.2. ARMOUR

Title: Large-Scale Experiments of IoT Security & Trust (Project nÂ°688237)

Programm: H2020

Duration: 2015 Dec to 2018

Coordinator: UPMC

Partners:

Synelixis Lyseis Pliroforikis Automatismou & Tilepikoinonion Monoprosopi EPE (Greece)

Smartesting Solutions & Services (France)

Unparallel Innovation, Lda (Portugal)

Easy Global Market (France)

ODIN Solutions (Spain)

Universite Pierre et Marie Curie - Paris 6 (France)

Inria contact: Eric Fleury

ARMOUR will provide duly tested, benchmarked and certified Security & Trust solutions for large-scale IoT using upgraded FIRE large-scale IoT/Cloud testbeds properly-equipped for Security & Trust experimentations. ARMOUR takes the top large-scale FIT IoT-LAB testbed â a FIRE OpenLAB / FIT IoT LAB facility â and enhances it as to enable experimentally-driven research on a key research dimension: large-scale IoT Security & Trust. Presently, no proper installations exist to experiment IoT Security & Trust on large-scale conditions; ARMOUR will develop and install such capability.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

Taiwan, ACADEMIA SINICA & IIIS. Signature of a MoU in the framework of IoT-LAB.

Algorithms research group of the University of Bergen, Norway. PICS project of CNRS on graph editing problems for analysis and modeling of complex networks.

9.3.1.2. Informal International Partners

University of Namur: Department of Mathematics/Naxys (Belgium). Collaboration with Renaud Lambiotte on dynamical processes on dynamical networks and communities detections.

Aalto University: Department of Biomedical Engineering and Computational Science (Finland). Collaboration with Jari Saramaki on modeling temporal networks and community like modular structure

Central European University (Hungary). Collaboration with János Kertész on modeling complex contagion phenomena.

ISI Foundation (Italy). Collaboration with Laetitia Gauvin on multiplex networks and transportation systems

University of South California (USA). Collaboration with Antonio Ortega on Graph Signal Processing

University of Pennsylvania (USA). Collaboration with Alejandro Ribeiro on Graph Signal Processing

LNCC, Petropolis (Brazil). Collaboration with Arthur Ziviani on Temporal Graph modeling ans algorithms.

College of Information and Computer Sciences at the University of Massachusetts Amherst.

University of California, Santa Cruz (USA). Collaboration with Alexandre Brandwajn on the solutions to multi-server queues.

9.3.2. Participation in Other International Programs

9.3.2.1. PHC Peridot
Participants: Mohammed Amer, Thomas Begin, Anthony Busson, Isabelle Guérin Lassous.

Framework for Control and Monitoring of Wireless Mesh Networks (WMN) using Software-Defined Networking (SDN). The main objective of this project is propose mechanisms and modifications in the SDN architecture, specifically in the OpenFlow, which allow SDN mechanisms to operate over WMN considering the dynamic network topology that WMN may experience and some other relevant characteristics. The project will involve devising mechanisms for controlling mesh switches through controllers in a wireless environment, which will require developing novel and WMN-specific rules, actions and commands. The project will involve proposing mechanism that consider dynamic environment of WMN along with providing redundancy in the network. Besides, there is a requirement to have an adaptive measurement API for WMN. This is the second objective of our research project. The proposed measurement API will enable the network operators to monitor network traffic over WMN which may be content-specific or host-specific. This is a joint project between DANTE and M. A. Jinnah University, Islamabad. It started in June 2015 and will end in June 2018.

9.3.2.2. STIC AMSUD UCOOL: Understanding and predicting human demanded COntent and mObiLity
Participants: Éric Fleury, Márton Karsai, Christophe Crespelle.

Finding new ways to manage the increased data usage and to improve the level of service required by the new wave of applications for smartphones is an essential issue nowadays. The improved understanding of user mobility (i.e. the context they experience) and the content they demand is of fundamental importance when looking for solutions for this problem in the modern communication landscape. The resulting knowledge can help at the design of more adaptable networking protocols or services as well as can help determining, for instance, where to deploy networking infrastructure, how to reduce traffic congestion, or how to fill the gap between the capacity granted by the infrastructure technology and the traffic load generated by mobile users.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Jacob Eisenstein

Date: May 2016

Institution: Georgia Tech (USA)

Alfred Hero

Date: May 2016

Institution: University of Michigan (USA)

Kimmo Kaski

Date: May 2016

Institution: Aalto University (Finland)

Nicola Perra

Date: June 2016

Institution:Greenwich University (England)

Alejandro Ribeiro

Date: June 2016

University of Pennsylvania (US)

János Kertész

Date: June-July 2016

Central European University (Hungary)

9.4.2. Visits to International Teams

9.4.2.1. Sabbatical programme

Begin Thomas

Date: Sep 2015 - Aug 2016

Institution: DIVA lab – University of Ottawa (Canada) on a CNRS grant and Inria sabbatical grant.

Christophe Crespelle

Date: Sep 2015 - Aug 2016

Institution: Institute of Mathematics, Vietnam Academy of Science and Technology, Hanoi (Vietnam) on a CNRS grant.

9.4.2.2. Research Stays Abroad

- Márton Karsai stayed 1 month at Aalto University Espoo, Finland
- Christophe Crespelle stayed 2 weeks at University of Bergen, Norway

<div align="center" style="color:red">DATAMOVE Team</div>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- **ANR grant MOEBIUS (2013-2017).** Multi-objective scheduling for large computing platforms. Coordinator: Grenoble-INP (DataMove). Partners: Grenoble-INP, Inria, BULL-ATOS .

8.1.2. Competitivity Clusters

- **PIA Avido (2015-2018)**. In situ analysis and visualization for large scale numerical simulation. Coordinator: EDF SA. Partners: EDF SA, Total SA, Kitware SAS , Université Pierre et Marie CURIE, Inria (DataMove).

- **FUI OverMind (2015-2017)**. Task planification and asset management for the cartoon productions. Coordinator: Teamto Studio. Partners: Teamto Studio, Folimage Studio, Ecole de Gobelins, Inria (DataMove).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. VELaSSCo

Title: Visualization For Extremely Large-Scale Scientific Computing

Program: STREP (Specific Targeted Research Project)

Duration: January 2014 - December 2016

Coordinator: Centre Internacional de Metodes Numerics en Enginyeria (Spain)

Partners: JOTNE (No.), SINTEF (No.), Fraunhofer IGD (D), ATOS (SP), Univ. Edinburgh (UK)

Inria contact: Toan Nguyen, Bruno Raffin

Abstract: VELaSSCo aims at developing a new concept of integrated end-user visual analysis methods with advanced management and post-processing algorithms for engineering modelling applications, scalable for real-time petabyte level simulations [59]. The interface will enable real-time interrogation of simulation data, generating key information for analysis. Main concerns have to do with handling of large amounts of data of a very specific kind intrinsically linked to geometrical properties; how to store, access, simplify and manipulate billion of records to extract the relevant information; how to represent information in a feasible and flexible way; and how to visualise and interactively inspect the huge quantity of information they produce taking into account end-user's needs. VELaSSCo achieves this by putting together experts with relevant background in Big Data handling, advanced visualisation, engineering simulations, and a User Panel including research centres, SMEs and companies form key European industrial sectors such as aerospace, household products, chemical, pharmaceutical and civil engineering.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. JLESC

Title: Joint Laboratory for Extreme-Scale-Computing.

International Partners:

University of Illinois at Urbana Champaign (USA)

Argonne National Laboratory (USA),

Barcelona Supercomputing Center (Spain),

Jülich Supercomputing Centre (Germany)

Riken Advanced Institute for Computational Science (Japan)

Start year: 2009

See also: https://jlesc.github.io/

The purpose of the Joint Laboratory for Extreme Scale Computing is to be an international, virtual organization whose goal is to enhance the ability of member organizations and investigators to make the bridge between Petascale and Extreme computing. The JLESC organizes a workshop every 6 months DataMove participates to. DataMove developed several collaborations related to in situ processing with Tom Peterka group (ANL) , the Argo exascale operating system with Swann Perarnau (ANL).

8.3.1.2. ANOMALIES@EXASCALE

Title: Anomalies Detection and Handling towards Exascale Platforms

International Partner:

University of Chicago (United States) - Argonne National Laboratory (ANL)

Start year: 2014. End year: 2016.

See also: http://anomalies.imag.fr

The Anomalies@exascale project intends to prospect new scheduling solutions for very large parallel computing platforms. In particular, we consider the new problems related to fault tolerance raising with the developments of exascale platforms. We expect to define new ways to detect both execution failures and more transient performance anomalies. Information gathered from the detectors will then be taken into account by schedulers to implement corrective measures. PI: Frederic Wagner

8.3.2. Inria Associate Teams Not Involved in an Inria International Labs

8.3.2.1. ExaSE

Title: Exascale Computing Scheduling and Energy

International Partners:

UFRGS, PUC Minas and UPS (Brazil)

Duration: 2014 - 2016

See also: https://team.inria.fr/exase/

The main scientific context of this project is high performance computing on Exascale systems: large-scale machines with billions of processing cores and complex hierarchical structures. This project intends to explore the relationship between scheduling algorithms and techniques and the energy constraints present on such exascale systems. PI: Jean-Marc Vincent (Polaris)

8.3.3. Participation in Other International Programs

8.3.3.1. LICIA

Title: International Laboratory in High Performance and Ubiquitous Computing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2011 - 2018

See also: http://licia-lab.org/

The LICIA is an Internacional Laboratory and High Performance and Ubiquitous Computing born in 2011 from the common desire of members of Informatics Institute of the Federal University of Rio Grande do Sul and of Laboratoire d'Informatique de Grenoble to enhance and develop their scientific partnership that started by the end of the 1970. LICIA is an Internacional Associated Lab of the CNRS, a public french research institution. It has support from several brazilian and french research funding agencies, such as CNRS, Inria, ANR, European Union (from the french side) and CAPES, CNPq, FAPERGS (from the Brazilian side). DataMove is deeply involved in the animation of LICIA. Bruno Raffin is LICIA associate director.

8.3.3.2. CAPES/COFECUB StarShip

Title: Scalable Tools and Algorithms para Resilient, Scalable, Hybrid Interactive Processing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2013 - 2016

PI: Bruno Raffin (DataMove) and Alexandre Carissimi (UFRGS)

8.4. International Research Visitors

8.4.1. Internships

PhD in progress: Marcos Amaris Gonzalez, Performance Evaluation for GPU, USP (Sao Paulo, Brasil). 1 year "sandwich" visit. Local adviser: Denis Trystram

8.4.2. Visits to International Teams

- Pierre François Dutot. Six month stay at University of Hawaii at Manoa (Sept. 2016 - Jan. 2017)

<h1 style="text-align:center; color:red;">DIANA Project-Team</h1>

8. Partnerships and Cooperations

8.1. Inria internal funding

- **User Discrimination on the Web:** we have been awarded funding for two post-doc positions each for one year with the the "Inria Actions Marquantes" with Nataliia Bielova from the INDES project-team. Natasa Sarafijanovic-Djukic have just started her post-doc on this project.

- **ADT ElectroSmart:** in the context of the Inria ADT call, we have a funding for a two year engineering position on the ElectroSmart project for the 2017-2019 period.

- **Transverse Master Interships:** we have a funding for a 6-month internship with Nataliia Bielova on Pixel Tracking.

- **ACQUA:** in the context of the Inria ADT call, we have a funding for a two year engineering position on the ACQUA project for the 2015-2017 period. Thierry Spetebroot is hired on this position.

8.2. UCN@Sophia Labex and UCA Idex funding

- **ElectroSmart:** this project has a funding for a two year engineering position from the UCN@Sophia Labex for the 2016-2018 period (Ravi Mondi is hired on this position) and 30KEuros fron the UCA (Université Côte d'Azur) RISE Academy.

- **PhD sholarships:** our team has currently four ongoing PhD thesis (Karyna Gogunska, Mohamed Naoufal Mahfoudi, Vitalii Poliakov and Luigi Vigneri) funded by the UCN@Sophia Labex.

8.3. Regional Initiatives

- **Plate-forme Telecom (Com4innov)** (2011-2017) is a DGCIS funded project, in the context of the competitivity cluster SCS, that aims at providing to PACA region industrials wishing to develop or validate new products related to future mobile networks and services and M2M application, a networking infrastructure and tools helpful for development, test and validation of those products. Other partners : 3Roam, Audilog Groupe Ericsson, Ericsson, Eurecom, Inria, iQsim, MobiSmart, Newsteo, OneAccess, Orange Labs, SCS cluster, ST Ericsson, Telecom Valley. Our contribution is centred around providing a test methodology and tools for wireless networks experimentation. In the context of this project we have realized a study on MPTCP performance in a wireless-wired environment with Orange Labs Sophia. The software tools that were developed in the project have been integrated in the R^2lab anechoic chamber.

8.4. National Initiatives

8.4.1. ANR

- **ANR FIT** (2011-2018): FIT (Future Internet of Things) aims at developing an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's Equipements of Excellence (Equipex) research grant programme. The project will benefit from a 5.8 million euro grant from the French government. Other partners are UPMC, IT, Strasbourg University and CNRS. See also http://fit-equipex.fr/.

- **ANR DISCO** (2014-2016): DISCO (DIstributed SDN COntrollers for rich and elastic network services) aims at exploring the way how Software Defined Networking changes network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. The project works throughout experimentations and application use cases on the next generation of Software-Defined Networking solutions for large and critical distributed systems. The project studied the distribution of the current SDN control plane and the optimization of network operations that the integrated system view of cloud computing-based architectures allows. See also http://anr-disco.ens-lyon.fr/.

- **ANR REFLEXION** (2015-2017): REFLEXION (REsilient and FLEXible Infrastructure for Open Networking) research project will study the robustness and scalability of the current SDN architectures and the flexibility leveraged by SDN for provisioning resources and virtualized network functions (VNF). The project will address four main scientific objectives: (1) Fault and disruption management for virtualized services, (2) Robust and scalable control plane for next generation SDN, (3) Dynamic performance management of low level resources in SDN/NFV environments and (4) Distribution and optimization of virtual network functions in SDN environments. Our contribution in this project will be focused on fault and disruption management for virtualized services. See also http://anr-reflexion.telecom-paristech.fr/.

- **ANR BottleNet** (2016-2019): BottleNet aims to deliver methods, algorithms, and software systems to measure Internet Quality of Experience (QoE) and diagnose the root cause of poor Internet QoE. This goal calls for tools that run directly at users' devices. The plan is to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. ANR BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

8.5. European Initiatives

8.5.1. FP7 & H2020 Projects

Program: FP7 FIRE programme

Project acronym: Fed4Fire+

Project title: Federation for FIRE Plus

Duration: January 2017 - December 2021

Coordinator: iMinds (Belgium)

Other partners: 20 european partners including IMEC (Belgium), UPMC (Fr), Fraunhofer (Germany), TUB (Germany), etc.

Web site: http://www.fed4fire.eu/

Abstract: The Fed4FIRE+ project has the objective to run and further improve Fed4FIRE's best-in-town federation of experimentation facilities for the Future Internet Research and Experimentation initiative. Federating a heterogeneous set of facilities covering technologies ranging from wireless, wired, cloud services and open flow, and making them accessible through common frameworks and tools suddenly opens new possibilities, supporting a broad range of experimenter communities covering a wide variety of Internet infrastructures, services and applications. Fed4FIRE+ will continuously upgrade and improve the facilities and include technical innovations, focused towards increased user satisfaction (user-friendly tools, privacy-oriented data management, testbed SLA and reputation, experiment reproducibility, service-level experiment orchestration, federation ontologies, etc.). It will open this federation to the whole FIRE community and beyond, for experimentation by industry and research organisations, through the organization of Open Calls and Open Access

mechanisms. The project will also establish a flexible, demand-driven framework which allows test facilities to join during the course of its lifetime by defining a set of entry requirements for new facilities to join and to comply with the federation. FIRE Experimental Facilities generate an ever increasing amount of research data that provides the foundation for new knowledge and insight into the behaviour of FI systems. Fed4FIRE+ will participate in the Pilot on Open Research Data in Horizon 2020 to offer open access to its scientific results, to the relevant scientific data and to data generated throughout the project's lifetime. Fed4FIRE+ will finally build on the existing community of experimenters, testbeds and tool developers and bring them together regularly (two times a year) in engineering conferences to have maximal interaction between the different stakeholders involved.

8.6. International Initiatives

8.6.1. Inria Associate Teams Not Involved in an Inria International Labs

8.6.1.1. UHD-on-5G

Title: Ultra High Definition video streaming on future 5G networks

International Partner (Institution - Researcher):

National Institute of Information and Communications Technology (NICT) (Japan) - Hitoshi Asaeda

Start year: 2016

See also: https://team.inria.fr/diana/uhd-on-5g/

The aim of this collaboration is to design and develop efficient mechanisms for streaming UHD video on 5G networks and to evaluate them in a realistic and reproducible way by using novel experimental testbeds.

Our approach leverages and extends when necessary ICN and SDN technologies to allow very high quality video streaming at large scale. We also plan to use Virtual Network Functions (VNF) in order to place easily and dynamically different functions (e.g. transcoding, caching) at strategic locations within the network. Specifically, the placement of these functions will be decided by SDN controllers to optimize the quality of experience (QoE) of users. Moreover, we plan to integrate ICN functionalities (e.g., name-based forwarding and multipath transport using in-network caching) with SDN/NFV to provide better QoE and mobility services support to users than traditional IP architectures. Monitoring mechanisms such as the Contrace tool we developed in a previous associated team (SIMULBED) will be helpful to provide an accurate view of the network at the SDN controllers side. In addition, we will build a large-scale testbed to evaluate our solutions through reproducible experimentations based on two testbeds: the ICN wired CUTEi tesbed developed by NICT and the wireless R^2lab testbed developed by Inria.

8.7. International Research Visitors

8.7.1. Visits of International Scientists

Max Ott from Data61/CSIRO (previously NICTA) visited us in November 2016. He gave a seminar on "Confidential Computing - Analysing Data Without Seeing Data" and an invited talk at the R^2lab inauguration ceremony.

8.7.1.1. Internships

  Ramon Dos Reis Fontes

    Date: from Apr 2016 until Sep 2016

    Institution: PhD intern, University of Campinas

    Supervisor: Thierry Turletti

    Subject: Evaluating and Validating Mininet-WiFi

  Anastasia Kuznetsova

    Date: from Mar 2016 until Aug 2016

    Institution: Ubinet Master intern, University of Nice Sophia Antipolis

    Supervisor: Arnaud Legout

    Subject: User discrimination on Pinterest

  Ahmed Loukili

    Date: from Mar 2016 until Aug 2016

    Institution: Ubinet Master intern, University of Nice Sophia Antipolis

    Supervisor: Damien Saucez

    Subject: Content Distribution over Software Defined Networks

  Hakob Melkonyan

    Date: from Mar 2016 until Aug 2016

    Institution: Ubinet Master intern, University of Nice Sophia Antipolis

    Supervisor: Arnaud Legout

    Subject: ElectroSmart Android Project for Exploring Electromagnetic Exposition

  Farzaneh Pakzad

    Date: from November 2016 to December 2016

    Institution: PhD intern, University of Queensland

    Supervisor: Thierry Turletti and Walid Dabbous

    Subject: Using R^2lab to evaluate MANET routing protocols

  Jimmy Rogala

    Date: from May 2016 until Aug 2016

    Institution: ENS Rennes intern

    Supervisor: Arnaud Legout

    Subject: Collecting statistics on Pinterest users

  Nawfal Abbassi Saber

    Date: from Mar 2016 until Aug 2016

    Institution: Ubinet Master intern, University of Nice Sophia Antipolis

    Supervisor: Chadi Barakat

    Subject: Experimenting and modeling YouTube Quality of Experience

8.7.2. *Visits to International Teams*

Walid Dabbous, Thierry Turletti and Hardik Soni visited NICT in Tokyo Japan in the context of the UHD-on-5G associated team in December 2016.

<div align="center">

DIONYSOS Project-Team

</div>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Adlen Ksentini is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yassine Hadjadj-Aoul is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yann Busnel is a member of the two following projects: Inhare granted by the ANR (ANR-15-CE19-0024) and DeSCeNt granted by the LabEx CominLabs (ANR-10-LABX-07-01).

9.2. Inria Project Labs

Participants: Yassine Hadjadj-Aoul, Gerardo Rubino, Bruno Tuffin.

Inria Project Labs' (IPL) initiatives enable the launch of ambitious research projects directly linked with the institute.

9.2.1. BetterNet

BetterNet aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where:

- tools, models and algorithms/heuristics will be provided to collect data,
- acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society,
- and new value-added services will be proposed to end-users.

Inria Project Teams involved: Diana, Dionysos, Inria Chile, Madynes, Muse, Spirals

9.3. European Initiatives

9.3.1. FINTEROP

Program: H2020-ICT-12-2015

Project acronym: F-Interop

Project title: FIRE+ online interoperability and performance test tools to support emerging technologies from research to standardization and market launch

Duration: November 2015 – October 2018

Coordinator: UPMC-LIP6

Other partners: 9 partners including our team Dionysos (F. Sismondi and C. Viho), and Eva (T. Watteyne)

Abstract: The goal of F-Interop is to extend FIRE+ with online interoperability and performance test tools supporting emerging IoT-related technologies from research to standardization and to market launch for the benefit of researchers, product development by SME, and standardization processes.

9.3.2. Collaborations with Major European Organizations

Partner 1: Sapienza University of Rome, Italy.

We work with Nicoló Rivetti and Leonardo Querzoni on the analysis of stream processing systems.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. MOCQUASIN

Title: Monte Carlo and Quasi- Monte Carlo for rare event simulation

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada)

Duration: started in 2013

See also: http://www.irisa.fr/dionysos/pages_perso/tuffin/MOCQUASIN/

The goal of this team is to compute integrals, sums or to solve equations or optimization problems by means of Monte Carlo methods, which are statistical tools used when the models have a high complexity (for instance a large dimension). They are unavoidable methods in areas such as finance, electronics, seismology, computer science, engineering, physics, transport, biology, social sciences... Nonetheless, they have the reputation of being slow, i.e. to require a large computational time to reach a given precision. The goal of the project is to work on acceleration techniques, meaning methods allowing to reach the targeted precision in a shorter computational time than with the standard procedure. A typical framework is that of rare event simulation for which getting even only one occurrence of the event could require a too long computing time. In this case, there are two main acceleration techniques: importance sampling and splitting, on which we work.

9.4.1.2. Collaborations with the UTFSM at Valparaíso, Chile

We maintain a strong line of collaborations with the Technical University Federico Santa María (UTFSM), Valparaíso, Chile. Over the years, this has taken different forms (associated team Manap, Stic AmSud project "AMMA", Stic AmSud project "DAT", see next module). Currently, we have a joint PhD work running (PhD of Nicolás Jara, to be defended in 2017), and a new joint PhD to be started in 2017 (PhD of Jonathan Olavarría). The first one is on optical network analysis and design, the second one on modeling evaluation techniques.

9.4.1.3. International Initiatives

DAT

Title: Dependability Analysis Tool

International Partners:

Prof. H. Cancela, Univ. of the Republic, Computer Science, Uruguay;

Prof. R. Vallejos, UTFSM, Valparaíso, Electrical Eng., Chile;

G. Rubino, Dionysos, Inria, general responsible for the project.

Duration: 2015 - 2016

Start year: 2015

The main scientific objective of this project is to develop new techniques to assess the most important dependability properties of a complex system subject to the failures and possible repairs of its components. The central argument behind our proposal is our previous work in the area and some unpublished preliminary and promising results that we believe deserve deep exploration and that should lead to faster evaluation procedures than those available today. We also intend to implement these techniques in an integrated software package usable both in industry and for teaching purposes. Concerning applications, again based on the skills of the participating teams and our past common work, we will illustrate our findings on problems coming from the wireless and optical networking domains.

SM-HCD-HDD

Title: Statistical methods for highly complex and/or high dimensional data

International Partners:

Prof. Ricardo Fraiman, Mathematics, Univ. of the Republic, Uruguay, head of the project;

many partners in Uruguay, Argentina and Chile,

G. Rubino for Dionysos, Inria

Duration: 2016 - 2017

Start year: 2016

The aim of this project is to develop theoretical and computational tools to solve statistical problems that occur when data leaves in high dimensional spaces and/or lives in complex spaces that induce complex geometries.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Jebali Ameni, from INSAT (Tunisia)

Jorge Graneri, from UDELAR, Uruguay

Héctor Cancela, from UDELAR, Uruguay

Franco Robledo, from UDELAR, Uruguay

Claudio Risso, from UDELAR, Uruguay

Reinaldo Vallejos, from UTFSM, Chile

Marta Barría, from university of Valparaíso, Chile

9.5.1.1. Research Stays Abroad

Yann Busnel has been granted as an invited professor at La Sapienza Universitá di Roma, Italy, for 3 months from March to June 2016.

<p style="text-align:center">**DIVERSE Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. GEMOC

- Coordinator: Inria (DIVERSE)
- Other partners: ENSTA Bretagne, Inria, IRIT, I3S, Obeo, Thales
- Dates: 2012-2016
- Abstract: GEMOC focuses on a generic framework for heterogeneous software model execution and dynamic analysis. This work has the ambition to propose an innovative environment for the design of complex software-intensive systems by providing: a formal framework that integrates state-of-the-art in model-driven engineering (MDE) to build domain-specific modeling languages (DSMLs), and models of computation (MoC) to reason over the composition of heterogeneous concerns; an open-source design and modeling environment associated to a well-defined method for the definition of DSMLs, MoCs and rigorous composition of all concerns for execution and analysis purposes.

  This requires addressing two major scientific issues: the design and verification of a formal framework to combine several different DSMLs relying on distinct MoCs; the design and validation of a methodology for DSMLs and MoC development. GEMOC aims at participating in the development of next generation MDE environments through a rigorous, tool-supported process for the definition of executable DSMLs and the simulation of heterogeneous models.

8.1.1.2. SOPRANO

- Coordinator: CEA
- CEA, University of Paris-Sud, Inria Rennes, OcamlPro, Adacore
- Dates: 2014-2017
- Abstract: Today most major verification approaches rely on automatic external solvers. However these solvers do not fill the current and future needs for verification: lack of satisfying model generation, lack of reasoning on difficult theories (e.g. floating-point arithmetic), lack of extensibility for specific or new needs. The SOPRANO project aims at solving these problems and prepare the next generation of verification-oriented solvers by gathering experts from academia and industry. We will design a new framework for the cooperation of solvers, focused on model generation and borrowing principles from SMT (current standard) and CP (well-known in optimisation). These ideas will be implemented in an open-source platform, with regular evaluations from the industrial partners.

8.1.1.3. Gdiv MRSE

- Coordinator: B. Baudry
- Inria Rennes
- Dates: 2014-2016
- Abstract: The objective of GDiv is to setup a strong network of European partners around the core team composed of Inria and SINTEF. This network will gather another academic partner and between 3 and 5 industry partners in the areas of software development and deployment. The project proposal setup by the GDiv network will address the risks of large scale software reuse through integrated, multi-level software diversification techniques.

8.1.2. BGLE / LEOC

8.1.2.1. CONNEXION

- Coordinator: EDF
- Other partners: Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict, CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech
- Dates: 2012-2016
- Abstract: The cluster CONNEXION (*digital command CONntrol for Nuclear EXport and renovatION*) aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. In this project the Triskell team investigates methods and tools to (i) automatically analyze and compare regulatory requirements evolutions and geographical differences; (ii) automatically generate test cases for critical interactive systems.

8.1.2.2. CLARITY

- Coordinator: Obéo
- Other partners: AIRBUS, Airbus Defence and Space, All4tec, ALTRAN Technologies, AREVA, Artal, C.E.S.A.M.E.S., Eclipse Foundation Europe, Inria Sophia Antipolis Méditerranée, PRFC, Scilab Enterprises, Thales Global Services, Thales Alenia Space, Thales Research & Technology, Thales Systèmes Aéroportés, Université de Rennes 1.
- Dates: 2014-2017
- Abstract: The CLARITY project aims to establish an international dimension ecosystem around Melody/Capella modeling workbench for systems engineering (MBSE) and engineering architectures (system, software, hardware).

8.1.2.3. Occiware

- Coordinator: Open Wide
- Open Wide, ActiveEon SA, CSRT - Cloud Systèmes Réseaux et Télécoms, Institut Mines-Télécom/Télécom SudParis, Inria, Linagora, Obeo, OW2 Consortium, Pôle Numérique, Université Joseph Fourier,
- Dates: 2014-2017
- Abstract: The Occiware project aims to establish a formal and equipped framework for the management of all cloud resource based on the OCCI standard.

8.1.3. DGA

8.1.3.1. MOTIV

- Coordinator: InPixal
- Other partners: Bertin, DGA, Inria
- Dates: 2012-2014
- Abstract: This project investigates innovative software test generation and management solutions to handle the very high degrees of variability in video processing algorithmic chains. The objective is to provide systematic criteria to qualify the testing activity when developing video processing software and to tailor these criteria to the variability dimensions that emerge in the context of visible images.

8.1.3.2. FPML (CYBERDEFENSE)

- Coordinator: DGA
- Partners: DGA MI, Inria
- Dates: 2014-2016

- Abstract: in the context of this project, DGA-MI and the Inria team DiverSE explore the existing approaches to ease the development of formal specifications of domain-Specific Languages (DSLs) dedicated to paquet filtering, while guaranteeing expressiveness, precision and safety. In the long term, this work is part of the trend to provide to DGA-MI and its partners a tooling to design and develop formal DSLs which ease the use while ensuring a high level of reasoning.

8.1.4. Cominlabs

8.1.4.1. PROFILE

- Coordinator: Université de Rennes 1
- Partners: Inria, Université de Rennes 2
- Dates: 2016-2019
- Abstract: The PROFILE project brings together experts from law, computer science and sociology to address the challenges raised by online profiling, following a multidisciplinary approach. More precisely, the project will pursue two complementary and mutually informed lines of research: (i) Investigate, design, and introduce a new right of opposition into the legal framework of data protection to better regulate profiling and to modify the behavior of commercial companies towards being more respectful of the privacy of their users; (ii)S Provide users with the technical means they need to detect stealthy profiling techniques as well as to control the extent of the digital traces they routinely produce. As a case study, we focus on browser fingerprinting, a new profiling technique for targeted advertisement. The project will develop a generic framework to reason on the data collected by profiling algorithms, to uncover their inner working, and make them more accountable to users. PROFILE will also propose an innovative protection to mitigate browser fingerprinting, based on the collaborative reconfiguration of browsers.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. FP7 FET STREP DIVERSIFY

- Coordinator: Inria (DIVERSE)
- Partners: SINTEF, Université de Rennes 1, Trinity College Dublin, Inria (DiverSE, SPIRALS)
- Dates: 2013-2016
- Abstract: DIVERSIFY explores diversity as the foundation for a novel software design principle and increased adaptive capacities in CASs. Higher levels of diversity in the system provide a pool of software solutions that can eventually be used to adapt to unforeseen situations at design time. The scientific development of DIVERSIFY is based on a strong analogy with ecological systems, biodiversity, and evolutionary ecology. DIVERSIFY brings together researchers from the domains of software-intensive distributed systems and ecology in order to translate ecological concepts and processes into software design principles.

8.2.1.2. FP7 STREP HEADS

- Coordinator: SINTEF
- Other partners: Inria, Software AG, ATC, Tellu, eZmonitoring
- Dates: 2013-2016
- Abstract: The idea of the HEADS project is to leverage model-driven software engineering and generative programming techniques to provide a new integrated software engineering approach which allow advanced exploitation the full range of diversity and specificity of the future computing continuum. The goal is to empower the software and services industry to better take advantage of the opportunities of the future computing continuum and to effectively provide new innovative services that are seamlessly integrated to the physical world making them more pervasive, more

robust, more reactive and closer (physically, socially, emotionally, etc.) to their users. We denote such services HD-services. HD-services (Heterogeneous and Distributed services) characterize the class of services or applications within the Future Internet whose logic and value emerges from a set of communicating software components distributed on a heterogeneous computing continuum from clouds to mobile devices, sensors and/or smart-objects.

8.2.1.3. H2020 ICT-10-2016 STAMP

- Coordinator: Inria (DIVERSE)
- Other partners: ATOS, ActiveEon, OW2, TellU, Engineering, XWiki, TU Delft, SINTEF
- Dates: 2016-2019
- Abstract: Leveraging advanced research in automatic test generation, STAMP aims at pushing automation in DevOps one step further through innovative methods of test amplification. It will reuse existing assets (test cases, API descriptions, dependency models), in order to generate more test cases and test configurations each time the application is updated. Acting at all steps of development cycle, STAMP techniques aim at reducing the number and cost of regression bugs at unit level, configuration level and production stage.

  STAMP will raise confidence and foster adoption of DevOps by the European IT industry. The project gathers 3 academic partners with strong software testing expertise, 5 software companies (in: e-Health, Content Management, Smart Cities and Public Administration), and an open source consortium. This industry-near research addresses concrete, business-oriented objectives. All solutions are open source and developed as microservices to facilitate exploitation, with a target at TRL 6.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

8.2.2.1. ICT COST Action MPM4CPS (IC1404)

- Chair of the Action: Prof Hans Vangheluwe (BE)
- Dates: 2014-2018
- Abstract: Truly complex, designed systems, known as Cyber Physical Systems (CPS), are emerging that integrate physical, software, and network aspects. To date, no unifying theory nor systematic design methods, techniques and tools exist for such systems. Individual (mechanical, electrical, network or software) engineering disciplines only offer partial solutions. Multi-paradigm Modelling (MPM) proposes to model every part and aspect of a system explicitly, at the most appropriate level(s) of abstraction, using the most appropriate modelling formalism(s). Modelling languages' engineering, including model transformation, and the study of their semantics, are used to realize MPM. MPM is seen as an effective answer to the challenges of designing CPS. This COST Action promotes the sharing of foundations, techniques and tools, and provide educational resources, to both academia and industry. This is achieved by bringing together and disseminating knowledge and experiments on CPS problems and MPM solutions. Benoit Combemale is a member of the management committee.

8.2.3. Collaborations with Major European Organizations

SINTEF, ICT (Norway): Model-driven systems development for the construction of distributed, heterogeneous applications. We collaborate since 2008 and are currently in two FP7 projects together.

Université du Luxembourg, (Luxembourg): Models runtime for dynamic adaptation and multi-objective elasticity in cloud management; model-driven development.

Open University (UK): models runtime for the Internet of Things.

8.3. International Initiatives

- Université de Montréal (Canada)

- McGill University (Canada)
- University of Alabama (USA)
- TU Wien (Austria)
- Michigan State University (USA)
- Aachen University (Germany)

8.3.1. Participation in Other International Programs

The GEMOC studio has been sustained through the creation of a Research Consortium at the Eclipse Foundation.

8.3.2. International initiative GEMOC

The GEMOC initiative (cf. http://www.gemoc.org) is an open and international initiative launched in 2013 that coordinate research partners worldwide to develop breakthrough software language engineering (SLE) approaches that support global software engineering through the use of multiple domain-specific languages. GEMOC members aim to provide effective SLE solutions to problems associated with the design and implementation of collaborative, interoperable and composable modeling languages.

The GEMOC initiative aims to provide a framework that facilitates collaborative work on the challenges of using of multiple domain-specific languages in software development projects. The framework consists of mechanisms for coordinating the work of members, and for disseminating research results and other related information on GEMOC activities. The framework also provides the required infrastructure for sharing artifacts produced by members, including publications, case studies, and tools.

The governance of the GEMOC initiative is ensured by the Advisory Board. The role of the Advisory Board is to coordinate the GEMOC work and to ensure proper dissemination of work products and information about GEMOC events (e.g., meetings, workshops).

Benoit Combemale is the co-founder and currently acts as principal coordinator of the GEMOC initiative. Benoit Combemale and Jean-Marc Jézéquel are part of the Advisory Board, and 9 DIVERSE members are part of the GEMOC initiative.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Yves Le Traon, Professor at the University of Luxembourg, visited the team in June and July 2016.

Tanja Mayerhofer, Junior Researcher at the TU Wien, visited the team in September 2016.

Bernhard Rumpe, Professor at Aachen University, visited the team in May 2016.

8.4.1.1. Internships

Vikas Mishra, Master intership at the Birla Institute of Technology & Science, visited the team from June to August 2016.

Alexandre Nuttinck, Axel Halin, Master interships at the University of Namur, visited the team from September 2016 to January 2017.

8.4.2. Visits to International Teams

Manuel Leduc visited CWI for 3 weeks in December 2016

Benoit Baudry visited Professor Stephanie Forrest at the University of New Mexico for one month in April 2016.

Benoit Combemale visited Professor Jorg Kienzle at McGill University for 3 weeks in June 2016; and visited Professor Bernhard Rumpe at Aachen University in April 2016.

8.4.2.1. Research Stays Abroad

Marcelino Rodriguez-Cancio visited Vanderbildt University from November 2016 to May 2017.

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DYOGENE Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Laboratory of Information, Networking and Communication Sciences (LINCS)

Dyogene participates in LINCS https://www.lincs.fr/, a research centre co-founded by Inria, Institut Mines-Télécom, UPMC and Alcatel-Lucent Bell Labs (currently Nokia Bell Labs) dedicated to research and innovation in the domains of future information and communication networks, systems and services. V. Anantharam [UC Berkeley] was invited professor by LINCS in June-July 2016. He was a speaker at the LINCS Shannon Day organized by M. Lelarge and F. Baccelli in June 2016.

9.2. National Initiatives

9.2.1. GdR GeoSto

Members of Dyogene participate in Research Group GeoSto (Groupement de recherche, GdR 3477) http://gdr-geostoch.math.cnrs.fr/ on Stochastic Geometry led by Pierre Calka [Université de Rouen]. This is a collaboration framework for all French research teams working in the domain of spatial stochastic modeling, both on theory development and in applications.

9.2.2. GdR IM

Members of Dyogene participate in GdR-IM (Informatique-Mathématiques), https://www.gdr-im.fr/, working groups ALEA and SDA2 (Systèmes dynamiques, Automates et Algorithmique).

9.2.3. GdR RO

Members of Dyogene participate in GdR-RO (Recherche Opérationelle; GdR CNRS 3002), http://gdrro.lip6.fr/, working group COSMOS (Stochastic optimization and control, modeling and simulation), lead by A. Busic and E. Hyon (LIP 6); http://gdrro.lip6.fr/?q=node/78

9.2.4. PGMO

Gaspard Monge Program for Optimization and Operations Research project Decentralized control for renewable integration in smart-grids (2015-17). PI: A. Busic.

9.2.5. ANR MARMOTE

Markovian Modeling Tools and Environments - coordinator: Alain Jean-Marie (Inria Maestro); local coordinator (for partner Inria Paris-Rocquencourt): A. Bušić; Started: January 2013; Duration: 48 months; partners: Inria Paris-Rocquencourt (EPI DYOGENE), Inria Sophia Antipolis Méditerranée (EPI MAESTRO), Inria Grenoble Rhône-Alpes (EPI MESCAL), Université Versaillese-St Quentin, Telecom SudParis, Université Paris-Est Creteil, Université Pierre et Marie Curie.

The aim of the project is to realize a modeling environment dedicated to Markov models. One part will develop the Perfect Simulation techniques, which allow to sample from the stationary distribution of the process. A second one will develop parallelization techniques for Monte Carlo simulation. A third one will develop numerical computation techniques for a wide class of Markov models. All these developments will be integrated into a programming environment allowing the specification of models and their solution strategy. Several applications will be studied in various scientific disciplines: physics, biology, economics, network engineering.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. PARIS

Title: Probabilistic Algorithms for Renewable Integration in Smart Grid

International Partner (Institution - Laboratory - Researcher):

University of Florida (United States) — Sean Meyn

Start year: 2015

See also: http://www.di.ens.fr/~busic/PARIS/

The importance of statistical modeling and probabilistic control techniques in the power systems area is now evident to practitioners in both the U.S. and Europe. Renewable generation has brought unforeseen volatility to the grid that require new techniques in distributed and probabilistic control. In a series of recent papers the two PIs have brought together their complementary skills in optimization, Markov modeling, simulation, and stochastic networks that may help to solve some pressing open problems in this area. This new research also opens many exciting new scientific questions.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

- B. Blaszczyszyn is collaborationg with T. Rolski, R. Szekli, (University of Wroclaw), D. Yogesh-waran (Indian Statistical Institute) and Y. Yukich (Lehigh University)

- A. Busic is participating to the ARPA-E Powernet project led by Ram Rajagopal (Stanford); https://web.stanford.edu/~ramr/powernet.htm

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Sean Meyn [Professor, University of Florida, Jun 2016]
- Adithya Munegowda Devraj [PhD student, University of Florida, May – Jul 2016]
- Sebastien Ziesche [PdD student, Karlsruhe Institute of Technology, March 2016]

<p style="text-align:center;color:red;font-weight:bold;">EVA Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

The Inria-EVA team has not been involved in an ANR project in 2016.

9.1.2. Competitivity Clusters

9.1.2.1. SAHARA

Participants: Pascale Minet, Erwan Livolant.

Period: 2011 - 2016.

Partners: EADS (coordinator), Astrium, BeanAir, CNES, ECE, EPMI, Eurocopter, GlobalSys, Inria, LIMOS, Oktal SE, Reflex CES, Safran Engineering Systems.

SAHARA is a FUI project, labeled by ASTECH and PEGASE, which aims at designing a wireless sensor network embedded in an aircraft. The proposed solution should improve the embedded mass, the end-to-end delays, the cost and performance in the transfers of non critical data.

This project ended in March 2016. After a presentation of the SAHARA project at the IEEE WISEE 2015 conference (Wireless for Space and Extreme Environments), we were selected to write a book chapter entitled "Multichannel Wireless Sensor Networks for Aircraft: Challenges and Issues" in the Wiley book "Wireless sensor systems for extreme environments: space, underwater, underground and industrial".

9.1.2.2. CONNEXION

Participants: Pascale Minet, Ines Khoufi, Erwan Livolant.

Period: 2012 - 2016.

Partners: EDF (coordinator), All4Tec, ALSTOM, AREVA, Atos WorldGrid, CEA, CNRS / CRAN, Corys TESS, ENS Cachan, Esterel Technologies, Inria, LIG, Predict, Rolls-Royce Civil Nuclear, Telecom ParisTech.

The Cluster CONNEXION (Digital Command Control for Nuclear EXport and renovatION) project aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. This architecture integrates a set of technological components developed by the academic partners (CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech) and based on collaborations between major integrators such as ALSTOM and AREVA, the operator EDF in France and "techno-providers" of embedded software (Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict). With the support of the competitiveness clusters System@tic, Minalogic and Burgundy Nuclear Partnership,the project started in April 2012. The key deliverables of the project covered several topics related demonstration concern-driven engineering models for the design and validation of large technical systems, design environments and evaluation of HMI, the implementation of Wireless Sensor Network context-nuclear, buses business object or real-time middleware facilitating the exchange of heterogeneous data and distributed data models standardized to ensure consistency of digital systems.

The EVA team focuses more particularly on the interconnection of the OCARI wireless sensor network with the industrial facility backbone and deployment algorithms of wireless sensors.

In the Cluster Connexion project, the goal for the EVA team was to design and implement new functionnalities for the OCARI wireless sensor network to allow it to:

- support the mobility of some sensor nodes (targeted application: remote dosimetry to monitor the exposition of people to radiations),

- transmit commands to sensors/actuators (e.g. configuration parameters, regeneration order),

- ensure data gathering during node recoloring,

- remotely manage the parameters of the OCARI network,

- aggregate in a single frame several heterogeneous measures originated from different sensors on a same wireless node,

- use a generic format for the measures: type, length, value.

- integrate this network to the middleware of context-aware services, OPC-UA/ROSA.

The demonstrator "a mobile connected worksite" developed in the Cluster Connexion project meets several objectives:

- Make the wireless sensor networks more reliable in an ionisating environment ionisant;

- Make easier the diagnostic and the repairing by means of the aggregation of data originated from heterogeneous sources;

- Take into account the requirements of information security in the architectures;

- Ensure a continuum of solutions for the industrial involved.

The Industrial IoT (Internet of Things) solution proposed by Connexion is an integrated chain, from the wireless sensor& actuator network up to the surveillance, diagnostic and health infrastructure monitoring applications, using a context-aware middleware fitting the industrial environment.

At the end of the Cluster Connexion project, we made the demonstration of a command/control loop for the regeneration of wireless sensor nodes in collaboration with CEA, Predict, Telecom ParisTech, EDF, ATOS and Inria highlighting the following steps:

- the upstream flow of health indicators from electronic devices,

- detection of an abnormal behavior by a monitoring software (KASEM),

- generation of a regeneration command and transmission of this command to the misbehaving sensor node.

- regeneration of the involved sensor

- insertion of the regenerated sensor in the OCARI network.

When the Cluster Connexion project ended, the results obtained with regard to the OCARI network and the OPC-UA/ROSA middleware have been transferred to the Task Force ConnexSensors hosted by AFNeT. The goals of the ConnexSensors TaskForce are:

- Federate industrial companies around an IoT solution IoT including wireless sensor & actuator networks and a standardized industrial middleware.

- Jointly valorize the OCARI wireless sensor & actuator network and the OPC-UA/ROSA middleware.

- Deploy the Connexion demonstrator in the basemenet of interested industrials.

- Ensure that industrials will keep the mastership of their data.

- Ensure the perennity of the solution proposed.

9.1.3. Other collaborations

EVA has a collaboration with Vedecom. **Paul Muhlethaler** supervises Younes Bouchaala's PhD funded by Vedecom. This PhD aims at studying vehicle-to-vehicle communication to improve roads safety.

9.2. European Initiatives

9.2.1. H2020 Projects

9.2.1.1. F-Interop

Type: H2020

Objective: Design and implement a cloud-based interoperability testing platform for low-power wireless standards.

Duration: Nov 2015 - Oct 2017

Coordinator: UPMC (FR)

Other partners: iMinds (BE), ETSI (FR), EANTC (DE), Mandat International (CH), DigiCat (UK), UL (LU), Inria (FR), Device Gateway (CH)

Inria contact: **Thomas Watteyne**

9.2.1.2. ARMOUR

Type: H2020

Objective: Security for the IoT

Duration: Dec 2015 – Nov 2017

Coordinator: UPMC (FR)

Other partners: Inria (FR), Synelixis (EL), Smartesting (FR), Unparallel (PT), JRC (BE), Ease Global Market (FR), Odin Solutions (ES)

Inria-EVA contact: **Thomas Watteyne**

9.2.1.3. Project Reviewing

- **Paul Muhlethaler** was reviewer for the E3Network project (E-band transceiver for the backhaul infrastructure of the future networks). The transceiver designed in the E3Network project will use modern digital multi-level modulations to achieve high spectral efficiency. This together with the huge bandwidth will enable high capacities above 10 Gbps.

9.2.2. Collaborations in European Programs, Except H2020

The Inria-EVA team has not participated in non-H2020 European Programs in 2016.

9.2.3. Collaborations with Major European Organizations

European Telecommunications Standards Institute (ETSI)

co-organize two ETSI 6TiSCH plugtests in 2016 (in Paris in February, in Berlin in July).

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. REALMS Associate Team

Type: Associate Team

Inria International Lab: Inria@SiliconValley

Title: Real-Time Real-World Monitoring Systems

Associate teams: Inria-EVA, Prof. Glaser's team (UC Berkeley), Prof. Kerkez's team (University of Michigan, Ann Arbor)

Duration: 2015-2017

Objective: Prof. Glaser's and Prof. Kerkez's teams are revolutionizing environmental monitoring by using low power wireless TSCH networks to produce continuous environmental data accessible in real time. They are successfully deploying these networks to study mountain hydrology, observe water quality in urban watersheds, and build intelligent urban stormwater grids. The REALMS associate team conducts research across the environmental engineering and networking research domains. Its 3-year goal is to develop easy-to-use real-world network monitoring solutions to provide real-time data for environmental and urban applications. This goal leads to the following objectives: building a long-term large-scale public connectivity dataset of the networks deployed; using that dataset to model TSCH networks; and building an ecosystem of tools around this technology.

website: http://www.snowhow.io/

Inria contact: **Thomas Watteyne**

9.3.1.2. DIVERSITY Associate Team

Type: Associate Team

Inria International Lab: Inria@SiliconValley

Title: Measuring and Exploiting Diversity in Low-Power Wireless Networks

Associate teams: Inria-EVA, Prof. Bhaskar Krishnamachari's team, USC, CA, USA

Duration: 2016-2018

Objective: The Grand Challenge of the DIVERSITY associate team is to develop the networking technology for tomorrow's Smart Factory. The two teams come with a perfectly complementary background on standardization and experimentation (Inria-EVA) and scheduling techniques (USC-ANRG). The key topic addressed by the joint team will be networking solutions for the Industrial Internet of Things (IIoT), with a particular focus on reliability and determinism.

Inria contact: **Thomas Watteyne**

9.3.2. Inria Associate Teams Not Involved in an Inria International Labs

9.3.2.1. Tassili

The Tassili project (N° MDU 17MDU988 - Campus France N° 37459VF) "Gestion des caches et orchestration intelligentes dans un environnement réseau virtulaisé" is a project in collaboration with Algeria and France. On the French side, the project is leaded by Samia Bouzefrane (associated professor at CNAM) and **Paul Muhlethaler** (EVA team Inria). On the Algerian side is leaded by the University Mouloud Mammeri of Tizi-Ouzou (UMMTO) représenté by Mehammed Daoui (associated professor).

This project will start in January 2017 and will last three years. Three PhD theses will be conducted in co-tutelle between CNAM and UMMTO. This project will support the stay of the tree PhD candidates for a four months visit in France. These two PhD theses will be co-directed by **Paul Muhlethaler**. The first subject is "New intelligent caching and mobility strategies for MEC/ICN based architectures" and the second subject concern the design of a safe architecture for Name Data Networking.

9.3.3. Inria International Partners

9.3.3.1. Declared Inria International Partners

University of California, Berkeley, CA, USA (Glaser)

- Collaboration with Prof. Steven Glaser, Ziran Zhang, Carlos Oroza, Sami Malek and Zeshi Zheng through the REALMS associate team, see Section 9.3.1.1 .
- Joint publication in 2016:
    - Long-term Monitoring of the Sierra Nevada Snowpack Using Wireless Sensor Networks. Ziran Zhang, Steven Glaser, Thomas Watteyne, Sami Malek. IEEE Internet of Things Journal, special issue on Large-scale Internet of Things: Theory and Practice, to appear in 2016.

- – Demo: SierraNet: Monitoring the Snow Pack in the Sierra Nevada. Keoma Brun-Laguna, Carlos Oroza, Ziran Zhang, Sami Malek, Thomas Watteyne, Steven Glaser. ACM International Conference on Mobile Computing and Networking (MobiCom), Workshop on Challenged Networks (CHANTS), 7 October 2016, New York, NY, USA.

- – (Not so) Intuitive Results from a Smart Agriculture Low-Power Wireless Mesh Deployment. Keoma Brun-Laguna, Ana Laura Diedrichs, Diego Dujovne, Rémy Léone, Xavier Vilajosana, Thomas Watteyne. ACM International Conference on Mobile Computing and Networking (MobiCom), Workshop on Challenged Networks (CHANTS), 7 October 2016, New York, NY, USA.

- – SOL: An End-to-end Solution for Real-World Remote Monitoring Systems. Keoma Brun-Laguna, Thomas Watteyne, Sami Malek, Ziran Zhang, Carlos Oroza, Steven Glaser, Branko Kerkez. IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Valencia, Spain, 4-7 September 2016.

University of Southern California, CA, USA

- Collaboration with Prof. Bhaskar Krishnamachari through the DIVERSITY associate team, see Section 9.3.1.2 .

- Joint publication in 2016:

  - – Insights into Frequency Diversity from Measurements on an Indoor Low Power Wireless Network Testbed. Pedro Henrique Gomes, Ying Chen, Thomas Watteyne, Bhaskar Krishnamachari. IEEE Global Telecommunications Conference (GLOBECOM), Workshop on Low-Layer Implementation and Protocol Design for IoT Applications (IoT-LINK), Washington, DC, USA, 4-8 December 2016.

  - – Reliability through Time-Slotted Channel Hopping and Flooding-based Routing. Pedro Henrique Gomes, Thomas Watteyne, Pradipta Gosh, Bhaskar Krishnamachari. International Conference on Embedded Wireless Systems and Networks (EWSN), Dependability Competition, ACM, Graz, Austria, 14-15 February 2016.

Universidad Tecnologica Nacional, Mendoza, Argentina

- Collaboration with Ana Laura Diedrichs, Juan Carlos Taffernaberry, Gustavo Mercado through the SticAmSud PEACH project.

- Joint publication(s) in 2016:

  - – PEACH: Predicting Frost Events in Peach Orchards Using IoT Technology. Thomas Watteyne, Ana Laura Diedrichs, Keoma Brun-Laguna, Javier Emilio Chaar, Diego Dujovne, Juan Carlos Taffernaberry, Gustavo Mercado. EAI Endorsed Transactions on the Internet of Things, to appear in 2016.

  - – A Demo of the PEACH IoT-based Frost Event Prediction System for Precision Agriculture. Keoma Brun-Laguna, Ana Laura Diedrichs, Javier Emilio Chaar, Diego Dujovne, Juan Carlos Taffernaberry, Gustavo Mercado, Thomas Watteyne. IEEE International Conference on Sensing, Communication and Networking (SECON), poster and demo session, London, UK, 27-30 June 2016

University of Michigan, Ann Arbor, MI, USA

- Collaboration with Prof. Branko Kerkez through the REALMS associate team, see Section 9.3.1.1 .

Linear Technology/Dust Networks, Silicon Valley, USA

- Collaboration with Prof. Kris Pister, Dr. Brett Warneke, Dr. Lance Doherty, Dr. Jonathan Simon and Joy Weiss on SmartMesh IP and 6TiSCH standardization.

9.3.3.2. Informal International Partners

      University of California, Berkeley, CA, USA (Pister)

- Collaboration with Prof. Kris Pister through the IETF 6TiSCH working group.
- Joint publication in 2016:
  - Simple Distributed Scheduling with Collision Detection in TSCH Networks. Kazushi Muraoka, Thomas Watteyne, Nicola Accettura, Xavi Vilajosana, Kris Pister. IEEE Sensors Letters, to appear in 2016.

      Open University of Catalunya, Spain

- Collaboration with Xavi Vilajosana and Pere Tuset through IETF 6TiSCH working group and the OpenWSN project.
- Joint publication(s) in 2016:
  - Distributed PID-based Scheduling for 6TiSCH Networks. Marc Domingo-Prieto, Tengfei Chang, Xavier Vilajosana, Thomas Watteyne. IEEE Communications Letters, vol PP, Issue 99, March 2016.
  - Poster Abstract: A Benchmark for Low-power Wireless Networking. Simon Duquennoy, Olaf Landsiedel, Carlo Alberto Boano, Marco Zimmerling, Jan Beutel, Mun Choon Chan, Omprakash Gnawali, Mobashir Mohammad, Luca Mottola, Lothar Thiele, Xavier Vilajosana, Thiemo Voigt, Thomas Watteyne. ACM Conference on Embedded Networked Sensor Systems (ACM Sensys), Stanford, CA, USA, 14-16 November 2016.
  - Rover: Poor (but Elegant) Man's Testbed. Zacharie Brodard, Hao Jiang, Tengfei Chang, Thomas Watteyne, Xavier Vilajosana, Pascal Thubert, Geraldine Texier. ACM International Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks (PE-WASUN), Valletta, Malta, 13-17 November 2016.
  - Determinism Through Path Diversity: Why Packet Replication Makes Sense. Jesica de Armas, Pere Tuset, Tengfei Chang, Ferran Adelantado, Thomas Watteyne, Xavier Vilajosana. International Conference on Intelligent Networking and Collaborative Systems (INCoS), Ostrava, Czech Republic, 7-9 September 2016.
  - OpenWSN & OpenMote: Demo'ing A Complete Ecosystem for the Industrial Internet of Things. Tengfei Chang, Pere Tuset-Peiro, Jonathan Munoz, Xavier Vilajosana, Thomas Watteyne. IEEE International Conference on Sensing, Communication and Networking (SECON), poster and demo session, London, UK, 27-30 June 2016.
  - OpenMote+: a Range-Agile Multi-Radio Mote. Pere Tuset, Xavier Vilajosana, Thomas Watteyne. International Conference on Embedded Wireless Systems and Networks (EWSN), NexMote Workshop, ACM, Graz, Austria, 14-15 February 2016.
  - Numerous IETF Internet-Drafts.

      University of Science and Technology, Beijing, China

- Collaboration with Qin Wang through IETF 6TiSCH working group. Tengfei Chang, engineer at Inria-EVA, comes from her team
- Joint publication(s) in 2016:
  - On-the-Fly Bandwidth Reservation for 6TiSCH Wireless Industrial Networks. Maria-Rita Palattella, Thomas Watteyne, Qin Wang, Kazuki Muraoka, Nicola Accettura, Diego Dujovne, Alfredo Grieco, Thomas Engel. IEEE Sensors Journal, 15 January 2016.

– LLSF: Low Latency Scheduling Function for 6TiSCH Networks. Tengfei Chang, Thomas Watteyne, Qin Wang, Xavier Vilajosana. IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS), Washington, DC, USA, 26-28 May 2016.

University of Bari, Italy

- Collaboration with Savio Sciancalepore, Giuseppe Piro and Gennaro Boggia through IETF 6TiSCH and OpenWSN.
- Joint publication in 2016:
    – Link-layer Security in TSCH Networks: Effect on Slot Duration. Savio Sciancalepore, Malisa Vucinic, Giuseppe Piro, Gennaro Boggia, Thomas Watteyne. Wiley Transactions on Emerging Telecommunications Technologies (ETT), to appear in 2016.

University of Trento, Italy

- Collaboration with Oana Iova through IETF 6TiSCH working group.
- Joint publication(s) in 2016:
    – The Love-Hate Relationship between IEEE802.15.4 and RPL. Oana Iova, Fabrice Theoleyre, Thomas Watteyne, Thomas Noel. IEEE Communications Magazine, to appear in 2016.

TU Berlin, Germany

- Collaboration with Vlado Handziski, Adam Wolisz through IETF 6TiSCH working group.
- Joint publication(s) in 2016:
    – Industrial Wireless IP-based Cyber Physical Systems. Thomas Watteyne, Vlado Handziski, Xavier Vilajosana, Simon Duquennoy, Oliver Hahm, Emmanuel Baccelli, Adam Wolisz. Proceedings of the IEEE, Vol. PP, Issue 99, pp. 1-14, March 2016.

Mandat International, Switzerland

- Collaboration with Sebastien Ziegler through the H2020 F-Interop project
- Joint publication(s) in 2016:
    – F-Interop – Online Platform of Interoperability and Performance Tests for the Internet of Things. Sébastien Ziegler, Serge Fdida, Cesar Viho, Thomas Watteyne. Conference on Interoperability in IoT (InterIoT), Paris, France, 26-28 October 2016.

KU Leuven, Belgium

- Collaboration with Prof. Danny Hughes, Prof. Wouter Joosen, Dr. Nelson Matthys, Fan Yang, Wilfried Daniels on MicroPnP.

Inria-EVA has a strong relationship with ENSI (Tunisia) and ENSIAS (Morocco). A significant part of our PhD students come from these engineering schools.

9.3.4. Participation in Other International Programs

9.3.4.1. PEACH

Program: STIC-AmSud 2015

Title: PEACH - PrEcision Agriculture through Climate researcH

Inria principal investigator: **Thomas Watteyne**

International Partners (Institution - Laboratory - Researcher):

Escuela de Informática y Telecomunicaciones, Universidad Diego Portales, Santiago, Chile. Coordinator: Prof. Diego Dujovne

Universidad Tecnológica Nacional - Facultad Regional Mendoza, Grupo de I&D en Tecnologías de la Información y Comunicaciones (GridTICS). Coordinator: Prof. Gustavo Mercado

DHARMa Lab, Universidad Tecnológica Nacional, Facultad Regional Mendoza, Argentina.

Cátedra de Fisiología Vegetal, Facultad de Ciencias Agrarias, Universidad Nacional de Cuyo, Mendoza, Argentina.

Duration: 2016-2017

Goal: Propose a design methodology for a lowpower wireless IoT sensing network, given the requirements and restrictions of a Machine Learning model to predict frost events in peach orchards and vineyards.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Professors/Researchers:
    - **Mario Gerla**, Professor, UCLA, USA, visit 10-20 December 2016
    - **Leila Saidane**, Professor, ENSI, Tunis, Tunisia, visit November 2016
    - **Felipe Lalanne**, Reseacher, Inria Chile, Chile, visit 19–26 October 2016
    - **Mario Gerla**, Professor, UCLA, USA, visit 31 August - 23 September 2016
    - **Diego Dujovne**, Professor, Universidad Diego Portales, Chile, visit 22-31 July 2016
    - **Ruben Milocco**, Universidad Nacional Comahue, Argentina, visit July 2016
    - **Branko Kerkez**, Professor, U. Michigan, USA, visit 17-22 June 2016
    - **Steven Glaser**, Professor, UC Berkeley, USA, visit 21-25 March 2016
    - **Xavi Vilajosana**,Professor, UOC/OpenMote, Spain, visit 2-4 February 2016
- PhD Students:
    - **Travis Massey**, PhD Student, UC Berkeley, USA, visit 22 July 2016
    - **Carlos Oroza**, PhD Student, UC Berkeley, USA, visit 23-29 July 2016
    - **David Burnett**, PhD Student, UC Berkeley, USA, visit 13-15 June 2016
    - **Filip Barac**, PhD Student, Mid Sweden University, Sweden, visit 8-19 February 2016

9.4.2. Internships

- **Jiangnan Yang**, internship on simulation of wireless TDMA networks with NS3, March-August 2016.

9.4.3. Visits to International Teams

9.4.3.1. Research Stays Abroad

- **Keoma-Brun Laguna**, stay in Prof. Glaser's lab at UC Berkeley, USA, August 2016.
- **Thomas Watteyne**, stay in Prof. Glaser and Prof. Pister's labs at UC Berkeley, USA, August 2016.

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FOCUS Project-Team

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8. Partnerships and Cooperations

8.1. National Initiatives

- REVER (Programming Reversible Recoverable Systems) is an ANR project with a 4-year duration. REVER aims to study the possibility of defining semantically well-founded and composable abstractions for dependable computing on the basis of a reversible programming language substrate, where reversibility means the ability to undo any distributed program execution, possibly step by step. The critical assumption behind REVER is that by adopting a reversible model of computation, and by combining it with appropriate notions of compensation and modularity, one can develop systematic and composable abstractions for recoverable and dependable systems. Main persons involved: Giachino, Lanese, Laneve, Zavattaro.

- PACE (Processus non-standard: Analyse, Coinduction, et Expressivité) is an ANR project with a 4-year duration. The project targets three fundamental ingredients in theories of concurrent processes, namely coinduction, expressiveness, and analysis techniques. The project targets processes that are beyond the realm of "traditional" processes. Specifically, the models studied exhibit one or more of the following features: probabilities, higher-order, quantum, constraints, knowledge, and confidentiality. These models are becoming increasingly important for today's applications. Coinduction is intended to play a pivotal role. Indeed, the approaches to expressiveness and the analysis techniques considered in the project are based on coinductive equalities. Main persons involved: Hirschkoff (project coordinator), Dal Lago, Lanese, Sangiorgi, Zavattaro.

- ELICA (Expanding Logical Ideas for Complexity Analysis) is an ANR project that started on October 2014 and that will finish on September 2018. ELICA focuses on methodologies for the static analysis of programs and their resource consumption. The project's aim is to further improve on logical methodologies for complexity analysis (type systems, rewriting, etc.). More specifically, one would like to have more powerful techniques with less false negatives, being able at the same time to deal with nonstandard programming paradigms (concurrent, probabilistic, etc.). Main persons involved: Avanzini, Cappai, Dal Lago, Hirschkoff, Martini, Sangiorgi.

- REPAS (Reliable and Privacy-Aware Software Systems via Bisimulation Metrics) is an ANR Project that started on October 2016 and that will finish on October 2020. The project aims at investigating quantitative notions and tools for proving program correctness and protecting privacy. In particular, the focus will be put on bisimulation metrics, which are the natural extension of bisimulation to quantitative systems. As a key application, we will develop a mechanism to protect the privacy of users when their location traces are collected. Main persons involved: Dal Lago, Martini, Sangiorgi.

- COCAHOLA (Cost models for Complexity Analyses of Higher-Order Languages) is an ANR Project that started on October 2016 and that will finish on October 2019. The project aims at developing complexity analyses of higher-order computations. The focus is not on analyzing fixed programs, but whole programming languages. The aim is the identification of adequate units of measurement for time and space, i.e. what are called reasonable cost models. Main persons involved: Dal Lago, Martini.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- ENVISAGE (Engineering Virtualized Services) is a EU FP7 project, with starting date October 1st, 2013, and with a 3-year duration. The project is about model-based development of virtualized services, including tool support for resource analysis. Most Focus members are involved.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

- The ICT COST Action BETTY (Behavioural Types for Reliable Large-Scale Software Systems). initiated in October 2012 and with a 4-year duration, uses behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreographies. Main persons involved: Bravetti, Giachino, Hirschkoff, Lanese, Laneve, Mauro, Sangiorgi, Zavattaro.

- ICT COST Action IC1405 (Reversible computation - extending horizons of computing). Initiated at the end of April 2015 and with a 4-year duration, this COST Action studies reversible computation and its potential applications, which include circuits, low-power computing, simulation, biological modeling, reliability and debugging. Reversible computation is an emerging paradigm that extends the standard forwards-only mode of computation with the ability to execute in reverse, so that computation can run backwards as naturally as it can go forwards.

    Main persons involved: Giachino, Lanese (vice-chair of the action).

- ICT COST Action IC1402 ARVI (Runtime Verification beyond Monitoring) Initiated in December 2014 and with a 4-year duration, this COST Action studies runtime verification, a computing analysis paradigm based on observing a system at runtime to check its expected behaviour.

    Main persons involved: Bravetti, Lanese.

- SMAll (Smart Mobility for All) SMAll is an EIT project that runs during 2016.

    The aim of the project is to develop a service-oriented platform, called the SMAll platform [0], to support the creation of a liquid market for transportation, facilitating the publication, retrieval, and orchestration of functionalities for transportation, owned by different operators.

    Jolie plays a prominent part in the development of the SMAll platform: it is the main language for the development of both the platform — the architecture of services that support publishing, organisation, and interaction among the functionalities for transportation — and of the services for mobility.

8.2.3. Collaborations with Major European Organizations

Simone Martini is a member of the Executive Board of EQANIE (European Quality Assurance Network for Informatics Education), from October 2014.

We list here the cooperations and contacts with other groups, without repeating those already listed in previous sections.

- ENS Lyon (on concurrency models and resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi, Vignudelli. Some visit exchanges during the year, in both directions. A new joint PhD started in september 2016 (Adrien Durier).

- Inria EPI Spades (on models and languages for components, reversibility). Contact person(s) in Focus: Lanese. Some visit exchanges during the year, in both directions.

- Laboratoire d'Informatique, Université Paris Nord, Villetaneuse (on implicit computational complexity). Contact person(s) in Focus: Dal Lago, Martini. An Italian PhD student (Marco Solieri) is working on his PhD thesis with joint supervision (Martini, Guerrini).

- Institut de Mathématiques de Luminy, Marseille (on lambda-calculi, linear logic and semantics). Contact person(s) in Focus: Dal Lago, Martini.

- Team PPS, IRIF Lab, University of Paris-Diderot Paris 7 (on logics for processes, resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi. Some short visits in both directions during the year.

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[0]https://github.com/small-dev/SMAll.Wiki/wiki

- IRILL Lab, Paris (on models for the representation of dependencies in distributed package based software distributions). Contact person(s) in Focus: Mauro, Zavattaro. Some short visits in both directions during the year.

- EPI Carte, Inria-Nancy Grand Est and LORIA (on implicit computational complexity). Contact person(s) in Focus: Dal Lago.

- LMU Munich (M. Hofmann) (on implicit computational complexity and IntML). Contact person(s) in Focus: Dal Lago.

- IMDEA Software, Madrid (G. Barthe) (on implicit computational complexity for cryptography). Contact person(s) in Focus: Dal Lago,Sangiorgi. Some visits during the year.

- Facultad de Informatica, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project "Desarrollo y Análisis formal de sistemas complejos en contextos DistribuidOS: fundamentos, herramientas y aplicaciones (DArDOS)" (Development and formal analysis of complex systems in distributed contexts: foundations, tools and applications) January 2016 - December 2018, funded by the Spanish Ministerio de Economia y Competitividad.

8.3. International Initiatives

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. CRECOGI

Title: Concurrent, Resourceful and Effectful Computation, by Geometry of Interaction

International Partner (Institution - Laboratory - Researcher):

Tokyo (Japan) - Department of Computer Science, Graduate School of Information Science and Technology - Ichiro HASUO

Start year: 2015

See also: http://crecogi.cs.unibo.it

Game semantics and geometry of interaction (GoI) are two closely related frameworks whose strength is to have the characters of both a denotational and an operational semantics. They offer a high-level, mathematical (denotational) interpretation, but are interactive in nature. The formalization in terms of movements of tokens through which programs communicate with each other can actually be seen as a low-level program. The current limit of GoI is that the vast majority of the literature and of the software tools designed around it have a pure, sequential functional language as their source language. This project aims at investigating the application of GoI to concurrent, resourceful, and effectful computation, thus paving the way to the deployment of GoI-based correct-by-construction compilers in real-world software developments in fields like (massively parallel) high-performance computing, embedded and cyberphysical systems, and big data. The presence of both the japanese GoI community (whose skills are centered around effects and coalgebras) and the french GoI community (more focused on linear logic and complexity analysis) will bring essential, complementary, ingredients.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

The following researchers have visited Focus for short periods; we list them together with the title of the talk they have given during their stay, or the topic discussed during their stay.

- Marco Bernardo: "Disjunctive Probabilistic Modal Logic is Enough for Bisimilarity on Reactive Probabilistic Systems."

- Guillermo Roman Diez: "Resource Analysis."

- Lukasz Mikulski: "On Concurrency Paradigms."
- Jean-Pierre Jouannaud: "Coq modulo theory."
- Paul Blain Levy: "Trace semantics of well-founded processes via commutativity."
- Akihisa Yamada: "Certifying Safety and Termination Proofs for Integer Transition Systems" (long visit).
- Ryo Tanaka: semantics of higher-order functional languages (long visit).
- Antonio Ravara: "Behavioural Type Inference for Object-Oriented Languages".
- Lukasz Mikulski: "On concurrency paradigms".
- Ludovic Henrio, "Deadlock analysis in distributed object systems".

8.4.2. Visits to International Teams

- Ugo Dal Lago: has spent two weeks in April at ENS Lyon, and 1 month at IRIF, Université Paris 7, in May/June.
- Charles Grellois has taken part in the programme "Automata, Logic and Games", 5 weeks (August-September), Singapore.
- Valeria Vignudelli has spent six months in the Inria Comète team, Inria Saclay/Ecole Polytechnique, Paris.
- Abel Garcia has spent 6 months at the Department of Computer Science, TUD Darmstadt.

8.4.2.1. Sabbatical programme

Maurizio Gabbrielli is, since 15 September 2014, Head of the EIT ICT Labs Doctoral School with Paris as his principal location.

<p align="center" style="color:red">FUN Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Tracaverre

Participants: Nathalie Mitton [correspondant], Gabriele Sabatino.

> Title: Tracaverre
>
> Type: FUI
>
> Duration: November 2012 - Dec 2016
>
> Coordinator: Saver Glass
>
> Others partners: Inria FUN IEMN Courbon Camus La Grande Marque LIRIS DISP
>
> Tracaverre studies the use of RFID for traceability of prestigious bottles. Tracaverre has yielded to the implementation of the T-Scan software.

9.1.2. StoreConnect

Participants: Nathalie Mitton [correspondant], Valeria Loscri.

> Title: StoreConnect
>
> Type: FUI
>
> Duration: September 2016 - October 2018
>
> Coordinator: NEOSENSYS
>
> Others partners: Inria FUN, SPIRALS and STARS, TeVolys, Ubudu, Smile, STIME, Leroy Merlin
>
> The aim of StoreConnect is to provide French large retailers with efficient and powerful tools in the in-store customer interaction.

9.1.3. PIPA

Participants: Nathalie Mitton [correspondant], Farouk Mezghani, Cristina Cano Bastidas.

> Title: Partager de l'Info PArtout à bas coût
>
> Type: Chercheur citoyen
>
> Duration: Dec 2015 - Dec 2017
>
> Coordinator: Inria FUN
>
> Others partners: SpotTrotter
>
> PIPA project aims to provide an innovative low cost solution to share information in places where communication infrastructure are lacking, insuffisant or not adapted, going beyond technical, economical or political limitations.

9.2. National Initiatives

9.2.1. Inria Project Lab

9.2.1.1. CityLab@Inria
Participants: Valeria Loscri, Abdoul Aziz Mbacke, Nathalie Mitton [correspondant].

- Title: CityLab@Inria
- Type: IPL
- Duration: 2015 - 2019
- Coordinator: Valerie Issarny
- CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. Obviously, running urban-scale experiments is a central concern of the Lab, so that we are able to confront proposed approaches to actual settings. The Lab's research leverages relevant effort within Inria project-teams that is further revisited as well as integrated to meet the challenges of smart cities. Research themes span: energy-efficient wireless communication protocols, urban-scale social and physical sensing, privacy by design, cloud-based urban data management, data assimilation, visual analysis, and urban system software engineering. In addition, CityLab Inria research builds upon collaborative effort at the International level, and especially collaboration in the context of the Inria SiliconValley program. This project has yield to the set up of a full course on Smart Cities via a MOOC.

9.2.2. ADT

9.2.2.1. RFunID
Participants: Clement Fumey, Nathalie Mitton [correspondant], Julien Vandaele.

Duration: September 2015 - August 2017

Coordinator: Inria FUN

The purpose of this project is to deploy a large scale experimental RFID platform that enables remote programmation of RFID scenario on heterogeneous devices.

9.2.2.2. ARUNTA
Participants: Emilio Compagnone, Valeria Loscri [correspondant], Julien Vandaele.

Title: Arduino-based Robots for Ubiquitous Network (ARUNTA)

Type: ADT

Duration: September 2014 - August 2016

Coordinator: Inria FUN

Abstract: This ADT focuses on the use of Arduino, an open-source electronics prototyping platform, really flexible and easy-to-use [1] to allow a fleet of robots to perform specific tasks. The goal of the ADT is to make experiments on Arduino-based robotic platforms, by implementing two robot cooperation algorithms that have been already tested through simulation tools. In order to extend the users' community and to allow more people to benefit from this research on robot cooperation, this ADT will output a tutorial and a test-bed will be developed. Moreover, the final project will be shared with the Arduino community and every interested user.

9.2.3. Equipements d'Excellence

9.2.3.1. FIT

Participants: Nathalie Mitton [correspondant], Julien Vandaele.

Title: Future Internet of Things

Type: EquipEx

Duration: March 2010 - December 2019

Coordinator: UPMC

See also: http://fit-equipex.fr/

Abstract: FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Equipements d'Excellence" (Equipex) research grant program. Coordinated by Professor Serge Fdida of UPMC Sorbonne Universités and running over a nine-year period, the project will benefit from a 5.8 million euro grant from the French government. This project has yield to several publications in 2016: [44], [43].

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. VITAL

Participants: Salvatore Guzzo Bonifacio, Valeria Loscri, Nathalie Mitton [correspondant], Riccardo Petrolo.

Title: Virtualized programmable InTerfAces for innovative cost-effective IoT depLoyments in smart cities

Programm: FP7

Duration: September 2013 - December 2016

Coordinator: National University of Ireland Galway (NUIG)

Partners:

> Research and Education Laboratory in Information Technologies (Greece)
>
> Atos Spain (Spain)
>
> Camden Town Center (United Kingdom)
>
> Images & Co (United Kingdom)
>
> Istanbul Metropolitan Municipality (Turkey)
>
> Istanbul Teknik Universitesi (Turkey)
>
> National University of Ireland, Galway (Ireland)
>
> Santer Reply Spa (Italy)
>
> Singularlogic Anonymi Etairia Pliroforiakon Sistimaton Kai Efarmogon Pliroforikis (Greece)

Inria contact: Nathalie Mitton

Internet-of-Things (IoT) applications are currently based on multiple architectures, standards and platforms, which have led to a highly fragmented IoT landscape. This fragmentation is evident in the area of smart cities, which typically comprise several technological silos (i.e. IoT systems that have been developed and deployed independently). Nowadays there is a pressing need to remove these silos in order to allow cities to share data across systems and coordinate processes across domains, thereby essentially improving sustainability and quality of life. In response to this need, VITAL will realize a radical shift in the development, deployment and operation of IoT applications, through introducing an abstract virtualized digital layer that will operate across multiple IoT architectures, platforms and business contexts. Specifically, VITAL will provide platform and business context agnostic access to Internet-Connected-Objects (ICO). Moreover, it will research virtualized filtering, complex event processing (CEP) and business process management mechanisms, which will be operational over a variety of IoT architectures/ecosystems. The mechanisms will compromise the diverse characteristics of the underlying ecosystems, thereby boosting interoperability at the technical and business levels. VITAL will also provide development and governance tools, which will leverage the project's interfaces for virtualized access to ICOs.VITAL will allow solution providers to (re)use a wider range of data steams, thereby increasing the scope of potential applications. It will also enable a more connected/integrated approach to smart city applications development, which will be validated in realistic deployments in London and Istanbul. The partners will contribute and adapt a host of readily available urban infrastructures, IoT platforms and novel IoT applications, which will ease the accomplishment of the project's goals based on an optimal value for EC money. Publications in 2016 in the framework of this project are: [21], [44], [43], [42].

9.3.1.2. VESSEDIA

Participant: Simon Duquennoy [correspondant].

Title: VERIFICATION ENGINEERING OF SAFETY AND SECURITY CRITICAL DYNAMIC INDUSTRIAL APPLICATIONS

Programm: H2020

Duration: January 2017 - Dec. 2019

TECHNIKON FORSCHUNGS UND PLANUNGSGESELLSCHAFT MBH (TEC) The VESSEDIA project will bring safety and security to many new software applications and devices. In the fast evolving world we live in, the Internet has brought many benefits to individuals, organisations and industries. With the capabilities offered now (such as IPv6) to connect billions of devices and therefore humans together, the Internet brings new threats to the software developers and VESSEDIA will allow connected applications to be safe and secure. VESSEDIA proposes to enhance and scale up modern software analysis tools, namely the mostly open-source Frama-C Analysis platform, to allow developers to benefit rapidly from them when developing connected applications. At the forefront of connected applications is the IoT, whose growth is exponential and whose security risks are real (for instance in hacked smart phones). VESSEDIA will take this domain as a target for demonstrating the benefits of using our tools on connected applications. VESSEDIA will tackle this challenge by 1) developing a methodology that allows to adopt and use source code analysis tools efficiently and produce similar benefits than already achieved for highly-critical applications (i.e. an exhaustive analysis and extraction of faults), 2) enhancing the Frama-C toolbox to enable efficient and fast implementation, 3) demonstrating the new toolbox capabilities on typical IoT (Internet of Things) applications including an IoT Operating System (Contiki), 4) developing a standardisation plan for generalizing the use of the toolbox, 5) contributing to the Common Criteria certification process, and 6) defining a label "Verified in Europe" for validating software products with European technologies such as Frama-C.

9.4. International Initiatives

9.4.1. *Inria International Labs*

9.4.1.1. PREDNET

Participants: Simon Duquennoy, Nathalie Mitton [correspondant], Viktor Toldov, Julien Vandaele.

Title: Predator network

Type: LIRIMA with Stellenbosch University, South Africa

Duration: January 2013 - December 2016

See also: https://iww.inria.fr/prednet/en/

Abstract: PREDNET (PREDator adhoc NETwork) proposes to do research on the most suitable topology and subsequent deployment of a wireless sensor network for sparsely populated outlying rural and wilderness areas, for effective monitoring and protection of resources and ecosystems. This collaboration gave birth to joint project submission, joint conference organization and several publications, among them for 2016 [47], [48], [48], [49].

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

9.4.2.1. DepIoT
Participants: Simon Duquennoy [correspondant], Nathalie Mitton.

Title: DepIoT: Coexistence and Security for Dependable Internet of Things

Type: North-European Inria Associate Team with SICS, Sweden

Duration: Sept 2016 - August 2018

Abstract: In order to foster the adoption of IoT technologies, dependability must be guaranteed. We will tackle this challenge by ensuring operation even in the presence of other networks sharing the same frequency band (coexistence) and by enabling a secure communication.

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

Université Mediterranea di Reggio Calabria (UNIC) (Italy) Objective of this collaboration is the design of an innovative architecture that enables autonomic and decentralized fruition of the services offered by the network of smart objects in many heterogeneous and dynamic environments, in a way that is independent of the network topology, reliable and flexible. The result is an 'ecosystem' of objects, self-organized and self-sustained, capable of making data and services available to the users wherever and whenever required, thus supporting the fruition of an 'augmented' reality thanks to a new environmental and social awareness. This collaboration has allowed students and researchers exchanges and joint publications, among them for 2016: [20], [19].

9.4.3.2. Informal International Partners
Southern University, China

The purpose of this collaboration is to study the green (or energy-efficient) communication problem in vehicular ad hoc networks (VANETs) and the application of vehicular network communication in green transportation. In this framework, Nathalie Mitton visited the Nanjing University. It gave birth to joint project submission, joint conference organization (UIC 2016) and joint publications, one in 2016 [27].

Arun Sen from Arizona State University, USA

The purpose of this collaboration is to study the joint scheduling and trajectory of RFID readers in a mobile environment. In this framework, Arun Sen visited the FUN team for 6 months in 2015 and in July 2016. It gave birth to joint project submission, joint conference submission and joint publications, among them in 2016 [30], [29].

Anna-Maria Vegni from Roma Tre University, Italy

The purpose of this collaboration is to study alternative communication paradigms and investigate their limitations and different effects on performances. In this framework, joint publications have been obtained, among them in 2016 [51], [26], [53], [50], [46], [40], [16], [55], [15], [45], [25].

9.4.3.3. PhD co-supervision
Participants: Nathalie Mitton [correspondant], Mouna Masmoudi.

Since January 2013, Nathalie Mitton co-supervises Mouna Rekik as a PhD student with Pr Zied Chtourou from Université de Sfax, Tunisia. Her topic is about swarm intelligence based multi-path geographic routing for wireless sensor and actuator networks.

This work has led to the following publications in 2016: [23]. Mouna defended her PhD on July 26th 2016.

Since 2014, Simon Duquennoy co-supervised Anwar Hithnawi as a PhD student with Pr Friedemann Mattern from ETH Zurich, Sweden. Her research is on low-power wireless systems coexistence, and mitigation of cross-technology inteference. This work has led to the following publications in 2016: [39]. Anwar defended her PhD on November 8, 2016.

9.4.4. Participation in Other International Programs

9.4.4.1. CROMO
Participants: Valeria Loscri, Nathalie Mitton [correspondant], Riccardo Petrolo, Abdoul Aziz Mbacke.

Title: Crowd Data In the mobile cloud

Duration: January 2015 - December 2019

CroMo (Crowd Data In the mobile cloud) is a submission to the CAPES-COFECUB project call lead by Inria from the French side and University of Rio de Janeiro from Brazilian Side. Other partner institutions are Université Pierre et Marie Curie and Université de la Rochelle.

Mobile cloud computing is an emerging paradigm to improve the quality of mobile applications by transferring part of the computational tasks to the resource-rich cloud. The multitude data sources combined with the known difficulties of wireless communications represent an important issue for mobile cloud computing. Therefore, the additional computational power added by the cloud has to deal with the constraints of the wireless medium. One could imagine a situation where different sensors collect data and require intensive computation. This data must be transmitted at high rates before becoming stale. In this case, the network becomes the main bottleneck, not the processing power or storage size. To circumvent this issue, different strategies can be envisioned. As usual alternatives, wireless data rates must be increased or the amount of data sent to the cloud must be reduced. CROMO tackles challenges from all these three components of the mobile clouds (data generation, collect and processing) to then integrate them as a whole enhanced mobile cloud with improved network performances in terms of delay, energy consumption, availability, and reliability.

In this context, joint exchanges and crossed visits have been done (Aziz went to Rio, Dianne went to Lille). The project yield to several publications such as [35], [36], [37].

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Senior researchers

Several researchers have visited our group in 2016, mainly from our partner universities but not only:

- Zied Chtourou, Univ. Sfax, Tunisia, July 2016
- Arun Sen, Arizona State University, USA, July 2016
- Ahmet Sekercioglu, Monash University, Australia, July 2016
- Riaan Wolhuter, Univ. Stellenbosch, South Africa, July 2016
- Anwar Hithnawi, ETH Zurich, Switzerland, March 2016
- Hossein Shafagh, ETH Zurich, Switzerland, March 2016
- Cédric Chauvenet from ERDF, May 2016

9.5.1.2. Internships

Other students have visited us from our partner universities in the framework of the joint project we run together. This is the case for William Pretorius (2 months) who came from Stellenbosch university, South Africa, in the framework of the PredNET program and Rahul Vyas from IIIT Allahabad, India (2 months).

9.5.2. Visits to International Teams

- Riccardo Petrolo visited Ericsson group in Finland in April 2016.
- Nathalie Mitton visited Southeast university in Nanjing, China in June 2016.
- Simon Duquennoy visited SICS in Sweden in September 2016 and May 2016.
- Aziz Mbacke visited UFRJ in Brazil in November 2016.

GANG Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Laboratory of Information, Networking and Communication Sciences (LINCS)*

Gang is participating to the LINCS, a research centre co-founded by Inria, Institut Mines-Télécom, UPMC and Alcatel-Lucent Bell Labs, dedicated to research and innovation in the domains of future information and communication networks, systems and services. Gang contributes to work on online social networks, content centric networking and forwarding information verification.

8.2. National Initiatives

8.2.1. *ANR Displexity*

Participants: Carole Gallet Delporte, Hugues Fauconnier, Pierre Fraigniaud, Amos Korman, Adrian Kosowski, Laurent Viennot.

Managed by University Paris Diderot, C. Delporte and H. Fauconnier lead this project that grants 1 Post-Doc.

Distributed computation keep raising new questions concerning computability and complexity. For instance, as far as fault-tolerant distributed computing is concerned, impossibility results do not depend on the computational power of the processes, demonstrating a form of undecidability which is significantly different from the one encountered in sequential computing. In the same way, as far as network computing is concerned, the impossibility of solving certain tasks locally does not depend on the computational power of the individual processes.

The main goal of DISPLEXITY (for DIStributed computing: computability and ComPLEXITY) is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing.

One difficulty to be faced by DISPLEXITY is to reconcile the different sub-communities corresponding to a variety of classes of distributed computing models. The current distributed computing community may indeed be viewed as two not necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues. The different working frameworks tackled by these two communities induce different objectives: computability is the main concern of the former, while complexity is the main concern of the latter.

Within DISPLEXITY, the reconciliation between the two communities will be achieved by focusing on the same class of problems, those for which the distributed outputs are interpreted as a single binary output: yes or no. Those are known as the yes/no-problems. The strength of DISPLEXITY is to gather specialists of the two main streams of distributed computing. Hence, DISPLEXITY will take advantage of the experience gained over the last decade by both communities concerning the challenges to be faced when building up a complexity theory encompassing more than a fragment of the field.

In order to reach its objectives, DISPLEXITY aims at achieving the following tasks:

- Formalizing yes/no-problems (decision problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.

- Formalizing decision problems (yes/no-problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.

- Revisiting the various explicit (e.g., failure-detectors) or implicit (e.g., a priori information) notions of oracles used in the context of distributed computing allowing us to express them in terms of decidability/complexity classes based on oracles.

- Identifying the impact of non-determinism on complexity in distributed computing. In particular, DISPLEXITY aims at a better understanding of the apparent lack of impact of non-determinism in the context of fault-tolerant computing, to be contrasted with the apparent huge impact of non-determinism in the context of network computing. Also, it is foreseen that non-determinism will enable the comparison of complexity classes defined in the context of fault-tolerance with complexity classes defined in the context of network computing.

- Last but not least, DISPLEXITY will focus on new computational paradigms and frameworks, including, but not limited to distributed quantum computing and algorithmic game theory (e.g., network formation games).

The project will have to face and solve a number of challenging problems. Hence, we have built the DISPLEXITY consortium so as to coordinate the efforts of those worldwide leaders in Distributed Computing who are working in our country. A successful execution of the project will result in a tremendous increase in the current knowledge and understanding of decentralized computing and place us in a unique position in the field.

The project has been extended until June 2016.

8.2.2. ANR DESCARTES

Participants: Carole Gallet Delporte, Hugues Fauconnier, Pierre Fraigniaud, Adrian Kosowski, Laurent Viennot.

Cyril Gavoille (U. Bordeaux) leads this project that grants 1 Post-Doc. H. Fauconnier is the local coordinator (This project began in October 2016).

Despite the practical interests of reusable frameworks for implementing specific distributed services, many of these frameworks still lack solid theoretical bases, and only provide partial solutions for a narrow range of services. We argue that this is mainly due to the lack of a generic framework that is able to unify the large body of fundamental knowledge on distributed computation that has been acquired over the last 40 years. The DESCARTES project aims at bridging this gap, by developing a systematic model of distributed computation that organizes the functionalities of a distributed computing system into reusable modular constructs assembled via well-defined mechanisms that maintain sound theoretical guarantees on the resulting system. DESCARTES arises from the strong belief that distributed computing is now mature enough to resolve the tension between the social needs for distributed computing systems, and the lack of a fundamentally sound and systematic way to realize these systems.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Amos Korman has an ERC Consolidator Grant entitled "Distributed Biological Algorithms (DBA)", started in May 2015. This project proposes a new application for computational reasoning. More specifically, the purpose of this interdisciplinary project is to demonstrate the usefulness of an algorithmic perspective in studies of complex biological systems. We focus on the domain of collective behavior, and demonstrate the benefits of using techniques from the field of theoretical distributed computing in order to establish algorithmic insights regarding the behavior of biological ensembles. The project includes three related tasks, for which we have already obtained promising preliminary results. Each task contains a purely theoretical algorithmic component as well as one which integrates theoretical algorithmic studies with experiments. Most experiments are strategically designed by the PI based on computational insights, and are physically conducted by experimental biologists that have been carefully chosen by the PI. In turn, experimental outcomes will be theoretically analyzed via an algorithmic perspective. By this integration, we aim at deciphering how a biological individual (such as an ant) "thinks", without having direct access to the neurological process within

its brain, and how such limited individuals assemble into ensembles that appear to be far greater than the sum of their parts. The ultimate vision behind this project is to enable the formation of a new scientific field, called algorithmic biology, that bases biological studies on theoretical algorithmic insights.

8.3.2. LIA Struco

Pierre Charbit is director of the LIA STRUCO, which is an Associated International Laboratory of CNRS between IÚUK, Prague, and IRIF, Paris. The director on the Czech side is Pr. Jaroslav Nešetřil. The primary theme of the laboratory is graph theory, more specifically: sparsity of graphs (nowhere dense classes of graphs, bounded expansion classes of graphs), extremal graph theory, graph coloring, Ramsey theory, universality and morphism duality, graph and matroid algorithms and model checking.

STRUCO focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work.

One of the main goals of STRUCO is to provide a sustainable and reliable structure to help Czech and French researchers cooperate on long-term projects, disseminate the results to students of both countries and create links between these students more systematically. The chosen themes of the project indeed cover timely and difficult questions, for which a stable and significant cooperation structure is needed. By gathering an important number of excellent researchers and students, the LEA will create the required environment for making advances, which shall be achieved not only by short-term exchanges of researchers, but also by a strong involvement of Ph. D students in the learning of state-of-the-art techniques and in the international collaborations.

STRUCO is a natural place to federate and organize these many isolated collaborations between our two countries. Thus, the project would ensure long-term cooperations and allow young researchers (especially PhD students) to maintain the fruitful exchanges between the two countries in the future years, in a structured and federated way.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

Ofer Feinerman (Physics department of complex systems, Weizmann Institute of Science, Rehovot, Israel), is a team member in Amos Korman's ERC project DBA. This collaboration has been formally established by signing a contract between the CNRS and the Weizmann Institute of Science, as part of the ERC project.

Rachid Guerraoui (School of Computer and Communication Sciences, EPFL, Switzerland) maintains an active research collaboration with Gang team members (Carole Delporte, Hugues Fauconnier).

Pierluigi Crescenzi (University of Florence, Italy) is a frequent visitor to the team and maintains an active research collaboration with Gang team members (Pierre Fraigniaud).

Sergio Rajsbaum (UNAM, Mexico) is a regular collaborator of the team, also involved formally in a joint French-Mexican research project (see next subsection).

Boaz Patt-Shamir (Tel Aviv University, Israel) is a regular collaborator of the team, also involved formally in a joint French-Israeli research project (see next subsection).

8.4.2. Participation in Other International Programs

Involvement in the bilateral Franco-Mexican project ECOS NORD (2013-2016) on "Distributed Verification". Pierre Fraigniaud was the project's co-coordinator for the French side. Partners: IRIF and LaBRI (France), UNAM (Mexico).

8.5. International Research Visitors

8.5.1. *Visits of International Scientists*

Eli Gafni (1 month – June 2016)

Zvi Lotker, guest of Amos Korman (2 months – May, June 2016)

Thomas Sauerwald, guest of Adrian Kosowski (1 month – November 2016)

8.5.2. *Visits to International Teams*

Sergio Rasjbaum's Team (UNAM), C. Delporte and H. Fauconnier, 10 days (March 2016)

<p style="text-align:center; color:red;">**HIEPACS Project-Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Inria Project Lab

9.1.1.1. C2S@Exa - Computer and Computational Sciences at Exascale

Since January 2013, the team is participating to the C2S@Exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

9.1.2. ANR

9.1.2.1. SOLHAR: SOLvers for Heterogeneous Architectures over Runtime systems

Participants: Emmanuel Agullo, Mathieu Faverge, Abdou Guermouche, Pierre Ramet, Jean Roman, Guillaume Sylvand.

Grant: ANR-MONU
Dates: 2013 – 2017
Partners: Inria (REALOPT, STORM Bordeaux Sud-Ouest et ROMA Rhone-Alpes), IRIT/INPT, CEA-CESTA et Airbus Group Innovations.
Overview:

During the last five years, the interest of the scientific computing community towards accelerating devices has been rapidly growing. The reason for this interest lies in the massive computational power delivered by these devices. Several software libraries for dense linear algebra have been produced; the related algorithms are extremely rich in computation and exhibit a very regular pattern of access to data which makes them extremely good candidates for GPU execution. On the contrary, methods for the direct solution of sparse linear systems have irregular, indirect memory access patterns that adversely interact with typical GPU throughput optimizations.

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computer equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. To date, the approaches proposed to achieve this objective are mostly based on a simple offloading of some computational tasks to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems. The development of a production-quality, sparse direct solver requires a considerable research effort along three distinct axes:

- linear algebra: algorithms have to be adapted or redesigned in order to exhibit properties that make their implementation and execution on heterogeneous computing platforms efficient and reliable. This may require the development of novel methods for defining data access patterns that are more suitable for the dynamic scheduling of computational tasks on processing units with considerably different capabilities as well as techniques for guaranteeing a reliable and robust behavior and accurate solutions. In addition, it will be necessary to develop novel and efficient accelerator implementations of the specific dense linear algebra kernels that are used within sparse, direct solvers;

- runtime systems: tools such as the `StarPU` runtime system proved to be extremely efficient and robust for the implementation of dense linear algebra algorithms. Sparse linear algebra algorithms, however, are commonly characterized by complicated data access patterns, computational tasks with extremely variable granularity and complex dependencies. Therefore, a substantial research effort is necessary to design and implement features as well as interfaces to comply with the needs formalized by the research activity on direct methods;

- scheduling: executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.

Given the wide availability of computing platforms equipped with accelerators and the numerical robustness of direct solution methods for sparse linear systems, it is reasonable to expect that the outcome of this project will have a considerable impact on both academic and industrial scientific computing. This project will moreover provide a substantial contribution to the computational science and high-performance computing communities, as it will deliver an unprecedented example of a complex numerical code whose parallelization completely relies on runtime scheduling systems and which is, therefore, extremely portable, maintainable and evolvable towards future computing architectures.

9.1.2.2. ANEMOS: Advanced Numeric for ELMs : Modeling and Optimized Schemes

Participants: Guillaume Latu, Pierre Ramet.

Grant: ANR-MN
Dates: 2012 – 2016
Partners: Univ. Nice, CEA/IRFM, CNRS/MDS.
Overview: The main goal of the project is to make a significant progress in understanding of active control methods of plasma edge MHD instabilities Edge Localized Modes (ELMs) wich represent particular danger with respect to heat and particle loads for Plasma Facing Components (PFC) in ITER. The project is focused in particular on the numerical modelling study of such ELM control methods as Resonant Magnetic Perturbations (RMPs) and pellet ELM pacing both foreseen in ITER. The goals of the project are to improve understanding of the related physics and propose possible new strategies to improve effectiveness of ELM control techniques. The tool for the non-linear MHD modeling is the JOREK code which was essentially developed within previous ANR ASTER. JOREK will be largerly developed within the present project to include corresponding new physical models in conjunction with new developments in mathematics and computer science strategy. The present project will put the non-linear MHD modeling of ELMs and ELM control on the solid ground theoretically, computationally, and applications-wise in order to progress in urgently needed solutions for ITER.

Regarding our contributions, the JOREK code is mainly composed of numerical computations on 3D data. The toroidal dimension of the tokamak is treated in Fourier space, while the poloidal plane is decomposed in Bezier patches. The numerical scheme used involves a direct solver on a large sparse matrix as a main computation of one time step. Two main costs are clearly identified: the assembly of the sparse matrix, and the direct factorization and solve of the system that includes communications between all processors. The efficient parallelization of JOREK is one of our main goals, to do so we will reconsider: data distribution, computation distribution or GMRES implementation. The quality of the sparse solver is also crucial, both in term of performance and accuracy. In the current release of JOREK, the memory scaling is not satisfactory to solve problems listed above , since at present as one increases the number of processes for a given problem size, the memory footprint on each process does not reduce as much as one can expect. In order to access finer meshes on available supercomputers, memory savings have to be done in the whole code. Another key point for improving parallelization is to carefully profile the application to understand the regions of the code that do not scale well. Depending on the timings obtained, strategies to diminish communication overheads will be evaluated and schemes that improve load balancing will be initiated. JOREK uses PaStiX sparse matrix library for matrix inversion. However, large number of toroidal harmonics and particular thin structures to resolve for realistic plasma parameters and ITER machine size still require more aggressive optimisation in numeric dealing with numerical stability, adaptive meshes etc. However many possible applications of JOREK code we proposed here which represent urgent ITER relevant issues related to ELM control by RMPs and pellets remain to be solved.

9.1.2.3. DEDALES: Algebraic and geometric domain decomposition for subsurface/groundwater flows
Participants: Emmanuel Agullo, Mathieu Faverge, Luc Giraud, Louis Poirel.

Grant: ANR-14-CE23-0005
Dates: 2014 – 2018
Partners: Inria EPI POMDAPI (leader); Université Paris 13 - Laboratoire Analyse, Géométrie et Applications; Maison de la Simulation; Andra.
Overview: Project DEDALES aims at developing high performance software for the simulation of two phase flow in porous media. The project will specifically target parallel computers where each node is itself composed of a large number of processing cores, such as are found in new generation many-core architectures. The project will be driven by an application to radioactive waste deep geological disposal. Its main feature is phenomenological complexity: water-gas flow in highly heterogeneous medium, with widely varying space and time scales. The assessment of large scale model is of major importance and issue for this application, and realistic geological models have several million grid cells. Few, if at all, software codes provide the necessary physical features with massively parallel simulation capabilities. The aim of the DEDALES project is to study, and experiment with, new approaches to develop effective simulation tools with the capability to take advantage of modern computer architectures and their hierarchical structure. To achieve this goal, we will explore two complementary software approaches that both match the hierarchical hardware architecture: on the one hand, we will integrate a hybrid parallel linear solver into an existing flow and transport code, and on the other hand, we will explore a two level approach with the outer level using (space time) domain decomposition, parallelized with a distributed memory approach, and the inner level as a subdomain solver that will exploit thread level parallelism. Linear solvers have always been, and will continue to be, at the center of simulation codes. However, parallelizing implicit methods on unstructured meshes, such as are required to accurately represent the fine geological details of the heterogeneous media considered, is notoriously difficult. It has also been suggested that time level parallelism could be a useful avenue to provide an extra degree of parallelism, so as to exploit the very large number of computing elements that will be part of these next generation computers. Project DEDALES will show that space-time DD methods can provide this extra level, and can usefully be combined with parallel linear solvers at the subdomain level. For all tasks, realistic test cases will be used to show the validity and the parallel scalability of the chosen approach. The most demanding models will be at the frontier of what is currently feasible for the size of models.

9.1.2.4. TECSER: Novel high performance numerical solution techniques for RCS computations
Participants: Emmanuel Agullo, Luc Giraud, Matthieu Kuhn.

Grant: ANR-14-ASTRID
Dates: 2014 – 2017
Partners: Inria EPI NACHOS (leader), Corida, HiePACS; Airbus Group Innovations, Nucletudes.
Overview: the objective of the TECSER projet is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Commissariat A L Energie Atomique et Aux Energies Alternatives (France)

Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)

Consiglio Nazionale Delle Ricerche (Italy)

The Cyprus Institute (Cyprus)

Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Forschungszentrum Julich (Germany)

Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany)

University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

The aim of the present proposal is to establish an Energy Oriented Centre of Excellence for computing applications, (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term

sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

9.2.1.2. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partners:

> Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)
>
> Iberdrola Renovables Energia (Spain)
>
> Repsol (Spain)
>
> Total S.A. (France)
>
> Lancaster University (United Kingdom)

Inria contact: Stéphane Lanteri

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO_2 emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

9.2.1.3. EXA2CT

Title: EXascale Algorithms and Advanced Computational Techniques

Programm: FP7

Duration: September 2013 - August 2016

Coordinator: IMEC

Partners:

Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

Interuniversitair Micro-Electronica Centrum Vzw (Belgium)

Intel Corporations (France)

Numerical Algorithms Group Ltd (United Kingdom)

T-Systems Solutions for Research (Germany)

Universiteit Antwerpen (Belgium)

Universita della Svizzera italiana (Switzerland)

Universite de Versaillesint-Quentin-En-Yvelines. (France)

Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)

Inria contact: Luc Giraud

Numerical simulation is a crucial part of science and industry in Europe. The advancement of simulation as a discipline relies on increasingly compute intensive models that require more computational resources to run. This is the driver for the evolution to exascale. Due to limits in the increase in single processor performance, exascale machines will rely on massive parallelism on and off chip, with a complex hierarchy of resources. The large number of components and the machine complexity introduce severe problems for reliability and programmability. The former of these will require novel fault-aware algorithms and support software. In addition, the scale of the numerical models exacerbates the difficulties by making the use of more complex simulation algorithms necessary, for numerical stability reasons. A key example of this is increased reliance on solvers. Such solvers require global communication, which impacts scalability, and are often used with preconditioners, increasing complexity again. Unless there is a major rethink of the design of solver algorithms, their components and software structure, a large class of important numerical simulations will not scale beyond petascale. This in turn will hold back the development of European science and industry which will fail to reap the benefits from exascale. The EXA2CT project brings together experts at the cutting edge of the development of solvers, related algorithmic techniques, and HPC software architects for programming models and communication. It will take a revolutionary approach to exascale solvers and programming models, rather than the incremental approach of other projects. We will produce modular open source proto-applications that demonstrate the algorithms and programming techniques developed in the project, to help boot-strap the creation of genuine exascale codes.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. MORSE

Title: Matrices Over Runtime Systems @ Exascale

International Partner (Institution - Laboratory - Researcher):

KAUST Supercomputing Laboratory (United States) - KSL - Hatem Ltaief

Start year: 2011

See also: http://icl.cs.utk.edu/morse/index.html

The goal of Matrices Over Runtime Systems at Exascale (MORSE) project is to design dense and sparse linear algebra methods that achieve the fastest possible time to an accurate solution on large-scale multicore systems with GPU accelerators, using all the processing power that future high end systems can make available. To develop software that will perform well on petascale and exascale systems with thousands of nodes and millions of cores, several daunting challenges have to be overcome, both by the numerical linear algebra and the runtime system communities. By designing

a research framework for describing linear algebra algorithms at a high level of abstraction,the MORSE team will enable the strong collaboration between research groups in linear algebra, runtime systems and scheduling needed to develop methods and libraries that fully benefit from the potential of future large-scale machines. Our project will take a pioneering step in the effort to bridge the immense software gap that has opened up in front of the High-Performance Computing (HPC) community.

9.3.1.2. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra

International Partner (Institution - Laboratory - Researcher):

> Stanford University (USA) - Institute for Computational and Mathematical Engineering - Eric Darve

Start year: 2015

See also: http://people.bordeaux.inria.fr/coulaud/projets/FastLA_Website/

In this project, we propose to study fast and scalable hierarchical numerical kernels and their implementations on heterogeneous manycore platforms for two major computational kernels in intensive challenging applications. Namely, fast multipole methods (FMM) and sparse linear solvers that appear in many intensive numerical simulations in computational sciences. For the solution of large linear systems, the ultimate goal is to design parallel scalable methods that rely on efficient sparse and dense direct methods using H-matrix arithmetic. Finally, the innovative algorithmic design will be essentially focused on heterogeneous manycore platforms by using task based runtime systems. The partners, Inria HiePACS, Lawrence Berkeley Nat. Lab and Stanford University, have strong, complementary and recognized experiences and backgrounds in these fields

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR AJACS

The AJACS project (Analyses of JavaScript Applications: Certification & Security) is by the ANR for 42 months, starting December 2014. The goal of AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts. The Indes members are involved in the tasks WP2 Certified Analyses and WP3 Security of JavaScript Applications. The partners of this project include Inria teams Celtique (coordinator), Toccata, and Prosecco.

6.1.2. FUI UCF

The 3 years long UCF project aims at developing a reactive Web platforms for delivering multimedia contents. The partners of the project are the startups Alterway, OCamlPro, and XWiki, and the academic research laboratories of University Pierre et Marie Curie, and Denis Diderot.

6.1.2.1. Actions marquante

Inria Sophia-Antipolis Actions Marquante is a special funding for 2 postdocs during one year to explore a new research direction. The joint project with DIANA team "User discrimination on the Web: measurement, causation and prevention" has obtained this funding. The goal of this project is to detect when users get discriminated on the Web, what are the technologies used to discriminate users and how we can prevent it without breaking the functionality and sometimes useful personalisation within Web applications.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

6.2.1.1. RAPP

Program: http://rapp-project.eu

Title: Robot App Store

Collaborator: Inria Hephaistos

Abstract: RAPP is a 36 months pan-european FP7 project, started in December 2013. Hop.js technology is used by partner academic and SME R&D teams to develop a distributed software platform and applications for assistive robotics.

6.2.2. Collaborations in European Programs, Except FP7 & H2020

6.2.2.1. ICT Cost Action IC1201 BETTY

Program:BETTY

Project acronym: BETTY

Project title: Behavioural Types for Reliable Large-Scale Software Systems

Duration: October 2012 - October 2016

Coordinator:Simon Gay, University of Glasgow

Other partners: several research groups, belonging to 22 european countries

Abstract: The aim of BETTY is to investigate and promote behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreography.

6.2.2.2. ICT Cost Action IC1405 on Reversible Computation

> Program: COST
>
> Project acronym: RC
>
> Project title: Reversible computation - extending horizons of computing
>
> Duration: November 2014 - November 2018
>
> Coordinator: Irek Ulidowski, University of Leicester
>
> Other partners: several research groups, belonging to 23 european countries
>
> Abstract: Reversible computation is an emerging paradigm that extends the standard mode of computation with the ability to execute in reverse. It aims to deliver novel computing devices and software, and to enhance traditional systems. The potential benefits include the design of reversible logic gates and circuits - leading to low-power computing and innovative hardware for green ICT, new conceptual frameworks and language abstractions, and software tools for reliable and recovery-oriented distributed systems. This is the first European network of excellence aimed at coordinating research on reversible computation.

6.2.2.3. Bilateral PICS project SuCCeSS

> Program: PICS
>
> Project acronym: SuCCeSS
>
> Project title: Security, Adaptability and time in Communication
>
> Duration: June 2016 - June 2019
>
> Coordinator: Cinzia Di Giusto, I3S, Sophia Antipolis
>
> Other partners: I3S, University of Gröningen
>
> Abstract: The project SuCCeSS is a CNRS-funded "Projet coopératif" (PICS 07313), involving 2 French teams in Sophia Antipolis (the MDSC team at the laboratory I3S, acting as coordinator, and the INDES team) and one Dutch team at the University of Gröningen. The project started in June 2016 and is due to end in June 2019. The objective of the project is to study formal models for reliable distributed communication-centric software systems. The project focusses on analysis and validation techniques based on behavioural types, aimed at enforcing various properties (safety, liveness, security) of structured communications.

6.3. International Research Visitors

6.3.1. Visits of International Scientists

6.3.1.1. Internships

> Raimil Cruz
>
> > Date: 01/05/16 - 30/07/16
> >
> > Institution: University of Chile

<p style="text-align:center;color:red;">INFINE Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. LiveGrid

Participants: Cedric Adjih, Emmanuel Baccelli.

Infine is one of the teams from Inria participating to LiveGrid: LiveGrid is a consortium of the main actors of industry, research organisations, local authorities and competitive cluster from the Paris-Saclay campus. The goal of LiveGrid is make the Paris-Saclay campus one of the leader regions of smart grids. Infine expertise is in infrastructure: testbeds, communication protocols, embedded open source OS.

8.2. National Initiatives

8.2.1. Equipex FIT

Participants: Cedric Adjih, Emmanuel Baccelli, Alexandre Abadie, Philippe Lubrano, Ichrak Amdouni, Alaeddine Weslati, Vincent Ladeveze.

Partners: Inria (Lille, Sophia-Antipolis, Grenoble), INSA, UPMC, Institut Telecom Paris, Institut Télécom Evry, LSIIT Strasbourg.

FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It provides this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project gives french internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the future internet. FIT was one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant program, in 2011.

One component of the FIT platform is the sets of IoT-LAB testbeds (see the IoT-LAB web site). These were motivated by the observation that the world is moving towards an "Internet of Things", in which most communication over networks will be between objects rather than people.

The Infine team is more specifically managing the FIT IoT-LAB site formerly at Rocquencourt, which recently moved to Saclay (on-going re-deployment), and is participating in the deployment of an additional IoT-lab testbed in Berlin (at Freie Universitaet Berlin).

The Infine team is actively collaborating with UPEC on wireless sensor network testbeds (and protocols): in 2015 and 2016, the testbed from UPEC with 45 Arduino nodes has been integrated with the FIT IoT-LAB testbed.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. AGILE (H2020 project)

Participants: Emmanuel Baccelli, Cedric Adjih.

> Program: H2020 ICT-30-2015 Topic: Internet of Things and Platforms for Connected Smart Objects
>
> Project acronym: AGILE
>
> Project title: Adoptive Gateways for dIverse muLtiple Environments

Duration: 2015-2017

Coordinator: Emmanuel Baccelli

Other partners: Canonical (UK), Eclipse IoT Foundation (IE), Mobistar (BE), Libelium (ES), Startupbootcamp IoT (SP), CREATE-NET (IT), iMinds (BE), Atos (SP), Rulemotion (UK), Jolocom (DE), Passau University (DE), Sky-Watch (DN), BioAssist (GR), Graz Technical University (AT), Eurotech (IT), IoTango (US).

Abstract:

The AGILE project is a 3-year H2020 project started in January 2016, which will deliver an integrated framework of open source tools and platforms that interoperate for enabling the delivery of adaptive, self-configurable and secure IoT elements (both software and hardware) that can be utilized in a variety of scenarios. Such tools target actors with heterogeneous skills, including entrepreneurs, researchers, and individuals, aiming to enable the realization of IoT applications respecting user privacy and data ownership.

8.3.1.2. ARMOUR (H2020 project)

Participants: Cedric Adjih, Emmanuel Baccelli, Oliver Hahm.

Program: H2020 ICT-12-2015 Topic: Integrating experiments and facilities in FIRE+

Project acronym: ARMOUR

Project title: Large-Scale Experiments of IoT Security Trust

Duration: 2016-2018

Coordinator: Serge Fdida (UPMC)

Other partners: UPMC (France), Synelixis (Greece), SMA (France), UI (Portugal), JRC (Belgium), EGM (France), OdinS (Spain).

Abstract:

The ARMOUR project is a 2-year H2020 project started in February 2016. The ARMOUR project is aimed at providing duly tested, benchmarked and certified Security & Trust technological solutions for large-scale IoT using upgraded FIRE large scale IoT/Cloud testbeds properly-equipped for Security & Trust experimentations. To this, ARMOUR will: (1) Enhance two outstanding FIRE testbeds (> 2700 nodes; 500 users) with the ARMOUR experimentation toolbox for enabling large-scale IoT Security & Trust experiments; (2) Deliver six properly experimented, suitably validated and duly benchmarked methods and technologies for enabling Security & Trust in the large-scale IoT; and (3) Define a framework to support the design of Secure & Trusted IoT applications as well as establishing a certification scheme for setting confidence on Security & Trust IoT solutions.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

8.3.2.1. EU CHIST-ERA MACACO

Participants: Aline Carneiro Viana, Emmanuel Baccelli, Eduardo Mucelli.

Program: EU CHIST-ERA, topic Context- and Content-Adaptive Communication Networks

Project acronym: MACACO

Project title: Mobile context-Adaptive CAching for COntent-centric networking

Duration: 2013-2016

Coordinator: Aline Carneiro Viana

Other partners: INPT-ENSEEIHT at University of Toulouse, University of Birmingham (UK), SUPSI (Switzerland), CNR (Italy) and Federal University of Minas Gerais (Brazil)

Abstract:

MACACO (Mobile context-Adaptive CAching for COntent-centric networking) is a 3-year CHIST-ERA European Project addressing the topic Context- and Content-Adaptive Communication Networks. It is funded by ANR in France, SNSF in Switzerland, and ESPRC in UK. It focus on data offloading mechanisms that take advantage of context and content information. Our intuition is that if it is possible to extract and forecast the behaviour of mobile network users in the three dimensional space of time, location and interest (i.e. what, when and where users are pulling data from the network), it is possible to derive efficient data offloading protocols. Such protocols would prefetch the identified data and cache it at the network edge at an earlier time, preferably when the mobile network is less charged, or offers better quality of service. This project has officially started in November 2013.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

- Renewed IOTPUSH collaboration with Freie Universitaet Berlin around the long-term stay of Emmanuel Baccelli in Berlin, on research topics about the Internet of Things, RIOT and Information-Centric Networking.
- The Inria teams Infine and Eva are part of the "D2D Communication for LTE Advanced Cellular Network" , a project funded by the Indo-French Centre for the Promotion of Advanced Research (CEFIPRA). With industrial partners, and also with Indian partners, this project is focusing on the evolution of cellular networks towards 5G: this includes exploration of device-to-device (D2D) communication, and more generally IoT communication in a cellular context. Research directions include efficient access for IoT devices (massive numbers of devices with low volume communication); combination of random access protocols/error coding/physical layer ; efficient neighbor discovery, ...

8.4.1.2. Informal International Partners

- On-going collaboration with Hamburg University of Applied Science around RIOT.
- Informal collaborations with UIUC and UMass.
- Informal collaborations with ENSI Tunis and Sesame Tunis.

8.4.2. Participation in Other International Programs

8.4.2.1. PHC PESSOA 2015

Participant: Aline Carneiro Viana.

PHC PESSOA 2015 with University of Coimbra (2015-2016).

Program: -FCT - Programa PESSOA

Project title: Routine-based Enhanced Connectivity under User Mobility

Duration: 2015-2016

Coordinator: Aline Carneiro Viana and João Paulo da Silva Machado Garcia Vilela (University of Coimbra)

Abstract: The main goal of this project is to improve WiFi connectivity of users under mobility. The steady growth of smart-phones usage has put cellular networks under great strain, justifying the need for WiFi offloading as a solution that transfers part of the demand on cellular networks to WiFi hotspots that are in many cases already available. However, this must be performed in a way that provides benefits to the cellular operator while ensuring users a similar level of connectivity that they would achieve with cellular networks, even under user mobility (e.g. walking, taking a bus/train, etc). In this work we aim at (1) developing prediction mechanisms for selection of best hotspots by users under mobility, and (2) develop lightweight security schemes to reduce the burden of the association/authentication process of WiFi networks, therefore making WiFi offloading an effective and secure alternative to the growing demand on cellular networks.

8.5. International Research Visitors

8.5.1. Visits to International Teams

8.5.1.1. Research Stays Abroad

Emmanuel Baccelli was Visiting Professor at Freie Universitaet (FU) Berlin in 2016, within the context of the formal collaboration IOTPUSH with this university on research topics about the Internet of Things, RIOT and Information-Centric Networking.

<p align="center" style="color:red">KERDATA Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. OverFlow (2015–2019)

- Project Acronym: OverFlow.
- Project Title: Workflow Data Management as a Service for Multisite Applications.
- Coordinator: Alexandru Costan.
- Duration: Octobre 2015–October 2019.
- Other Partners: None (Young Researcher Project).
- External collaborators: Kate Keahey (University of Chicago and Argonne National Laboratory), Bogdan Nicolae (Huawei Research) and Christophe Blanchet (Institut Français de Bioinformatique).
- Abstract: This JCJC project led by Alexandru Costan investigates approaches to data management enabling an efficient execution of geographically distributed workflows running on multi-site clouds. Ultimately, OverFlow will propose a new, pioneering paradigm: Workflow Data Management as a Service — a general and easy-to-use, cloud-provided service that bridges for the first time the gap between single- and multi-site workflow data management. It aims to reap economic benefits from the geo-diversity while accelerating the scientific discovery through a democratization of access to globally distributed data.

9.1.2. Other National Projects

9.1.2.1. DISCOVERY (2015–2019)

- Project Acronym: DISCOVERY.
- Project Title: DIStributed and COoperative framework to manage Virtual EnviRonments autonomically.
- Coordinator: Adrien Lèbre.
- Duration: 2015–2019.
- Partners: Inria Project-Teams including ASAP, ASCOLA, Avalon, Myriads, and KerData.
- Abstract: An Inria Project Lab, led by Adrien Lèbre (ASCOLA), that aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet. The goal is to deliver widely distributed platforms that can better match the geographical dispersal of users, as well as the unending demand.

  Within DISCOVERY, S. Ibrahim (KerData Inria Team) is working with Gilles Fedak (Avalon Inria Project-Team) to address the VM images management challenge.

9.1.2.2. ADT Damaris

- Project Acronym: ADT Damaris
- Project Title: Technology development action for te Damaris environment.
- Coordinator: Alexandru Costan.
- Duration: 2016–2018.
- Abstract: This action aims to support the development of the Damaris software. Inria's *Technological Development Office* (D2T, *Direction du Développement Technologique*) provided 2 years of funding support for a senior engineer.

  Hadi Salimi is funded through this project to document, test and extend the Damaris software and make it a safely distributable product.

9.1.2.3. Grid'5000.

We are members of Grid'5000 community and run experiments on the Grid'5000 platform on a daily basis.

9.2. European Initiatives

9.2.1. FP7 and H2020 Projects

9.2.1.1. BigStorage

- Title: BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data.
- Programme: H2020.
- Duration: January 2015–December 2018.
- Coordinator: Universidad Politécnica de Madrid (UPM).
- Partners:
  - Barcelona Supercomputing Center — Centro Nacional de Supercomputacion (Spain)
  - CA Technologies Development Spain (Spain)
  - CEA — Commissariat à l'énergie atomique et aux énergies alternatives (France)
  - Deutsches Klimarechenzentrum (Germany)
  - Foundation for Research and Technology Hellas (Greece)
  - Fujitsu Technology Solutions (Germany)
  - Johannes Gutenberg Universitaet Mainz (Germany)
  - Universidad Politecnica de Madrid (Spain)
  - Seagate Systems UK (United Kingdom)
- Inria contact: G. Antoniu and Adrien Lèbre.
- URL: http://www.bigstorage-project.eu/.
- Description: BigStorage is a European Training Network (ETN) whose main goal is to train future *data scientists*. It aims at enabling them and us to apply holistic and interdisciplinary approaches to take advantage of a data-overwhelmed world. This world requires *HPC* and *Cloud* infrastructures with a redefinition of *storage* architectures underpinning them — focusing on meeting highly ambitious performance and *energy* usage objectives. The KerData team will be hosting 2 *Early Stage Researchers* in this framework.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. JLESC: Joint Laboratory on Extreme-Scale Computing

The Joint Laboratory on Extreme-Scale Computing is jointly run by Inria, UIUC, ANL, BSC, JSC and RIKEN/AICS. It has ben created in 2014 as a follow-up of the Inria-UIUC JLPC, the *Joint Laboratory for Petascale Computing*.

The KerData team is collaborating with teams from ANL and UIUC within this lab since 2009 on several topics in the areas of I/O, storage and in situ processing and cloud computing. This collaboration has been initially formalized as the *Data@Exascale* Associate Team with ANL and UIUC (2013–2015) followed by *Data@Exascale 2* Associate Team with ANL (2016–2018).

Since 2015, Gabriel Antoniu serves as a topic leader for Inria for the *I/O, Storage and In Situ Processing* topic.

9.3.1.1.1. Associate Team involved in the International Lab: Data@Exascale 2

Project Acronym: Data@Exascale 2.

Project Title: Convergent Data Storage and Processing Approaches for Exascale Computing and Big Data Analytics.

International Partner:

- Argonne National Laboratory (United States) — Mathematics and Computer Science Division (MCS) — Rob Ross.

Start year: 2013.

URL: http://www.irisa.fr/kerdata/data-at-exascale/.

Description: In the past few years, countries including United States, the European Union, Japan and China have set up aggressive plans to get closer to what appears to be the next goal in terms of high-performance computing (HPC): Exaflop computing, a target which is now considered reachable by the next-generation supercomputers in 2020-2023. While these government-led initiatives have naturally focused on the big challenges of Exascale for the development of new hardware and software architectures, the quite recent emergence of the Big Data phenomenon introduces what could be called a tectonic shift that is impacting the entire research landscape for Exascale computing. As data generation capabilities in most science domains are now growing substantially faster than computational capabilities, causing these domains to become data-intensive, new challenges appeared in terms of volumes and velocity for data to be stored, processed and analyzed on the future Exascale machines.

To face the challenges generated by the exponential data growth (a general phenomenon in many fields), a certain progress has already been made in the recent years in the rapidly-developing, industry-led field of cloud-based Big Data analytics, where advanced tools emerged, relying on machine-learning techniques and predictive analytics.

Unfortunately, these advances cannot be immediately applied to Exascale computing: the tools and cultures of the two worlds, HPC (High-Performance Computing) and BDA (Big Data Analytics) have developed in a divergent fashion (in terms of major focus and technical approaches), to the detriment of both. The two worlds share however multiple similar challenges and unification now appears as essential in order to address the future challenges of major application domains that can benefit from both.

The scientific program we propose for the Data@Exascale 2 Associate Team is defined from this new, highly-strategic perspective and builds on the idea that the design of innovative approaches to data I/O, storage and processing allowing Big Data analytics techniques and the newest HPC architectures to leverage each other clearly appears as a key catalyst factor for the convergence process.

9.3.2. Inria International Partners

9.3.2.1. DataCloud@Work

Title: DataCloud@Work.

International Partner:

- Polytechnic University of Bucharest (Romania), Computer Science Department, Nicolae Tapus and Valentin Cristea.

Duration: 4 years.

Start year: 2013. The status of IIP was established right after the end of our former *DataCloud@work* Associate Team (2010–2012).

URL: https://www.irisa.fr/kerdata/doku.php?id=cloud_at_work:start.

Description: Our research topics address the area of distributed data management for cloud services, focusing on autonomic storage. The goal is explore how to build an efficient, secure and reliable storage IaaS for data-intensive distributed applications running in cloud environments by enabling an autonomic behavior.

9.3.3. Informal International Partners

National University of Singapore (NUS): We collaborate on resource management for workflows in the cloud and optimizing graph processing in geo-distributed data-centers.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Guillaume Aupy (Vanderbilt University) visited the KerData team for one week (February 2016).

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

CIC-IPN, Mexico:
Participants: Gabriel Antoniu, Alexandru Costan, Luis Eduardo Pineda Morales, Pierre Matri.

From October 31 to November 4, four members of our team visited the Informatics Research Centre of the National Polytechnic Institute (CIC-IPN for its acronym in Spanish) in Mexico City, Mexico.

The visit was a follow up to previous discussions held with the Network and Data Science Laboratory. The goal is to create a scientific collaboration on the grounds of cloud-based big data for smart cities, for which a proposal has been submitted in August to the program ECOS-NORD (Mexico-France). The visit included scientific presentations from both teams, a plenary talk from KerData to the IPN community, as well as discussions on future common research lines. Additionally, we held meetings with the partnering coordinator to talk about possible funding sources for students exchanges.

ANL, USA:
Participant: Nathanaël Cheriere.

Nathanaël Cheriere visited Matthieu Dorier and Rob Ross at ANL for 5.5 months, co-funded by the PUF NextGen project in the context of the Joint Laboratory for Extreme-Scale Computing (JLESC).

Vanderbilt University, USA:
Participant: Tien-Dat Phan.

Tien-Dat Phan visited(Guillaume Aupy, Padma Raghavan at Vanderbilt University for 2 months, funded by Vanderbilt University.

Technische Universitat Munchen and Huawei Research Center in Munich:
Participant: Ovidiu-Cristian Marcu.

Ovidiu-Cristian Marcu is doing an internship at Huawei in Munich, Germany for 4 months, starting October 2016. The goal is to create a framework to improve memory management for streaming systems.

National University of Singapore, Singapore:
Participant: Tien-Dat Phan.

Tien-Dat Phan is visiting NUS (Bingsheng He) for 3 months, co-funded by a Mobility grant from University Bretagne Loire (UBL) and NUS.

<p style="text-align:center">**MADYNES Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. 6PO Research Region Lorraine and UL project

Participants: Emmanuel Nataf, Ye-Qiong Song, Laurent Ciarletta [contact].

Funded by Region Lorraine and Université de Lorraine since 2013. Adel Belkadi (CRAN & LORIA) is co-directed by L. Ciarletta and Didier Theilliol (CRAN correspondant).

6PO ("Systèmes Cyber-Physiques et Commande Coopérative Sûre de Fonctionnement pour une Flotte de Véhicules sans Pilote") is a joint research project between the Loria and CRAN laboratories. As a part of the Aetournos ecosystem, it also aims at researching solutions for safe formation flying of collaborative UAVs seen as part of a collection of Cyber Physical Systems mixing computer science and automation solutions.

It is reinforced by a PhD grant from this federation that started in october 2014 (*Conception de méthodes de diagnostic et de tolérance aux fautes des systèmes multi-agents: Application à une flotte de véhicules autonomes*, Adel Belkadi).

This led to common publications, notably on the subjects of the robust control of a fleet or flock of UAVs (with or without leader, using agents paradigms and particle swarm optimisation [12] and [36]).

The project provides common use cases and scientific challenges that serve as catalysts for collaboration between teams from different research topics :

- Cyber Physical Systems, Real Time, Quality of service, Performance and Energy in Wireless Sensors and Activator Networks
- Collaborative, communicating autonomous systems and Unmanned Vehicles
- Safety, Dependabilty, Reliability, Diagnosis, Fault-Tolerance

8.1.2. Hydradrone FEDER Région Lorraine project

Participants: Adrien Guenard, Zhixiang Liu, Laurent Ciarletta [contact].

Feder funding

The Madynes team has been working on the Hydradrone project since July 2014. It started as a collaborative R&D initiative funded by *Région Lorraine* and is now FEDER funded. This project started as a joint work between Madynes and PEMA (*Pedon Environnement et Milieux Aquatiques*), an SME/VSE (small and medium size Entreprise, PME/TPE). The consortium now includes Alerion another VSE, spinoff from Loria.

It consists in developing a new solution for the surveillance of aquatic environment, the Hydradrone:

- starting with an actual need for automated and remote operation of environmental sensing expressed by PEMA
- based on an hybrid UxV (Unmanned Air, Surface... Vehicle),
- some Cyber Physical bricks in coherence with the Alerion's concepts (ease of use, safety, autonomy)
- and an integration in the Information System of the company

PEMA, as an environmental company, is providing the use cases and terrain (and business) validation, while Alerion is working on the integration and engineering of the solution.

This second year has been dedicated to the development of the initial controllers for the Hydradrones (smal and large one), and the beginning of the integration of the environmental sensors.

8.1.3. Satelor AME Lorraine regional project

Participants: François Despaux, Lei Mo, Mohamed Tlig, Bernardetta Addis, Evangelia Tsiontsiou, Ye-Qiong Song [contact].

The Madynes team is involved in Satelor, a regional research and development project funded by the AME (Agence de Mobilisation Economique) of Lorraine (October 2013 – September 2017). The consortium includes academic (Univ. of Lorraine, Inria), medical (OHS) and industrial (Diatelic-Pharmagest (lead), ACS, Kapelse, Salendra, Neolinks) partners. It aims at developing innovative and easily deployable ambient assisted living solutions for their effective use in the tele-homecare systems. The Madynes team is mainly involved in the data collection system development based on wireless sensors networks and IoT technology. The first topic consists in defining the basic functions of the future SATEBOX – a gateway box for interconnecting in-home sensors to the medical datacenter, based on our previously developed MPIGate software. A beta-version prototype of the future Satebox gateway has been realased. It now includes Zigbee wireless sensors, EnOcean battery-free sensors and Bluetooth Low Energy sensors. It provides a low-cost and easily deployable solution for the daily activity monitoring. After its first real-world deployment at a OHS hospital room, a second prototype testbed has been prepared for a further test deployment including several rooms. The second topic is related to improving the data transfer reliability while still keep minimum energy consumption. This has led us to focus on the multi-hop mesh network topology with multi-constrained QoS routing problem (PhD thesis of Evangelia Tsiontsiou) [33]. The third topic is related to the wireless charging of sensor nodes (PhD work of Lei MO) in order to keeping sensors in perpetual working state. A new direction has been also investigated which consists in using the CSI (channel signal information) of the omnipresent WiFi (IEEE802.11n) as a new generation of contactless sensors. A first test bed of using CSI to measure the respiration rate has been set up.

8.2. National Initiatives

8.2.1. ANR BottleNet

Participants: Isabelle Chrisment [contact], Thibault Cholez, Vassili Rivron, Paul Andrey, Quentin Rouy.

The Quality of Experience (QoE) when accessing the Internet, on which more and more human activities depend, is a key factor for today's society. The complexity of Internet services and of user's local connectivity has grown dramatically in the last years with the proliferation of proxies and caches at the core and access technologies at the edge (home wireless and 3G/4G access), making it difficult to diagnose the root cause of performance bottlenecks. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure end-to-end Internet QoE and to diagnose the cause of experienced issues. The result can then be used by users, network and service operators or regulators to improve the QoE.

The ANR BottleNet project (https://project.inria.fr/bottlenet) started this year with a kick-off on the 1st of February 2016. It involves many partners in the field of computer networks and QoE: Inria Muse and Diana teams, Lille1 University, Telecom Sud-Paris, Orange, IP-Label. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet QoE and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users' devices. We plan to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

Our first research question was to evaluate the impact of web advertisement on users' QoE. An interdisciplinary approach was developed at MADYNES, by which we extend the common notion of "quality of information" on free news websites (usually based on journalistic content) to a notion of quality of experience for the user, that takes into account the degraded delivery of information by the multiplication of third party contents. We implemented a measurement tool as a web browser extension and made a dataset by browsing many news websites accessed with and without ad-blockers. The first statistical results retrieved from the

dataset show that web-advertisement has a huge negative impact on QoE, for example multiplying the mean page load time by more than one order of magnitude and increasing the variance even more, while adblockers' profiles show faster and more uniform performances. These results have to be further refined but already show that web-advertisement, and more generally third-party content provider, play a huge role in poor Internet QoE and that it is a key parameter to investigate in the project. This study is leading to a structural analysis of the ad regulation mechanisms in the field of web journalism. Adblockers not only upgrades the QoE of visitors, but also contributes to define what "acceptable ads" should be.

This year the following task have been completed:

- Development of a platform to collect QoS & QoE on french news websites (Quentin Rouy, Telecom Nancy student). The first exploratory data collecting campaign measured the impact of Web Advertisement on client QoS, using FatHom plugin for Firefox (a tool from MUSE/Inria, partner of the BottleNet ANR project).

- Implementation of statistical treatment schemes (Paul Andrey, ENSAE student) to correlate QoS, economic models and adblocking effects on news websites.

- Preparation of a systematized measurement campaign on french and international news sites, in order to publish to a large audience.

8.2.2. ANR Doctor

Participants: Thibault Cholez [contact], Thomas Silverston [contact], Xavier Marchal, Cédric Enclos, Elian Aubry, Daishi Kondo, Olivier Festor.

The DOCTOR project http://www.doctor-project.org is an applied research project funded by the French National Research Agency (ANR), grant <ANR-14-CE28-000>, and supported by the French Systematic cluster. The project started on December 2014 for three years. It involves five partners specialized in network monitoring and security: Orange Labs (lead), Thales, Montimage, Université de technologie de Troyes and LORIA/CNRS. The DOCTOR project advocates the use of virtualized network equipment (Network Functions Virtualization), to enable the co-existence of new Information-Centric Networking stacks (e.g.: Named-Data Networking) with IP, and the progressive migration of traffic from one stack to the other while guaranteeing the good security and manageability of the network. Therefore in DOCTOR, the main goals of the project are: (1) the efficient deployment of NDN as a virtualized networking environment; (2) the monitoring and security of this virtualized NDN stack.

We presented the whole project at the IRTF Information-Centric Networking Research Group (ICNRG) in January.

This year, we made contributions in three critical points for the deployment of virtualized NDN network: security, performances and interoperability. First, we identified a critical vulnerability in the NDN protocol design that allows an attacker to perform efficient DoS attacks [46] by either self-answering to his own requests or answering to clients before the server. We proposed several remediation strategies to this problem.

On the performance topic, we designed and implemented a tool similar to Iperf, Ndnperf [22][0], that can measure the maximum throughput of a program serving NDN Data. We identified critical limitations that can harm real-time services (live streaming, VOIP, etc.), and proposed several recommendations and improvements that can increase the throughput up to 8 times when combined together.

Finally, we also designed and implemented an HTTP/NDN gateway that can be used to transport web content on an NDN network, thus benefiting from its caching and multicast properties while being totally transparent for the client and the server [47]. Those three contributions were published and demonstrated in the main conference of the domain: ACM ICN.

8.2.3. PIA LAR

Participants: Kévin Roussel, Ye-Qiong Song [contact].

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[0]http://madynes.loria.fr/software/ndnperf_cpp.zip

LAR (Living Assistant Robot) is a PIA (Projet investissement d'avenir) national project getting together Inria (MAIA and MADYNES projects), *Crédit Agricole* (lead), Diatelic and Robotsoft. The aim is to develop an ambient assisted living system for elderly including both sensors and assistant robots. The task of Madynes team is the development of a WSN-based system integrating both sensors of the environment and sensors and actuators embedded on a mobile robot. The research issues include the QoS, energy and mobility management.

This project has ended in March 2016. Some new results are obtained including the use of Cooja simulator for RIOT OS based WSN simulation and an in-depth analysis of some timing inaccuracy problems introduced by MSPSim which is an emulator of MSP430 MCU [27]. A synthesis of our achievements on LAR project is reported in the PhD thesis of Kévin Roussel (http://www.theses.fr/196570603).

8.2.4. FUI HUMA

Participants: Jonathan Arnault, Giulia de Santis, Pierre-Olivier Brissaud, Jérôme François [contact], Abdelkader Lahmadi, Isabelle Chrisment.

The HUMA project (*L'HUmain au cœur de l'analyse de données MAssives pour la sécurité*) is funded under the national FUI Framework (Fonds Unique Interministeriel) jointly by the BPI (Banque Publique d'Investissement) and the Région Lorraine. It has been approved by two competitive clusters: Systematic and Imaginove. The consortium is composed of three academic (ICube, Citi, Inria) and five industrial (Airbus Defence and Space, Intrinsec, Oberthur, Wallix, Sydo) partners. The leader is Intrinsec.

This project targets the analysis of Advanced Persistent Threat. APT are long and complex attacks which thus cannot be captured with standard techniques focused on short time windows and few data sources. Indeed, APTs may be several months long and involve multiple steps with different types of attacks and approaches. The project will address such an issue by leveraging data analytics and visualization techniques to guide human experts, which are the only one able to analyze APT today, rather than targeting a fully automated approach.

In 2016, our contribution focused on defining a clustering technique in order to group individual events into a common one. We applied our technique to darknet data as shown in section 6.2.1 . In addition, we also start the modeling of an attacker process by considering the first phase of APT, *i.e.* the reconnaissance phase by analyzing scanning activities using Hidden Markov Model in section 6.2.1 . We also technically contribute to the definition of APT scenarios by providing a very stealthy scanning approach (Wiscan described in 6.1.2). Finally, from a project management point of view, Inria is in charge of leading the work-package related to data analytics technique for analyzing security probe events.

8.2.5. Inria-Orange Joint Lab

Participants: Jérôme François [contact], Rémi Badonnel, Olivier Festor, Maxime Compastié, Paul Chaignon.

The challenges addressed by the Inria-Orange joint lab relate to the virtualization of communication networks, the convergence between cloud computing and communication networks, and the underlying software-defined infrastructures. This lab aims at specifying and developing a GlobalOS (Global Operating System) approach as a platform or a software infrastructure for all the network and computing resources required by the Orange network operator. Our work, started in November 2015, concerns in particular monitoring methods for software-defined infrastructures, and management strategies for supporting software-defined security in multi-tenant cloud environments.

8.2.6. CNRS-INS2I PEPS NEFAE

Participants: Thibault Cholez [contact], Wazen Shbair, Isabelle Chrisment, Jérôme François.

The need to monitor the increasing proportion of HTTPS traffic while preserving the privacy of users led us to propose a privacy-preserving monitoring framework that allows efficient identification of encrypted traffic (based on full TLS sessions), without relying on any decryption (no HTTPS proxy). It is based on a new set of well-tuned network features to characterise the service inside the encrypted traffic and on machine learning algorithms. The CNRS PEPS founded NEFAE project aims to specifically address the practical challenges toward real time identification of encrypted traffic by developing a next-generation firewall prototype.

This year we first built and made publicly available a new HTTPS dataset[0] (with complete raw data) so that researchers can compare their identification algorithms. We also improved our HTTPS monitoring framework to allow real-time identification of HTTPS services with only a few data packets instead of the full TLS session. We show better performances that the related work in all dimensions: better accuracy, earlier decision and more fine-grained identification). A running prototype is also under development to evaluate the scalability and overhead of our solution.

8.2.7. *CNRS-INS2I PEPS SURF*

Participants: Abdelkader Lahmadi [contact], Jérôme François, Isabelle Chrisment.

The SURF project, funded by the CNRS PEPS program, addresses the challenge of a developing a methodology for the joint modelling and the analysis of the Cyber security and the safety of industrial systems in the context of the factory of the future. The project involves partners from the Heudiasyc Laboratory of the University of Technology of Compiègne (UTC), the CRAN laboratory and the Inria Madynes team. The goal of the project is to make a joint effort from safety and cyber security communities to address the challenges of a joint modelling of industrial systems while including attacks, vulnerabilities and failures. During the year 2016, with the partners of the project, we have mainly identified the key challenges regarding this issue where we identified the common models, metrics and analysis methods that should be built. We have also organized a scientific day (http://surf.loria.fr) with many industrials (EDF, PSA and Sentryo) and academic to share with them our work and clearly identify the requirement and experience regarding this issue. This short term project is ended by this year, however a consortium is established for further long term projects (ANR, FUI or H2020) to address the identified challenge of a joint analysis of the cyber security and the safety of industrial control systems.

8.2.8. *ANR FLIRT*

Participants: Olivier Festor [contact], Rémi Badonnel, Thibault Cholez, Jérôme François, Abdelkader Lahmadi, Laurent Andrey.

FLIRT (Formations Libres et Innovantes Réseaux & Télécom) is an applied research project leaded by the Institut Mines-Télécom, for a duration of 4 years. It includes 14 academic partners (engineering schools including Telecom Nancy), 3 industrial partners (Airbus, Nokia Group and Orange), 2 innovative startups (the MOOC agency, and Isograd), as well as 3 professional or scientific societies (Syntec Numérique, Unetel, SEE). The project objective is to build a collection of 10 MOOCs (Massive Open Online Courses) in the area of networks and telecommunications, 3 training programmes based on this collection, as well as several innovations related to pedagogical efficiency (such as virtualization of practical labs, management of student cohorts, and adaptative assessment). The Madynes team is leading a working group dedicated to the building of a MOOC on network and service management. This MOOC will cover the fundamental concepts, architectures and protocols of the domain, as well as their evolution in the context of future Internet, and will include practical labs and exercises using widely-used tools and technologies.

8.2.9. *Technological Development Action (ADT)*

8.2.9.1. ADT UASS

The goal of this ADT is while still providing assistance in developing the Aetournos platform to help in the UAV Challenge Medical Express. Through this ADT, funded by Inria, Raphaël Cherfan has coordinated students work on the platform and tutoring the Aetournos team for the 2016 Outback Joe Search and Rescue / Medical Express Challenge, and help in the design and buidling of a novel Hybrid UAV.

8.2.9.2. ADT VERTEX

This ADT started on 2016 and will end on 2018. The Madynes project is a major partner funded at the level of 120k€. ADT VERTEX buildt upon the foundations of the Grid'5000 testbed aims to reinforce and extend it towards new use cases and scientific challenges. Several directions are being explored: networks and Software Defined Networking, Big Data, HPC, and production computation needs. Already developed prototypes are also being consolidated, and the necessary improvements to user management and tracking are also being performed.

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[0]http://betternet.lhs.loria.fr/datasets/https/

8.2.9.3. ADT COSETTE

This ADT started on 2013 and is endind on 2016. The Madynes project is the only partner funded at the level of 120k€. ADT COSETTE, for *COherent SET of Tools for Experimentation* aims at developing or improving a tool suite for experimentation at large scale on testbeds such as Grid'5000. Specifically, we will work on (1) the development of Ruby-CUTE, a library gathering features useful when performing such experiments; (2) the porting of Kadeploy, Distem and XPFlow on top of Ruby-CUTE; (3) the release of XPFlow, developed in the context of Tomasz Buchert's PhD; (4) the improvement of the Distem emulator to address new scientific challenges in Cloud and HPC. E. Jeanvoine (SED) is delegated in the Madynes team for the duration of this project. A subsequent project is planned to start at the end of 2016 (ADT SDT).

8.2.9.4. ADT RIOT

RIOT ADT is a multi-site project with Infine and Madynes teams, which started in December 2016 for a duration of two years. The high-level objective is to (1) contribute open source code, upstream, to the RIOT code base, (2) coordinate RIOT development within Inria, with other engineers and researchers using/developing RIOT, (3) coordinate RIOT development outside Inria, help maintain the RIOT community at large (see http://www.riot-os.org and http://www.github.com/RIOT-OS/RIOT) which aims to become the equivalent of Linux for IoT devices that cannot run Linux because of resource constraints.

This year MADYNES team has mainly contributed to the efficient MAC layer protocol implementation issues. We have built a general MAC protocol module (gnrc mac module) for providing critical development tools for MAC protocol developers in the RIOT community (https://github.com/RIOT-OS/RIOT/pull/5941; https://github.com/RIOT-OS/RIOT/pull/5942; https://github.com/RIOT-OS/RIOT/pull/5949; https://github.com/RIOT-OS/RIOT/pull/5950; https://github.com/RIOT-OS/RIOT/pull/6069; https://github.com/RIOT-OS/RIOT/pull/6072). Based on these generic functions, we first contributed to the functionality and performance improvement of an universal example MAC protocol (Lw-MAC) (https://github.com/RIOT-OS/RIOT/pull/5941). We then implemented iQueue-MAC, which is a robust, energy efficient and traffic adaptive MAC protocol (https://github.com/RIOT-OS/RIOT/pull/5618). Currently, we have finished to implement most of the designed features of iQueue-MAC, such as the low duty-cycle scheme, the adaptive slots allocation scheme and the multi-channel operation. Experimental results collected from samr21-Xplained-pro boards showed that iQueue-MAC is robust and has a extremely low packet drop ratio, even when interference is strong.

8.2.10. Inria Project Lab

8.2.10.1. IPL BetterNet
Participants: Isabelle Chrisment [contact], Thibault Cholez, Vassili Rivron.

The Inria Project Lab BetterNet (https://project.inria.fr/betternet) launched in October 2016. Its goal is to build and deliver a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. We will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Tools, models and algorithms will be provided to collect data that will be shared and analyzed to offer a valuable service to scientists, stakeholders and civil society.

The Madynes team leads the IPL and in particular Isabelle Chrisment who coordinates the project. Several actions have already been done over the first months:

- Organization of the Kick-Off the 19th November in Paris;
- Recruitment of a shared PhD with SPYRALS (Inria/University of Lille3) in order to develop probes and collecting platform;
- Servers installation in LHS (High Security Laboratory) for the hosting of the different BottleNet and BetterNet data collection and opendata platforms;
- Preparation of small and middle scale QoE and QoS data collection with users. Conception of incentives and rewards (value added services).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Flamingo

Title: Management of the Future Internet

Programm: FP7

Duration: November 2012 - December 2016

Coordinator: University Twente

Partners:

      Iminds Vzw (Belgium),

      Jacobs University Bremen Ggmbh (Germany),

      University College London (United Kingdom),

      Université de Lorraine (France),

      Universitaet Der Bundeswehr Muenchen (Germany),

      Universitat Politecnica de Catalunya (Spain),

      Universiteit Twente (Netherlands),

      Universitaet Zuerich (Switzerland)

Inria contact: Jérôme François

The goals of FLAMINGO are (a) to strongly integrate the research of leading European research groups in the area of network and service management, (b) to strengthen the European and worldwide research in this area, and (c) to bridge the gap between scientific research and industrial application.

In 2016, our research activities in Flamingo have been focused on (a) the analysis and evaluation of OpenFlow message usage for security applications, in particular to enable fast deployment and reconfiguration of mitigation technique (6.2.4) in cooperation with Universitaet Der Bundeswehr Muenchen; (b) passive monitoring of Internet-of-Things using the RPL protocol in cooperation with the Jacobs University Bremen; (c) monitoring of HTTPS traffic to identify user services without necessity of decrypting (6.1.4) and (d) low-footprint Internet wide scanning using our WISCAN software developed last year.

We have pursued leading the standardization activities of the project (WP leader).

8.3.2. Collaborations in European Programs, Except FP7 & H2020

8.3.2.1. RETINA

Program: Eurosatrs-2

Project acronym: RETINA

Project title: Real-Time support for heterogenous networks in automotive applications

Duration: April 2016 - March 2018

Coordinator: TCN (Time critical networks)

Other partners: TCN (Sweden), Alkit (Sweden), Viktoria (Sweden), TNO (Netherlands), Scuola Superiore Sant'Anna (Italy), Evidence (Italy), University of Lorraine (France)

Abstract: The project will develop integrated software tools to predict, simulate, test and support real-time communication in heterogeneous vehicular networks. The tool set will allow SMEs and larger industry to design, develop and evaluate time-critical applications such as advanced safety systems and autonomous vehicles. This will put high requirements on both in-vehicle infrastructure, as well as vehicle-to-vehicle and vehicle-to infrastructure utilizing the next generation of mobile networks for ITS.

8.4. International Initiatives

8.4.1. Inria Associate Teams Not Involved in an Inria International Labs

8.4.1.1. IoT4D

Title: Internet of Things for Developping countries

International Partner (Institution - Laboratory - Researcher):

UY (Cameroon) - MASECNeSS - Thomas DJOTIO NDIE

Start year: 2016

We want connect wireless sensors networks to the Internet through gateways. Wireless network should have several acessible gateways (depending on the size and quality of service needed) and gateways should be used by several wireless sensors networks. This is an optimization problem in this perticular context, with unreliable communications and equipments that are easily disturbed by the environment

8.4.1.2. Masdin

Title: MAnagement of Software-Defined INfrastructure

International Partner (Institution - Laboratory - Researcher):

University of Luxembourg (Luxembourg) - SnT (Interdisciplinary Centre for Security, Reliability and Trust) - Radu State

Start year: 2016

See also: https://project.inria.fr/masdin

Networking is deeply evolving with the rise of programmability and virtualization. The concept of SDI (Software-Defined Infrastructure) has emerged from SDN (Software-Defined Networking) and NFV (Network Function Virtualization) making thus the configuration of the network highly dynamic and adaptable in real-time. However, new methods and tools have to be defined to properly monitor and configure this type of infrastructure. Current works are mainly limited to apply former approaches of traditional network but do not exploit the novel capabilities offered by these technologies. The goal of the associate team is thus to define methodologies taking benefit of them for an efficient monitoring and use of SDI resources while investigating security issues it brings.

8.4.1.3. STIC-AmSud AKD Project

Participants: Rémi Badonnel [contact], Olivier Festor, Gaetan Hurel, Amedeo Napoli.

The AKD project, funded by the STIC-AmSud Program, addresses the challenge of autonomic knowledge discovery for security vulnerability prevention in self-governing systems. The partners include Federal University of Rio Grande do Sul (UFRGS, Brazil), Republic University of Uruguay (INCO, Uruguay), Technical University of Federico Santa Maria (UTFSM, Chile), and Inria (Orpailleur, Madynes). Computer vulnerabilities constitute one of the main entry points for security attacks, and therefore, vulnerability management mechanisms are crucial for any computer systems. However autonomic mechanisms for assessing and remediating vulnerabilities can degrade the performance of the system and might contradict existing operational policies. In that context, this project focuses on the design of solutions able to pro-actively understand the behavior of systems and networks, in order to prevent vulnerable states. For that purpose, our work concerns more specifically the exploitation and integration of knowledge discovery techniques within autonomic systems for providing intelligent self-configuration and self-protection. It also investigates the building of flexible and dynamic security management mechanisms taking benefits from software-defined methods and techniques.

<div align="center">**MAESTRO Project-Team**</div>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Marmote

Participants: Alain Jean-Marie, Issam Rabhi.

ANR Program: Modèles Numériques (MN) 2012, number ANR-12-MONU-0019

Project title: MARkovian MOdeling Tools and Environments

Duration: January 2013 - June 2017

Coordinator: Alain Jean Marie (Inria)

Partners: Inria (project-teams DYOGENE, MAESTRO and MESCAL), Univ. Versailles-Saint-Quentin (DAVID lab.), Telecom SudParis (SAMOVAR lab.), Univ. Paris-Est Créteil (LACL), and Univ. Pierre-et-Marie-Curie (LIP6)

Abstract: ANRMARMOTE aims, among other goals, at realizing the prototype of a software environment dedicated to modeling with Markov chains. It brings together seven partner teams, expert in Markovian analysis, who will develop advanced solution algorithms and applications in different scientific domains: reliability, distributed systems, biology, physics and economics.

https://wiki.inria.fr/MARMOTE/Welcome

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Participant: Konstantin Avrachenkov.

Program: EU COST

Project acronym: ACROSS

Project title: Autonomous Control for a Reliable Internet of Services

Duration: November 2013 - November 2017

Coordinator: Rob Van Der Mei (CWI) and J.L. Van Den Berg (TNO), The Netherlands

Other partners: see http://www.cost-across.nl/

Abstract: Currently, we are witnessing a paradigm shift from the traditional information-oriented Internet into an Internet of Services (IoS). This transition opens up virtually unbounded possibilities for creating and deploying new services. Eventually, the ICT landscape will migrate into a global system where new services are essentially large-scale service chains, combining and integrating the functionality of (possibly huge) numbers of other services offered by third parties, including cloud services. At the same time, as our modern society is becoming more and more dependent on ICT, these developments raise the need for effective means to ensure quality and reliability of the services running in such a complex environment. Motivated by this, the aim of this Action is to create a European network of experts, from both academia and industry, aiming at the development of autonomous control methods and algorithms for a reliable and quality-aware IoS.

Program: EU COST

Project acronym: COSTNET

Project title: European Cooperation for Statistics of Network Data Science

Duration: May 2016 - April 2020

Coordinator: Ernst Wit (NL), Gesine Reinert (UK)

Other partners: see http://www.cost.eu/COST_Actions/ca/CA15109

Abstract: A major challenge in many modern economic, epidemiological, ecological and biological questions is to understand the randomness in the network structure of the entities they study: for example, the SARS epidemic showed how preventing epidemics relies on a keen understanding of random interactions in social networks, whereas progress in curing complex diseases is aided by a robust data-driven network approach to biology.

Although analysis of data on networks goes back to at least the 1930s, the importance of statistical network modelling for many areas of substantial science has only been recognized in the past decade. The USA is at the forefront of institutionalizing this field of science through various interdisciplinary projects and networks. Also in Europe there are excellent statistical network scientists, but until now cross-disciplinary collaboration has been slow.

This Action aims to facilitate interaction and collaboration between diverse groups of statistical network modellers, establishing a large and vibrant interconnected and inclusive community of network scientists. The aim of this interdisciplinary Action is two-fold. On the scientific level, the aim is to critically assess commonalities and opportunities for cross-fertilization of statistical network models in various applications, with a particular attention to scalability in the face of Big Data. On a meta-level, the aim is to create a broad community which includes researchers across the whole of Europe and at every stage in their scientific career and to facilitate contact with stakeholders.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. THANES

Participants: Eitan Altman, Konstantin Avrachenkov, Jithin Kazhuthuveettil Sreedharan, Philippe Nain, Giovanni Neglia.

Title: THeory and Application of NEtwork Science

International Partners (Institution - Laboratory - Researcher):

CMU (Brazil) - Department of Computer Science - Bruno Ribeiro

UFRJ (Brazil) - Department of Computer and Systems Engineering - Edmundo de Souza e Silva, Daniel Ratton Figueiredo, Daniel Sadoc

Duration: 2014 – 2017

See also: https://team.inria.fr/thanes/

Our goal is to study how services in Online Social Networks (OSN) can be efficiently designed and managed. This research requires to answer 3 main questions: 1) How can the topology of an OSN be discovered? Many services need or can take advantage of some knowledge of the network structure that is usually not globally available and in any case changes continuously due to structural dynamics. 2) How does services' adoption spread across the OSN? On the one hand the popularity of a service is determined by word-of-mouth through the links of the OSN and, on the other end, the service may contribute to reshape the structure of the OSN (e.g. by creating new connections). 3) How do different services compete for the finite attention and money of OSN users? In particular our purpose is to provide analytical models (corroborated by simulations and experiments on real networks) to understand such complex interactions.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

MAESTRO has continued collaborations with researchers from GERAD, Univ. Montreal (Canada), Flinders Univ. (Australia), National Univ. of Rosario (Argentina), Technion - Israel Institute of Technology (Israel), Univ. of Arizona (USA), Univ. of Illinois at Urbana-Champaign (USA), Univ. of Liverpool (UK), Univ. of Massachusetts at Amherst (USA), Univ. of Florence (Italy), Univ. of Palermo (Italy), Univ. of Twente (The Netherlands) and Petrozavodsk State Univ. (Russia); Ghent Univ. (Belgium); see Sections 9.4.1.1 and 9.4.2.1 .

9.3.3. Participation in Other International Programs

MAESTRO has continued collaborations with researchers from IIT Mumbai and IISc Bangalore. In 2015, these collaborations where partly supported by IFCAM and Cefipra.

9.3.3.1. International Initiatives

DyGaMe

Title: Dynamic Games Methods: theory, algorithmics and application

International Partners (Institution - Laboratory - Researcher):

Univ. de Chile (Chile) - Department of Industrial Engineering - Fernando Ordóñez

Univ. Nacional de Rosario (Argentina) - Facultad de Ciencias Exactas, Ingeniería y Agrimensura - Eugenio Della Vecchia

CNRS (France) - LIP6 - Emmanuel Hyon

Duration: 2016 - 2017

Start year: 2016

See also: https://project.inria.fr/dygame

Stochastic Dynamic Game Theory is developing in Engineering sciences and is in need of more theoretical results, algorithms and applications. This project brings together researchers from Applied Mathematics, Operations Research and Economics, with the objective of contributing to these aspects. It will more specifically concentrate on agent rationality and the game structure, look for efficient solution algorithms by crossing Applied Mathematics and Operations Research techniques, and apply the results to problems originating from, on the one hand, security/conservation concerns, and on the other hand, sustainable development problems.

CEFIPRA Grant Monte Carlo, no.5100-IT1

Title: Monte Carlo and Learning Schemes for Network Analytics

International Partners (Institution - Laboratory - Researcher):

IIT Bombay (India) - Department of Electrical Engineering - Prof. V.S. Borkar;

IIS Bangalore (India) - Department of Electrical Engineering - Prof. R. Sundaresan.

Duration: 2014 - 2017

Start year: 2014

The project aims to approach various computation problems in network analytics by means of Markov Chain Monte Carlo (MCMC) and related simulation techniques as well as machine learning algorithms such as reinforcement learning, ant colony optimization, etc. This will include network diagnostics such as ranking, centrality measures, computation on networks using local message passing algorithms, resource allocation issues pertaining to networks and network-based systems such as the internet, peer-to-peer networks, social networks. The work will involve both development of analytical tools and extensive validation thereof using simulation studies. The research will draw upon techniques from graph theory, probability, optimization, and distributed computation.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Professors / Researchers

Bernardo Amorim

Date: 4-8 April 2016

Institution: Federal Univ. of Rio de Janeiro (Brazil)

Vivek Borkar

Date: 26-29 May and 4-17 September 2016

Institution: IIT Mumbai (India)

Damiano Carra

Date: 22-27 February and 18-22 July 2016

Institution: Univ. of Verona (Italy)

Francesco De Pellegrini

Date: 19-22 December 2016

Institution: CREATE-NET (Italy)

Ioannis Dimitriou

Date: 5-10 September 2016

Institution: Univ. of Patras (Greece)

Daniel Figueiredo

Date: 4-8 April 2016

Institution: Federal Univ. of Rio de Janeiro (Brazil)

Michele Garetto

Date: 4-5 April 2016

Institution: Univ. of Torino (Italy)

Moshe Haviv

Date: 15-19 June 2016

Institution: Univ. of Jerusalem (Israel)

Nidhi Hegde

Date: 10-13 June 2016

Institution: Nokia Bell Labs (France)

Giulio Iacobelli

Date: 11-21 January and 4-8 April 2016

Institution: Federal Univ. of Rio de Janeiro (Brazil)

Philippe Jacquet

Date: 1 December 2016

Institution: Nokia Bell Labs (France)

Jean-Yves Le Boudec

Date: 2 June 2016

Institution: EPFL (Switzerland)

Emilio Leonardi

Date: 6-16 December 2016

Institution: Politecnico di Torino (Italy)

Nelly Litvak

Date: 1-4 December 2016

Institution: Univ. of Twente (Netherlands)

Natalia Markovich

Date: 18-27 June 2016

Institution: Russian Academy of Sciences (Russia)

Evzey Morozov

Date: 21-29 July 2016

Institution: Petrozavodsk Univ. (Russia)

Fernando Ordóñez

      Date: 27-30 September

      Institution: Univ. of Chile (Chile)

Sreenath Ramanath

      Date: 17-27 May 2016

      Institution: IIT Bombay (India)

Bruno Ribeiro

      Date: 10-20 June 2016

      Institution: Carnegie Mellon Univ. (USA)

Daniel Sadoc

      Date: 4-8 April 2016

      Institution: Federal Univ. of Rio de Janeiro (Brazil)

Matteo Sereno

      Date: until March 2016 and 28 Nov-2 Dec 2016

      Institution: Univ. of Torino (Italy)

Vinod Sharma

      Date: 15-30 November 2016

      Institution: IIS Bangalore (India)

Flora Spieksma

      Date: 5-7 July 2016

      Institution: Univ. of Leiden (Netherlands)

Rajesh Sundaresan

      Date: 05-26 May 2016

      Institution: IIS Bangalore (India)

Josh Taylor

      Date: 24 June 2016

      Institution: Univ. of Toronto (Canada)

Don Towsley

      Date: 1-3 December 2016

      Institution: Univ. of Massachusetts (USA)

Kavitha Voleti Veeraruna

      Date: 17-27 May 2016

      Institution: IIT Bombay (India)

Uri Yechiali

      Date: 15-28 April 2016

      Institution: Tel Aviv Univ. (Israel)

9.4.1.2. Post-doc / Ph.D. students

      Víctor Bucarey López

            Date: 27-30 September 2016

            Institution: Univ. of Chile

      Ricardo Coelho Silveira

            Date: from Sep 2016 until Nov 2016

            Institution: Univ. of Rio de Janeiro (Brazil)

Eduardo Hargreaves
> Date: 20-23 June 2016
> Institution: Univ. of Rio de Janeiro (Brazil)

Yahui Tian
> Date: from Jun 2016 until Jul 2016
> Institution: Univ. of Texas (USA)

9.4.1.3. Internships

Mikhail Kamalov
> Date: from Jun 2016 until Jul 2016
> Institution: Saint Petersburg State Univ. (Russia)
> Supervisor: Konstantin Avrachenkov

Mohamed Lamghari
> Date: from Apr 2016 until Aug 2016
> Institution: UNS (France)
> Supervisor: Giovanni Neglia

Maksim Mironov
> Date: from Aug 2016 until Sept 2016
> Institution: MIPT (Russia)
> Supervisor: Konstantin Avrachenkov

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Konstantin Avrachenkov
> Date: 4 - 8 April 2016
> Institution: IIT Mumbai (India)
> Date: 25 April - 5 May 2016
> Institution: Moscow Institute of Physics and Technology and Yandex (Russia)
> Date: 10-11 August 2016
> Institution: Aaalto Univ. (Finland)

Alain Jean-Marie
> Date: 5 - 16 December 2016
> Institution: Univ. of Montreal (Canada)
> Date: 28 March - 1 April 2016
> Institution: Univ. National of Rosario (Argentina)
> Date: 3 - 14 April 2016
> Institution: Univ. de Chile (Chile)

Arun Kadavankandy
> Date: 12-30 April 2016
> Institution: Yandex (Russia)
> Date: 12-17 July 2016
> Institution: IIS Bangalore (India)

Giovanni Neglia
> Date: 14 - 22 February; 1 - 4 April; 20 - 25 September; 7 - 10 and 25 - 30 October 2016
> Institution: Univ. of Florence (Italy)
> Dates: 11 - 16 May; 21 - 23 December 2016
> Institution: Univ. of Palermo (Italy)

Dimitra Politaki
> Date: 18 October - 2 November and 12 - 20 December 2016
> Institution: Univ. of Torino (Italy)

MIMOVE Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Inria Support

8.1.1.1. Inria IPL CityLab@Inria

Participants: Valérie Issarny [correspondent], Fadwa Rebhi.

- **Name:** CityLab@Inria – *Overcoming the Smart City Challenge – Toward Environmental and Social Sustainability*
- **Related activities:** § 7.3 and § 6.3
- **Period:** [January 2014 – December 2018]
- **Inria teams:** CLIME, DICE, FUN, MIMOVE, MYRIADS, SMIS, URBANET, WILLOW
- **URL:** http://citylab.inria.fr

The Inria Project Lab (IPL) CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. Obviously, running experiments is a central concern of the Lab, so that we are able to confront proposed approaches to actual settings.

8.1.1.2. Inria ADT CityLab Platform

Participants: Valérie Issarny [correspondent], Fadwa Rebhi.

- **Name:** CityLab Platform – *A Platform for Smarter Cities Promoting Social and Environmental Sustainability*
- **Related activities:** § 7.3 and § 6.3
- **Period:** [November 2014 – October 2016]
- **Partners:** Inria MiMove, Inria CLIME.

The CityLab Platform ADT is part of the CityLab Inria Project Lab. The ADT is more specifically focused on the development of a middleware platform supporting mobile crowd-Xing for environmental pollution monitoring through user-led observations.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. H2020 ICT CHOReVOLUTION

Participants: Nikolaos Georgantas [correspondent], Valérie Issarny [correspondent].

Name: CHOReVOLUTION – *Automated Synthesis of Dynamic and Secured Choreographies for the Future Internet*

URL: http://www.chorevolution.eu

Type: Research & Innovation Action (ICT)

Topic: Tools and Methods for Software Development

Related activities: § 7.2 and § 6.2

Period: [January 2015 - December 2017]

Partners: CEFRIEL (Italy), Inria MiMove, OW2 Consortium (France), Thales Communications S.A. (France) [**coordinator**], Università degli Studi dell'Aquila (Italy) [**scientific leader**], Softeco Sismat SrL (Italy), Tirasa (Italy), Viktoria Swedish ICT (Sweden).

The Future Internet (FI) represents an age of unprecedented opportunities for social, economic, and business growth thanks to the global scale connectivity of the virtual as well as of the physical world. This indeed opens up a wealth of innovative and revolutionary real-life scenarios, as for instance illustrated by the smarter cities perspectives where envisioned scenarios significantly ease daily human activities and give support for the growth of new markets and employment opportunities. However, leveraging the FI for the development of innovative software applications remain a challenging task even though major enablers are readily available by ways of service-oriented and cloud computing. It is in particular our vision that enabling the choreography of FI services shall play a significant role in the provisioning of innovative applications. However, existing choreography-based service composition approaches are rather static and are poorly suited to the need of the FI that is a highly dynamic networking environment, further bringing together highly heterogeneous services ranging from Thing- to Business-based services that span different security domains. As a result, the technology is not mature enough for market take-up. CHOReVOLUTION elevates the Readiness Level of existing choreography technologies in order to drop the dynamism and cross-organization security barriers via the automated synthesis of dynamic and secured choreographies in the FI. To meet its objectives, CHOReVOLUTION undertakes both research and innovation tasks. The former concentrates on choreography modelling, synthesis, adaptation, service bus, security, and cloud; the latter focus on industrial validation, development support and integration platform, and the establishment of a CHOReVOLUTION community and market take- up. Last but not least CHOReVOLUTION outcomes are assessed by experimenting with new applications in the field of Intelligent Transportation Systems.

8.2.1.2. H2020 ICT FIESTA-IoT

Participants: Valérie Issarny [correspondent], Nikolaos Georgantas [correspondent].

> **Name:** FIESTA-IoT – *Federated Interoperable Semantic IoT/cloud Testbeds and Applications*
>
> **URL:** http://fiesta-iot.eu
>
> **Type:** Research & Innovation Action (ICT)
>
> **Topic:** FIRE+ (Future Internet Research & Experimentation)
>
> **Related activities:** § 7.5
>
> **Period:** [February 2015 - January 2018]
>
> **Partners:** Fraunhofer FOKUS (Germany) [**coordinator**], INSIGHT @ National University of Galway (Ireland) [**co-coordinator**], University of Southampton IT Innovation Centre (UK), Inria MiMove, University of Surrey (UK), Unparallel Innovation Lda (Portugal), Easy Global Market (France), NEC Europe Ltd (UK), University of Cantabria (Spain), Com4innov (France), Athens Information Technology (Greece), SOCIEDAD PARA EL DESARROLLO REGIONAL DE CANTABRIA (Spain), Ayuntamiento de Santander (Spain), Korea Electronics Technology Institute (Korea).

Despite the proliferation of IoT and smart cities testbeds, there is still no easy way to conduct large scale experiments that leverage data and resources from multiple geographically and administratively distributed IoT platforms. Recent advances in IoT semantic interoperability provide a sound basis for implementing novel cloud-based infrastructures that could allow testbed-agnostic access to IoT data and resources. FIESTA will open new horizons in IoT experimentation at a global scale, based on the interconnection and interoperability of diverse IoT testbeds. FIESTA will produce a first-of-a-kind blueprint experimental infrastructure (tools, techniques and best practices) enabling testbed operators to interconnect their facilities in an interoperable way, while at the same time facilitating researchers in deploying integrated experiments, which seamlessly transcend the boundaries of multiple IoT platforms. FIESTA will be validated and evaluated based on the interconnection of four testbeds (in Spain, UK, France and Korea), as well as based on the execution of novel experiments in the areas of mobile crowd-sensing, IoT applications portability, and dynamic intelligent discovery of IoT resources. In order to achieve global outreach and maximum impact, FIESTA will integrate an additional testbed and experiments from Korea, while it will also collaborate with IoT experts from USA. The participation of a Korean partner (based its own funding) will maximize FIESTA's value for EC money. Moreover, the project will take advantage of open calls processes towards attracting third-parties that will

engage in the integration of their platforms within FIESTA or in the conduction of added-value experiments. As part of its sustainability strategy, FIESTA will establish a global market confidence programme for IoT interoperability, which will enable innovative platform providers and solution integrators to ensure/certify the openness and interoperability of their developments.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

8.2.2.1. EIT Digital Env&You

Participant: Valérie Issarny [correspondent].

> **Name:** Env&You – *Personalizing environmental science for your home, your neighborhood and your life*
>
> **URL:** http://ambiciti.io
>
> **Related activities:** § 7.3 and § 6.3
>
> **Period:** [January 2016 - December 2016]
>
> **Partners:** Ambientic (F), CapDigital (F), Forum Virium Helsinki (FI), Inria CLIME, Inria MIMOVE [**coordinator**], NumTech (F), TheCivicEngine (USA).

There is a clear, and probably increasing, desire from the citizens to better know their individual exposure to pollution. Partial solutions exist to the exposure data problem but each focuses on one or another domain of information – crowdsourcing exposure, translating government open data to usable consumer information, harnessing social media information, harnessing biometrics – what is unique about Env&You is that we assimilate a multi-dimensional picture of exposure and provide the integrated information to citizen, government, and business use (spanning: B2G, B2B and B2C business cases).

8.2.2.2. EIT Digital CivicBudget

Participants: Valérie Issarny [correspondent], Nikolaos Georgantas [correspondent].

> **Name:** CivicBudget – *Software platform supporting Internet-based participatory budgeting campaigns*
>
> **Related activities:** § 7.4 and § 6.4
>
> **Period:** [January 2016 - December 2016]
>
> **Partners:** CITRIS (USA), Inria MIMOVE, MissionsPubliques (F) [**coordinator**], Nexus (DE), and TU Berlin (DE).

Many cities in Europe and the U.S.A, and around the world, commit a percentage of their annual budget (often 5%) to implement citizen-proposed projects through a process called Participatory Budgeting (PB). However, supporting urban-scale participatory budgeting campaigns is greatly challenged as it still principally relies on physical meetings. CivicBudget addresses this challenge by leveraging latest ICT so as to promote urban-scale inclusion. CivicBudget fosters a new and inclusive urban public sphere of citizenship. It is especially designed for community groups and activists who want to participate in the PB process. City governments will also be able to promote its use. CivicBudget will facilitate the mobilization of residents both to promote their proposals and to monitor their progress through the PB process to implementation.

8.3. International Initiatives

8.3.1. Inria International Labs

Valérie Issarny acts as scientific manager of the Inria@Silicon Valley program (https://project.inria.fr/inria-siliconvalley/) since summer 2013; she is visiting scholar at the EECS Department of University of California, Berkeley, and hosted by CITRIS.

8.3.2. Inria Associate Teams Not Involved in an Inria International Labs

8.3.2.1. Inria DRI/DST-CEFIPRA Associate Team: SARATHI

Participant: Rachit Agarwal [correspondent].

> **Name:** SARATHI – *Personalized Mobility Services for Urban Travelers*
> **Instrument:** Inria DRI/DST-CEFIPRA Associate Team
> **Related activities:** § 7.6
> **Period:** [January 2014 - December 2016]
> **Partners:** Indraprastha Institute of Information Technology (IIIT) Delhi (India), Inria MiMove.
> **Website:** http://sarathi.gitlab.io/web/

The focus of the *Sarathi* project is on creating a personalized mobility service platform for urban travelers. The proposed work would require work on large scale mobile participatory sensing, urban transportation, location-aware services, machine learning, and software engineering. The individual strength of MiMove and IIIT provide complementary technical benefits for the project. MiMove leverages its work on large scale mobile participatory sensing (so far focused on EU-based transit contexts) addressing challenges brought to the fore by dynamic large scale systems in India; IIIT will build up on their previous work on mobile based system to provide route information and work on learning and mining techniques for inferring events of interest in transport systems.

Besides the complementary technical benefits, the collaboration will also help the project in evaluating the proposed solution in context of both developing and developed countries with different societal structure and preferences. Since personalized services are an integral part of the solution, the variety in social structures of India and France will help in developing solutions that are valid across continents. A deployment of the proposed solution in India will also test scalability and robustness of the solution in resource-constrained environments (e.g. intermittent network connectivity, low bandwidth) and will help in developing solutions that can be deployed in different working environments. Similarly, France (with already an advanced transit system) offers opportunities in verifying the requirements of a successful sustainable transport system.

8.3.2.2. Inria/Brazil Associate Team: ACHOR

Participant: Nikolaos Georgantas [correspondent].

> **Name:** ACHOR – *Adaptive enactment of service choreographies*
> **Instrument:** Inria/Brazil Associate Team
> **Related activities:** § 7.2 and § 6.2
> **Period:** [January 2016 - December 2018]
> **Partners:** Universidade Federal de Goiás (UFG), Brazil, Inria MiMove.
> **Website:** http://www.inf.ufg.br/projects/achor

Service choreographies are distributed compositions of services (e.g., Web services) that coordinate their execution and interactions without centralized control. Due to this decentralized coordination and the ability to compose third-party services, choreographies have shown great potential as an approach to automate the construction of large-scale, on-demand, distributed applications. Technologies to enable this approach are reaching maturity level, such as modeling languages for choreography specification and engines that operate the deployment of services and enactment of choreographies at Future Internet scales. Nevertheless, a number of problems remain open on the way to fully realize the approach, among them: (i) Deployment of multiple choreographies on top of a collection of shared services (considering service sharing as an effective way to increase the utilization of resources); (ii) Dynamic adaptation of functional and non-functional properties due to runtime changes in the environment and user requirements (adapting the set of services and/or the resources used to run the services in order to add/remove/change functions and maintain QoS properties, respectively); and (iii) Seamless and dynamic integration of mobile services (e.g., smartphone apps, sensors and actuators on handhelds and wearables) and cloud- based services (including the need to consider: mobility of both devices and services, resource constraints of mobile devices, temporary disconnection, interoperability between different interaction paradigms (message-passing, event-based, data-sharing) at the middleware layer, and effect of these paradigms on end-to-end QoS).

The overall goal of the project is to design an architecture for adaptive middleware to support service choreographies in large-scale scenarios that involve dynamicity and diversity in terms of application requirements, service interaction protocols, and the use of shared local, mobile and cloud resources.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Garvita Bajaj (from May 2016 until Sept 2016)

> PhD internship funded by Associate Team Sarathi and H2020 FIESTA-IoT project.
>
> Subject: *Extending current FIESTA-IoT Ontology*
>
> Institution: Indraprastha Institute of Information Technology (IIIT) Delhi (India)

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Valérie Issarny is visiting scholar at the EECS Department at UC Berkeley; she is hosted by CITRIS in the context of which she carries out collaborative research in the area of smart cities and acts as scientific coordinator of the Inria@SiliconValley program.

MUSE Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. BottleNet: Understanding and Diagosing end-to-end communication problems

Type: ANR Project (N ANR-15-CE25-0013-01)

Instrument: PRCE

Duration: February 2016 - 36 mois

Coordinator: Renata Teixeira

Other partners: Inria Paris, LORIA, Ip-label SaS, ORANGE SA , TSP (SAMOVAR) Telecom SudParis, University of Lille 1 (CRIStAL)

Inria contact: Renata Teixeira

Abstract: As our lives become more dependent on the Internet, it is easy to understand peoples frustration when poor Internet performance prevents them from accomplishing ever-more important online activities. The Quality of Experience (QoE) when accessing the Internet is thus a key factor for todays society. When users experience poor Internet QoE, they are often helpless. The complexity of Internet services and of users local connectivity has grown dramatically in the last years with the proliferation of proxies and caches at the core and of home wireless and 3G/4G access. However, it is hard even for experts to diagnose the sources of performance bottlenecks. We argue that the new rules for regulating Internet access and plans to improve it should focus on the end-to-end Internet QoE - i.e., the user experience when performing her usual online activities on the Internet - and should provide means for all different players to accurately diagnose the sources of poor Internet QoE. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet QoE and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users devices. We plan to collect network and application performance metrics directly at users devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

7.1.2. CNRS Big Data Projects

7.1.2.1. BigGeoQUP: Big Geospatial Data Quality and User Privacy

Type: CNRS Mission Interdisciplinarité (MI) DEFI MASTODONS "La qualité des données dans les Big Data"

Instrument: AAP 2016

Duration: Mars 2016 - 12 mois

Coordinator: Dimitris Kotzinos (University of Cergy Pointoise)

Other partners: Inria Paris, IGN-COGIT

Inria contact: Vassilis Christophides

Abstract: Big Geo Data represents an important type of the crowd sourced data that are available today at a global scale. This kind of data refers to locations, i.e., Points of Interest (POIs), and is usually published in social media (e.g., Facebook, Google+) or in specialized platforms (e.g., Open Street Maps, Yelp). The quality (e.g., precision, accuracy, consistency) of geo-referenced crowd sourced content depends on the origin (machine vs. human generated), the level of detail of the extraction methods, as well as the obfuscation techniques used to protect users privacy. There is clearly a tradeoff between enhancing the quality of published geo data and the privacy risks entailed for the individuals, also known as geoprivacy, to uncover places visited, trajectories pursuit etc. Understanding the different aspects of geographic/geometric/geospatial quality involved in crowd-sourced geo data and assessing the privacy risks introduced by enhancing its quality in personal, social, and urban applications is a challenging topic. In this project we are interested in studying the following questions in concrete use-cases:

- How can we measure the quality of geographic/geometric/geospatial data involved in crowd-sourced content?

- How can we assess the privacy risks introduced by enhancing geospatial quality in personal, social and urban applications especially in the context of social media platforms?

In this project Inria (MUSE) is interested in the opportunities and privacy concerns of mobile location analytics supporting customers or travellers experience in venues of various types and sizes (e.g., retail stores, shopping malls, airports, theme parks, etc.). Such (indoor) location-based services in smart spaces presents new privacy risks as data continuously flows between visitors mobile devices, networked sensors embedded into the environment as well as the backend analytics platform in order to track users and anticipate their needs.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. User-Centric Networking (UCN)

Type: FP7

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2016

Coordinator: Technicolor

Other partners: Eurecom, Fraunhofer FOKUS, Intamac, University of Cambridge, University of Nottingham, Martel, NICTA, Portugal Telecom

Inria contact: Renata Teixeira

Abstract: This project introduces the concept of User Centric Networking (UCN), which is a new paradigm leveraging user information at large to deliver novel content recommendation systems and content delivery frameworks. UCN recommendation and content delivery systems will leverage in-depth knowledge about users to help them find relevant content, identify nearby network resources and plan how to deliver the actual content to the appropriate device at the desired time. These systems will additionally account for influences from users' social networks on their content consumption. The goal of this project is to design a UCN system architecture for user-centric connected media services. We will build UCN upon three complementary research pillars:

1. understanding user context: This data can be broadly categorized into three groups. First, the physical and environmental context A second category of data is that which can be extracted from social network interactions. The third category of data is behavioural

2. profiling and predicting user interests: By gaining a deep understanding of the user, we may be able to cast a much wider net in the content ocean and locate a richer catalogue of interesting content for the user

3. personalizing content delivery: Rather than the user (or the service provider) having to worry about the mode of connectivity, device, service, location, etc., the network intelligently directs and adapts the transport stream, or perhaps pre-fetches and replicates content chunks, to the particular and immediate needs of the user.

See also: http://usercentricnetworking.eu/

7.3. International Initiatives

7.3.1. Inria Associate Teams Not Involved in an Inria International Labs

- BetterNet (Inria Project Lab): An observatory to measure and Improve Internet Service Access from User Experience. Project Coordinator: Isabelle Chrisment, Partners: Inria teams Spirals, Diana, Muse, Dionysos and Madynes, Inria Chile

BetterNet intends to build and deliver a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. We will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where:

- tools, models and algorithms/heuristics will be provided to collect data,
- acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society, and
- new value-added services will be proposed to end-users.

This project will also allow Inria to become a key reference in the digital field, not only for scientist researchers but also for policy makers, rulers, and, for citizens in general, by giving them a more accurate and reliable basis for decisions making at an individual scale (privacy strategies) or at a collective scale (legal norms). An originality of our proposal is to ensure that researchers from different disciplines (exact sciences, applied sciences and social sciences) will collaborate in the design of this observatory, in the dissemination of results for the research community, executives and public at large.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

- Princeton (Prof. Nick Feamster): We have a long-term collaboration on measuring the performance of residential broadband Internet access networks and more recently on home network diagnosis.
- ICSI (Dr. Srikanth Sundaresan, Dr. Christian Kreibich, Dr. Robin Sommer): With C. Kreibich, we have been developing Fathom, a browser-based network measurement platform. We are now adding home network diagnosis capabilities to Fathom. We are collaborating with S. Sundaresan on detecting last-mile bottlenecks. In addition, with Robin Sommer we are working on the potential of matching the profiles of a user across multiple online social networks.
- Northwestern University (Prof. Fabian Bustamante and his doctoral student Zachary Bischof): we are working on identifying user activity from network traffic.

7.4. International Research Visitors

7.4.1. Internships

- Arash Molavi Kakhki, Ph.D Student, Northeastern University, from Nov 2016
- Julio Adriazola Soto, M2 Student, Inria Chile, from Jan 2016 until Mar 2016
- Michele Pittoni, M2 Student, Univ. Paris VI, from Feb 2016 until Jul 2016
- Adhir Chakravarti, M2 Student, Univ. Paris VI, from Feb 2016 until Jul 2016
- Zied Ben Houidi Bell Labs (Alcatel), from Apr 2016

MYRIADS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. IRT B-Com

Participants: Yvon Jégou, Edouard Outin, Jean-Louis Pazat.

Yvon Jégou and Jean-Louis Pazat are at IRT B-Com [0] one day per week. With Édouard Outin, B-com PhD student, they contribute to the B-Com *Indeed* project, which aims at developing a distributed cloud software stack with a high degree of adaptability.

In the last period, they were involved in the elaboration of new projects in the Cloud Computing lab of B-Com.

9.1.2. CominLabs EPOC project (2013-2017)

Participants: Sabbir Hasan Rochi, Yunbo Li, Anne-Cécile Orgerie, Jean-Louis Pazat.

In this project, partners aim at focusing on energy-aware task execution from the hardware to application's components in the context of a mono-site data center (all resources are in the same physical location) which is connected to the regular electric Grid and to renewable energy sources (such as windmills or solar cells). In this context, we tackle three major challenges:

- Optimizing the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services.
- Designing a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed systems.
- Investigating energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

9.1.3. INDIC - Cybersecurity Pole of Excellence (2014-2018)

Participants: Anna Giannakou, Christine Morin, Jean-Louis Pazat, Louis Rilling, Amir Teshome Wonjiga.

Our study carried out in the framework of a collaboration with DGA-MI aims at defining and enforcing SLA for security monitoring of virtualized information systems. To this aim we study three topics:

- defining relevant SLA terms for security monitoring,
- enforcing and evaluating SLA terms,
- making the SLA terms enforcement mechanisms self-adaptable to cope with the dynamic nature of clouds.

The considered enforcement and evaluation mechanisms should have a minimal impact on performance. The funding from DGA funds two PhD students: Anna Giannakou and Amir Teshome Wonjiga.

9.2. National Initiatives

9.2.1. Inria ADT GinFlow (2014-2016)

Participants: Christine Morin, Matthieu Simonin, Cédric Tedeschi.

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[0] http://b-com.org/wp/

The GinFlow technological development action funded by INRIA targets the development of a fully-operational workflow management system based on the HOCL-TS software prototype developed during the PhD thesis of Hector Fernandez between 2009 and 2012. Also, it allows the integration of this software with the TIGRES workflow engine developed at the Lawrence Berkeley National Lab so as to make the workflows submitted using the TIGRES programming model run in a decentralized fashion. These developments led to the release of the GinFlow software and its deposit at the APP (Agence de Protection des Programmes).

9.2.2. *Inria ADT SaaP (2016-2018)*
Participant: Martin Quinson.

The SaaP technological development action (SimGrid As A Platform) funded by INRIA targets the refactoring of SimGrid to make it ready to use in production and teaching contexts. Our ultimate goal is to sustain the development of the framework by involving 5 to 10 companies that are using it internally. Our target of the teaching context is thus an intermediate goal, as we think that the best solution to ensure the adoption of our tool by the industrial engineers is that they discovered the tool during their studies.

The technical actions envisioned for this ADT are the complete rearchitecturation of the software (to make it easier to script a new model within the tool kernel) and a reorganization of the interfaces (for a better integration in the Java and python language). This work is lead in collaboration with the whole SimGrid community, which provide valuable feedback.

9.2.3. *Inria IPL Discovery (2015-2019)*
Participants: Anne-Cécile Orgerie, Matthieu Simonin, Cédric Tedeschi.

The Inria IPL Discovery officially started in September 2015. It targets the design, development and deployment of a distributed Cloud infrastructure within the network's backbone. It will be based upon a set of building blocks whose design will take locality as a primary constraint, so as to minimize distant communications and consequently achieve better network traffic, partition management and improved availability.

Its developments are planned to get integrated within the OpenStack framework. An energy/cost benefit analysis of the fully distributed Discovery architecture will also be performed to show the energy efficiency of the chosen approach.

9.2.4. *Inria IPL CityLab (2015-2018)*
Participant: Christine Morin.

The Inria Project Lab (IPL) CityLab@Inria (https://citylab.inria.fr) studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. City-scale experiments of the proposed platforms and services are planned in cities in California and France, thereby learning lessons from diverse setups.

Myriads investigates advanced cloud solutions for the Future Internet, which are critical for the processing of urban data. It leverages its experience in cloud computing and Internet of services while expanding its research activities to the design and implementation of cloud services to support crowd-Xing applications and mobile social applications.

In 2016, Christine Morin was involved in the MOOC entitled *Villes Intelligentes : défis technologiques et sociétaux* (Smart cities : technological and social challenges) run on the FUN platform from January to March 2016. She prepared eight sequences on urban data management in clouds. In 2016, we also conducted a comparative experimental evaluation of data stream processing environments executed on clusters and in a cloud. We compared the performance and energy consumption of Heron, Storm and SparkStreaming frameworks.

9.2.5. *Inria IPL Hac Specis (2016-2020)*
Participants: Anne-Cécile Orgerie, Martin Quinson.

The goal of the HAC SPECIS (High-performance Application and Computers: Studying PErformance and Correctness In Simulation) project (http://hacspecis.gforge.inria.fr/) is to answer methodological needs of HPC application and runtime developers and to allow to study real HPC systems both from the correctness and performance point of view. To this end, we gather experts from the HPC, formal verification and performance evaluation community.

The Anh Pham started a PhD thesis in November 2016, co-advised by Thierry Jéron (team SUMO, formal methods) and Martin Quinson. The envisionned work will pursue the previous efforts to formally assess distributed applications within the SimGrid framework.

9.2.6. COSMIC PRE (2016 - 2018)

Participants: Benjamin Camus, Anne-Cécile Orgerie.

The distributed nature of Cloud infrastructures involves that their components are spread across wide areas, interconnected through different networks, and powered by diverse energy sources and providers, making overall energy monitoring and optimization challenging. The COSMIC project aims at taking advantage of the opportunity brought by the Smart Grids to exploit renewable energy availability and to optimize energy management in distributed Clouds. This PRE, led by Anne-Cécile Orgerie also involves Fanny Dufossé from Dolphin team (Inria Lille) and Benjamin Camus, who has started a 18 months post-doc in October 2016 in the context of this project.

9.2.7. MIHMES ANR Investissements d'Avenir (2012 - 2018)

Participants: Yvon Jégou, Christine Morin, Manh Linh Pham, Nikos Parlavantzas.

The MIMHES project (http://www.inra.fr/mihmes) led by INRA/BioEpAR aims at producing scientific knowledge and methods for the management of endemic infectious animal diseases and veterinary public health risks. Myriads team provides software tools to efficiently manage and ease the use of a distributed computing infrastructure for the execution of different simulation applications.

In 2016, we further developed a distributed framework which allows to exploit multiple compute servers in parallel. Parallelism is exploited both at server level using OpenMP and at data-center level using this framework. To facilitate the deployment of the workloads on heterogeneous environments, this framework limits the requirements concerning the server configurations. They need not share any file system, the workloads can be programmed in differing programming language. These servers need only the capability to communicate through the network. The system allows to dynamically add and stop servers. To some extend, it is tolerant to server failures. The framework had being repackaged to facilitate its reuse for new workloads. We also worked on the automated deployment of the framework on top of one or multiple IaaS clouds.

9.2.8. PIA ELCI (2015-2018)

Participant: Anne-Cécile Orgerie.

The PIA ELCI project deals with software environment for computation-intensive applications. It is leaded by BULL. In the context of this project, we collaborate with ROMA and Avalon teams from Lyon: we co-supervise a PhD student (Issam Rais) funded by this project with these teams on multicriteria scheduling for large-scale HPC environments.

9.2.9. CNRS PEPS EcoSmart (2016)

Participant: Anne-Cécile Orgerie.

Smart Grids are connected to telecommunication networks and can thus optimize the production, distribution and consumption of electricity. Virtualized distributed systems (Clouds) are the major players in providing services over the Internet. The success of these on-demand services makes the energy consumption of these systems worrying. This project aims to optimize the energy consumption of these large consumers, namely virtualized distributed Clouds consisting of computing, storage and communication resources. The objective is to exploit the capabilities offered by smart grids to control the consumption of these systems and be able to influence it according to the availability or the nature of the electricity used.

9.2.10. CNRS GDS EcoInfo

Participant: Anne-Cécile Orgerie.

The EcoInfo group deals with reducing environmental and societal

impacts of Information and Communications Technologies from hardware to software aspects. This group aims at providing critical studies, lifecycle analyses and best practices in order to improve the energy efficiency of printers, servers, data centers, and any ICT equipment in use in public research organizations.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. PaaSage

Title: PaaSage: Model Based Cloud Platform Upperware

Programm: FP7

Duration: October 2012 - September 2016

Coordinator: ERCIM

Partners:

Akademia Gorniczo-Hutnicza Im. Stanislawa Staszica W Krakowie (Poland)

Automotive Simulation Center Stuttgart Ev (Germany)

Be.Wan Sprl (Belgium)

Centred'Excellence en Technologies de l'Information et de la Communication (Belgium)

Geie Ercim (France)

Evry As (Norway)

Flexiant (United Kingdom)

Foundation for Research and Technology Hellas (Greece)

Gesellschaft Fur Wissenschaftliche Datenverarbeitung Mbh Gottingen (Germany)

Ibsac - Intelligent Business Solutions Ltd (Cyprus)

Inria (France)

Lufthansa Systems (Germany)

Stiftelsen Sintef (Norway)

Science and Technology Facilities Council (United Kingdom)

University of Cyprus (Cyprus)

Universitaet Stuttgart (Germany)

Universitaet Ulm (Germany)

Universitetet I Oslo (Norway)

Inria contact: Christine Morin

PaaSage (2012-2016) (http://www.paasage.eu) is an FP7 collaborative project that develops an open-source cloud platform, with an accompanying methodology and language, which enables developers to access cloud services in a technology-neutral approach while guiding them to configure their applications for best performance. PaaSage facilitates application deployment on multiple clouds while enhancing the flexibility, adaptivity and scalability of applications. Myriads develops the Adapter subsystem that supports dynamic, cross-cloud application adaptation. In 2016, we improved the Adapter implementation and evaluated its use within the business scenarios of PaaSage partners.

9.3.1.2. Fed4Fire

Title: Federation for FIRE

Programm: FP7

Duration: October 2012 - September 2016

Coordinator: Interdisciplinary institute for broadband technology (iMinds, Belgium)

Partners:

> University of Southampton (It Innovation, United Kingdom)
>
> Universite Pierre et Marie Curie - paris6 (UPMC, France)
>
> Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.v (Fraunhofer, Germany)
>
> Technische Universitat Berlin (TUB, Germany)
>
> The University of Edinburgh (UEDIN, United Kingdom)
>
> National Ict Australia Limited (NICTA, Australia)
>
> Atos Spain SA (Atos, Spain)
>
> Panepistimio Thessalias (University of Thessaly) (UTH, Greece)
>
> National Technical University of Athens (NTUA, Greece)
>
> University of Bristol (UNIVBRIS, United Kingdom)
>
> Fundacio Privada i2cat, Internet I Innovacio Digital a Catalunya (i2cat, Spain)
>
> Eurescom-European Institute for Research and Strategic Studies in Telecommunications (EUR, Gmbh Germany)
>
> Delivery of Advanced Network Technology to Europe limited (DANTE limited, United Kingdom)
>
> Universidad de Cantabria (UC, Spain)
>
> National Information Society agency (NIA, Korea (republic of))

Inria contact: Walid Dabbous

Fed4FIRE is an FP7 Integrated Project project running between October 2012 and September 2016 (http://www.fed4fire.eu), extended to December 2016. In Fed4FIRE, we investigate the means by which our experimental platforms (BonFIRE, and in a secondary way Grid'5000) could be made interoperable with a wider eco-system of experimental platforms in Europe and beyond. 2016 is the sustainability year of Fed4FIRE, and as usage from experimenters is not bringing any revenue, we closed the BonFIRE platform as it was become unmaintainable without significant effort.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. NESUS

Participant: Anne-Cécile Orgerie.

> Program: ICT COST
>
> Project acronym: NESUS
>
> Project title: Network for Sustainable Ultrascale Computing (ICT COST Action IC1305)
>
> Duration: 2014 - 2018
>
> Coordinator: Prof. Jesus Carretero, University Carlos III of Madrid, Spain, http://www.nesus.eu
>
> Other partners: 33 COST countries and 11 non-COST countries

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to gluing disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society. Anne-Cécile Orgerie is co-responsible of the focus group on metrics, monitoring, instrumentation and profiling in the Working Group 5 on Energy Efficiency.

9.3.3. Collaborations with Major European Organizations

Partner 1: EPFL, Network architecture lab (Switzerland)

We collaborate with Katerina Argyraki's research group on the integration of networking and cloud computing technologies in order to support placement constraints between cloud resources.

Partner 2: VU University Amsterdam, dept. of Computer Science (the Netherlands)

We collaborate with Thilo Kielmann's research group at VU University Amsterdam on research and development around the ConPaaS system.

Partner 3: University of Neuchâtel, dept. of Computer Science (Switzerland)

We collaborate with Pascal Felber's research group on energy efficiency in Clouds and in particular on the design of energy cost models for virtual machines.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. DALHIS

Title: Data Analysis on Large Heterogeneous Infrastructures for Science

International Partner (Institution - Laboratory - Researcher):

Lawrence Berkeley National Laboratory (United States) - Data Science and Technology department - Deb Agarwal

Start year: 2016

See also: https://project.inria.fr/dalhis/

Data produced by scientific instruments (large facilities like telescopes or field data), large-scale experiments, and high-fidelity simulations are increasing in magnitude and complexity. Existing data analysis methods, tools and infrastructure are often difficult to use and unable to provide the complete data management, collaboration, and curation environment needed to manage these complex, dynamic, and large-scale data analysis environments. The goal of the Inria-LBL DALHIS associate team involving the Myriads (PI) and Avalon Inria project-teams and the Data Science and Technology (DST) department at Lawrence Berkeley National Laboratory (LBL) is to create a collaborative distributed software ecosystem to manage data lifecycle and enable data analytics on distributed data sets and resources. Specifically, our goal is to build a dynamic software stack that is user-friendly, scalable, energy-efficient and fault tolerant. Our research will determine appropriate execution environments that allow users to seamlessly execute their end-to-end dynamic data analysis workflows

in various resource environments and scales while meeting energy-efficiency, performance and fault tolerance goals. We will engage in deep partnerships with scientific teams (Fluxnet in environmental science and SNFactory and LSST experiences in cosmology) and use a mix of user research with system software R&D to address specific challenges that these communities face. Our experience will in turn inform future research directions.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Partner: Rutgers University, dept. of Computer Science (New Jersey, United States)

We collaborate with Manish Parashar's research group on energy efficiency in edge Clouds and in particular on the design of energy cost models for such environments.

Partner: Northeastern University, dept. of Computer Science (Massachusetts, United States)

We collaborate with Gene Cooperman 's research group on virtualization technologies for the study of large-scale distributed systems.

Partner: University of Guadalajara (Mexico)

We collaborate with the team of Prof. H$\sqrt{}$©ctor Duran-Limon on application and resource management in the cloud. In 2016, we produced a joint journal publication [14]. Nikos Parlavantzas is co-advising a PhD student enrolled in the University of Guadalajara (Carlos Ruiz Diaz).

Partner: Tlemcen University (Algeria)

We collaborate with Djawida Dib on energy-efficient fault-tolerant resource and application management in containerized clouds. Christine Morin will co-advise a PhD student enrolled in the University of Tlemcen (Yasmina Bouizem) from December 2016.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Deb Agarwal, senior scientist at Lawrence Berkeley National Laboratory, who has been awarded an Inria International Chair for the 2015-2019 period, visited Myriads team during two months from May 1st to June 30th, 2016.

Christian Heinrich, PhD student in the Polaris team at Inria Grenoble, spent one month in October in the Myriads team to improve how large-scala distributed systems are declared in the SimGrid framework.

Professor Gene Cooperman, Northeastern University, Boston, USA, visited the Myriads team for one week in June to revive our collaboration on the virtualization of large-scale distributed systems.

Professor Peter Hubwieser, Technic University of Munchen, Germany, visited the Myriads team for two weeks in November to start a collaboration on the didactics of computer science with Martin Quinson.

Carlos Ruiz Diaz, PhD student in the University of Guadalajara, Mexico, spent 6 months in the Myriads team (from September 2015 to February 2016) to advance his work on adapting cloud configurations.

9.5.1.1. Internships

Benjamin Trubert
Date: May-August 2016
Institution: University of Rennes 1
Supervisor: Guillaume Pierre

Kartik Sathyanarayanan
Date: May-July 2016
Institution: Birla Institute of Technology & Science, Pilani (India)
Supervisor: Christine Morin

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Anna Giannakou did a 3-month research internship in the Data Science and Technology department of the Lawrence Berkeley National Laboratory from August to October 2016. She worked with Sean Peisert, staff scientist, on building a workflow for anomaly Detection in HPC environments using statistical data.

- Yunbo Li did a 2 month research internship in the Computer Science department of Rutgers University from August to September 2016. He worked with Prof. Manish Parashar on building an energy cost model for edge cloud applications.

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PHOENIX Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Independent living with intellectual disabilities – ANDDI – 2014 - 2017

ANDDI leverages the abilities of individuals with ID and the recent technological advances to develop a variety of assistive services addressing their daily needs. These services draw on our expertise in cognitive science and computer science, dedicated to assisting users with technologies. In particular, we use our platform, named HomeAssist, dedicated to the independently living of older adults. This project is funded by the Region of Aquitaine.

9.1.2. Platform for Assisted Living – HomeAssist 24 – 2013 – 2016

The objective of this project is to provide an open platform of digital assistance dedicated to aging in place. This project is in collaboration with researchers in Cognitive Science (University of Bordeaux) and the UDCCAS Gironde (Union Départementale des Centres Communaux d'Action Sociale) managing elderly care. This project includes a need analysis, the development of assistive applications and their experimental validation. To validate HomeAssist 24 homes of older adults are equipped during 9 months, and matched with 24 control, non-equipped participants. This work is funded by CARSAT, the Region of Aquitaine, and the District of Gironde.

9.1.3. Populational Study of HomeAssist – HomeAssist 500 – 2015 - 2017

We conduct a Randomized Controlled Trial (RCT) of HomeAssist with older adults, ranging from autonomous to mildly cognitively impaired (e.g., Alzheimer disease (AD) in its early stage). The RCT is considered as the gold standard of a true experimental design. Furthermore, it provides strong evidence for causal relationships, as well as the ability to generalize the results to people outside the study's sample. The study design will thus be a single-blinded RCT. It will include up to 500 participants, matched with non-equipped participants. The HomeAssist intervention will involve monitoring as well as compensation services to support independent living in place. The duration of the HomeAssist intervention is of 12 months. This project is funded by the Region of Aquitaine, the Districts of Gironde and Pyrénées Atlantique, CARSAT Aquitaine, UDCCAS, and CNSA.

9.2. National Initiatives

9.2.1. School Inclusion for Children with Autism

The objective of this project is to provide children with assistive technologies dedicated to the school routines. This project is in collaboration with the "Handicap et Système Nerveux" research group (EA 4136, Bordeaux University), the PsyCLÉ research center (EA 3273, Provence Aix-Marseille University) and the "Parole et Langage" research laboratory (CNRS, Provence Aix-Marseille University).

This work is funded by the French Ministry of National Education and Orange Foundation.

9.3. International Initiatives

9.3.1. Participation in Other International Programs

- Cooperation program with UB-University of Waterloo-Canada — Aging (2015-16), Coordinated by M. Fernandes and H. Sauzéon.
- International exchange program Idex (2016-17) — Pr. Luc Noreau, Centre Interdisciplinaire de Recherche en réadaptation et intégration sociale-University of Laval, Canada. Coordinated by P. Dehail.
- Mobility program Idex UB-University of Waterloo, Canada — Aging (2016-17), Coordinated by M. Fernandes and H. Sauzéon.

<p style="text-align:center">**POLARIS Team**</p>

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. Mont-Blanc 2

Program: FP7 Programme

Project acronym: Mont-Blanc 2

Project title: Mont-Blanc: European scalable and power efficient HPC platform based on low-power embedded technology

Duration: October 2013 - September 2016

Coordinator: BSC (Barcelone)

Other partners: BULL - Bull SAS (France), STMicroelectronics - (GNB SAS) (France), ARM - (United Kingdom), JUELICH - (Germany), BADW-LRZ - (Germany), USTUTT - (Germany), CINECA - (Italy), CNRS - (France), Inria - (France), CEA - (France), UNIVERSITY OF BRISTOL - (United Kingdom), ALLINEA SW LIM - (United Kingdom)

Abstract: Energy efficiency is already a primary concern for the design of any computer system and it is unanimously recognized that future Exascale systems will be strongly constrained by their power consumption. This is why the Mont-Blanc project has set itself the following objective: to design a new type of computer architecture capable of setting future global High Performance Computing (HPC) standards that will deliver Exascale performance while using 15 to 30 times less energy. Mont-Blanc 2 contributes to the development of extreme scale energy-efficient platforms, with potential for Exascale computing, addressing the challenges of massive parallelism, heterogeneous computing, and resiliency. Mont-Blanc 2 has great potential to create new market opportunities for successful EU technology, by placing embedded architectures in servers and HPC.

The Mont-Blanc 2 proposal has 4 objectives:
1. To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support.
2. To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system.
3. To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips).
4. To provide continued support for the Mont-Blanc consortium, namely operations of the Mont-Blanc prototype, and hands-on support for our application developers

8.1.1.2. QUANTICOL

Program: The project is a member of Fundamentals of Collective Adaptive Systems (FOCAS), a FET-Proactive Initiative funded by the European Commission under FP7.

Project acronym: QUANTICOL

Project title: A Quantitative Approach to Management and Design of Collective and Adaptive Behaviours

Duration: 04 2013 – 03 2017

Coordinator: Jane Hillston (University of Edinburgh, Scotland)

Other partners: University of Edinburgh (Scotland); Istituto di Scienza e Tecnologie della Informazione (Italy); IMT Lucca (Italy) and University of Southampton (England).

Abstract: The main objective of the QUANTICOL project is the development of an innovative formal design framework that provides a specification language for collective adaptive systems (CAS) and a large variety of tool-supported, scalable analysis and verification techniques. These techniques will be based on the original combination of recent breakthroughs in stochastic process algebras and associated verification techniques, and mean field/continuous approximation and control theory. Such a design framework will provide scalable extensive support for the verification of developed models, and also enable and facilitate experimentation and discovery of new design patterns for emergent behaviour and control over spatially distributed CAS.

8.1.1.3. HPC4E

Title: HPC for Energy

Program: H2020

Duration: 01 2016 – 01 2018

Coordinator: Barcelona Supercomputing Center

Inria contact: Stephane Lanteri

Other partners:

- Europe: Lancaster University (ULANC), Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), Repsol S.A. (REPSOL), Iberdrola Renovables Energía S.A. (IBR), Total S.A. (TOTAL).

- Brazil: Fundação Coordenação de Projetos, Pesquisas e Estudos Tecnoclógicos (COPPE), National Laboratory for Scientific Computation (LNCC), Instituto Tecnológico de Aeronáutica (ITA), Petroleo Brasileiro S. A. (PETROBRAS), Universidade Federal do Rio Grande do Sul (INF-UFRGS), Universidade Federal de Pernambuco (CER-UFPE)

Abstract: The main objective of the HPC4E project is to develop beyond-the-state-of-the-art high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using the state-of-the-art HPC systems. The other objective is to improve the cooperation between energy industries from EU and Brazil and the cooperation between the leading research centres in EU and Brazil in HPC applied to energy industry. The project includes relevant energy industrial partners from Brazil and EU, which will benefit from the project's results. They guarantee that TRL of the project technologies will be very high. This includes sharing supercomputing infrastructures between Brazil and EU. The cross-fertilization between energy-related problems and other scientific fields will be beneficial at both sides of the Atlantic.

8.1.2. Collaborations with Major European Organizations

EPFL: Laboratoire pour les communications informatiques et leurs applications 2, Institut de systèmes de communication ISC, Ecole polytechnique fédérale de Lausanne (Switzerland). We collaborate with Jean-Yves Leboudec (EPFL) and Pierre Pinson (DTU) on electricity markets.

TU Wien: Research Group Parallel Computing, Technische Universität Wien (Austria). We collaborate with Sascha Hunold on experimental methodology and reproducibility of experiments in HPC. In particular we co-organize the REPPAR workshop on "Reproducibility in Parallel Computing".

BSC (Barcelona): Barcelona Supercomputer Center (Spain). We collaborate with the performance evaluation group through the HPC4E project, the Mont-blanc 2 project, and the JLESC.

University of Edinburgh and Istituto di Scienza e Tecnologie della Informazione: we strongly collaborate through the Quanticol European project.

8.2. International Initiatives

8.2.1. Inria International Labs

8.2.1.1. North America

- JLESC (former JLPC) (Joint Laboratory for Extreme-Scale Computing) with University of University of Illinois Urbana Champaign, Argonne Nat. Lab and BSC. Several members of POLARIS are partners of this laboratory, and have done several visits to Urbana-Champaign or NCSA.

8.2.2. Inria Associate Teams not involved in an Inria International Labs

8.2.2.1. EXASE

Title: Exascale Computing Scheduling and Energy

International Partner (Institution - Laboratory - Researcher):

Universidade Federal do Rio Grande do Sul (Brazil) - INF (INF) - Nicolas MAILLARD

Start year: 2014

See also: https://team.inria.fr/exase/

The main scientific goal of this collaboration for the three years is the development of state-of-the-art energy-aware scheduling algorithms for exascale systems. Three complementary research directions have been identified : (1) Fundamentals for the scaling of schedulers: develop new scheduling algorithms for extreme exascale machines and use existing workloads to validate the proposed scheduling algorithms (2) Design of schedulers for large-scale infrastructures : propose energy-aware schedulers in large-scale infrastructures and develop adaptive scheduling algorithms for exascale machines (3) Tools for the analysis of large scale schedulers : develop aggregation methodologies for scheduler analysis to propose synthetic visualizations for large traces analysis and then analyze schedulers and energy traces for correlation analysis

8.2.3. Inria International Partners

8.2.3.1. Declared Inria International Partners

- POLARIS has strong connections with both UFRGS (Porto Alegre, Brazil) and USP (Sao Paulo, Brazil). The creation of the LICIA common laboratory (see next section) has made this collaboration even tighter.
- POLARIS has strong bounds with the University of Illinois Urbana Champaign and Barcelona Supercompter Center, within the (Joint Laboratory on Petascale Computing, see previous section).

8.2.4. Participation in Other International Programs

8.2.4.1. South America

- *LICIA:* The CNRS, Inria, the Universities of Grenoble, Grenoble INP, and Universidade Federal do Rio Grande do Sul have created the LICIA (*Laboratoire International de Calcul intensif et d'Informatique Ambiante*). LICIA's main research themes are high performance computing, language processing, information representation, interfaces and visualization as well as distributed systems. Jean-Marc Vincent is the director of the laboratory on the French side and visited Porto Alegre for two weeks in November 2016.

  More information can be found at http://www.inf.ufrgs.br/licia/.

- *ECOS-Sud:* POLARIS is a member of the Franco-Chilean collaboration network LEARN with CONICYT (the Chilean national research agency), formed under the ECOS-Sud framework. The main research themes of this network is the application of continuous optimization and game-theoretic learning methods to traffic routing and congestion control in data networks. Panayotis Mertikopoulos was an invited researcher at the University of Chile in October 2016.

  More information can be found at http://www.conicyt.cl/pci/2016/02/11/programa-ecos-conicyt-adjudica-proyectos-para-el-ano-2016.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Matthieu Jonckeere (Buenos Aires University) visited for 3 weeks.
- Mario Bravo (University of Santiago, Chile) visited POLARIS for 1 week in Feb. 2016.
- Mathias Staudigl (Maastricht University) visited POLARIS for 2 weeks in July 2016.

8.3.2. Visits to International Teams

8.3.2.1. Sabbatical programme

- Florence Perronnin spent one year in sabbatical leave (rachat de service) at the Université Versailles-Saint-Quentin (DAVID lab)

8.3.2.2. Research Stays Abroad

- Panayotis Mertikopoulos was an invited professor at the University of Athens, Athens, Greece, for four months (March–June 2016).
- Panayotis Mertikopoulos was an invited professor at LUISS Guido Carli University, Rome, Italy, for one month (Sept. 2016).

<p style="text-align:center;color:red;font-weight:bold;">RAP Project-Team</p>

6. Partnerships and Cooperations

6.1. International Research Visitors

6.1.1. Visits of International Scientists

- Louigi Addario-Berri (McGill)
- Gabor Lugosi (ICREA and Pompeu Fabra)
- Christina Goldschmidt (Oxford)
- Hui He (Beijing Normal University)
- Elie de Panafieu (Bell Labs France)
- Minmin Wang (Buenos Aires)
- Neil Walton (UK)

6.1.1.1. Internships

- Thanhh-Huy, Nguyen, M1 student at Polytechnique (Avril-July 2016). Internship on"Resource allocation in vehicle-sharing systems".

6.1.2. Visits to International Teams

- *Nicolas Broutin* has visited the mathematics department of the University of Bath, the School of Computer Science at McGill University, the computer science laboratory in Bordeaux (LaBRI) and the NYU-ECNU institute for mathematical sciences at NYU Shanghai.
- *Philippe Robert* (17-27 April 2016) and *Wen Sun* (25-29 April 2016) have visited the Department of Applied Mathematics at Brown University.

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REGAL Project-Team

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8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Labex SMART - (2012–2019)

Members: ISIR (UPMC/CNRS), LIP6 (UPMC/CNRS), LIB (UPMC/INSERM), LJLL (UPMC/CNRS), LTCI (Institut Mines-Télécom/CNRS), CHArt-LUTIN (Univ. Paris 8/EPHE), L2E (UPMC), STMS (IRCAM/CNRS).

Funding: Sorbonne Universités, ANR.

Description: The SMART Labex project aims globally to enhancing the quality of life in our digital societies by building the foundational bases for facilitating the inclusion of intelligent artifacts in our daily life for service and assistance. The project addresses underlying scientific questions raised by the development of Human-centered digital systems and artifacts in a comprehensive way. The research program is organized along five axes and Regal is responsible of the axe "Autonomic Distributed Environments for Mobility."

The project involves a PhD grant of 100 000 euros over 3 years.

8.1.2. ESTATE - (2016–2020)

Members: LIP6 (Regal, project leader), LaBRI (Univ. de Bordeaux); Verimag (Univ. de Grenoble).

Funding: ESTATE is funded by ANR (PRC) for a total of about 544 000 euros, of which 233 376 euros for Regal.

Objectives: The core of ESTATE consists in laying the foundations of a new algorithmic framework for enabling Autonomic Computing in distributed and highly dynamic systems and networks. We plan to design a model that includes the minimal algorithmic basis allowing the emergence of dynamic distributed systems with self-* capabilities, *e.g.*, self-organization, self-healing, self-configuration, self-management, self-optimization, self-adaptiveness, or self-repair. In order to do this, we consider three main research streams:

(i) building the theoretical foundations of autonomic computing in dynamic systems, (ii) enhancing the safety in some cases by establishing the minimum requirements in terms of amount or type of dynamics to allow some strong safety guarantees, (iii) providing additional formal guarantees by proposing a general framework based on the Coq proof assistant to (semi-)automatically construct certified proofs.

The coordinator of ESTATE is Franck Petit.

8.1.3. RainbowFS - (2016–2020)

Members: LIP6 (Regal, project leader), Scality SA, CNRS-LIG, Télécom Sud-Paris.

Funding: is funded by ANR (PRC) for a total of 919 534 euros, of which 359 554 euros for Regal.

Objectives: RainbowFS proposes a "just-right" approach to storage and consistency, for developing distributed, cloud-scale applications. Existing approaches shoehorn the application design to some predefined consistency model, but no single model is appropriate for all uses. Instead, we propose tools to co-design the application and its consistency protocol. Our approach reconciles the conflicting requirements of availability and performance vs. safety: common-case operations are designed to be asynchronous; synchronisation is used only when strictly necessary to satisfy the application's integrity invariants. Furthermore, we deconstruct classical consistency models into orthogonal primitives that the developer can compose efficiently, and provide a number of tools for quick, efficient

and correct cloud-scale deployment and execution. Using this methodology, we will develop an entreprise-grade, highly-scalable file system, exploring the rainbow of possible semantics, and we demonstrate it in a massive experiment.

The coordinator of RainbowFS is Marc Shapiro.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. SyncFree

Title: Large-scale computation without synchronisation

Programm: FP7

Duration: October 2013 – December 2016

Coordinator: Inria

Partners:

Basho Technologies (United Kingdom)

Faculdade de Ciencias E Tecnologiada Universidade Nova de Lisboa (Portugal)

Koc University (Turkey)

Rovio Entertainment OY (Finland)

Trifork AS (Denmark)

Université Catholique de Louvain (Belgium)

Technische Universitaet Kaiserslautern (Germany)

Erlang Solutions Ltd (United Kingdom).

Inria contact: Marc Shapiro

The goal of SyncFree is to enable large-scale distributed applications without global synchronisation, by exploiting the recent concept of Conflict-free Replicated Data Types (CRDTs). CRDTs allow unsynchronised concurrent updates, yet ensure data consistency. This revolutionary approach maximises responsiveness and availability; it enables locating data near its users, in decentralised clouds.

Global-scale applications, such as virtual wallets, advertising platforms, social networks, online games, or collaboration networks, require consistency across distributed data items. As networked users, objects, devices, and sensors proliferate, the consistency issue is increasingly acute for the software industry. Current alternatives are both unsatisfactory: either to rely on synchronisation to ensure strong consistency, or to forfeit synchronisation and consistency altogether with ad-hoc eventual consistency. The former approach does not scale beyond a single data centre and is expensive. The latter is extremely difficult to understand, and remains error-prone, even for highly-skilled programmers.

SyncFree avoids both global synchronisation and the complexities of ad-hoc eventual consistency by leveraging the formal properties of CRDTs. CRDTs are designed so that unsynchronised concurrent updates do not conflict and have well-defined semantics. By combining CRDT objects from a standard library of proven datatypes (counters, sets, graphs, sequences, etc.), large-scale distributed programming is simpler and less error-prone. CRDTs are a practical and cost-effective approach.

The SyncFree project will develop both theoretical and practical understanding of large-scale synchronisation-free programming based on CRDTs. Project results will be new industrial applications, new application architectures, large-scale evaluation of both, programming models and algorithms for large-scale applications, and advanced scientific understanding.

8.2.1.2. LightKone

Title: Lightweight Computation for Networks at the Edge

Programm: H2020-ICT-2016-2017

Duration: January 2017 - December 2019

Coordinator: Université Catholique de Louvain

Partners:

Université Catholique de Louvain (Belgium)

Technische Universitaet Kaiserslautern (Germany)

INESC TEC - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciencia (Portugal)

Faculdade de Ciencias E Tecnologiada Universidade Nova de Lisboa (Portugal)

Universitat Politecnica De Catalunya (Spain)

Scality (France)

Gluk Advice B.V. (Netherlands)

Inria contact: Marc Shapiro

The goal of LightKone is to develop a scientifically sound and industrially validated model for doing general-purpose computation on edge networks. An edge network consists of a large set of heterogeneous, loosely coupled computing nodes situated at the logical extreme of a network. Common examples are networks of Internet of Things, mobile devices, personal computers, and points of presence including Mobile Edge Computing. Internet applications are increasingly running on edge networks, to reduce latency, increase scalability, resilience, and security, and permit local decision making. However, today's state of the art, the gossip and peer-to-peer models, give no solution for defining general-purpose computations on edge networks, i.e., computation with shared mutable state. LightKone will solve this problem by combining two recent advances in distributed computing, namely synchronisation-free programming and hybrid gossip algorithms, both of which are successfully used separately in industry. Together, they are a natural combination for edge computing. We will cover edge networks both with and without data center nodes, and applications focused on collaboration, computation, and both. Project results will be new programming models and algorithms that advance scientific understanding, implemented in new industrial applications and a startup company, and evaluated in large-scale realistic settings.

8.3. International Initiatives

8.3.1. Inria International Labs

Inria Chile
Associate Team involved in the International Lab:

8.3.1.1. ARMADA

Title: hARnessing MAssive DAta flows

International Partner (Institution - Laboratory - Researcher):

Universidad Tecnica Federico Santa Maria (Chile) - Department of Computer Science (Department of Comput) - Xavier Bonnaire

Start year: 2014

See also: http://web.inria-armada.org

The ARMADA project aims at designing and implementing a reliable framework for the management and processing of massive dynamic dataflows. The project is two-pronged: fault-tolerant middleware support for processing massive continuous input, and a redundant storage service for mutable data on a massive scale.

8.3.2. Participation in Other International Programs

8.3.2.1. CNRS-Inria-FAP's

Title: Autonomic and Scalable Algorithms for Building Resilient Distributed Systems

International Partner (Institution - Laboratory - Researcher):

Universida de Federal do Paraná (UFPR), Brazil, Prof. Elias Duarte

Duration: 2015–2017

In the context of autonomic computing systems that detect and diagnose problems, self-adapting themselves, the VCube (Virtual Cube), proposed by Prof. Elias Duarte , is a distributed diagnosis algorithm that organizes the system nodes on a virtual hypercube topology. VCube has logarithmic properties: when all nodes are fault-free, processes are virtually connected to form a perfect hypercube; as soon as one or more failures are detected, links are automatically reconnected to remove the faulty nodes and the resulting topology, connecting only fault-free nodes, keeps the logarithmic properties. The goal of this project is to exploit the autonomic and logarithmic properties of the VCube by proposing self-adapting and self-configurable services.

8.3.2.2. Capes-Cofecub

Title: CHOOSING - Cooperation on Hybrid cOmputing clOuds for energy SavING

French Partners: Paris XI (LRI), Regal, LIG, SUPELEC

International Partners (Institution - Laboratory - Researcher):

Universidade de São Paulo - Instituto de Matemática e Estatística - Brazil, Unicamp - Instituto de Computação - Brazil

Duration: 2014–2018

The cloud computing is an important factor for environmentally sustainable development. If, in the one hand, the increasing demand of users drive the creation of large datacenters, in the other hand, cloud computing's "multitenancy" trait allows the reduction of physical hardware and, therefore, the saving of energy. Thus, it is imperative to optimize the energy consumption corresponding to the datacenter's activities. Three elements are crucial on energy consumption of a cloud platform: computation (processing), storage and network infrastructure. Therefore, the aim of this project is to provide different techniques to reduce energy consumption regarding these three elements. Our work mainly focuses on energy saving aspects based on virtualization, i.e., pursuing the idea of the intensive migration of classical storage/processing systems to virtual ones. We will study how different organizations (whose resources are combined as hybrid clouds) can cooperate with each other in order to minimize the energy consumption without the detriment of client requirements or quality of service. Then, we intend to propose efficient algorithmic solutions and design new coordination mechanisms that incentive cloud providers to collaborate.

8.3.2.3. Spanish research ministry project

Title: BFT-DYNASTIE - Byzantine Fault Tolerance: Dynamic Adaptive Services for Partitionable Systems

French Partners: Labri, Irisa, LIP6

International Partners (Institution - Laboratory - Researcher):

University of the Basque Country UPV - Spain, EPFL - LSD - Switzerland, Friedrich-Alexander-Universitat Erlangen-Nurenberg - Deutschland, University of Sydney - Australia

Duration: 2017–2019

The project BFT-DYNASTIE is aimed at extending the model based on the alternation of periods of stable and unstable behavior to all aspects of fault-tolerant distributed systems, including synchrony models, process and communication channel failure models, system membership, node mobility, and network partitioning. The two main and new challenges of this project are: the consideration of the most general and complex to address failure model, known as Byzantine, arbitrary or malicious, which requires qualified majorities and the use of techniques form the security area; and the operation of the system in partitioned mode, which requires adequate reconciliation mechanisms when two partitions merge.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Ajoy Kumar Datta

Date: May 2016 - June 2016

Institution: University of Nevada, Las Vegas (USA)

João Barreto

Date: April 2016 - September 2016

Institution: Instituto Superior Técnico, Lisbon, INESC-ID (Portugal)

8.4.1.1. Internships

Alvarez Colombo Santiago Javier

Date: Jul 2015 - Jan 2016

Institution: Universidad de Buenos Aires (Argentina)

<div align="center">

RMOD Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

Participants: Anne Etien, Nicolas Anquetil, Olivier Auverlot, Stéphane Ducasse. From Sept 2016 to Dec. 2018.

Lille Nord Europe European Associated Team with the PreCISE research center of Pr. A. Cleve from Namur University (Belgium).

This project aims to study the co-evolution between database structure and programs and to propose recommendations to perform required changes on cascade. These programs are either internal to the schema as functions or triggers or external as applications written in Java or Php built on top of the DB. Our intuition is that software engineering techniques can be efficient for such issues. This project also aims to unify the abstract representation of the DB and its relationships with the internal or external program.

9.2. European Initiatives

9.2.1. *Collaborations with Major European Organizations*

Marco Naddéo is a PhD student co-supervised by Damien Cassou, Stéphane Ducasse and Viviana Bono from University of Turin (Italy).

9.3. International Initiatives

9.3.1. *Inria International Labs*

Inria Chile
Associate Team involved in the International Lab:

9.3.1.1. *PLOMO2*

Title: Infrastructure for a new generation of development tools

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Computer Science Department, PLEIAD laboratory (DCC) - Alexander Bergel

Start year: 2014

See also: http://pleiad.cl/research/plomo2

Performing effective software development and maintenance are best achieved with effective tool support. Provided by a variety of tools, each one presenting a specific kinds of information supporting the task at hand. With Plomo2, we want to invent a new generation tools to navigate and profile programs by combining dynamic information with visualization to improve the development environment.

9.3.2. *Inria Associate Teams Not Involved in an Inria International Labs*

9.3.2.1. *Informal International Partners*

We are working with the Uqbar team from different argentinian universities. We hired three of the people: Nicolas Passerini(engineer), Esteban Lorenzano (engineer) and Pablo Tesone (PhD).

We are starting to work with Dr. Robert Pergl from the University of Prague.

9.3.3. Participation in Other International Programs

9.3.3.1. STIC AmSud projects

We were involved in two STIC AmSud projects:

Participants: Damien Cassou [correspondant], Gustavo Santos [RMoD], Martin Dias [RMoD], David Röthlisberger [UDP - Universidad Diego Portales, Santiago, Chile], Marcelo Almeida Maia [UFU - Federal University of Uberlândia, Brasil], Romain Robbes [Departamento de Ciencias de la Computación (DCC), Universidad de Chile, Santiago, Chile], Martin Monperrus [Spirals]. Project Partners: Inria RMOD, Inria Spirals, DCC Universidad de Chile, Universidad Diego Portale Chile, Federal University of Uberlândia, Brasil.

This project aims at facilitating the usage of frameworks and application programming interfaces (APIs) by mining software repositories. Our intuition is that mining reveals how existing projects instantiate these frameworks. By locating concrete framework instantiations in existing projects, we can recommend to developers the concrete procedures for how to use a particular framework for a particular task in a new system. Our project also tackles the challenge of adapting existing systems to new versions of a framework or API by seeking repositories for how other systems adapted to such changes. We plan to integrate recommendations of how to instantiate a framework and adapt to changes directly in the development environment. Those points taken together, considerably distinguish our approach from existing research in the area of framework engineering.

Thanks to this project, a PhD student of Federal University of Uberlândia in Brasil (Klérisson Vinícius Ribeiro da Paixão) did a six months internship in RMod, and prof. Marcelo Almeida Maia (from the same university) visited us for one week.

Participants: Nicolas Anquetil [correspondant], Anne Etien [RMoD], Gustavo Santos [RMoD], Marco Tulio Valente [UFMG - Federal University of Minas Gerais, Brazil], Alexander Bergel [Departamento de Ciencias de la Computación (DCC), Universidad de Chile, Santiago, Chile], Project Partners: Inria RMOD, DCC Universidad de Chile, Federal University of Minas Gerais, Brazil.

The goals of the collaboration is to provide tools to help software engineer restructure a large software system in an iterative and incremental way with input from both expert architect and advanced tool. The tools consist of: extraction of a model from source code, manipulation of the model to experiment with possible restructuring, architecture evaluation tool, recommendation tool to help the software engineers to define the new structure, and tool to back port the modification to the source code.

Pr. Marco Tulio Valente of Federal University of Minas Gerais (Brazil)visited RMod for one week.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Prof. Serge Demeyer, 2 days
- Prof. Marcelo Almeida Maia, 1 week, November 2016;
- Prof. Alain Plantec, 5 days, November 2016;
- Prof. Alexandre Bergel, 1 week, December 2016;
- Prof. Marco Tulio Valente, 1 week, December 2016;
- Eliot Miranda, Cadence,1 week, August 2016;
- Dr. Andrei Chis, 3 days, Decembrer 2016.

9.4.1.1. Internships

- Klérisson Vinícius Ribeiro da Paixão, Federal University of Uberlândia, Uberlândia (MG), Brazil, from September, 2015 to July, 2016;
- Lionel Akue, University of Lomé, Togo, from Oct 2016 to Nov 2016
- Julien Delplanque, University of Mons, Belgium, from September 2016 to December 2016.

9.4.2. Visits to International Teams

The whole RMod team spent two days in January at the Vrije Universiteit Brussel (Belgium) to discuss with the Software Languages Lab team: Coen De Roover, Elisa Gonzalez Boix, and their students.

Stéphane Ducasse and Damien Cassou visited Dr. Robert Pergl's team at Czech Technical University in Prague, one week in April.

9.4.2.1. Research Stays Abroad

Marcus Denker: Visit PLEIAD DCC University of Chile, Santiago de Chile 04/12-21/12. Visit in the context of the Inria Associated Team PLOMO2.

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ROMA Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. PhD grant laboratoire d'excellence MILYON-Mumps consortium

Thanks to the doctoral program from the MILYON labex dedicated to applied research in collaboration with industrial partners, we obtained 50% of a PhD grant, the other 50% being funded by the MUMPS consortium. The PhD student will focus on improvements of the solution phase of the MUMPS solver, in accordance to requirements from industrial members of the consortium.

9.2. National Initiatives

9.2.1. ANR

ANR Project SOLHAR (2013-2017), 4 years. The ANR Project SOLHAR was launched in November 2013, for a duration of 48 months. It gathers five academic partners (the HiePACS, Cepage, ROMA and Runtime Inria project-teams, and CNRS-IRIT) and two industrial partners (CEA/CESTA and EADS-IW). This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators.

The proposed research is organized along three distinct research thrusts. The first objective deals with linear algebra kernels suitable for heterogeneous computing platforms. The second one focuses on runtime systems to provide efficient and robust implementation of dense linear algebra algorithms. The third one is concerned with scheduling this particular application on a heterogeneous and dynamic environment.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. SCORPIO

Title: Significance-Based Computing for Reliability and Power Optimization

Programm: FP7

Duration: June 2013 - May 2016

Coordinator: Kentro Erevnas Technologias Kai Anaptyxix Thessalias

Partners:

Ethniko Kentro Erevnas Kai Technologikis Anaptyxis (Greece)

Ecole Polytechnique Federale de Lausanne (Switzerland)

The Queen's University of Belfast (United Kingdom)

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Interuniversitair Micro-Electronica Centrum Vzw (Belgium)

Inria contact: Frédéric Vivien

Manufacturing process variability at low geometries and power dissipation are the most challenging problems in the design of future computing systems. Currently manufacturers go to great lengths to guarantee fault-free operation of their products by introducing redundancy in voltage margins, conservative layout rules, and extra protection circuitry. However, such design redundancy may result into energy overheads. Energy overheads cannot be alleviated by lowering supply voltage below a nominal value without hardware components experiencing faulty operation due to timing errors. On the other hand, many modern workloads, such as multimedia, machine learning, visualization, etc. are designed to tolerate a degree of imprecision in computations and data. SCoRPiO seeks to exploit this observation and to relax reliability requirements for the hardware layer by allowing a controlled degree of imprecision to be introduced to computations and data. It proposes to introduce methodologies that allow the system- and application-software layers to synergistically characterize the significance of various parts of the program for the quality of the end result, and their tolerance to faults. Based on this information, extracted automatically or semi-automatically, the system software will steer computations and data to either low-power, yet unreliable or higher-power and reliable functional and storage units. In addition, the system will be able to aggressively reduce its power footprint by opportunistically powering hardware modules below nominal values. Significance-based computing lays the foundations for not only approaching the theoretical limits of energy reduction of CMOS technology, but moving beyond those limits by accepting hardware faults in a controlled manner. Significance-based computing promises to be a preferred alternative to dark silicon, which requires that large portions of a chip be powered-off in every cycle to avoid excessive power dissipation.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. JLESC — Joint Laboratory on Extreme Scale Computing

The University of Illinois at Urbana-Champaign, Inria, the French national computer science institute, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and the Riken Advanced Institute for Computational Science formed the Joint Laboratory on Extreme Scale Computing, a follow-up of the Inria-Illinois Joint Laboratory for Petascale Computing. The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, BSC and JSC. It focuses on software challenges found in extreme scale high-performance computers.

Research areas include:

- Scientific applications (big compute and big data) that are the drivers of the research in the other topics of the joint-laboratory.
- Modeling and optimizing numerical libraries, which are at the heart of many scientific applications.
- Novel programming models and runtime systems, which allow scientific applications to be updated or reimagined to take full advantage of extreme-scale supercomputers.
- Resilience and Fault-tolerance research, which reduces the negative impact when processors, disk drives, or memory fail in supercomputers that have tens or hundreds of thousands of those components.
- I/O and visualization, which are important part of parallel execution for numerical silulations and data analytics
- HPC Clouds, that may execute a portion of the HPC workload in the near future.

Several members of the ROMA team are involved in the JLESC joint lab through their research on resilience. Yves Robert is the Inria executive director of JLESC.

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

9.4.2.1. Keystone

Title: Scheduling algorithms for sparse linear algebra at extreme scale

International Partner (Institution - Laboratory - Researcher):

Vanderbilt University (United States) - Padma Raghavan

Start year: 2016

See also: http://graal.ens-lyon.fr/~abenoit/Keystone

The Keystone project aims at investigating sparse matrix and graph problems on NUMA multicores and/or CPU-GPU hybrid models. The goal is to improve the performance of the algorithms, while accounting for failures and trying to minimize the energy consumption. The long-term objective is to design robust sparse-linear kernels for computing at extreme scale. In order to optimize the performance of these kernels, we plan to take particular care of locality and data reuse. Finally, there are several real-life applications relying on these kernels, and the Keystone project will assess the performance and robustness of the scheduling algorithms in applicative contexts. We believe that the complementary expertise of the two teams in the area of scheduling HPC applications at scale (ROMA — models and complexity; and SSCL — architecture and applications) is the key to the success of this associate team. We have already successfully collaborated in the past and expect the collaboration to reach another level thanks to Keystone.

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

- Christophe Alias has a regular collaboration with Sanjay Rajopadhye from Colorado State University (USA) through the advising of the PhD thesis of Guillaume Iooss.
- Anne Benoit, Frédéric Vivien and Yves Robert have a regular collaboration with Henri Casanova from Hawaii University (USA). This is a follow-on of the Inria Associate team that ended in 2014.

9.4.4. Cooperation with ECNU

ENS Lyon has launched a partnership with ECNU, the East China Normal University in Shanghai, China. This partnership includes both teaching and research cooperation.

As for teaching, the PROSFER program includes a joint Master of Computer Science between ENS Rennes, ENS Lyon and ECNU. In addition, PhD students from ECNU are selected to conduct a PhD in one of these ENS. Yves Robert is responsible for this cooperation. He has already given two classes at ECNU, on Algorithm Design and Complexity, and on Parallel Algorithms, together with Patrice Quinton (from ENS Rennes).

As for research, the JORISS program funds collaborative research projects between ENS Lyon and ECNU. Yves Robert and Changbo Wang (ECNU) are leading a JORISS project on resilience in cloud and HPC computing.

In the context of this collaboration two students from ECNU, Li Han and Changjiang Gou, have joined Roma for their PhD.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Samuel McCauley visited the team for four months (Oct. 2015 - Feb. 2016) to work with Loris Marchal, Bertrand Simon and Frédéric Vivien on the minimization of I/Os during the out-of-core execution of task trees.

9.5.1.1. Internships

- Laure Gonnord supervised two Master Students in Spring 2016, Vitor Paisante (static analyses for pointers) and Julien Braine (static analyses for data structures).

- Bora Uçar supervised an Raluca Portase, an Erasmus student, for three months (June–September 2016).

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Yves Robert has been appointed as a visiting scientist by the ICL laboratory (headed by Jack Dongarra) at the University of Tennessee Knoxville. He collaborates with several ICL researchers on high-performance linear algebra and resilience methods at scale.

<p align="center">**SOCRATE Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Equipex FIT- Future Internet of Things

The FIT projet is a national equipex (*equipement d'excellence*), headed by the Lip6 laboratory. As a member of Inria, Socrate is in charge of the development of an Experimental Cognitive Radio platform that is used as test-bed for SDR terminals and cognitive radio experiments. This has been operational since 2014 and is maintained for a duration of 7 years. To give a quick view, the user will have a way to configure and program through Internet several SDR platforms (MIMO, SISO, and baseband processing nodes).

8.1.2. ANR - MetalibM

The goal of the Metalibm - "Automatic Generation of Function and Filters" (2014-2017, 200 keuros) project is to provide a tool for the automatic implementation of mathematical (libm) functions. A function f is automatically transformed into machine-proven C code implementing an polynomial approximation in a given domain with given accuracy. This project is led by Inria, with researchers from Socrate and AriC; PEQUAN team of Laboratoire d'Informatique de Paris 6 (LIP6) at Université Pierre et Marie Curie, Paris; DALI team from Université de Perpignan Via Domitia and Laboratoire d'Informatique, Robotique et Microélectronique de Montpellier (LIRMM); and SFT group from Centre Européen de Recherche Nucléaire (CERN).

8.1.3. FUI SMACS

The SMACS projet - "SMart And Connected Sensors" (2013-2016, 267 keuros) targets the deployement of an innovating wireless sensor network dedicated to many domains sport, health and digital cities. The projet involves Socrate (Insavalor), HIKOB and wireless broadcasting company Euro Media France. The main goal is to develop a robust technologie enabling real-time localization of mobile targets (like cyclist for instance), at a low energy (more generaly low cost). The technology will be demonstrated at real cycling races (Tour de France 2013 and 2014). One of the goal is to include localisation information with new radio technology. Another subject of study is distributed wireless consensus algorithms for maintaining a neighborhood knowledge with a low energy budget that scales (more than 200 cycles together)

8.1.4. ADT Sytare

The SYTARE project (Développement d'un SYsTème embArqué faible consommation à mémoiRE persistante - ADT Inria 2015-2017) aims to develop and study novel operating system mechanisms for NVRAM-based embedded systems. The term NVRAM collectively describes an emerging generation of memory technologies which are both non-volatile and byte-addressable. These two properties together make the classical RAM+ROM memory architecture obsolete, and enable the design of embedded systems running on intermittent power. This is very attractive in the context of energy-constrained scenarios, for instance systems harvesting their power from the environment. But working with NVRAM also poses novel challenges in terms of software programming. For instance, application state consistency must be guaranteed accross reboots, even though the system includes both NVRAM and volatile elements (e.g. CPU, hardware peripherals). The SYTARE project is funded by Inria via the ADT program.

8.1.5. ADT CorteXlab

The Socrate project-team is in charge of the FIT/CorteXlab platform (section 5.6). This platform (ADT Inria 2015-2017) makes use of many complex technologies from signal processing to computer science through micro-electornics and FPGA. The objectiv of the CorteXlab ADT is to maintain a support to the user of the FPGA-based platform of CorteXlab and to provide tutorial and running experiment that will help them in builing experimentation using the PicoSDR machines.

8.1.6. Taiwan III

In the context of the MoU signed between Inria and The National Science Council of Taiwan. Taiwan's Institute for Information Industry (III) and Socrate signed a one-year contract on 5G M2M (2015-2016) for a research proposal containing two items: a first to study the OFDMA-based RACH access from theoretical or mathematical models and a second to set up an experiment in CorteXlab that will emulate a given number of M2M device using a narrow band radio protocol and record the resulting radio environment.

8.1.7. ANR - Ephyl

The general objective of the project EPHYL - "Enhanced PHY for Cellular Low Power Communication IoT" (2016-2019, 183 keuros) is to investigate coming and future LPWA technologies with the aim to improve coverage, data rate and connectivity while keeping similar level of complexity and power consumption at the node for the access. New waveforms enablers will be investigated and trialled in order to increase the efficiency of future systems and to provide efficient and fair access to the radio resource. The proposed new waveforms should comply with system constraints and with the coexistence of multiple communications.

8.1.8. ANR - Arburst

In this project Arburst - "Acheivable region of bursty wireless networks" (2016-2020, 195 KEuros), we propose an original approach complementary to other existing projects. Instead of proposing one specific technical solution, our objective is to define a unified theoretical framework devoted to the study of IoT networks fundamental limits. We aim at establishing the fundamental limits for a decentralized system in a bursty regime which includes short packets of information and impulsive interference regime. We are targeting the fundamental limits, their mathematical expression (according to the usual information theory framework capturing the capacity region by establishing a converse and achievability theorems). We will use the recent results relative to finite block-length information theory and we will evaluate the margin for improvement between existing approaches and these limits and we will identify the scientific breakthrough that may bring significant improvements for IoT/M2M communications. This project will contribute to draw the roadmap for the development of IoT/M2M networks and will constitute a unified framework to compare existing techniques, and to identify the breakthrough concepts that may afford the industry the leverage to deploy IoT/M2M technical solutions.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CYBERNETS

Title: Cybernetic Communication Networks: Fundamental Limits and Engineering Challenges

Programm: H2020

Duration: June 2015 - June 2017

Coordinator: Inria

Inria contact: Samir M. Perlaza

This Reintegration Panel proposal, CYBERNETS, focuses on the study of Cybernetic Communication Networks (CCN). CCNs are wireless networks that are context-aware, possess learning capabilities and artificial intelligence to guarantee reliability, efficiency and resilience to changes, failures or attacks via autonomous, self-configuring and self-healing individual and network behavior. Typical examples of CCNs are beyond-5G cellular systems and critical communication systems, e.g., law enforcement, disaster relief, body- area, medical instruments, space, and indoor/outdoor commercial applications. A practical implementation of a CCN requires extending classical communication systems to embrace the dynamics of fully decentralized systems whose components might exhibit either cooperative, non-cooperative or even malicious behaviors to improve individual and/or global performance. In this context, CYBERNETS aims to develop a relevant understanding of the interactions

between information theory, game theory and signal processing to tackle two particular problems from both theoretical and practical perspectives: (I) use of feedback and (II) behavior adaptation in fully decentralized CCNs. In the former, the main objectives are: (i) to determine the fundamental limits of data transmission rates in CCNs with feedback; and (ii) to develop and test in real-systems, transmit-receive configurations to provide a proof-of-concept of feedback in CCNs. For the achievement of these practical objectives, CYBERNETS relies on the world-class testbed infrastructure of Inria at the CITI Lab for fully closing the gap between theoretical analysis and real-system implementation. In the latter, the main objectives are: (i) to identify and explore alternatives for allowing transmitter-receiver pairs to learn equilibrium strategies in CCNs with and without feedback; (ii) to study the impact of network-state knowledge on scenarios derived from the malicious behavior of network components.

8.2.1.2. COM-MED

Title: COMMunication systems with renewable Energy micro-griD

Programm: H2020

Duration: October 2016 - October 2019

Coordinator: Inria

Inria contact: Samir M. Perlaza

A smart micro-grid is a small-scale power-grid system consisting of a number of distributed energy sources and loads which is responsible to ensure power sufficiency in a small area. The effectiveness of a smart micro-grid depends on the proper implementation of a communications and networking system which monitors, controls and manages the grid's operations. Due to the ever growing worldwide energy consumption, the need of an efficient framework for managing the way power is distributed and utilized has increased. The main objective of the project COM-MED is to study the fundamental interplay between communications and power networks in the context of smart micro-grids and renewable energy sources. On one hand, we study advanced signal processing techniques and communications methods to optimize the operation of smart micro-grid systems. On the other hand, we focus on mobile communications networks with renewable energy base-stations (BSs) and we investigate communications and networking techniques that take into account both data traffic and energy profiles to support high quality-of-service (QoS). The objectives of each technical WP have been assigned in such a way as to ensure that the project's target is realized during the project's time period. The theoretical results derived from the WPs 3, 4 and 5 will be tested using the telecommunication network of MTN in Cyprus but also the state-of-the-art equipment of the CITI/Inria research lab in France. The outcome of this project will provide a theoretical framework for the optimal cooperation between communications networks and power networks in the context of smart micro-grids and renewable energy sources. This is in line with the objectives of the call's theme "Renewable Energy" and is of paramount importance for the Mediterranean area. The consortium of the project has the expertise and the infrastructure to implement the objectives set and to bring the project to a successful end.

8.3. International Initiatives

8.3.1. *Inria Associate Teams Not Involved in an Inria International Labs*

8.3.1.1. CoWIN

Title: Cognitive Wireless Networks from Theory to Implementation

International Partner: Princeton University, School of Engineering and Applied Science. Princeton N.J. USA. Prof. H. Vincent Poor

Start year: 2015

See also: https://project.inria.fr/cowin/

The objective of this team is to strengthen the research efforts on emerging software radio and cognitive radio technologies. The team will count on: first, the cognitive radio test-bed CorteXlab recently set up by the Socrate team within the FIT Equipex, second the leading position of Vincent Poor's team in the field of network information theory and third the Orbit Platform of Rutgers university. The goal is to lead research in both the information theory community and the applied research community so as to reinforce the link between both communities. This work will concern architecture and programs of software radio equipments, distributed and cognitive algorithms for radio resource allocation, cognitive radio scenario experimentations, fundamental limits of cooperative wireless channels and the set up of common experimental infrastructure and protocols for research on cognitive wireless networks.

8.3.1.2. Informal International Partners

Socrate has strong collaborations with several international partners.

- **Princeton University**, School of Applied Science, Department of Electrical Engineering, NJ. USA. This cooperation with Prof. H. Vincent Poor is on topics related to decentralized wireless networks. Samir M. Perlaza has been appointed as Visiting Research Collaborator at the EE Department for the academic period 2016-2017. Scientific-Leaders at Inria: Samir M. Perlaza and Jean-Marie Gorce.

- **Technical University of Berlin**, Dept. of Electrical Engineering and Computer Science, Germany. This cooperation with Prof. Rafael Schaffer is on secrecy and covert communications. Scientific-Leaders at Inria: Samir M. Perlaza.

- **National University Singapore (NUS)**, Department of Electrical and Computer Engineering, Singapore. This collaboration with Prof. Vincent Y. F. Tan is on the study of finite block-length transmissions in multi-user channels and the derivation of asymptotic capacity results with non-vanishing error probabilities. Scientific-Leaders at Inria: Samir M. Perlaza

- **University of Sheffield**, Department of Automatic Control and Systems Engineering, Sheffield, UK. This cooperation with Prof. Inaki Esnaola is on topics related to information-driven energy systems and multi-user information theory. Scientific-in-charge at Inria: Samir M. Perlaza.

- **Rutgers University**, Winlab, Orbit testbed. This cooperation with Ivan Seskar is related to experimental wireless testbed. Orbit has been one of the first wireless testbeds of its type. Tanguy Risset and Leonardo Sampaio-Cardoso have visited Winlab and I. Seskar visited the Socrate team for one week. Their collaboration is on the development of tools to ease experiment handling on wireless testbeds: visualisation, synchronization etc. Scientific-Leader at Inria: Tanguy Risset

- **University of Arizona**, Department of Electrical and Computer Engineering, Tucson, AZ, USA. This cooperation with Prof. Ravi Tandon is on topics related to channel-output feedback in wireless networks. Scientific-Leader at Inria: Samir M. Perlaza.

- **University of Cyprus**, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus. This cooperation with Prof. Ioannis Krikidis is on topics related to energy-harvesting and wireless communications systems. Scientific-Leaders at Inria: Guillaume Villemaud and Samir M. Perlaza.

- **Universidade Federal do Ceará**, GTEL, Departamento de Teleinformática, Fortaleza, Brazil. This recently started cooperation with Prof. Tarcisio Ferreira Maciel is on topics related to the optimization of radio ressources for massive MIMO in 5G and 5G-like wireless communications systems. Scientific-in-charge at Inria: Leonardo Sampaio-Cardoso.

- **Universidad Nacional del Sur**, LaPSyC laboratory, Bahía Blanca , Argentina. This cooperation with Prof. Juan Cousseau is on topics related to Full-Duplex communications and Interference Alignment. Scientific-in-charge at Inria: Guillaume Villemaud.

- **Bell Labs New Jersey, USA**, This cooperation with Prof. Antonia Tulino (affiliated to Bell Labs and to University of Napoli, Italy) is on caching in wireless networks. The objective is to demonstrate the efficiency of caching at the edge of wireless networks through experimentations on CorteXlab. This work will be published in 2017 in a special issue of IEEE Communication magazine (Yasser

Fadlallah, Antonia M. Tulino, Dario Barone, Giuseppe Vettigli, Jaime Llorca and Jean-Marie Gorce: Coding for caching in 5G networks, IEEE Communication Magazine, 2017, accepted for publication). Scientific leader at Inria : Jean-Marie Gorce.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Dr. Martin Kumm, from University of Kassel, spent one week at CITI to work on FPGA arithmetic.

8.4.2. Short-Term Visits to International Teams

- Samir M. Perlaza was visiting the Department of Automatic Control and Systems Engineering at the University of Sheffield, UK, hosted by Prof. Iñaki Esnaola.
- Samir M. Perlaza and David Kibloff were visiting the Department of Telecommunication Systems at the Technical University of Berlin, Germany, hosted by Prof. Rafael Schaefer.
- Selma Belhadj Amor was visiting the Center for Wireless Communication and Signal Processing Research (CWCSPR), ECE Department, New Jersey Institute of Technology (NJIT), USA, hosted by Prof. Osvaldo Simeone.
- Florin Hutu was visiting the Department of Electrical and Electronics Engineering", University of Buea, Cameroun, hosted by Pr. Emmanuel Tanyi.
- Lionel Morel was visiting the SCI-STI-MM Multimedia Group at École Polytechnique Fédérale de Lausanne, hosted by Dr Marco Mattavelli.

8.4.2.1. Research Stays Abroad

- Selma Belhadj Amor was hosted by the Electrical Engineering Department at Princeton University, New Jersey, USA, as a Visiting Scholar. Host: Prof. H. Vincent Poor.
- Selma Belhadj Amor hosted by the Electrical and Computer Engineering Department at the National University Of Singapore (NUS), Singapore. Host: Prof. Vincent F. Y. Tan.

<p style="text-align: center; color: red;">**SPIRALS Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Région Nord-Pas De Calais*

9.1.1.1. *Citizen Awareness and Contribution to Air Quality Monitoring*
Participants: Daniel Romero Acero, Romain Rouvoy [correspondant], Lionel Seinturier.

This is a 3-year project in the context of the so-called "Chercheur citoyen" program that started in 2015. The partners are LISIC/Université Côte d'Opale (leader), ATMO Nord-Pas De Calais, Association Bâtisseurs d'Economie Solidaire. This project targets the distributed monitoring of air quality with crowd-sensing solutions obtained via sensors connected to smart devices. We aim at inciting citizens to perform their own measures, and to obtain thanks to GPS geo-localisation a large-scale database and a dynamic fine-grained cartography of air quality. This project takes advantage of the APISENSE® crowdsensing platform (see Section 6.1).

9.1.2. *Inria Lille - Nord Europe*

9.1.2.1. *ADT Spoon3R*
Participants: Gérard Paligot, Martin Monperrus [correspondant].

ADT Spoon3R (2014–16) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of the SPOON software library. (see Section 6.4) Spoon3R aims at extending SPOON with the features defined in the context of our research activities on automated software repair.

9.1.2.2. *ADT LibRepair*
Participants: Benjamin Danglot, Martin Monperrus [correspondant], Simon Urli.

ADT LibRepair (2016–18) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of an integrated library of automated software repair algorithms and techniques. This ADT builds on our results about with the Astor, Nopol and NpeFix that have been obtained in the context of the defended PhD theses of Matias Martinez [66] and Benoit Cornu [57].

9.1.2.3. *North European Lab LLEX*
Participants: Martin Monperrus [correspondant], Lionel Seinturier.

North European Lab LLEX (2015–17) is an international initiative supported by the Inria Lille - Nord Europe Center that takes place in the context of a collaboration between Inria and University College London. LLEX deals with research on automatic diagnosis and repair of software bugs. Automatic software repair is the process of fixing software bugs automatically An automatic software repair system fixes software bugs with no human intervention. The goal of automatic software repair is to save maintenance costs and to enable systems to be more resilient to bugs and unexpected situations. This research may dramatically improve the quality of software systems. The objective of the partnership is to work on the automated diagnosis of exceptions with a focus on null pointer exceptions.

9.1.2.4. *LEDA*
Participant: Philippe Merle [correspondant].

LEDA (2013–16) Laboratoire d'Expérimentation et de Démonstrations Ambiantes is a demonstration space allocated by the Inria Lille - Nord Europe Center whose goal is to show the scientific results of the Spirals team in the domains of distributed systems, adaptable middleware, software product lines, green computing, and ambiant computing. These results are illustrated around the scenario of a mock digital home.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR BottleNet
Participants: Romain Rouvoy [correspondant], Walter Rudametkin Ivey, Lionel Seinturier.

BottleNet is a 48-month project funded by ANR that started on October 2015. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet Quality of Experience (QoE) and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users' devices. We plan to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

9.2.1.2. ANR SATAS
Participants: Philippe Merle [correspondant], Romain Rouvoy, Lionel Seinturier.

SATAS is a 48-month project funded by ANR that started on October 2015. SATAS aims to advance the state of the art in massively parallel SAT solving with a particular eye to the applications driving progress in the field. The final goal of the project is to be able to provide a "pay as you go" interface to SAT solving services, with a particular focus on its power consumption. This project will extend the reach of SAT solving technologies, daily used in many critical and industrial applications, to new application areas, which were previously considered too hard, and lower the cost of deploying massively parallel SAT solvers on the cloud.

9.2.2. Competitivity Clusters

9.2.2.1. FUI StoreConnect
Participants: Julien Duribreux, Romain Rouvoy, Lionel Seinturier [correspondant], Antoine Veuiller.

StoreConnect is a 24-month project funded by FUI and labelized by the PICOM (Pôle des Industries du COMmerce) competitivity cluster which has started in September 2016. The partners are Neosensys (leader), Tevolys, Ubudu, Smile, STIME, Leroy Merlin, Insiteo, Inria Spirals, Inria Fun, Inria Stars. The goal of the project is to define a modular multi-sensors middleware platform for indoor geolocation.

9.2.3. Programme Investissement d'Avenir (PIA)

9.2.3.1. PIA Datalyse
Participants: Romain Rouvoy, Lionel Seinturier [correspondant], Bo Zhang.

Datalyse is a 42-month project of the Programme Investissement d'Avenir Cloud Computing 3rd call for projects. The project started in May 2013. The partners are Eolas (leader), Business & Decision, Groupement des Mousquetaires, Université Grenoble 1, Université Lille 1, Inria, Université Montpellier 2. The project aims at defining an elastic cloud computing infrastructure for processing big volumes of data. The originality of the project is to consider jointly data generated by users and by the infrastructure, and to correlate data at these two levels.

9.2.3.2. PIA OCCIware
Participants: Romain Rouvoy, Philippe Merle [correspondant], Lionel Seinturier.

OCCIware is a 36-month project of the Programme Investissement d'Avenir Cloud Computing and Big Data 4th call for projects. The project started in December 2014. The partners are Open Wide (leader), ActiveEon SA, CSRT, Institut Mines-Télécom/Télécom SudParis, Inria, Linagora GSO, Obeo, OW2 Consortium, Pôle Numérique, and Université Joseph Fourier - Grenoble. The project aims at defining a formal framework for managing every digital resources in the clouds, based on *Open Cloud Computing Interface* (OCCI) recommendations from *Open Grid Forum* (OGF).

9.2.4. Inria National Initiatives

9.2.4.1. Inria ADT Focus CrowdLab
Participants: Julien Duribreux, María Gómez Lacruz, Romain Rouvoy [correspondant], Antoine Veuiller.

The purpose of the ADT Focus CrowdLab (2014–2016) is to strengthen the technological part of the Metroscope consortium and to promote the APISENSE® crowd-sensing platform (see Section 6.1) as a reference platform fo gathering mobile data within the scientific community. The CrowdLab project focuses on three stringent goals: (1) consolidating the current technological solutions, (2) technical and logistical support of the research activities initiated in different scientific domains, and (3) the improvement of security and anonymity of collected data. In addition to the Metroscope consortium, the Inria research teams participating of the ADT Focus CrowdLab project are: Spirals (coordinator), Madynes, Diana, Muse.

9.2.4.2. Inria IPL BetterNet
Participants: Lakhdar Meftah, Romain Rouvoy [correspondant].

BetterNet (2016–19) aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where: (1) tools, models and algorithms/heuristics will be provided to collect data, (2) acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society, (3) and new value-added services will be proposed to end-users. IPL BetterNet is lead by Isabelle Chrisment (Inria Madynes), with the participation of the Diana, Dionysos, Inria Chile, Muse, and Spirals Inria project-teams.

9.2.5. Others

9.2.5.1. CNRS INS2I JCJC FPDefendor
Participant: Walter Rudametkin Ivey [correspondant].

FPDefendor is a 12-month project funded by the CNRS INS2I institute. The JCJC program targets young researchers. Walter Rudametkin is the recipient of such a grant. The project aims at better understanding browser fingerprinting, its risks to privacy, and to provide measures to detect it and effective countermeasures to mitigate it. The proposal brings together software engineering, security and privacy, and formal verification to propose a platform that uses dynamic reconfiguration as a means to evade fingerprint tracking.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: FP7 ICT.

Project acronym: PaaSage.

Project title: Model Based Cloud Platform Upperware.

Duration: October 2012–September 2016.

Coordinator: ERCIM.

Other partners: ERCIM (Fr), SINTEF (No), STFC (UK), U. of Stuttgart (De), Inria (Fr), CETIC (Be), FORTH (El), Be.Wan (Be), EVRY Solutions (No), SysFera (Fr), Flexiant (UK), Lufthansa Systems AG (De), Gesellschaft fur wissenschaftliche Datenverarbeitung mbh Gottingen (De), Automotive Simulation Center Stuttgart (De).

Abstract: Cloud computing is a popular and over-hyped concept in ICT. The concept of infinitely scalable elastic resources changing without complex systems administration and paying only for resources used is attractive. These benefits are not immediately realizable. Within organisation benefits are realizable at considerable cost. IaaS (*Infrastructure-as-a-Service*) public Clouds have different interfaces and conditions of use thus for an organisation to "scale out" requires considerable investment using skilled technical staff. The business need is to allow organisations to "scale out" from their private Cloud to public Clouds without a technical chasm between. This cannot easily be achieved. Aligned with the EU strategic direction of an open market for services, SOA (*Service-Oriented architecture*) offers a way to virtualize across heterogeneous public Clouds and organizational private Clouds. It opens a market for European SMEs to provide services to be utilized (and paid for) by business applications and for all organisations to benefit from a catalogue of services that can be used across the environment. PaaSage will deliver an open and integrated platform, to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimisation, and deployment of existing and new applications independently of the existing underlying Cloud infrastructures. Specifically it will deliver an IDE (*Integrated Development Environment*) incorporating modules for design time and execution time optimisation of applications specified in the Cloud Modeling Language (Cloud ML), execution-level mappers and interfaces and a metadata database.
Participants: Laurence Duchien, Daniel Romero Acero, Romain Rouvoy, Lionel Seinturier [correspondant].

Program: FP7 FET.
Project acronym: DIVERSIFY.
Project title: More software diversity. More adaptivity in CAS.
Duration: 36 months (2013–16).
Coordinator: Inria.
Other partners: SINTEF (Norway), Trinity College Dublin (Ireland), University of Rennes 1 (France).
Abstract: DIVERSIFY explores diversity as the foundation for a novel software design principle and increased adaptive capacities in CASs (*Collective Adaptive Systems*). Higher levels of diversity in the system provide a pool of software solutions that can eventually be used to adapt to unforeseen situations at design time. The scientific development of DIVERSIFY is based on a strong analogy with ecological systems, biodiversity, and evolutionary ecology. DIVERSIFY brings together researchers from the domains of software-intensive distributed systems and ecology in order to translate ecological concepts and processes into software design principles.
Participants: Martin Monperrus [correspondant].

Program: H2020 ICT-10-2016.
Project acronym: STAMP.
Project title: Software Testing Amplification.
Duration: 36 months (2016–19).
Coordinator: Inria.
Other partners: ActiveEon (France), Atos (Spain), Engineering (Italy), OW2 (France), SINTEF (Norway), TellU (Norway), TU Delft (The Netherlands), XWiki (France).
Abstract: By leveraging advanced research in automatic test generation, STAMP aims at pushing automation in DevOps one step further through innovative methods of test amplification. It will reuse existing assets (test cases, API descriptions, dependency models), in order to generate more test cases and test configurations each time the application is updated. Acting at all steps of development cycle, STAMP techniques aim at reducing the number and cost of regression bugs at unit level, configuration level and production stage.
Participants: Benjamin Danglot, Martin Monperrus [correspondant].

Program: H2020 JU Shift2Rail.

Project acronym: X2Rail-1.

Project title: Start-up activities for Advanced Signalling and Automation System.

Duration: 36 months (2016–19).

Coordinator: Siemens.

Other partners: 19 partners, among others Bombardier, Siemens, Thales, IRT Railenium.

Abstract: Our contribution to the project is focused on adaptive communication middleware for cyber-physical railway systems.

Participants: Lionel Seinturier [correspondant].

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: EUREKA Celtic-Plus.

Project acronym: SENDATE.

Project title: SEcure Networking for a DATa Center Cloud in Europe.

Duration: 36 months (2016–19).

Coordinator: Nokia.

Other partners: 50+ partners in Finland, France, Germany, Norway, and Sweden. Selected partners involved: Nokia, Orange.

Abstract: The project addresses the convergence of telecommunication networks and IT in the context of distributed data centers. We are involved in the TANDEM subproject that targets the infrastructure of such a distributed system. More specifically, we are studying new approaches in terms of software engineering and component-based solutions for enabling this convergence of network and IT.

Participants: Lionel Seinturier [correspondant].

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. SOMCA

Title: Self-Optimization of Service Oriented Architectures for Mobile and Cloud Applications

International Partner (Institution - Laboratory - Researcher):

Université du Québec À Montréal (Canada) - LATECE - Naouel MOHA

Start year: 2014

See also: http://sofa.uqam.ca/somca.php

The long-term goal of this research program is to propose a novel and innovative methodology embodied in an software platform, to support the runtime detection and correction of anti-patterns in large-scale service-oriented distributed systems in order to continuously optimize their quality of service. One originality of this program lies in the dynamic nature of the service-oriented environments and the application on emerging frameworks for embedded and distributed systems (e.g., Android/iOS for mobile devices, PaaS/SaaS for Cloud environments), and in particular mobile systems interacting with remote services hosted on the Cloud.

9.4.2. Participation in Other International Programs

9.4.2.1. STIC AmSud - Project MineAPI

Participants: María Gómez Lacruz, Martin Monperrus [correspondant], Vincenzo Musco, Gérard Paligot, Romain Rouvoy.

MineAPI is a STIC AmSud project (2015–16) between with University Diego Portales, Santiago, Chile, and Federal University of Uberlândia, Brazil. The coordinator on the French side is Damien Cassou from Inria Rmod. The project aims at facilitating the usage of frameworks and application programming interfaces (APIs) by mining software repositories. Our intuition is that mining reveals how existing projects instantiate these frameworks. By locating concrete framework instantiations in existing projects, we can recommend to developers the concrete procedures for how to use a particular framework for a particular task in a new system. Our project also tackles the challenge of adapting existing systems to new versions of a framework or API by seeking repositories for how other systems adapted to such changes.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Prof. Marcelo Maia, from the Federal University of Uberlândia, Brazil, visited us for 1 week in November 2016 in the context of the MineAPI project.

Fernanda Madeiral Delfim, PhD Student from the Federal University of Uberlândia, Brazil, started a 6-month visit in December 2016 in the context of the MineAPI project.

Mohamed Berkane, associate professor at the University Constantine 2, Algeria, visited us for 1 month in October 2016.

9.5.1.1. *Research Stays Abroad*

María Gómez spent 4 months from January to April 2016 at Universität Hamburg in the research group of Prof. Walid Maalej.

<p style="text-align:center; color:red;">**STORM Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. PIA

ELCI   The ELCI project (Software Environment for HPC) aims to develop a new generation of software stack for supercomputers, numerical solvers, runtime and programming development environments for HPC simulation. The ELCI project also aims to validate this software stack by showing its capacity to offer improved scalability, resilience, security, modularity and abstraction on real applications. The coordinator is Bull, and the different partners are CEA, Inria, SAFRAN, CERFACS, CNRS CORIA, CENAERO, ONERA, UVSQ, Kitware and AlgoTech.

8.1.2. ANR

ANR SOLHAR   (http://solhar.gforge.inria.fr/doku.php?id=start).

ANR MONU 2013 Program, 2013 - 2016 (36 months)

Identification: ANR-13-MONU-0007

Coordinator: Inria Bordeaux/LaBRI

Other partners: CNRS-IRIT, Inria-LIP Lyon, CEA/CESTA, EADS-IW

Abstract: This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. Several attempts have been made to accomplish the porting of these methods on such architectures; the proposed approaches are mostly based on a simple offloading of some computational tasks (the coarsest grained ones) to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool developed in the runtime team (Bordeaux). Although the SOLHAR project will focus on heterogeneous computers equipped with GPUs due to their wide availability and affordable cost, the research accomplished on algorithms, methods and programming models will be readily applicable to other accelerator devices such as ClearSpeed boards or Cell processors.

ANR Songs   Simulation of next generation systems (http://infra-songs.gforge.inria.fr/).

ANR INFRA 2011, 01/2012 - 12/2015 (48 months)

Identification: ANR-11INFR01306

Coordinator: Martin Quinson (Inria Nancy)

Other partners: Inria Nancy, Inria Rhône-Alpes, IN2P3, LSIIT, Inria Rennes, I3S.

Abstract: The goal of the SONGS project is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

8.1.3. ADT - Inria Technological Development Actions

ADT K'Star   (http://kstar.gforge.inria.fr/#!index.md)
Participants: Olivier Aumage, Nathalie Furmento, Samuel Pitoiset, Samuel Thibault.

Inria ADT Campaign 2013, 10/2013 - 9/2015 (24 months)

Coordinator: Thierry Gautier (team AVALON, Inria Grenoble - Rhône-Alpes) and Olivier Aumage (team RUNTIME, Inria Bordeaux - Sud-Ouest)

Abstract: The Inria action ADT K'Star is a joint effort from Inria teams AVALON and RUNTIME to design the Klang-Omp source-to-source OpenMP compiler to translate OpenMP directives into calls to the API of AVALON and RUNTIME respective runtime systems (XKaapi for AVALON, StarPU for RUNTIME).

8.1.4. IPL - Inria Project Lab

C2S@Exa - Computer and Computational Sciences at Exascale **Participant:** Olivier Aumage.

Inria IPL 2013 - 2017 (48 months)

Coordinator: Stéphane Lantéri (team Nachos, Inria Sophia)

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

HAC-SPECIS - High-performance Application and Computers, Studying PErformance and Correctness In Simulation **Participants:** Samuel Thibault, Luka Stanisic.

Inria IPL 2016 - 2020 (48 months)

Coordinator: Arnaud Legrand (team Polaris, Inria Rhône Alpes)

Since June 2016, the team is participating to the HAC-SPECIS http://hacspecis.gforge.inria.fr/ Inria Project Lab (IPL). This national initiative aims at answering methodological needs of HPC application and runtime developers and allowing to study real HPC systems both from the correctness and performance point of view. To this end, it gathers experts from the HPC, formal verification and performance evaluation community.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. INTERTWinE

Title: Programming Model INTERoperability ToWards Exascale

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: EPCC

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Institut National de Recherche en Informatique et en Automatique (France)

Kungliga Tekniska Hoegskolan (Sweden)

T-Systems Solutions for Research (Germany)

The University of Edinburgh (United Kingdom)

Universitat Jaume I de Castellon (Spain)

The University of Manchester (United Kingdom)

Inria contact: Olivier Aumage

This project addresses the problem of programming model design and implementation for the Exascale. The first Exascale computers will be very highly parallel systems, consisting of a hierarchy of architectural levels. To program such systems effectively and portably, programming APIs with efficient and robust implementations must be ready in the appropriate timescale. A single, "silver bullet" API which addresses all the architectural levels does not exist and seems very unlikely to emerge soon enough. We must therefore expect that using combinations of different APIs at different system levels will be the only practical solution in the short to medium term. Although there remains room for improvement in individual programming models and their implementations, the main challenges lie in interoperability between APIs. It is this interoperability, both at the specification level and at the implementation level, which this project seeks to address and to further the state of the art. INTERTWinE brings together the principal European organisations driving the evolution of programming models and their implementations. The project will focus on seven key programming APIs: MPI, GASPI, OpenMP, OmpSs, StarPU, QUARK and PaRSEC, each of which has a project partner with extensive experience in API design and implementation. Interoperability requirements, and evaluation of implementations will be driven by a set of kernels and applications, each of which has a project partner with a major role in their development. The project will implement a co- design cycle, by feeding back advances in API design and implementation into the applications and kernels, thereby driving new requirements and hence further advances.

8.2.1.2. Mont-Blanc 2

Title: Programming Model INTERoperability ToWards Exascale

Programm: FP7

Duration: September 2013 - January 2017

Coordinator: BSC

Partners: Atos/Bull, ARM, Jülich, LRZ, Univ. Stuttgart, CINECA, CNRS, CEA, Univ. Bristol, Allinea Software, Univ. Cantabria

Inria contact: Olivier Aumage

The Mont-Blanc project aims to develop a European Exascale approach leveraging on commodity power-efficient embedded technologies. The project has developed a HPC system software stack on ARM, and will deploy the first integrated ARM-based HPC prototype by 2014, and is also working on a set of 11 scientific applications to be ported and tuned to the prototype system. Team STORM has been involved in porting the MAQAO binary code analyzer and instrumenter on ARM platforms and interfacing it with the kernel autotuning framework BOAST.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

- Team STORM is supervising the membership of Inria as part of the OpenMP Architecture Review Board (ARB), the international body in charge of the standardisation of the OpenMP parallel programming language. The membership has been supported by an InriaHUB/Standardisation grant.

- Team STORM is member of the Khronos Group Advisory Panel about the standardization of the OpenCL and SYCL programming languages.

TACOMA Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Project: Modélisation des activités de site consommateur d'énergie pour favoriser l'autoconsommation d'énergies renouvelables produites localement

Partner: OKWIND

Starting: Nov 2016; ending: Nov 2019

Abstract: OKWind [0] is a company specialized in local production of renewable energy. This project, with Inria DiverSE and TACOMA teams, aims at building a system that optimizes the use of different sources of renewable energy, choosing the most suitable source for the current demand and anticipating future needs, so as to favor the consumption of locally produced electricity. The system must be able to model clients' activities. It must also trigger actions (local consumption vs. local storage). The final goal is to use " locally produced" energy in a smarter way and to tend towards a self-consumption optimum.

Project: EkoHub

Partners: Ekolis, Delaye transport

Starting: Nov 2014; ending: Nov 2017

Abtract: The EkoHub project has been architectured around hors multi-technologies gateway and leverages on the one developped in the ITSSv6 European project. In addition to the multiple interfaces of our platforms, sensor devices have been incorporated into the project and we studied different scenarios elaborated with our professional partners (Layaye Logistics). Intelligent data management schemes are being studied to adapt to the communication environment and the needs of the application consuming the data.

8.2. National Initiatives

Project: Pervasive_RFID

Partner: IETR

Starting: July 2013; ending: July 2016

Abtract: Pervasive_RFID is a joint effort (within the CominLabs initiative, see http://www.cominlabs.ueb.eu/) started in July 2013 with IETR (institut d'électronique et de télécommunications de Rennes) to study and design innovative RFID reading protocols in the context of pervasive computing applications. Some limitations of existing RFID technology become challenging: unlike standard RFID application scenarios, pervasive computing often involves uncontrolled environment for RFID, where tags and reader have to operate in much more difficult situations that those usually encountered or expected for classical RFID systems.

Project: GLIE - Guidage Lumineux par l'Intelligence de l'Environnement

Partner: OyaLight

Starting: December 2014; ending: April 2016

Abstract: GLIE is a collaborative projet with OYALIGT and TACOMA group. The objective of the project is to design and demonstrate a new service combining connected LEDs provided by OYALIGHT and a software tool developed by TACOMA. By integrating and analyzing data transmitted by the sensors integrated into LEDs, the service must be able to detect a given context and to react accordingly.

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[0] http://www.okwind.fr/

Project: Greenfeed

http://greenfeed.org

Partner: BeNomad, Mines St Etiennes, Enedis, G2MOBILITY, GreedPocket

Starting: July 2013; ending: Nov 2016

Abstract: Greenfeed aims at improving electro-mobility, which means the ease with which users can travel using electric cars. In order to achieve its goal, the project focuses three main operators: electro-mobility service provider (EMSP), distribution service operator (DSO), and charging station operator (CSO). During the project, the role of these actors have been precisely defined, so were the role of the systems they were in charge of. A great effort has been put on interoperability, so that the developed systems could collaborate with each other. One of the key use case was to enable the smart management of available power on a 10 charging site. This led to a demonstration in which a Renault Zoé, customized by the Institut Védécom, was able to negotiate a charge planning with the electric power grid. Then a grid initiated renegotiation was demonstrated, once the initial smart charging process had began. This was the first time this behavior had been achieved with a vehicle in France.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Project acronym: SCOOP@F part 2

Partners: MEDE, Renault, PSA

Starting: January 2016; ending: Dec 2018

Abstract: SCOOP@F is a Cooperative ITS pilot deployment project that intends to connect approximately 3000 vehicles with 2000 kilometers of roads. It consists of 5 specific sites with different types of roads: Ile-de-France, "East Corridor" between Paris and Strasbourg, Brittany, Bordeaux and Isère. SCOOP@F is composed of SCOOP@F Part 1 from 2014 to 2015 (ongoing) and SCOOP@F Part 2 from 2016 to 2018. Its main objective is to improve the safety of road transport and of road operating staff during road works or maintenance. The project includes the validations of Cooperative ITS services in open roads, cross border tests with other EU Member States (Spain, Portugal and Austria) and development of a hybrid communication solution (3G-4G/ITS G5).

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Project acronym: SEAS (ITEA3)

Partners: Telecom Paris Tech, Telecom Saint Etienne, Mines Saint Etienne, Engie, Kerlink, BeNomad, ICAM, CNR, VTT

Starting: Feb 2014; ending: Jan 2017

Abstract: The SEAS project addresses the problem of inefficient and unsustainable energy consumption, which is due to a lack of sufficient means to control, monitor, estimate and adapt the energy use of systems versus the dynamic use situations and circumstances influencing the energy use. The objective of the SEAS project is to enable energy, ICT and automation systems to collaborate at consumption sites, and to introduce dynamic and refined ICT-based solutions to control, monitor and estimate energy consumption. Proposed solution should enable energy market participants to incorporate micro-grid environments and active customers. We are involved in the project to design a distributed system architecture and to implement two proofs of concept: the first one is related to the electric vehicle charging and the other one to the prevision of solar energy production.

TADAAM Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

ANR MOEBUS Scheduling in HPC (http://moebus.gforge.inria.fr/doku.php).

ANR INFRA 2013, 10/2013 - 9/2017 (48 months)

Coordinator: Denis Trystram (Inria Rhône-Alpes)

Other partners: Inria Bordeaux Sud-Ouest, Bull/ATOS

Abstract: This project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments

ANR SATAS SAT as a Service.

AP générique 2015, 01/2016 - 12-2019 (48 months)

Coordinator: Laurent Simon (LaBRI)

Other partners: CRIL (Univ. Artois), Inria Lille (Spirals)

Abstract: The SATAS project aims to advance the state of the art in massively parallel SAT solving. The final goal of the project is to provide a "pay as you go" interface to SAT solving services and will extend the reach of SAT solving technologies, daily used in many critical and industrial applications, to new application areas, which were previously considered too hard, and lower the cost of deploying massively parallel SAT solvers on the cloud.

9.1.2. IPL - Inria Project Lab

MULTICORE - Large scale multicore virtualization for performance scaling and portability

Participants: Emmanuel Jeannot and Farouk Mansouri.

Multicore processors are becoming the norm in most computing systems. However supporting them in an efficient way is still a scientific challenge. This large-scale initiative introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. It aims to build collaborative virtualization mechanisms that achieve essential tasks related to parallel execution and data management. We want to unify the analysis and transformation processes of programs and accompanying data into one unique virtual machine. We hope delivering a solution for compute-intensive applications running on general-purpose standard computers.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

COLOC: the Concurrency and Locality Challenge (http://www.coloc-itea.org).

Program: ITEA2

Project acronym: COLOC

Project title: The Concurrency and Locality Challenge

Duration: November 2014 - November 2017

Coordinator: BULL/ATOS

Other partners: BULL/ATOS (France); Dassault Aviation (France) ; Enfeild AB (Sweden); Scilab entreprise (France); Teratec (France); Inria (France); Swedish Defebnse Research Agency - FOI (France); UVSQ (France).

Abstract: The COLOC project aims at providing new models, mechanisms and tools for improving applications performance and supercomputer resources usage taking into account data locality and concurrency.

NESUS: Network for Ultrascale Computing (http://www.nesus.eu)

> Program: COST
>
> Project acronym: NESUS
>
> Project title: Network for Ultrascale Computing
>
> Duration: April 2014 - April 2018
>
> Coordinator: University Carlos III de Madrid
>
> Other partners: more than 35 countries
>
> Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society.

9.2.2. Collaborations with Major European Organizations

> Partner 1: INESC-ID, Lisbon, (Portugal)
>
> Subject 1: Application modeling for for hierarchical memory system
>
> Partner 2: Argonne National Lab
>
> Subject 2: Topology-aware data aggregation for I/O intensive application
>
> Partner 3: BSC, Barcelona (Spain)
>
> Subject 3: High-performance communication on new architectures; load-balancing and meshing: improve the distribution of data accross the processors for a flow and particle simulation in the human nasal cavity.
>
> Partner 4: University of Liege (Belgium), Université Catholique de Louvain (Belgium), Weierstrass Institute for Applied Analysis and Stochastics (WIAS) (Germany)
>
> Subject 4: Coupling sequential remeshers with PaMPA began in 2016. The work [23] is in progress and it concerns Tetgen developped by Hang Si, and Gmsh by Christophe Geuzaine and Jean-François Remacle.

9.3. International Initiatives

9.3.1. Inria International Labs

Joint-Lab on Extreme Scale Computing (JLESC):

> Coordinators: Franck Cappello and Marc Snir.
>
> Other partners: Argonne National Lab, University of Urbanna Champaign, Tokyo Riken, Jülich Supercomputing Center, Barcelona Supercomputing Center.
>
> Abstract: The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, Riken, Jülich, and BSC. It focuses on software challenges found in extreme scale high-performance computers.

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

Partner 1: AMD Research

Subject 1: Managing locality in the Heterogeneous System Architecture.

AMD provided hardware and details about its future architectures and programming models (HSA) to improve locality support for its products in the HWLOC software.

9.3.2.2. Informal International Partners

Partner 1: ICL at University of Tennessee

Subject 1: on instrumenting MPI applications and modeling platforms (works on HWLOC take place in the context of the OPEN MPI consortium) and MPI and process placement

Partner 2: Cisco Systems

Subject 2: network topologies and platform models

Partner 3: University of Tokyo and RIKEN

Subject 3: Adaptation of MPI and runtime systems to lightweight kernels used on clusters of manycores. This action has been submitted as a JLESC project proposal, currently beeing evaluated.

Partner 4: Lawrence Livermore National Laboratory

Subject 4: Testing of the mapping features of SCOTCH on very large process graphs (more than two billion vertices) and very large target architectures (more than 200,000 parts).

Partner 5: Sandia National Lab

Subject 5: Topology-aware management and allocation of computing resources in runtime systems.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Balazs Gerofi from RIKEN visited us to present his work on micro-kernels for HPC. His visit led to a project proposal for JLESC.
- Jose-Luiz Garcìa Zapata, stayed for three months in the team to work on spectral partitioning and mapping. He implemented a spectral bipartitioning method in SCOTCH.

<div align="center">**URBANET Team**</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

- BQR INSA CROME 12/2013-12/2016
  Participants: Fabrice Valois
  The partners in this project are the CITI DynaMid team and LIRIS. The project studies the coordination of a fleet of mobile robots for the multi-view analysis of complex scenes.

- Labex IMU Priva'Mov 10/2013-10/2016
  Participants: Stéphane D'Alu, Hervé Rivano, Razvan Stanica
  The partners in this project are DRIM LIRIS, Inria Privatics, INSA EVS, and LET ENTPE. The aim of this project is to develop and deploy a crowdsensing platform to collect mobility traces from a sample of real users equipped with android devices, while carrying research on privacy preservation issues. Our contribution consists on developing the platform and using the collected data to analyze cellular network offloading strategies.

- Labex IMU UrPolSens 10/2015-10/2018
  Participants: Ahmed Boubrima, Leo Le Taro, Walid Bechkit, Hervé Rivano
  The partners in this project are Ifsttar, LMFA, EVS, TUBA, and Air Rhone-Alpes, with Inria Urbanet leading the project. UrPolSens deals with the monitoring of air pollution using low-cost sensors interconnected by a wireless networks. Although they are less accurate than the high-end sensors used today, low-cost autonomous air quality sensors allow to achieve a denser spatial granularity and, hopefully, a better monitoring of air pollution. The main objectives of this project are to improve the modeling of air pollution dispersion; propose efficient models to optimize the deployment the sensors while considering the pollution dispersion and the impact of urban environment on communications; deploy a small-scale network for pollution monitoring as a proof of concept; compare the measured and estimated levels of exposure; study the spatial disparities in exposure between urban areas.

- Capt-PolAir 01/2016-12/2016
  PEPS project CNRS and Université de Lyon
  Participants: Ahmed Boubrima, Leo Le Taro, Walid Bechkit, Hervé Rivano
  The partners in this project are Ifsttar, LMFA, EVS, and TUBA, with Inria Urbanet leading the project. This project deals with the practical issues of the low cost wireless sensor deployment for air pollution monitoring. This projet complete the experimental part of UrPolSens.

- ARC6 "Robot fleet mobility under communication constraints" 10/2016-09/2019
  Participants: Fabrice Valois
  This work is a joint project with the Inria Chroma research group. Considering a fleet of drones moving in a 3D area, looking for a given target, we focus on how to maintain the wireless connectivity of the network of drones while the drones patroll autonomously.The other partners in this project are University of Grenoble and Viameca.

9.2. National Initiatives

9.2.1. ANR

- ANR ABCD 10/2013-04/2017.
  Participants: Angelo Furno, Anh-Dung Nguyen, Razvan Stanica
  The partners in the ANR ABCD project are: Orange Labs, Ucopia, Inria UrbaNet, UPMC LIP6 PHARE, Telecom ParisTech. The objective of ABCD is to characterize large-scale user mobility and content consumption in urban areas via mobile data mining, so as to achieve efficient deployment and management of cloud resources via virtual machines. Our contribution in the project consists on the characterization of human mobility and service consumption at a city scale, and the design of appropriate resource allocation techniques at the cellular network level.
- ANR IDEFIX 10/2013-04/2017.
  Participants: Soukaina Cherkaoui, Hervé Rivano, Fabrice Valois
  The partners in the ANR IDEFIX project are: Orange Labs, Alcatel Lucent - Bell Labs, Telecom Paris Tech, Inria UrbaNet, Socrate and Dyogene.

9.2.2. DGA

- DGA CLOTHO 10/2016-03/2018.
  Particpants: Junaid Khan, Romain Pujol, Razvan Stanica, Fabrice Valois
  The partners in the DGA CLOTHO project are Traqueur and Sigfox. The objective of the project is to reduce the energy consumption of the device tracking functionality, by taking profit of short-range communications between the tracked objects.

9.2.3. PIA

- PIA ADAGE 07/2016-06/2018.
  Particpants: Razvan Stanica
  The partners in the PIA ADAGE project are Orange, LAAS-CNRS and Inria Privatics. The objective of the ADAGE project is to design and evaluate anonymization algorithms for the specific case of mobile traffic data. Our role in the project is focused on evaluating whether the anonymized data is still usable for adaptive networking mechanisms.

9.2.4. Pôle ResCom

- Ongoing participation (since 2006)
  Communication networks, working groups of GDR ASR/RSD, CNRS (http://rescom.inrialpes.fr). Hervé Rivano is member of the scientific committee of ResCom.

9.2.5. EquipEx

- SenseCity
  We have coordinated the participation of several Inria teams to the SenseCity EquipEx. Within the SenseCity project, several small reproduction of 1/3rd scale city surroundings will be built under a climatically controlled environment. Micro and nano sensors will be deployed to experiment on smart cities scenarios, with a particular focus on pollution detection and intelligent transport services. Urbanet will have the opportunity to tests some of its capillary networking solutions in a very realistic but controlled urban environment. A proof of concept test site has been built in 2015. We have deployed an experiment on low cost sensor network for vehicle detection and one on atmospheric pollution sensor calibration. The operational site is under construction and should be finalized in 2017.

9.2.6. Inria Project lab

- CityLab
  Urbanet is involved in the CityLab Inria Project Lab lead by Valérie Issarny. Within this project, Hervé Rivano co-advises, with Nathalie Mitton (FUN team, Inria Lille-Nord-Europe), the PhD thesis of Abdoul Aziz Mbacke on "Data gathering in sensor and passive RFID with energy harvesting for urban infrastructure monitoring".

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- **University of Waterloo, ON, Canada**. Joint publications and visits to/from the group of Prof. Catherine Rosenberg.
- **CNR-IEIIT, Turin, Italy**. Joint publications and projects with Dr. Marco Fiore.
- **IMDEA Networks, Madrid, Spain**. Collaboration around the OpenVLC platform with the group of Dr. Domenico Giustiniano.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Catherine Rosenberg, Professor, University of Waterloo, Canada: invited professor at INSA Lyon (Spring semester, 2016).
- Michele Noguiera, Professor, University of Parana, Brazil : visiting professor (one week, February 2016).
- Wei Wennie Shu, Professor, University of New Mexico, USA : visiting professor (one month, December 2016).
- Min-You Wy, Professor, University of Shanghai Jiao Tong, China : visiting professor (one month, December 2016).

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Alexis Duque visited the group of Dr. Domenico Giustinano, at IMDEA Networks, Madrid, Spain (one week, Nov. 2016).
- Alexis Duque visited the group of Prof. Josep Paradells Aspas, at Universitat Politecnica de Catalunya, Barcelona, Spain (one week, Nov. 2016).

<p style="text-align:center;color:red">**WHISPER Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

- City of Paris, 2016-2019, 100 000 euros. As part of the "Émergence - young team" program the city of Paris is supporting part of our work on domain-specific languages.

9.2. National Initiatives

9.2.1. ANR

ITrans - awarded in 2016, duration 2017 - 2020

Members: LIP6 (Whisper), David Lo (Singapore Management University)

Coordinator: Julia Lawall

Whisper members: Julia Lawall, Gilles Muller

Funding: ANR PRCI, 287,820 euros.

Objectives:

Large, real-world software must continually change, to keep up with evolving requirements, fix bugs, and improve performance, maintainability, and security. This rate of change can pose difficulties for clients, whose code cannot always evolve at the same rate. This project will target the problems of *forward porting*, where one software component has to catch up to a code base with which it needs to interact, and *back porting*, in which it is desired to use a more modern component in a context where it is necessary to continue to use a legacy code base, focusing on the context of Linux device drivers. In this project, we will take a *history-guided source-code transformation-based* approach, which automatically traverses the history of the changes made to a software system, to find where changes in the code to be ported are required, gathers examples of the required changes, and generates change rules to incrementally back port or forward port the code. Our approach will be a success if it is able to automatically back and forward port a large number of drivers for the Linux operating system to various earlier and later versions of the Linux kernel with high accuracy while requiring minimal developer effort. This objective is not achievable by existing techniques.

Chronos network, Time and Events in Computer Science, Control Theory, Signal Processing, Computer Music, and Computational Neurosciences and Biology - (2015 - 2016)

Coordinator: Gerard Berry

Whisper member: Gilles Muller

Funding: ANR 2014, Défi "Société de l'information et de la communication".

The Chronos interdisciplinary network aims at placing in close contact and cooperation researchers of a variety of scientific fields: computer science, control theory, signal processing, computer music, neurosciences, and computational biology. The scientific object of study will be the understanding, modeling, and handling of time- and event-based computation across the fields.

Chronos will work by organizing a regular global seminar on subjects ranging from open questions to concrete solutions in the research fields, workshops gathering subsets of the Chronos researchers to address specific issues more deeply, a final public symposium presenting the main contributions and results, and an associated compendium.

9.2.2. *Multicore Inria Project Lab*

The Multicore IPL is an Inria initiative, led by Gilles Muller, whose goal is to develop techniques for deploying parallel programs on heterogeneous multicore machines while preserving scalability and performance. The IPL brings together researchers from the ALF, Algorille, CAMUS, Compsys, DALI, REGAL, Runtime and Whisper Inria Teams. These connections provide access to a diversity of expertise on open source development and parallel computing, respectively. In this context, Gilles Muller and Julia Lawall are working with Jens Gustedt and Mariem Saeid of Inria Lorraine on developing a domain-specific language that eases programming with the ordered read-write lock (ORWL) execution model. The goal of this work is to provide a single execution model for parallel programs and to allow them to be deployed on multicore machines with varying architectures.

9.3. International Initiatives

9.3.1. *Inria International Partners*

9.3.1.1. Informal International Partners

We collaborate with David Lo and Lingxiao Jiang of Singapore Management University, who are experts in software mining, clone detection, and information retrieval techniques. Our work with Lo and/or Jiang has led to 7 joint publications since 2013 [66], [77], [81], [82], [83], [86], [84], at conferences including ASE and ICSME.

9.4. International Research Visitors

9.4.1. *Visits of International Scientists*

9.4.1.1. Internships

Natacha Crooks, PhD student at the University of Austin, Texas, spent three months in Whisper from May to August working on Ipanema.

Derek Palinski, undergraduate at Oberlin College, USA, spent January and June to August working on understanding of device driver evolution, including the evaluation of Prequel.

Vatika Harlalka, undergraduate at the International Institute of Information Technology - Hyderabad, India, spent May to July working on strategies for improving the performance of multicore real-time systems.

Denis Merigoux, final-year student from Ecole Polytechnique, spent March to August working on inference of Coccinelle semantic patches from examples.

Roman Delgado, undergraduate at UPMC, spent June to August working with Pierre-Évariste Dagand on implementing dependent induction in type theory.

Swaraj Dash, undergraduate at Cambridge University, spent August to September working with Pierre-Évariste Dagand on the derivative of indexed datatypes.

Redha Gouicem, Master 2 at UPMC, spent March to August working on memory access control for multicore real-time systems.

Axelle Piot, Master 2 at ENS, spent March to July working on Ipanema.

ALICE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

CPER (2014-2020) 50 k€. Sylvain Lefebvre coordinates a work package for the CPER 2014-2020. It involves several members of ALICE as well as laboratories within the Nancy area (Institut Jean Lamour, LRGP, ERPI). Our goal is to consider the interaction between software and material in the additive manufacturing process, with a focus on filament-based printers.

PIC (2015-2017) 150 k€. The PIC project (Polymères Innovants Composites) is a collaboration between Inria, Institut Jean Lamour and Ateliers Cini, funded by Région Lorraine. The goal is to develop a new additive manufaturing process using filament of composite materials with applications in mechanical engineering and the medical domain. Our goal in the project is to provide novel ways to deposit the filament that is better suited to the considered materials and improves the quality of the final parts.

8.2. National Initiatives

8.2.1. ANR BECASIM (2013 – 2016)

890 k€. X. Antoine heads the second partner, which includes Bruno Lévy. Budget for Nancy: 170 k€ of which 100 k€ are for IECL (team CORIDA). This project is managed by Inria. Becasim is a thematic "Numerical Models" ANR project granted by the French Agence Nationale de la Recherche for years 2013-2016. The acronym Becasim is related to Bose-Einstein Condensates: Advanced SIMulation Deterministic and Stochastic Computational Models, HPC Implementation, Simulation of Experiments. The members of the ANR Project Becasim belong to 10 different laboratories.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. SHAPEFORGE

Title: ShapeForge: By-Example Synthesis for Fabrication

Programm: FP7

Duration: December 2012 - November 2017

Coordinator: Inria

Inria contact: Sylvain Lefebvre

Despite the advances in fabrication technologies such as 3D printing, we still lack the software allowing for anyone to easily manipulate and create useful objects. Not many people possess the required skills and time to create elegant designs that conform to precise technical specifications. 'By–example' shape synthesis methods are promising to address this problem: New shapes are automatically synthesized by assembling parts cutout of examples. The underlying assumption is that if parts are stitched along similar areas, the result will be similar in terms of its low–level representation: Any small spatial neighborhood in the output matches a neighborhood in the input. However, these approaches offer little control over the global organization of the synthesized shapes, which is randomized. The ShapeForge challenge is to automatically produce new objects visually similar to a set of examples, while ensuring that the generated objects can enforce a specific purpose, such as supporting weight distributed in space, affording for seating space or allowing for light to go through. These properties are crucial for someone designing furniture, lamps, containers, stairs and many of the common objects surrounding us. The originality of our approach is to cast a new

view on the problem of 'by–example' shape synthesis, formulating it as the joint optimization of 'by–example' objectives, semantic descriptions of the content, as well as structural and fabrication objectives. Throughout the project, we will consider the full creation pipeline, from modeling to the actual fabrication of objects on a 3D printer. We will test our results on printed parts, verifying that they can be fabricated and exhibit the requested structural properties in terms of stability and resistance.

8.4. International Initiatives

8.4.1. Inria Associate Teams Not Involved in an Inria International Labs

8.4.1.1. PREPRINT3D

Title: Model Preparation for 3D Printing

International Partner (Institution - Laboratory - Researcher):

University of Hong Kong, Computer science department, with Li-Yi Wei and Wenping Wang

Start year: 2014

We seek to develop novel ways to prepare objects for 3D printing which better take into account limitations of the fabrication processes as well as real-world properties such as the mechanical strength of the printed object. This is especially important when targeting an audience which is not familiar with the intricacies of industrial design. We target complex, intricate shapes such as models of vegetation and highly detailed meshes, as well as models with thin walls such as architectural models. Our methods will modify the object geometry and topology while remaining as close as possible to its initial appearance.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

We have on-going collaborations with Marc Alexa (TU Berlin) regarding slicing algorithms for additive manufacturing and Niloy Mitra (University College London) on minimal wastage design of furniture.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Denis Salem (CESI-EXIA), 6-months intern started in September 2016, working on point distributions along surfaces using GPU algorithms. Théo Poisson (CESI-EXIA) was an intern from February to May 2016, working on quality testing and improvements to our software IceSL. Yuexin Ma, PhD student with Wenping Wang (HKU), 1 month visit in the context of the PrePrint3D associated team.

ALPAGE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. LabEx EFL (Empirical Foundations of Linguistics) (2011 – 2021)

Participants: Laurence Danlos, Benoît Sagot, Marie-Hélène Candito, Benoît Crabbé, Pierre Magistry, Djamé Seddah, Maximin Coavoux, Éric Villemonte de La Clergerie.

Linguistics and related disciplines addressing language have achieved much progress in the last two decades but improved interdisciplinary communication and interaction can significantly boost this positive trend. The LabEx (excellency cluster) EFL (Empirical Foundations of Linguistics), launched in 2011 and headed by Jacqueline Vaissière, opens new perspectives by adopting an integrative approach. It groups together some of the French leading research teams in theoretical and applied linguistics, in computational linguistics, and in psycholinguistics. Through collaborations with prestigious multidisciplinary institutions (CSLI, MIT, Max Planck Institute, SOAS...) the project aims at contributing to the creation of a Paris School of Linguistics, a novel and innovative interdisciplinary site where dialog among the language sciences can be fostered, with a special focus on empirical foundations and experimental methods and a valuable expertise on technology transfer and applications.

Alpage is a very active member of the LabEx EFL together with other linguistic teams we have been increasingly collaborating with: LLF (University Paris 7 & CNRS) for formal linguistics, LIPN (University Paris 13 & CNRS) for NLP, LPNCog (University Paris 5 & CNRS) LSCP (ENS, EHESS & CNRS) for psycholinguistics, MII (University Paris 4 & CNRS) for Iranian and Indian studies. Alpage resources and tools have already proven relevant for research at the junction of all these areas of linguistics, both before the start of the LabEx EFL and within several EFL "scientific operations". Moreover, the LabEx provides Alpage with opportunities for collaborating with new teams, e.g., on language resource development and empirical studies in collaboration with descriptive linguists.

The LabEx EFL's scientific activities are spread accross 7 autonomous scientific "strands". In 2016, Benoît Sagot, Marie Candito and Benoît Crabbé were respectively deputy-head of strand 6 on "Language Resources", strand 5 on "Computational semantic analysis" and strand 2 on "Experimental grammar from a cross-linguistic perspective". Several project members are in charge of research operations within these 3 strands.

8.1.2. ANR

8.1.2.1. ANR project Profiterole (2017 - 2020)

Participants: Benoît Crabbé, Éric Villemonte de La Clergerie, Benoît Sagot.

PROFITEROLE is a 4-year ANR research project led by Sophie Prévost (LATTICE) that involves computational linguists and specialists of Medieval French from LATTICE (Univ. Paris 3, CNRS, ENS), ALPAGE and ICAR (Univ. Lyon, ENS).

PROFITEROLE has three closely correlated main goals that fall within the fields of linguistics and Natural Language Processing (NLP): (1) formal and computational modeling phonological, morphological and syntactic aspects of the diachronic evolution of French; (2) targeting the development of a methodology to explore and annotate heterogeneous linguistic data while providing automatic analysers for various stages of the French language; (3) expanding linguistic resources for French, by building a large annotated corpus (1 million words) of Medieval French (9th-15th centuries) and morphological lexicons (plus NLP tools) covering several stages of French. Alpage members will essentially be involved on the computational and formal modeling aspects of the project and on the design of automated processing tools for lexicon and syntax.

8.1.2.2. ANR project PARSITI (2016 - 2020)

Participants: Marie-Hélène Candito, Djamé Seddah [principal investigator], Benoît Crabbé, Éric Villemonte de La Clergerie, Benoît Sagot.

Exploiting multilingual user-generated content (UGC), for applications such as information extraction, text mining or summarization, and facilitate their access to a wider audience implies a qualitative step-ahead in Natural Language Understanding. This is because UGC differs from better-studied edited data in many ways, including by non-canonical syntax, highly contextualised nature and rich lexical variability. The ParSiTi ANR project focuses on three critical aspects: (1) Robust Parsing Technologies, (2) Accurate Machine Translation Engines and (3) Context-aware Methods, all backed by State-of-the-Art Morphological Analysers and Normalization tools. To showcase the different models and algorithms designed during the project, a Machine Translation System will be developed that will be able to translate UGC between French, Arabic and English.

8.1.2.3. ANR project PARSEME-FR (2016 - 2019)

Participants: Marie-Hélène Candito, Mathieu Constant [principal investigator], Benoît Crabbé, Laurence Danlos, Éric Villemonte de La Clergerie, Djamé Seddah.

PARSEME-FR is a 4-year ANR research project headed by Mathieu Constant (LIGM, Université Paris-Est Marne-la-Vallée, currently in "délégation" at Alpage). PARSEME-FR partners are LIGM, Alpage, LI (Université de Tours), LIF (Aix-Marseille Université) and LIFO (Université d'Orléans). This project aims at improving linguistic representativeness, precision and computational efficiency of Natural Language Processing (NLP) applications, notably parsing. The project focuses on the major bottleneck of these applications: Multi-Word Expressions (MWEs), i.e. groups of words with a certain degree of idiomaticity such as "hot dog", "to kick the bucket", "San Francisco 49ers" or "to take a haircut". In particular, it aims at investigating the syntactic and semantic representation of MWEs in language resources, the integration of MWE analysis in (deep) syntactic parsing and its links to semantic processing. Expected deliverables include enhanced language resources (lexicons, grammars and annotated corpora) for French, MWE-aware (deep) parsers and tools linking predicted MWEs to knowledge bases. This proposal is a spin-off of the European IC1207 COST action PARSEME on the same topic.

Alpage is participating mainly to two tasks: (i) the production of an evaluation corpus annotated with MWE and (ii) the production of MWE-aware statistical parsers, both for surface syntax and deep syntax. MWE recognition can be viewed as part of a more ambitious task of recovering the semantic units of a sentence. Combining it to deep syntactic parsing will provide a further step towards semantic parsing.

8.1.2.4. ANR project SoSweet (2015 - 2019)

Participants: Djamé Seddah, Marie-Hélène Candito, Benoît Sagot, Éric Villemonte de La Clergerie, Benoît Crabbé.

Led by Jean-Phillipe Magué (ENS Lyon), the SoSweet project focuses on the synchronic variation and the diachronic evolution of the variety of French language used on Twitter. Its goal is to provide a state-of-the-art socio-linguistic description of half a billion tweets collected over 5 years.

Alpage, specialized in natural language processing, takes care of the linguistics enrichment part, which provides the other partners with normalized and structurally enriched forms of text. Alpage is also responsible of providing distributional analysis of our corpus, by the means of various forms of word clustering in order to define sociolinguistic variants in the tweets.

8.1.2.5. ANR project ASFALDA (2012 – 2016)

Participants: Marie-Hélène Candito [principal investigator], Marianne Djemaa, Benoît Sagot, Éric Villemonte de La Clergerie, Laurence Danlos.

Alpage is principal investigator team for the ANR project ASFALDA, lead by Marie Candito. The other partners are the Laboratoire d'Informatique Fondamentale de Marseille (LIF), the CEA-List, the MELODI team (IRIT, Toulouse), the Laboratoire de Linguistique Formelle (LLF, Paris Diderot) and the Ant'inno society.

The project aims to provide both a French corpus with semantic annotations and automatic tools for shallow semantic analysis, using machine learning techniques to train analyzers on this corpus. The target semantic annotations are structured following the FrameNet framework [54] and can be characterized roughly as an explicitation of "who does what when and where", that abstracts away from word order / syntactic variation, and to some of the lexical variation found in natural language.

The project relies on an existing standard for semantic annotation of predicates and roles (FrameNet), and on existing previous effort of linguistic annotation for French (the French Treebank). The original FrameNet project provides a structured set of prototypical situations, called frames, along with a semantic characterization of the participants of these situations (called *roles*). We propose to take advantage of this semantic database, which has proved largely portable across languages, to build a French FrameNet, meaning both a lexicon listing which French lexemes can express which frames, and an annotated corpus in which occurrences of frames and roles played by participants are made explicit. The addition of semantic annotations to the French Treebank, which already contains morphological and syntactic annotations, will boost its usefulness both for linguistic studies and for machine-learning-based Natural Language Processing applications for French, such as content semantic annotation, text mining or information extraction.

To cope with the intrinsic coverage difficulty of such a project, we adopt a hybrid strategy to obtain both exhaustive annotation for some specific selected concepts (commercial transaction, communication, causality, sentiment and emotion, time), and exhaustive annotation for some highly frequent verbs. Pre-annotation of roles will be tested, using linking information between deep grammatical functions and semantic roles.

The project is structured as follows:

- Task 1 concerns the delimitation of the focused FrameNet substructure, and its coherence verification, in order to make the resulting structure more easily usable for inference and for automatic enrichment (with compatibility with the original model);
- Task 2 concerns all the lexical aspects: which lexemes can express the selected frames, how they map to external resources, and how their semantic argument can be syntactically expressed, an information usable for automatic pre-annotation on the corpus;
- Task 3 is devoted to the manual annotation of corpus occurrences (we target 20000 annotated occurrences);
- In Task 4 we will design a semantic analyzer, able to automatically make explicit the semantic annotation (frames and roles) on new sentences, using machine learning on the annotated corpus;
- Task 5 consists in testing the integration of the semantic analysis in an industrial search engine, and to measure its usefulness in terms of user satisfaction.

The scientific key aspects of the project are:

- an emphasis on the diversity of ways to express the same frame, including expression (such as discourse connectors) that cross sentence boundaries;
- an emphasis on semi-supervised techniques for semantic analysis, to generalize over the available annotated data.

8.1.2.6. ANR project Polymnie (2012-2016)

Participants: Laurence Danlos, Éric Villemonte de La Clergerie, Timothée Bernard.

Polymnie is an ANR research project headed by Sylvain Podogolla (Sémagramme, Inria Lorraine) with Melodi (INRIT, CNRS), Signes (LABRI, CNRS) and Alpage as partners. This project relies on the grammatical framework of Abstract Categorial Grammars (ACG). A feature of this formalism is to provide the same mathematical perspective both on the surface forms and on the more abstract forms the latter correspond to. ACG allows for the encoding of a large variety of grammatical formalisms, in particular Tree Adjoining grammars (TAG).

The role of Alpage in this project is to develop sentential or discursive grammars written in TAG and to participate in their conversion in ACG. Results were first achieved in 2014 concerning text generation: GTAG formalism created by Laurence Danlos in the 90's has been rewritten in ACG [64], [65], [66]. As regards discursive analysis, D-STAG formalism created by Laurence Danlos in the 00's has also been rewritten in ACG in 2015 [67] (see also [27]).

8.1.3. Other national initiatives

8.1.3.1. "RAPID" project VerDI (2016 – 2019)
Participants: Benoît Sagot, Héctor Martínez Alonso.

The ANR "RAPID" project VerDI focuses on the automatic identification of information dissimulation on the Internet and on social networks. Such dissimulations can be produced by omiting crucial pieces of information within documents or during written online discussions, by hiding them within a massive information flow, or using other techniques. VerDI aims at extending an existing journalistic fact-checking tool developed by Trooclick, the company that leads the project.

8.1.3.2. FUI project COMBI (2014-2016)
Participant: Laurence Danlos.

COMBI is is an "FUI 16" project. It started in February 2014 for a two year duration. It groups 5 industrial partners (Temis, Isthma, Kwaga, Yseop and Qunb) and Alpage. Temis and Istma work on data mining from texts and big data. Kwaga works on the interpretation and inferences that can be drawn from the data retrieved in the analysis module. Alpage and Qunb work, under the supervision of Yseop, on the production of respectively texts and graphics describing the results of the interpretation module. Currently, COMBI aims at creating the full chain for a user case concerning the weekly activity of an on-line service.

Alpage works on text generation, with the adaptation of TextElaborator, a generation system developed in the 10's by WatchAssistance and based on G-TAG. Alpage also works on the opportunity to describe pieces of information by texts, graphics or both.

8.1.3.3. Institut de Linguistique Française and Consortium CORLI within the TGIR Huma-Num
Participants: Benoît Sagot, Stéphane Riou, Djamé Seddah.

Huma-Num is a TGIR (Very Large Research Infrastructure) dedicated to digital humanities. Among Huma-Num initiatives are a dozen of consortia, which bring together most members of various research communities. Among them is the CORLI consortium (following, among other, the *Corpus Écrits* consortium in which previously participating), which is dedicated, among other topics, to all aspects related to written corpora, from NLP to corpus development, corpus specification, standardization, and others. All types of written corpora are covered (French, other languages, contemprorary language, medieval language, specialized text, non-standard text, etc.). The consortium CORLI is managed by the Institut de Linguistique Française, a CNRS federation of which Alpage is a member since June 2013, under the supervision of Franck Neveu.

Alpage is involved in various projects within this consortium, and especially in the development of corpora for CMC texts (blogs, forum posts, SMSs, textchat...) and shallow corpus annotation, especially with MElt, and in the development of a preliminary version of the future Corpus de Référence du Français (French Reference Corpus).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. H2020 PARTHENOS
Participants: Laurent Romary, Luca Foppiano, Mohamed Khemakhem, Marie Puren, Charles Riondet, Dorian Seillier.

This EU project Parthenos of the H2020 INFRADEV program aims et strengthening the cohesion of research in the broad sector of Linguistic Studies, Humanities, Cultural Heritage, History, Archaeology and related fields through a thematic cluster of European Research Infrastructures, integrating initiatives, e-infrastructures and other world-class infrastructures, and building bridges between different, although tightly interrelated, fields. Within this project started in May 2015, Alpage has the leadership over the work package dedicated to the promotion and development of standards in the humanities.

In 2015, Laurent Romary and Charles Riondet have identified digital humanities use cases where standards play a central role and specified an architecture for organising standards related information (specification, software, bibliography, reference material, experts) at the service of scholars in the humanities.

8.2.1.2. H2020 EHRI
Participants: Laurent Romary, Luca Foppiano, Charles Riondet.

The EHRI 2 (European Holocaust Research Infrastructure), also in the INFRADEV program of H2020, seeks to transform archival research on the Holocaust, by providing methods and tools to integrate and provide access to a wide variety of archival content. The project has started in June 2015 and will led us to work on both standards for the representation of archival content and develop data mining components for archival textual data.

In 2015, we have focused on the identification of available data sources resulting from the first phase of the project in the previous years and compile specifications for the description of authorities according to the EAC (Encoded Archival Context) standard.

8.2.1.3. H2020 Iperion
Participants: Laurent Romary, Luca Foppiano, Marie Puren.

The H2020 Iperion project aims at coordinating infrastructural activities in the cultural heritage domain. Our team has a small participation in relation to the definition of data management and representation issues. This will directly contribute to increase our experience in curating the kind of heterogeneous linguistic data that we gathered over the years.

In 2015, we have designed a questionnaire for all data producers in the project in order to gather feedback on their existing practices (data flows, licences, formats) concerning the creation, management and dissemination of cultural heritage data. On this basis, we have produced a first version of the data management plan for the project.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

Program: IC1207 COST

Project acronym: PARSEME

Project title: PARSing and Multi-word Expressions

Duration: March 2013 - March 2017

Coordinator: Agata Savary

Other partners: interdisciplinary experts (linguists, computational linguists, computer scientists, psycholinguists, and industrials) from 30 countries

Abstract: The aim of this project is to improve linguistic representativeness, precision and computational efficiency of Natural Language Processing (NLP) applications, focusing on the major bottleneck of these applications: Multi-Word Expressions (MWEs), i.e., sequences of words with unpredictable properties such as "to count somebody in" or "to take a haircut". A breakthrough in their modelling and processing is targeted, as the result of a coordinated effort of multidisciplinary experts working on fourteen different languages.

Program: ISCH COST Action IS1312

Project acronym: TextLink

Project title: Structuring Discourse in Multilingual Europe

Duration: April 2014 - April 2018

Coordinator: Liesbeth Degand

Other partners: experts in computational linguistics and discourse from 24 countries

France MC members: Laurence Danlos and Philippe Muller (IRIT)

Abstract: This action will facilitate European multilingualism by (1) identifying and creating a portal into discourse-level resources within Europe - including annotation tools, search tools, and discourse-annotated corpora; (2) delineating the dimensions and properties of discourse annotation across corpora; (3) organising these properties into a sharable taxonomy; (4) encouraging the use of this taxonomy in subsequent discourse annotation and in cross-lingual search and studies of devices that relate and structure discourse; and (5) promoting use of the portal, its resources and sharable taxonomy.

Program: **ISCH COST Action IS1305**

Project acronym: ENeL

Project title: European Network of e-Lexicography

Duration: October 2013 - October 2017

Coordinator: Prof Martin EVERAERT (NL)

Other partners: interdisciplinary experts (linguists, computational linguists, computer scientists, lexicographers, and industrials) from 31 countries

Abstract: The proposed Action aims to establish a European network of lexicographers in order to deal with the following issues: give easier access to scholarly dictionaries, establish a systematic exchange of expertise on common standards and solutions, develop a common approach to e-lexicography that forms the basis for a new type of lexicography that fully embraces the pan-European nature of much of the vocabularies of the languages spoken in Europe

AVIZ Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *ANR FITOC: From Individual To Collaborative Visual Analytics*

Participants: Petra Isenberg [correspondant], Jean-Daniel Fekete, Pierre Dragicevic, Pascal Goffin, Wesley Willett.

The goal of this project is to help bringing collaboration to existing individual visual data analysis work. It is situated in the domain of information visualization, a subdomain of computer science, but views and tries to support data analysis as a social process. The work is motivated by the fact that a large amount of data analysis work is conducted by individuals in isolated tool, such as Excel, R, SPSS, Tableau, and others. Synthesis and sharing of the results then happens in another set of tools such as notes, email, or office documents. The research is situated in the domain of visualization which has a long tradition of building tools and techniques for individual data analysis. Currently there are technological innovations under way to help people analyze data together, but there is still a disconnect between the two modes of data analysis (collaborative and individual). In this project, we want to find ways in which information can best be used and shared visually while transitioning between individual and collaborative data analysis activities.

The project ended in July, 2016.

8.2. European Initiatives

8.2.1. *FP7 & H2020 Projects*

8.2.1.1. CENDARI

Title: Collaborative EuropeaN Digital/Archival Infrastructure

Programm: FP7

Duration: February 2012 - January 2016

Coordinator: Trinity College - Dublin

Partners:

Consortium of European Research Libraries (United Kingdom)

Koninklijke Bibliotheek (Netherlands)

Fondazione Ezio Franceschini Onlus (Italy)

Freie Universitaet Berlin (Germany)

King's College London (United Kingdom)

"matematicki Institutnu, Beograd" (Serbia)

Narodni Knihovna Ceske Republiky (Czech Republic)

Societa Internazionale Per Lo Studio Del Medioevo Latino-S.I.S.M.E.L.Associazione (Italy)

The Provost, Fellows, Foundation Scholars & The Other Members of Board of The College of The Holy & Undivided Trinity of Queen Elizabeth Near Dublin (Ireland)

Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (Germany)

The University of Birmingham (United Kingdom)

Universitaet Stuttgart (Germany)

Universita Degli Studi di Cassino E Del Lazio Meridionale (Italy)

Inria contact: L. Romary

'The Collaborative EuropeaN Digital Archive Infrastructure (CENDARI) will provide and facilitate access to existing archives and resources in Europe for the study of medieval and modern European history through the development of an 'enquiry environment'. This environment will increase access to records of historic importance across the European Research Area, creating a powerful new platform for accessing and investigating historical data in a transnational fashion overcoming the national and institutional data silos that now exist. It will leverage the power of the European infrastructure for Digital Humanities (DARIAH) bringing these technical experts together with leading historians and existing research infrastructures (archives, libraries and individual digital projects) within a programme of technical research informed by cutting edge reflection on the impact of the digital age on scholarly practice. The enquiry environment that is at the heart of this proposal will create new ways to discover meaning, a methodology not just of scale but of kind. It will create tools and workspaces that allow researchers to engage with large data sets via federated multilingual searches across heterogeneous resources while defining workflows enabling the creation of personalized research environments, shared research and teaching spaces, and annotation trails, amongst other features. This will be facilitated by multilingual authority lists of named entities (people, places, events) that will harness user involvement to add intelligence to the system. Moreover, it will develop new visual paradigms for the exploration of patterns generated by the system, from knowledge transfer and dissemination, to language usage and shifts, to the advancement and diffusion of ideas.'

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- Univ. of Konstanz, Jean-Daniel Fekete collaborates with Michael Behrischon network exploration based on matrices [4], [3].
- NYU, Jean-Daniel Fekete collaborates with Enrico Bertini and his students on multidimensional visualization and exploration [23]/
- Microsoft Research Redmond, Jean-Daniel Fekete collaborates with Nathalie Henry-Riche on the visualization of dynamic networks (see 6.3).
- Stanford University. Mathieu Le Goc, Jean-Daniel Fekete and Pierre Dragicevic collaborate with Sean Follmer on Swarm User Interfaces and the design of the Zooids (section 7.1).
- Univ of Calgary. Pierre Dragicevic collaborates with Wesley Willett on situated data visualization.
- Univ of Washington, Univ Chicago and Univ Zurich. Pierre Dragicevic collaborates with Matthew Kay, Steve Haroz and Chat Wacharamanotham on transparent statistical reporting.
- Microsoft Research, Redmond, University of Waterloo, University of Calgary. Petra Isenberg and Tobias Isenberg collaborate with Bongshin Lee, Mark Hancock, Diane Watson, and Sheelagh Carpendale on touch vs. mouse interaction
- Microsoft Research, Redmond. Petra Isenberg collaborates with Bongshin Lee on mobile visualization research.
- Univ. of Vienna, Austria: Petra Isenberg and Tobias Isenberg collaborate with Torsten Möller and Michael Sedlmair on visualization practices and evaluation of visualization.
- Univ. of Maryland, Baltimore County, USA: Petra Isenberg and Tobias Isenberg collaborate with Jian Chen on visualization practices and evaluation of visualization.
- Georgia Tech, USA: Petra Isenberg and Tobias Isenberg collaborate with John Stasko on visualization practices.
- Univ. Groningen, the Netherlands: Petra Isenberg and Tobias Isenberg collaborate with Lingyun Yu and Konstantinos Efstathiou on context-aware 3D selection.

- Univ. of Granada, Spain: Tobias Isenberg collaborates with Domingo Martín on non-photorealistic rendering.
- Techn. Univ. of Vienna, Austria: Tobias Isenberg collaborates with Ivan Viola on illustrative visualization.
- Univ. of Bergen, Norway: Tobias Isenberg collaborates with Stefan Bruckner on interactive visualization.
- Univ. of Ulm, Germany: Tobias Isenberg collaborates with Timo Ropinski on interactive visualization.
- Worms Univ. of Appl. Sciences, Germany: Tobias Isenberg collaborates with Alexander Wiebel on interactive visualization.
- Univ. Koblenz-Landau, Germany: Tobias Isenberg collaborates with Kai Lawonn on illustrative visualization.
- Univ. Magdeburg, Germany: Tobias Isenberg collaborates with Bernhard Preim on illustrative visualization.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Sriram Karthik Badam, PhD, Univ. of Maryland, from Jun 2016 until Sep 2016
- Yanhong Wu, PhD, Hong-Kong Univ. of Science and Technology, from May to Sep. 2016

AYIN Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Josiane Zerubia has been in contact with Dr. Sandrine Mathieu, image processing quality expert at Thales Alenia Space in Cannes (https://www.thalesgroup.com/en/worldwide/space) to discuss AYIN's research in remote sensing.

- Josiane Zerubia is part of the FAULTS-R-GEMS project funded by Academy 3 of Idex UCA-Jedi (http://univ-cotedazur.fr/english/idex-uca-jedi/academies-of-excellence), PI: Isabelle Manighetti of Geoazur (OCA, CNRS, UCA), in collaboration with Yuliya Tarabalka from TITANE Inria team, as well as members of UCA, Institut de Physique du Globe in Paris, Geoscience in Montpellier, ETH Zurich, CalTech, Arizona State University and UNAVCO consortium in the USA.

7.2. International Initiatives

7.2.1. Inria International Partners

- Josiane Zerubia has a strong collaboration with University of Genoa, Italy, for more than 20 years [11].

- Another collaboration in Canada with Mc Master University, Hamilton, started in 2012 [9], and has been extended to Juravinski Cancer Center (http://www.jcc.hhsc.ca/) in Hamilton and Simon Fraser University.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Research Stays Abroad

Josiane Zerubia was invited to spend 2 months, from late August to late October, at the Coordinated Science Laboratory (CSL, http://www.csl.illinois.edu/) of the University of Illinois at Urbana Champaign (UIUC) to work with Prof. Farzad Kamalabadi (https://www.ece.illinois.edu/directory/profile/farzadk) and his team on FUV image processing for ICON NASA mission.

<div align="center">

CEDAR Team

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8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- AIDE ("A New Database Service for Interactive Exploration on Big Data") is an ANR "Young Researcher" project led by Y. Diao, to start at the end of 2016.

- CBOD ("Cloud-Based Organizational Design") is a 4-year ANR started in 2014, coordinated by prof. Ahmed Bounfour from UPS. Its goal is to study and model the ways in which cloud computing impacts the behavior and operation of companies and organizations, with a particular focus on the cloud-based management of data, a crucial asset in many companies.

- ContentCheck (2015-2018) is an ANR project in collaboration with U. Rennes 1 (F. Goasdoué), INSA Lyon (P. Lamarre), the LIMSI lab from U. Paris Sud, and the Le Monde newspaper, in particular their fact-checking team Les Décodeurs. Its aim is to investigate content management models and tools for journalistic fact-checking.

- Datalyse is funded for 3.5 years as part of the *Investissement d'Avenir - Cloud & Big Data* national program. The project is led by the Grenoble company Eolas, a subsidiary of Business & Decision. It is a collaboration with LIG Grenoble, U. Lille 1, U. Montpellier, and Inria Rhône-Alpes aiming at building scalable and expressive tools for Big Data analytics. The project has ended in November 2016.

8.1.2. LabEx, IdEx

- Structured, Social and Semantic Search (S4) is a 3-year project started in October 2013, financed by the *LabEx (Laboratoire d'Excellence)*DIGICOSME. The project aims at developing a data model for rich structured content enriched with semantic annotations and authored in a distributed setting, as well as efficient algorithms for top-k search on such content. The project has ended in September 2016.

- CloudSelect is a three-years project started in October 2015. It is financed by the *Institut de la Société Numérique* (ISN) of the IDEX Paris-Saclay; it funds the PhD scholarship of S. Cebiric. The project is a collaboration with A. Bounfour from the economics department of Université Paris Sud. The project aims at exploring technical and business-oriented aspects of data mobility across clo ud services, and from the cloud to outside the cloud. Research contributing to this project is carried in collaboration with U. California in San Diego (UCSD) (see Section 3.1).

8.1.3. Others

- ODIN is a four-year project started in 2014, funded by the Direction Générale de l'Armement, between the SemSoft company, IRISA Rennes and Cedar. The project aims to develop a complete framework for analytics on Web data, in particular taking into account uncertainty, based on Semantic Web technologies such as RDF.

- Google Award I. Manolescu has received a Google Award in collaboration with X. Tannier from LIMSI/CNRS and Université de Paris-Sud. The award is given within a call specifically dedicated to computing tools for computational journalism. The project given the award focuses on "Event Thread Extraction for Viewpoint Analysis"; the project has finished at the end of 2016.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

The permanent members of the team participate to build a proposal called GDMA (Graph Data Management and Analytics, for an European Joint Doctorate within the Initial Training Network (ITN) chapter of Europe's H2020 program, with the University of Aalborg (Denmark), Université Libre de Bruxelles, Universitat Politecnica de Catalunya, and University of Ioannina (Greece). If successful the project would involve six PhD thesis co-supervised in Cedar and starting in 2018, three students mostly residing with us, and three abroad working with our partners from Aalborg and Brussels.

I. Manolescu has submitted a Marie-Curie proposal titled IDEAA (An interactive toolbox to help citizens understand and build a viewpoint on specific issues by monitoring, analysing, and interlinking public data from EU institutions) to host a junior researcher (Mirjana Mazuran from Politecnico di Milano) for two years.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

We continue collaborating with U. California in San Diego (UCSD) following the OAKSAD associated team (2013-2015), in particular in the Estocada project (Section 7.1).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Several international guests gave seminars in our group:

- L. Ach and M. Rezk (Rakuten)
- D. Calvanese (University of Bolzano)
- R. Cheng (Hong Kong University)
- M. Franklin (University of Berkeley)
- R. Kontchakov, S. Kikot, M. Zakharyaschev (Birbeck University College)
- Y. Papakonstantinou (University of California in San Diego)
- V. Vianu (University of California in San Diego)

8.4.1.1. Internships

- R. Alotaibi visited the team for two months working on scalable heterogeneous stores with D. Bursztyn and I. Manolescu.
- D. Lanti visited the team for five months, working on efficient semantic query answering with D. Bursztyn.

<p style="text-align:center">**CHROMA Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Projet AAP ARC6 (2015-18)

Participants: Olivier Simonin, Anne Spalanzani, Fabrice Valois [Insa de Lyon, Inria Urbanet].

Regional project (Rhône-Alpes) "Mobilité au sein de flottes de robots sous contrainte de maintien de la connectivité" ARC6, 2015-2018. Leader : O. Simonin.

This project funds the PhD thesis of Mihai-Ioan Popescu, who started on november 2015, and co-advized by O. Simonin, A. Spalanzani and F. Valois. The project involves also the Pole de compétitivité "Via Meca".

9.1.2. Projet AAP ARC6 (2016-19)

Participants: Gérard Bailly [CNRS, GIPSA Lab. Grenoble], Olivier Simonin, Anne Spalanzani.

Regional project (Rhône-Alpes) "TENSIVE Robots de TEléprésence : Navigation Sociale et Interaction VErbale immersives" ARC6, 2016-2019. Leader : G. Bailly.

This project funds the PhD thesis of Remi Cambuzat who started on october 2016, and co-advized by G. Bailly (Dir.), O. Simonin and A. Spalanzani.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR "VIMAD" (2015-17)

The VIMAD project aims at developing a robust and reliable perception system, only based on visual and inertial measurements, to enhance the navigation capabilities of fully autonomous micro aerial drones. It also aims at acquiring a deep theoretical comprehension of the problem of fusing visual and inertial measurements, by investigating its observability properties in challenging scenarios.

The activities related to this project, followed the work-plan (first year). They regarded the usage of our closed-form solution (recently published on the journal of computer vision, [70]) in the framework of micro aerial navigation in order to:

1. automatically perform state initialization;
2. improve the data matching process.

Additionally, the activities of VIMAD regarded the investigation of an unsolved problem in control theory, which is the unknown input observability problem in the nonlinear case, and its applications to the visual-inertial structure from motion problem.

See section 7.3.1 for a description of the results obtained during this first year of the project.

9.2.1.2. ANR "Valet" (2016-18)

The ANR VALET project proposes a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers. An optimal routing algorithm is in charge of defining platoons drivers' routes to the parking areas where the followers are parked in a complete automated mode. The consortium is made of 2 academic partners : Inria (RITS, Chroma, Prima) and Ircyyn Ecole Centrale de Nantes and the AKKA company.

In the VALET project we will propose a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers, retrieving vehicles parked randomly on the urban parking network by users. The phD student (Pavan Vashista) recruited in this project will focus on integrating models of human behaviors (pedestrian and/or drivers), proxemics (human management of space) and traffic rules to evaluate and communicate a risk to pedestrians that may encounter the trajectory of the VALET vehicle. His PhD thesis has started on february 2016 and is co-supervized by D. Vaufreydaz (Inria/PervasiveInteraction).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. "ENABLE" Ecsel Project

ENABLE-S3 means "European Initiative to Enable Validation for Highly Automated Safe and Secure Systems". It is a H2020 Ecsel project.

ENABLE-S3 is *industry-driven* and therefore aims to foster the leading role of the European industry. This is also reflected in its *use case driven approach*. The main technical objectives are extracted from the use cases defined by the industrial partners, in order to validate the success of the developed methods and tools.

Recent scientific publications from the automotive domain predict that more than 100 Mio km of road driving is required for the thorough validation of a fully automated vehicle. Only if this extensive test is done, it is statistically proven that the automated vehicle is as safe as a manually driven car. Taking further into account the high number of vehicle variants and software versions, one can easily understand that *new validation approaches* are required to validate new Electronics, Components and Systems (ECS) for automated vehicles within a reasonable time period at reasonable costs. The same characteristic hold for other transportation domains such as aeronautics, maritime or rail.

The ENABLE-S3 project will provide European industry with leading-edge technologies that *support the development of reliable, safe and secure functions for highly automated and/or autonomously operating systems* by enabling the *validation and verification at reduced time and costs*.

Enables-S3 is a large European consortium, involving a French consortium leaded by Valeo, and including Thales, Renault and Inria. The project will start in March-April 2016 and will have a duration of 3 years.

9.3.2. Collaborations with Major European Organizations

- Autonomous System laboratory: ETHZ, Zurich (Switzerland)

  Subject: Vision and IMU data Fusion for 3D navigation in GPS denied environment.

- Robotics and Perception Group: University of Zurich (Switzerland)

  Subject: Vision and IMU data Fusion for 3D navigation in GPS denied environment.

- Karlsruhe Institut fur Technologie (KIT, Germany)

  Subject: Autonomous Driving (student exchanges and common project).

- Vislab Parma (Italy)

  Subject: Embedded Perception & Autonomous Driving (visits, projects submissions, and book chapter in the new edition of the Handbook of Robotics).

- University of Babes-Bolyai, Cluj-Napoca, Romania.

  Subject: Multi-robot patrolling and Machine Learning (Visit and PHC "DRONEM" 2017-18 obtained in December 2016).

- Department of Electrical & Computer Engineering: University of Thrace, Xanthi (GREECE)

  Subject: 3D coverage based on Stochastic Optimization algorithms

- Universidade de Aveiro (Portugal)

  Subject: Leader following. co-direction of P. Stein phD.

- Centro De Automatica y Robotica, UPM-CSIC, Madrid (Spain)

  Subject: Target interception.

- Bonn-Rhein-Sieg University of Applied Sciences (Germany)

  Subject: Using Semantic Information for Robot Navigation.

- Social Robotics Laboratory, Freiburg (Germany)

  Subject: Human behavior understanding.

- BlueBotics: BlueBotics Company, Lausanne (Switzerland)

  Subject: Implementation of self-calibration strategies for wheeled robots and SLAM algorithms for industrial purposes.

9.4. International Initiatives

9.4.1. Inria International Labs

- iCeiRA [0] international robotics laboratory led by Prof Ren Luo from NTU (Taiwan). Christian Laugier (Inria) and Raja Chatila (UPMC & CNRS) have actively participated to the starting of this laboratory in 2012 and are external Principal Investigators.

  Subject: Human centered robotics.

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

9.4.2.1. SAMPEN

Title: self adaptive mobile perception and navigation

International Partner (Institution - Laboratory - Researcher):

Start year: 2014

See also: http://emotion.inrialpes.fr/people/spalanzani/HomeSAMPEN.html

The associate team project is a Robotic project. The aim of the project is to propose a self-adaptive system of perception combined with a system of autonomous navigation. Usually, systems of perception rely on a set of specific sensors and a calibration is done in a specific environment. We propose to develop some methods to make perception systems adaptive to the environmental context and to the set of sensors used. This perception, that can be embedded on the mobile robot as well as on home structures (wall, ceiling, floor), will be helpful to localize agents (people, robot) present in the scene. Moreover, it will give information to better understand social scenes. All information will be used by the navigation system to move with a behavior that fit the context.

9.4.3. Inria International Partners

9.4.3.1. Informal International Partners

- UC Berkeley & Stanford University (CA, USA)

  Subject: Autonomous Driving (postdoc in the scope of Inria@SV, common publications and patent).

- Massachussetts Institute of Technology (MIT), Cambridge, MA (USA)

  Subject: Decentralized Control of Markov Decision Processes.

9.4.4. Participation in Other International Programs

- IEEE Robotics and Automation. Christian Laugier is member of several IEEE committees, in particular: IROS Steering committee, co-chair of Technical Committee on Autonomous Ground vehicles and Intelligent Transport Systems, Steering committee and Senior Editor of IEEE Transactions on Intelligent Vehicles. Olivier Simonin is member of the TC on Multi-Robot Systems (MRS).

  Subject: International Robotics Research Supporting.

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[0]International Center of Excellence in Intelligent Robotics and Automation Research.

<p align="center">**DAHU Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Acronym: PRODAQ

Title: Proof systems for Data Queries

Coordinator: Sylvain Schmitz

Duration: January 2015 – September 2019

Abstract: The project aims at developing proof systems for data logics. It is at the interface between several research communities in database theory, infinite-state system verification and proof theory. The main thrust behind the project is the investigation of proof-theoretic tools for data logic, using in particular insights from substructural logics, and using counter systems as a means to obtain algorithms and complexity results.

8.2. International Research Visitors

8.2.1. Visits of International Scientists

Victor Vianu, June 15 to September 15, UC San diego

<div align="center">

DEFROST Team

</div>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Inserm

Olivier Goury was hired as a postdoctoral researcher by the "Réhabilitation chirurgicale mini-invasive et robotisée de l'audition" to collaborate with the DEFROST team on the simulation of Cochlear Implant surgery. The contract stopped since Olivier has been recruited as a Research scientist. The collaboration with Inserm will be continued with the hiring of Piyush Jain as an engineer.

9.1.2. ANR

- **Sorcery** The goal of this project was to work on the modeling, simulation and control of soft surgical robot with a particular focus in cochlear implantology. A very good consortium was built around the project that went to phase 2 in the ANR project. Unfortunately, the project has not been funded.
- **IDeaS**, Image-Driven Simulation, Jeremie Dequidt, Magrit, MIMESIS and Nancy Hospital, 42 months,: this is a project targeted at per-operative guidance for interventional radiology procedures. Our main goal is to provide effective solutions for the two main drawbacks of interventional radiology procedures, namely: reduce radiation exposure and provide a fully 3D and interactive visual feedback during the procedure. To do so, our project relies on an original combination of computer vision algorithms and interactive physics-based medical simulation.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Program: FET Open

Project acronym: RoboSoft

Project title: Coordination Action for Soft Robotics

Duration: 2014-2016

Coordinator: Cecilia Laschi (Scuola Superiore Sant'Anna)

9.3. International Initiatives

9.3.1. Declared Inria International Partners

We have a collaboration with King's College (Profs Kaspar Althoefer and Hongbin Liu) on soft hydraulic robots with the support of the program North European associate team of the center Inria Lille North Europe (2014-2016)

We have started a collaboration with the Université Libre de Bruxelles (Profs Denis Terwagne, Serge Massar, Marc Haelterman and Guillaume Tillema) on the use of soft robot simulation to build control strategies based on artificial intelligence algorithms (2016-2018)

9.3.2. Informal International Partners

This section includes some recent collaboration. We have initiated research work with Prof. Bordas at the University of Luxembourg on Model reduction with contacts. We are also working with Adrien Escande and with Prof. Yoshida, at AIST Japan, on the simulation of deformable objects in contact and with Prof Miguel Otaduy at URJC Madrid on human hand grasping and manipulation (Conference paper in 2014 and journal paper in 2015).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Ugo Chouinard was a research intern in the Defrost team from September to December 2016. He is a PhD candidate in mechanical engineering at Polytechique Montréal (Canada) and obtained the Mitacs-Globalink Research Award that allowed him to join our team for a few months. He investigated the effect of design change on the compliance of deformable manipulators. The result of his research will help to better understand and design soft robotic manipulators. Indeed, with the research he carried out, it will be easier to design robots that meet the design specifications. Furthermore, his internship might lead to further collaboration with Polytechnique Montréal for the design of soft robotics systems.

- Alejandro Rodriguez Aguilera from the University of Granada, stayed from March to June 2016. His works on GPU computing allowed him to develop a parallelized hydraulics systems simulation and integrate it into the SOFA Framework.

9.4.1.1. Internships

- Valentin Owczarek was a research intern in the Defrost team from March to September 2016. He worked on using genetics algorithm to generate task specific soft-robot designs.

- During the internship of Piyush Jain (India) from April 2016 to September 2016, it was observed that it is possible to create the concept of self-contained pneumatic actuation for soft robots without the need for an external pneumatic supply.

EX-SITU Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MultiVis – Novel Interaction Models for Multi-surface Visualization

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2014-2017

Coordinator: James Eagan (Institut Mines Telecom)

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to design, evaluate, and implement novel interaction models that help users appropriate multiple computational surfaces in the sense-making process. Our initial approach is to operationalize and extend the instrumental interaction model to specifically accommodate the specific needs of the sense-making process for information visualization. This project funds Marc-Emmanuel Perrin, a joint PhD student between the VIA group at Institut Mines-Telecom and ExSitu.

9.1.2. MoveIT – Modeling the Speed/Accuracy Trade-Off of Human Aimed Movement with the Tools of Information Theory

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2015-2018

Coordinator: Olivier Rioul (Institut Mines Telecom)

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to conduct fundamental studies of aimed movements based on information theory. The project studies the interaction phenomena involved in pointing, in order to discover novel, more effective pointing techniques. This project funds Wanyu Liu, a joint Ph.D. student between the COMELEC and VIA groups at Institut Mines Telecom and ExSitu.

9.1.3. SensoMotorCVE – Sensor-motor Interface for Collaborative Virtual Environments with Heterogeneous Devices: Application to Industrial Design

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2014-2017

Coordinator: Patrick Bourdot (LIMSI-CNRS)

Partners: Univ. Paris-Sud, Inria, CNRS

Inria contact: Cédric Fleury

Abstract: In the context of collaborative virtual environments, the goal of this project is to develop a sensorimotor interface model for CAD data manipulation that supports heterogeneous interactive systems such as wall-sized displays or immersive virtual reality rooms. This project funds Yujiro Okuya, a joint Ph.D. student between the VENISE group at LIMSI and ExSitu.

9.1.4. La Grande Vitrine des Choses

Type: Art-science grant

Funding: IDEX Paris-Saclay

Duration: 2015-2016

Coordinators: Michel Beaudouin-Lafon & Wendy Mackay

Partners: Univ. Paris-Sud, Inria, CNRS, Theater group $n + 1$

Abstract: Art-science project funded by "La Diagonale Paris-Saclay" to create, in collaboration with the theather group "n+1", an interactive store front in the form of an advent calendar, where users must discover which gestures to perform in order make an animated character open the next window. This installation raises the question of who is controlling whom: Participants think that their gestures directly control the character, but the system actually uses shaping techniques from experimental psychology that encourage users to make successive approximations to the correct gesture. The installation was demonstrated at the Fête de la Science in October, 2016, and was shown during the month of December, 2016 in the Evry shopping mall, next to the Agora Theater. It will also be shown in the Curiositas festival in Gif-sur-Yvette in May, 2017.

9.2. National Initiatives

9.2.1. Investissements d'Avenir

9.2.1.1. Digiscope - Collaborative Interaction with Complex Data and Computation

Type: EQUIPEX (Equipement d'Excellence)

Duration: 2011-2020

Coordinator: Michel Beaudouin-Lafon

Partners: FCS Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, Ecole Centrale Paris, Université Versailles - Saint-Quentin, ENS Cachan, Maison de la Simulation

Overall budget: 22.5 Meuros, including 6.7 Meuros public funding from ANR

Abstract: The goal of the project is to create ten high-end interactive rooms interconnected by high-speed networks and audio-video facilities to support remote collaboration across interactive visualization environments. The equipment will be open to outside users and targets four main application areas: scientific discovery, product lifetime management, decision support for crisis management, and education and training. Digiscope includes the existing WILD room, and funded the WILDER room. ExSitu contributes its expertise in the design and evaluation of advanced interaction techniques and the development of distributed software architectures for interactive systems. At the end of 2016, all ten rooms are operational, and the telepresence network is being deployed.

9.2.2. Institut Universitaire de France

9.2.2.1. The Instrumental Paradigm

Type: IUF senior fellowship

Duration: 2011-2016

Principal investigator: Michel Beaudouin-Lafon

Abstract: Tools or instruments are a natural way to interact with the real world, and can serve as a powerful metaphor to interact with on-line information. An instrument reifies interaction: it turns an interaction into a meaningful object for users, designers and developers. We envision a future where large, monolithic and closed applications are replaced by a rich ecology of instruments and information containers that can interoperate, giving users the power to shape their own environments. Our work on multisurface interaction [2] and Webstrates [5] illustrate this approach.

9.3. European Initiatives

9.3.1. European Research Council (ERC)

9.3.1.1. Creating Human-Computer Partnerships

Program: ERC Advanced Grant

Project acronym: CREATIV

Project title: Creating Human-Computer Partnerships

Duration: mois année début - mois année fin

Coordinator: Wendy Mackay

Abstract: CREATIV explores how the concept of co-adaptation can revolutionize the design and use of interactive software. Co-adaptation is the parallel phenomenon in which users both adapt their behavior to the system's constraints, learning its power and idiosyncrasies, and appropriate the system for their own needs, often using it in ways unintended by the system designer. A key insight in designing for co-adaptation is that we can encapsulate interactions and treat them as first class objects, called interaction instruments This lets us focus on the specific characteristics of how human users express their intentions, both learning from and controlling the system. By making instruments co-adaptive, we can radically change how people use interactive systems, providing incrementally learnable paths that offer users greater expressive power and mastery of their technology. The initial goal of the CREATIV project is to fundamentally improve the learning and expressive capabilities of advanced users of creative software, offering significantly enhanced methods for expressing and exploring their ideas. The ultimate goal is to radically transform interactive systems for everyone by creating a powerful and flexible partnership between human users and interactive technology.

9.3.1.2. Unified Principles of Interaction

Program: ERC Advanced Grant

Project acronym: ONE

Project title: Unified Principles of Interaction

Duration: October 2016 - September 2020

Coordinator: Michel Beaudouin-Lafon

Abstract: The goal of ONE is to fundamentally re-think the basic principles and conceptual model of interactive systems to empower users by letting them appropriate their digital environment. The project addresses this challenge through three interleaved strands: empirical studies to better understand interaction in both the physical and digital worlds, theoretical work to create a conceptual model of interaction and interactive systems, and prototype development to test these principles and concepts in the lab and in the field. Drawing inspiration from physics, biology and psychology, the conceptual model combines *substrates* to manage digital information at various levels of abstraction and representation, *instruments* to manipulate substrates, and *environments* to organize substrates and instruments into digital workspaces.

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. DECibel

Title: Discover, Express, Create – Interaction Technologies For Creative Collaboration

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical and Computer Engineering, Center for Magnetic Resonance Research - Bjoern Hartmann

Start year: 2016

The DECibel associated team includes Inria's ExSitu and the CITRIS Connected Communities Initiative (CCI) at UC Berkeley. ExSitu explores extreme interaction, working with creative professionals and scientists who push the limits of technology to develop novel interactive technologies that offer new strategies for creative exploration. ExSitu's research activities include: developing underlying theory (co-adaptive instruments and substrates), conducting empirical studies (participatory design with creative professionals), and implementing interactive systems (creativity support tools). The CITRIS Connected Communities Initiative investigates collaborative discovery and design through new technologies that enhance education, creative work, and public engagement. It develops interactive tools, techniques and materials for the rapid design and prototyping of novel interactive products, expertise sharing among designers, and citizen science investigations. DECibel will combine the strengths of these two groups to to investigate novel tools and technologies that support Discovery, Expressivity, and Creativity.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Joanna McGrenere, Professor at University of British Columbia, Vancouver, Canada, visited ExSitu for her entire sabbatical, from September, 2015 to July, 2016.
- Jim Hollan, Professor at University of California at San Diego (UCSD), visited from April to June, 2016.

<h1 style="text-align:center;color:red">EXMO Project-Team</h1>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Lindicle

Program: ANR-Blanc international 2

Project acronym: LINDICLE

Project title: Linking data in cross-lingual environment

Duration: January 2013 - December 2016

Coordinator: Inria EXMO/Jérôme David

Participants: Jérôme Euzenat, Manuel Atencia Arcas, Jérôme David, Tatiana Lesnikova, Adam Sanchez Ayte, Armen Inants

Other partners: Tsinghua university (CN)

See also: http://lindicle.inrialpes.fr

Abstract: The LINDICLE project investigates multilingual data interlinking between French, English and Chinese data sources (see §6.2).

7.2. International Initiatives

7.2.1. Informal International Partners

EXMO (and other colleagues from Oxford, Trento, Mannheim, Linköping, Milano, Amsterdam, Galway and the Open university) organises yearly the Ontology alignment evaluation initiative (OAEI).

7.2.2. Participation in Other International Programs

Jérôme Euzenat is benefiting from a special visiting researcher grant from the Brazilian Ciência sem Fronteiras program on "Methodology and algorithms for ontology refinement and matching" (2015-2017). He is working with the team of Fernanda Baião and Kate Revoredo at the Universidade Federal do Estado do Rio de Janeiro (UNIRIO). Together, they investigate methods for evolving ontologies and alignments which involve users and agents. The goal of the project is to design methods and algorithms using theory revision to deal with knowledge evolution in a reliable manner and obtaining better quality alignments.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

- Karima Akli (USTHB, Algiers) visited EXMO in September 2016, working on rough sets for link key extraction.
- Yan Zhang (U. Tsinghua) and Zhichun Wang (Beijing Normal University) visited EXMO in September 2016 in the framework of the Lindicle project, working cross-lingual data interlinking and query-driven ontology matching.

7.3.2. Research Stays Abroad

- Jérôme Euzenat visited the Universidade Federal do Estado do Rio de Janeiro (UNIRIO) for two months in March and November 2016 (see §7.2.2).

<p align="center" style="color:red">FLOWERS Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Poppy Education

> Poppy Education
>
> Program: Feder - Région Aquitaine
>
> Duration: January 2014 - December 2017
>
> Coordinator: PY Oudeyer, Inria Flowers
>
> Partners: Inria Flowers
>
> Funding: 1 million euros (co-funded by Feder/EU Commission, Region Aquitaine and Inria)

Poppy Education aims to create, evaluate and disseminate pedagogical kits "turnkey solutions" complete, open-source and low cost, for teaching computer science and robotics. It is designed to help young people to take ownership with concepts and technologies of the digital world, and provide the tools they need to allow them to become actors of this world, with a considerable socio-economic potential. It is carried out in collaboration with teachers and several official french structures (French National Education/Rectorat, Highschools, engineering schools, ...). It targets secondary education and higher education, scientific literacy centers, Fablabs.

Poppy robotic platform used in the project is free hardware and software, printed in 3D, and is intended primarily for:

- learning of computer science and robotics,
- introduction to digital manufacturing (3D printing ...)
- initiation to the integration of IT in physical objects in humanoid robotics, mechatronics.
- artistic activities.

Educational sectors covered by the project are mainly: Enseignement d'exploration ICN en seconde, enseignement ISN en terminale S et bientôt en 1ère , filière STI2D, MPS seconde. Web: http://www.poppy-project.org/education .

9.1.2. ENSAM

The orientation of a (high school) student, choosing a career, is often based on an imagined representation of a discipline, sector of activity or training. Moreover, higher education is sometimes for a college student or a student a self centered universe, with inaccessible teaching methodologies and level of competence.

The Arts and Métiers campus at Bordeaux-Talence in partnership with Inria contributes with its educational and scientific expertise to the development of new teaching methods and tools. The objective is to develop teaching sequences based on a project approach relying on an attractive multidisciplinary technological system: the humanoid Inria Poppy robot. These teaching sequences will be built and tailored to different levels of training, from high schools to Engineer schools.

The new formation "Bachelor of Technology", started in September 2014 at Ensam Bordeaux, is resolutely turned towards a project based pedagogy, outlining concepts from concrete situations. The humanoid Inria Poppy robot offers an open platform capable of providing an unifying thread for the different subjects covered during the 3-years of the Bachelor formation: mechanics, manufacturing (3D printing), electrical, mechatronics, computer sciences, design…

For the 1st and 2nd year of the ENSAM Engineer cursus, the Poppy robot is now used to support the teaching and to conduct further investigation.

9.1.3. *KidLearn and Region Aquitaine*

A Conseil Régional d'Aquitaine Project (KidLearn, 2015-) began, coordinated by Manuel Lopes entitled KidLearn. Will fund 50% of a 3 years PhD student.

We propose here a research project that aims at elaborating algorithms and software systems to help humans learn efficiently, at school, at home or at work, by adapting and personalizing sequences of learning activities to the particularities of each individual student. This project leverages recent innovative algorithmic models of human learning (curiosity in particular, developed as a result of ERC European project of the Flowers team), and combines it with state-of-the-art optimization algorithms and an original integration with existing expert knowledge (human teachers). Given a knowledge domain and a set of possible learning activities, it will be able to propose the right activity at the right time to maximize learning progress. It can be applied to many learning situations and potential users: children learning basic knowledge in schools and with the support of their teachers, older kids using educational software at home, of adults needing to acquire new skills through professional training ("formation professionnelle"). Because it combines innovations in computational sciences (machine learning and optimization) with theories of human cognition (theories of human learning and of education), this project is also implementing a strong cross-fertilization between technology and human sciences (SHS).

9.1.4. *Comacina Capsule Creative Art/Science project and Idex/Univ. Bordeaux*

The artist community is a rich source of inspiration and can provide new perspectives to scientific and technological questions. This complementarity is a great opportunity that we want to enforce in the Poppy project by making the robot accessible to non-robotic-expert users. The Comacina project, in collaboration with the Flowers team and supported by funding from Idex/Univ. Bordeaux, explored the role of movements and light in expressing emotions. This project was implemented through several residencies during the year, and several performances at various cultural places in Aquitaine, including at Pole Evasion in Ambares-et-Lagrave. a report is available at https://flowers.inria.fr/RencontreAutourDuGeste.pdf . It benefitted from funding from the Art/Science Idex call for project.

9.2. National Initiatives

PY Oudeyer and M Lopes collaborated with Aymar de Rugy, Daniel Cattaert and Florent Paclet (INCIA, CNRS/Univ. Bordeaux) about the design of myoelectric robotic prostheses based on the Poppy platform, and on the design of algorithms for co-adaptation learning between the human user and the prosthesis. This was funded by a PEPS CNRS grant.

D. Roy is the Inria leader of project "Ecole du code" http://www.ecoleducode.net/ which provides teachers and animators formations and learning games to initiate young people to computer science and robotics.

D. Roy is member of the Class'code team (Inria is member of the consortium of this project) https://pixees.fr/classcode/accueil/. Class'code is a blended formation for teachers and animators who aim to initate young people to computer science and robotics. D. Roy has in charge the robotics module of the project.

D. Roy is member of the organization of computer science exhibition in "Palais de la découverte" which will begin on 2017 September for three years. He participates for robotics part.

D. Roy is member of the Scratch Conference (Bordeaux, 2017 July) organization team.

D. Roy is member of the team "Education en Scène" which organize educational activities with robotics in Bordeaux Digital City (2017 July).

D. Roy is member of "CRIC" Project, about Robotics in Vocational Schools, with Canope Ile de France, Lutin Userlab (Cité des SCiences), CNAM.

D. Roy is project leader of Thymio Simulator for Classcode project. Specifications and coordination of work.

D. Roy is project leader of Thymio Scratch and Thymio Snap! development, with D. Sherman. Inria, EPFL and Mobsya collaboration.

Around Robotics for education, many collaborations were put in place. With the LSRO Laboratory from EPFL (Lausanne) and others collaborations with French National Education/Rectorat d'Aquitaine, with Canopé Educational Network, with ESPE (teacher's school) Aquitaine, ESPE Martinique, ESPE Poitiers, National Directorate of Digital Education, Fondation "La Main à la Pâte", Maison for Science in Bordeaux University, Orange Fondation.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. 3rd HAND

> Title: Semi-Autonomous 3rd Hand
>
> Programm: FP7
>
> Duration: October 2013 - September 2017
>
> Coordinator: Inria
>
> Partners:
>
> > Technische Universität Darmstadt (Germany)
> >
> > Universität Innsbruck (Austria)
> >
> > Universität Stuttgart (Germany)
>
> Inria contact: Manuel Lopes
>
> Robots have been essential for keeping industrial manufacturing in Europe. Most factories have large numbers of robots in a fixed setup and few programs that produce the exact same product hundreds of thousands times. The only common interaction between the robot and the human worker has become the so-called 'emergency stop button'. As a result, re-programming robots for new or personalized products has become a key bottleneck for keeping manufacturing jobs in Europe. The core requirement to date has been the production in large numbers or at a high price.Robot-based small series production requires a major breakthrough in robotics: the development of a new class of semi-autonomous robots that can decrease this cost substantially. Such robots need to be aware of the human worker, alleviating him from the monotonous repetitive tasks while keeping him in the loop where his intelligence makes a substantial difference.In this project, we pursue this breakthrough by developing a semi-autonomous robot assistant that acts as a third hand of a human worker. It will be straightforward to instruct even by an untrained layman worker, allow for efficient knowledge transfer between tasks and enable a effective collaboration between a human worker with a robot third hand. The main contributions of this project will be the scientific principles of semi-autonomous human-robot collaboration, a new semi-autonomous robotic system that is able to: i) learn cooperative tasks from demonstration; ii) learn from instruction; and iii) transfer knowledge between tasks and environments. We will demonstrate its efficiency in the collaborative assembly of an IKEA-like shelf where the robot acts as a semiautonomous 3rd-Hand .

9.3.1.2. DREAM

> Title: Deferred Restructuring of Experience in Autonomous Machines
>
> Programm: H2020
>
> Duration: January 2015 - December 2018
>
> Coordinator: UPMC
>
> Partners:
>
> > Armines (ENSTA ParisTech)
> >
> > Queen Mary University London (England)
> >
> > University of A Coruna (Spain)
> >
> > Vrije University Amsterdam (Holland)

Contact: David Filliat

Abstract: A holy grail in robotics and artificial intelligence is to design a machine that can accumulate adaptations on developmental time scales of months and years. From infancy through adult- hood, such a system must continually consolidate and bootstrap its knowledge, to ensure that the learned knowledge and skills are compositional, and organized into meaningful hierarchies. Consolidation of previous experience and knowledge appears to be one of the main purposes of sleep and dreams for humans, that serve to tidy the brain by removing excess information, to recombine concepts to improve information processing, and to consolidate memory. Our approach – Deferred Restructuring of Experience in Autonomous Machines (DREAM) – incorporates sleep and dream-like processes within a cognitive architecture. This enables an individual robot or groups of robots to consolidate their experience into more useful and generic formats, thus improving their future ability to learn and adapt. DREAM relies on Evo- lutionary Neurodynamic ensemble methods (Fernando et al, 2012 Frontiers in Comp Neuro; Bellas et al., IEEE-TAMD, 2010) as a unifying principle for discovery, optimization, re- structuring and consolidation of knowledge. This new paradigm will make the robot more autonomous in its acquisition, organization and use of knowledge and skills just as long as they comply with the satisfaction of pre-established basic motivations. DREAM will enable robots to cope with the complexity of being an information-processing entity in domains that are open-ended both in terms of space and time. It paves the way for a new generation of robots whose existence and purpose goes far beyond the mere execution of dull tasks. http://www.robotsthatdream.eu

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. IGLU

Title: Interactive Grounded Language Understanding (IGLU)

Programm: CHIST-ERA

Duration: October 2015 - September 2018

Coordinator: University of Sherbrooke, Canada

Partners:

       University of Sherbrooke, Canada

       Inria Bordeaux, France

       University of Mons, Belgium

       KTH Royal Institute of Technology, Sweden

       University of Zaragoza, Spain

       University of Lille 1 , France

       University of Montreal, Canada

Inria contact: Manuel Lopes

Language is an ability that develops in young children through joint interaction with their caretakers and their physical environment. At this level, human language understanding could be referred as interpreting and expressing semantic concepts (e.g. objects, actions and relations) through what can be perceived (or inferred) from current context in the environment. Previous work in the field of artificial intelligence has failed to address the acquisition of such perceptually-grounded knowledge in virtual agents (avatars), mainly because of the lack of physical embodiment (ability to interact physically) and dialogue, communication skills (ability to interact verbally). We believe that robotic agents are more appropriate for this task, and that interaction is a so important aspect of human language learning and understanding that pragmatic knowledge (identifying or conveying intention) must be present to complement semantic knowledge. Through a developmental approach where knowledge grows in complexity while driven by multimodal experience and language interaction with a human, we propose an agent that will incorporate models of dialogues, human emotions and intentions as part of its decision-making process. This will lead anticipation and reaction not only

based on its internal state (own goal and intention, perception of the environment), but also on the perceived state and intention of the human interactant. This will be possible through the development of advanced machine learning methods (combining developmental, deep and reinforcement learning) to handle large-scale multimodal inputs, besides leveraging state-of-the-art technological components involved in a language-based dialog system available within the consortium. Evaluations of learned skills and knowledge will be performed using an integrated architecture in a culinary use-case, and novel databases enabling research in grounded human language understanding will be released. IGLU will gather an interdisciplinary consortium composed of committed and experienced researchers in machine learning, neurosciences and cognitive sciences, developmental robotics, speech and language technologies, and multimodal/multimedia signal processing. We expect to have key impacts in the development of more interactive and adaptable systems sharing our environment in everyday life. http://iglu-chistera.github.io/

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. NEUROCURIOSITY

Title: NeuroCuriosity

International Partner (Institution - Laboratory - Researcher):

Columbia Neuroscience (United States) - ___DEPARTMENT???___ - JACQUELINE GOTTLIEB

Start year: 2016

See also: https://flowers.inria.fr/neurocuriosity

Curiosity can be understood as a family of mechanisms that evolved to allow agents to maximize their knowledge of the useful properties of the world. In this project we will study how different internal drives of an animal, e.g. for novelty, for action, for liking, are combined to generate the rich variety of behaviors found in nature. We will approach such challenge by studying monkeys, children and by developing new computational tools.

9.4.1.2. Informal International Partners

Benjamin Clement and Manuel Lopes just begin a collaboration with Joseph Jay Williams (Harvard University), Douglas Selent and Neil Heffernan (Worcester Polytechnic Institute) to use Kidlearn algorithm and contextual multi-armed bandit to recommend explanation on ASSISTments online tutoring system. Joseph Jay Williams and Neil Heffernan used multi-armed bandit algorithm on ASSISTments platform [179] to provide efficient explanation, and new we are looking to use new algorithm to provide a more personal and relevant feedback.

Pierre-Yves Oudeyer and Didier Roy have create a collaboration with LSRO EPFL and Pr Francesco Mondada, about Robotics and education. The two teams co-organize the annual conference "Robotics and Education"in Bordeaux. Didier Roy teaches "Robotics and Education" in EPFL several times a year.

Didier Roy has created a collaboration with HEP VAud (Teachers High School) and Bernard Baumberger and Morgane Chevalier, about Robotics and education. SCientific discussions and shared professional training.

9.4.2. Participation in Other International Programs

David Filliat participates in the ITEA3 DANGUN project with Renault S.A.S. in france and partners in Korea. The purpose of the DANGUN project is to develop a Traffic Jam Pilot function with autonomous capabilities using low-cost automotive components operating in France and Korea. By incorporating low-cost advanced sensors and simplifying the vehicle designs as well as testing in different scenarios (France & Korea), a solution that is the result of technical cooperation between both countries should lead to more affordable propositions to respond to client needs in the fast moving market of intelligent mobility.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Lauriane Rat-Fisher, IAST, Toulouse (November 23-25th)
- Fumihide Tanaka, ISI Lab, University of Tokyo, Japan (November 9th)
- Romain Brette, Institut de la Vision, Paris (February, 12th)
- Tony Belpaeme, Univ. Plymouth, UK (January)
- Tobjorn Dahl, Univ. Plymouth, UK (January)
- Jens Moenig, SAP Research, Germany (June)
- Stéphane Magnegnat, ETH Zurich, Switzerland (June)
- Francesco Mondada, EPFL, Lausanne, Switzerland Jjune)

9.5.1.1. Internships

- Yasmin Ansari, The Biorobotics Institute, Scuola Superiore S. Anna, Pontedera, Italy (January to May, 2016)

<div align="center">

GRAPHDECO Project-Team

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8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR DRAO
Participant: Adrien Bousseau.

https://www-sop.inria.fr/members/Adrien.Bousseau/drao/

The ANR DRAO is a young researcher project coordinated by Adrien Bousseau, in collaboration with the InSitu project team at Inria Saclay - Ile de France (W. Mackay and T. Tsandilas) and the MANAO project team (P. Barla and G. Guennebaud) and POTIOC project team (M. Hachet) at Inria Bordeaux - Sud Ouest. The goal of this collaboration is to develop novel drawing tools for amateurs as well as for expert designers and illustrators, combining expertise in Computer Graphics (REVES and MANAO) and Human-Computer Interaction (InSitu, POTIOC). This ANR project funds the PhD of Emmanuel Iarussi.

While the ANR DRAO ended in 2015, it has resulted in a publication at ACM Conference on Human Factors in Computing Systems (CHI) 2016 [9]. Adrien Bousseau received an ANR Young Researcher Award for coordinating this project.

8.1.1.2. ANR SEMAPOLIS
Participants: George Drettakis, Abdelaziz Djelouah, Theo Thonat.

This ANR project started in October 2013. The goal is to use semantic information to improve urban reconstruction and rendering. The consortium is led by ENPC (R. Marlet) and includes the Inria Willow team and the GREY-C laboratory on image processing. Our contribution will be in the rendering of urban models, in particular using image-based rendering algorithms.

This year, the ANR SEMAPOLIS resulted in five publications on multi-view segmentation [10], multi-view inpainting [13], image-based rendering of cars [12] and interiors [6], and procedural modeling of buildings [8]. Two of these projects rely on a deep learning method from the ENPC group to identify semantic object categories in images (e.g., cars, people etc.) [13], [12]. In [12] we also collaborated with the ENPC group to use a deep learning method to allow the use of rendered images to identify objects in photographs. These collaborations have been extremely fruitful for our group, and have opened the way to several new collaborations with ENPC.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CR-PLAY – Capture Reconstruct Play

http://www.cr-play.eu

Type: COOPERATION (ICT)

Instrument: Specific Targeted Research Project

Objectif: Creativity

Duration: November 2013 - October 2016

Coordinator: Testaluna SA (IT)

Partner: TU Darmstadt (DE), UC London (UK), U. Patras (GR), Miniclip UK, Cursor Oy (FI)

Inria contact: George Drettakis

Abstract: The goal of this project is to use image- and video-based rendering and relighting techniques in the context of games and in particular mobile or casual games. The computer graphics and vision partners (UCL, TUD) are leaders in their fields, and have developed algorithms allowing easy capture of scenes using images and video, and reconstruction using vision algorithms. UCL and Inria have developed image- and video-based rendering algorithms which can be useful for games. These tools need to be perfected, reducing artifacts and difficulty of use so that they can be useful and productive for games companies. For evaluation, the HCI lab of the University of Patras will provide cutting-edge methodologies to make the resulting systems useable. The consortium is led by the games company Testaluna, based in Genova Italy. Other industrial partners include Cursor Oy (a regional group of games companies in Finland, which is a leader in Europe in Casual games) and Miniclip, which is one of the major players in the online game market.

This year we had four results related to CR-PLAY on multi-view segmentation [10], multi-view in-painting [13], image-based rendering of cars [12] and indoors [6]. The work on indoors rendering was led by the CR-PLAY partner UCL. The CR-PLAY project ended in October, and was success-fully evaluated in November. The project has resulted in a number of technological developments related to the Ph.D. work of R. Ortiz-Cayon and T. Thonat, as well as the postdoc of A. Djelouah which will be the object of a market study in the goal of a technology transfer.

8.2.1.2. EMOTIVE

Type: COOPERATION (ICT)

Instrument: Reseach Innovation Action

Objectif: Virtual Heritage

Duration: November 2016 - October 2019

Coordinator: EXUS SA (UK)

Partner: Diginext (FR), ATHENA (GR), Noho (IRL), U Glasgow (UK), U York (UK)

Inria contact: George Drettakis

Abstract: Storytelling applies to nearly everything we do. Everybody uses stories, from educators to marketers and from politicians to journalists to inform, persuade, entertain, motivate or inspire. In the cultural heritage sector, however, narrative tends to be used narrowly, as a method to communicate to the public the findings and research conducted by the domain experts of a cultural site or collection. The principal objective of the EMOTIVE project is to research, design, develop and evaluate methods and tools that can support the cultural and creative industries in creating Virtual Museums which draw on the power of 'emotive storytelling'. This means storytelling that can engage visitors, trigger their emotions, connect them to other people around the world, and enhance their understanding, imagination and, ultimately, their experience of cultural sites and content. EMOTIVE will do this by providing the means to authors of cultural products to create high-quality, interactive, personalized digital stories.

GRAPHDECO will contribute by developing novel image-based rendering techniques to help museum curators and archeologists provide more engaging experiences.

8.3. International Initiatives

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. CRISP2

Title: Creating and Rendering Images based on the Study of Perception

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science Department (EECS) - Maneesh Agrawala

Start year: 2014

See also: http://www-sop.inria.fr/reves/crisp/

The CRISP collaboration aims at developing novel techniques to create and manipulate effective numerical imagery. We adopt a multidisciplinary approach, focusing on understanding how people create and perceive images, on developing new rendering algorithms based on this understanding, and on building interactive tools that enable users to efficiently produce the images they have in mind. The participants of CRISP share complementary expertise in computer graphics, human computer interaction and human visual perception. In 2016, the CRISP collaboration supported the postdoc of George Koulieris, who spent 6 months at UC Berkeley and is now at Inria. Johanna Delanoy also spent 2 weeks at UC Berkeley to collaborate with Alexei Efros.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Canada. A. Bousseau collaborates regularly with the University of Toronto (K. Singh) and the University of British Columbia (A. Sheffer).

India. A. Bousseau collaborates with Vinay Namboodiri from IIT Kanpur and hosted several of his students for internships (Rahul Arora and Srinivasa Rao Gadhamchetty).

UK. G. Drettakis collaborates with UCL in the context of the CR-PLAY projects, resulting in a publication on indoor image-based rendering [6].

United States. We regularly collaborate with Adobe Research. Most recently, G. Drettakis worked with Eli Shechtman and Sylvain Paris on multi-view inpainting [13]. We also collaborate with Daniel Aliaga from Purdue University on sketch-based procedural modeling [8].

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Martin Banks (UC Berkeley) visited our group for two weeks in the context of the Associate Team CRISP (Sec. 8.3.1.1). We also hosted Philip Isola, Richard Zhang and Alexei Efros (UC Berkeley) for two days, also in the context of CRISP. Several international researchers made short visits and talks: Elena Garces (University of Zaragoza), Yulia Gryditskaya (MPI), Jan Jermyn (Durham University) , Christian Lessig (Otto-von-Guericke Universitat Magdeburg), Marc Stamminger (Erlangen University). Finally, we hosted Frédo Durand from MIT (10 months) and Eugene Fiume from university of Toronto (6 months) for their sabbatical.

8.4.1.1. Internships

Sai Praveen Bangaru and Srinivasa Rao Gadhamchetty were master interns from IIT Madras and IIT Kampur respectively.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

George Koulieris spent 6 months at UC Berkeley (Feb. 1 - Jul. 31) to work with Martin S. Banks in the context of the CRISP Inria associate team. Johanna Delanoy also visited UC Berkeley for two weeks to work with Alexei Efros.

<p style="text-align:center;color:red;font-weight:bold;">GRAPHIK Project-Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ASPIQ

Participants: Jean-François Baget, Madalina Croitoru, Fabien Garreau, Marie-Laure Mugnier, Jérôme Fortin, Michel Leclère, Odile Papini, Swan Rocher.

ASPIQ (ASP technologIes for Querying large scale multisource heterogeneous web information), is an ANR white project that started in January 2013 (duration: 4 years, extended to July 2017). It involves partners from CRIL, LERIA and LSIS. The project coordinator is Odile Papini (LSIS). http://aspiq.lsis.org/

The main objective of this project is to propose:

- extensions of standard ASP for representing OWL2 tractable sublanguages;
- new operations for merging conflicting information in this extended ASP;
- the identification of subclasses of this extended ASP allowing for efficient query answering mechanisms;
- an implementation of a prototype reasoning system.
- *See Section 6.1 and 6.2 for this year's results.*

8.1.1.2. Pagoda

Participants: Meghyn Bienvenu, Jean-François Baget, Marie-Laure Mugnier, Swan Rocher, Federico Ulliana.

Pagoda (Practical Algorithms for Ontology-based Data Access) is an ANR JCJC (young researchers) project that started in Jan. 2013 (duration: 4 years, extended to August 2017). The project coordinator is Meghyn Bienvenu (initially in LRI, now member of GraphIK). It involves partners from the EPI LEO, the LIG, and the Anatomy Laboratory of Grenoble. http://pagoda.lri.fr/

The primary aim of this project is to address challenges brought by scalability and the handling of data inconsistencies by developing novel OBDA (Ontology Based Data Access) query answering algorithms and practical methods for handling inconsistent data.

- *See Section 6.1 and 6.2 for this year's results.*

8.1.1.3. Qualinca

Participants: Michel Leclère, Michel Chein, Madalina Croitoru, Rallou Thomopoulos, Alain Gutierrez, Swan Rocher, Clément Sipieter, Marie-Laure Mugnier.

Qualinca is an ANR Contint project that started in Apr. 2012 (duration: 4 years, extended to September 2016). The project coordinator is Michel Leclère (GraphIK). It involves partners from LRI, LIG, ABES and INA. http://www.lirmm.fr/qualinca/index8ece.html?q=en/en/home

The main objective is to elaborate mechanisms allowing to:

- evaluate the quality of an existing document base;
- maintain a given level of quality by controlling updating operations;
- increase the quality of a given base;
- develop generic methods that take into account the quality of a given base (for instance for searching documents or interconnecting bases).
- *See Section 6.3 for this year's results.*

8.1.1.4. Dur-Dur

Participants: Abdallah Arioua, Pierre Bisquert, Patrice Buche, Madalina Croitoru, Jérôme Fortin, Abdelraouf Hecham, Rallou Thomopoulos.

Dur-Dur (Innovations agronomiques, techniques et organisationnelles pour accroître la DURabilité de la filière blé DUR) is an ANR project that started in March 2014 (duration: 3 years). It is led by IATE Laboratory. http://umr-iate.cirad.fr/projets/dur-dur

The Dur-Dur project develops a systematic approach to investigate the questions related to the management of the nitrogen, energy and contaminants, to guarantee a global quality of products throughout the production and the processing chain. The knowledge representation task of Dur-Dur proposes to map the stakeholders' objectives into a multicriteria cartography, as well as possible means to reach them, and computes the compatibility / incompatibility of these objectives on the basis of argumentation methods. The research methods used are qualitative and based both on argumentation theory and on Social Multi- Criteria Evaluation (SMCE) theory. They will be extended and adapted to the needs of the project to provide a formal framework of assessment of the various orientations considered for the durum wheat chain.

- *See Section 6.2 for this year's results.*

8.1.2. Other projects

8.1.2.1. Pack4Fresh

Participants: Patrice Buche, Pierre Bisquert, Madalina Croitoru, Bruno Yun.

Pack4Fresh (Sept. 2015 - Sept. 2017) is a project selected in the framework of the GloFood INRA-CIRAD metaprogramme. The multi-year metaprogramme GloFoodS (Transitions to global food security) is dedicated to the investigation of pathways to worldwide food security in a context of competition for land and natural resources, and is jointly conducted by INRA and Cirad, the two leading French research institutions for agriculture. Involving research on crop yield and livestock systems, land use changes, food processing and waste, nutrition and governance, GloFoodS aims at articulating global modeling of food supply and demand, with local issues of production and access to food.

In this context, Pack4Fresh focuses on the big fragility of fresh foods which generates enormous post-harvest wastes, short shelf-life, and constitutes a major lock to their consumption and health benefit. This project aims at initiating an eco-design approach of the post-harvest phase of fresh foods working on the interdependency relation between environmental impact (1) positive for waste reduction, et (2) negative for technologies, which aims at reducing the waste, in order to minimize the ratio between those two parameters.

- *See Section 6.2 for this year's results.*

8.1.2.2. OBDA-KeyVal: Ontology-Based Data Access for NoSQL Databases

Participants: Federico Ulliana, Marie-Laure Mugnier.

OBDA-KeyVal is a one-year PEPS project (JCJC INS2I 2016, funded by CNRS-INS2I) dedicated to Ontology Based Data Access for NOSQL Databases. Its goal is to study the problem of answering ontology-mediated queries on top of non-relational databases, and more precisely Key-Value stores. These are a family of NOSQL databases dealing with data represented as nested-structures (JSON records), processed on distributed systems but also increasingly exchanged on the Web, slowly replacing XML and RDF formats. Key-value stores have been designed with performance and scalability in mind, and this opens the possibility to implement OBDA in a novel and efficient distributed setting. The work carried out in this project builds on our first results published at AAAI 2016 [39], see also Sect. 6.1 . We addressed both practical and theoretical aspects of OBDA for key-value stores. First, a prototype of the reasoning framework for key-value stores has been developed by master students (https://github.com/OBDA-KEYVAL/graal-keyval). Second, a novel first-order logic semantics for the setting (in contrast to the former operational semantics) has been defined and investigated from a decidability viewpoint. This still ongoing work is a necessary step towards bridging this setting with the relational OBDA.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. NoAW (No Agricultural Waste)

Participants: Patrice Buche, Pierre Bisquert, Madalina Croitoru, Nikolaos Karanikolas, Rallou Thomopoulos.

Website: http://cordis.europa.eu/project/rcn/203384_en.html

NoAW (No Agricultural Waste) is an H2020 european project led by INRA-IATE, started in Oct. 2016. Driven by a "near zero-waste" society requirement, the goal of NoAW project is to generate innovative efficient approaches to convert growing agricultural waste issues into eco-efficient bio-based products opportunities with direct benefits for both environment, economy and EU consumer. To achieve this goal, the NoAW concept relies on developing holistic life cycle thinking able to support environmentally responsible R&D innovations on agro-waste conversion at different TRLs, in the light of regional and seasonal specificities, not forgetting risks emerging from circular management of agro-wastes (e.g. contaminants accumulation).

GraphIK will contribute on two aspects. On one hand we will participate in the annotation effort of knowledge bases (using the @Web tool). On the other hand we will further investigate the interplay of argumentation with logically instantiated frameworks and its relation with social choice in the context of decision making.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

8.2.2.1. COST FoodMC.

Participants: Madalina Croitoru, Rallou Thomopoulos.

Website: http://www6.inra.fr/foodmc

Rallou Thomopoulos is involved as Co-coordinator (together with Alberto Tonda and Kamal Kansou) in the European COST Action "FoodMC" (Mathematical and Computer Science Methods for Food Science and Industry) started in 2016. Both Madalina Croitoru and Rallou Thomopoulos are Members of the Management Committee, representing France.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- University of Buenos Aires, Ricardo Rodriguez, since 2013. Work in progress.
- University of Aberdeen, Nir Oren, since 2010. Work in progress.
- Technical University of Dresden, Sebastian Rudolph, since 2012. [34], co-organizer for GKR@IJCAI 2017.
- University of Liverpool, Frank Wolter, since 2009. [11], [27]
- Sapienza University (Rome), Riccardo Rosati, since 2012. [28]
- University of Bremen, Carsten Lutz, since 2009. [27], [11]
- Technical University of Vienna, Magdalena Ortiz and Mantas Simkus, since 2010. Work in progress.
- Laval University (Quebec), Irène Abi-Zeid, since 2015, and Bernard Moulin, since 2012. [44], [38]
- University of Amsterdam, Ulle Endriss, since 2015. Work in progress.

8.3.2. Participation in Other International Programs

Patrice Buche is involved in the RDA AgriSemantics working group (https://www.rd-alliance.org/groups/agrisemantics-wg.html). The goal of the Agrisemantics WG is to gather community-based requirements and use cases for an infrastructure that supports appropriate use of semantics for data interoperability, with special focus on agriculture.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Nov. 2016 (1 week). Visit of Elena Botoeva (Univ. of Bolzano), Stanislav Kikot (London Univ.), Roman Kontchakov (London Univ.) Vladislav Rhyzhikov (Univ. of Bolzano), and Michael Zakharyaschev (London Univ.) to work on the complexity on ontology-mediated query answering with description logics and linear existential rules. Seminars: "Query Inseparability of Description Logic Knowledge Bases and TBoxes" by Elena Botoeva and "The Complexity of Ontology-Based Data Access with OWL 2 QL and Bounded Treewidth Queries" by Stanislav Kikot.

- Nov. 2016 (2 days). Visit of Sebastian Rudolph (TU Dresden) in the context of Swan Rocher's PhD defense. Seminar: "The Curse of Finiteness: Undecidability of Database-Inspired Reasoning Problems in Very Expressive Description Logics".

- Sept. 2016 (1 week) Visit of Ricardo Rodriguez (Univ. of Buenos Aires) to work on belief revision for inconsistent tolerant semantics.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Pierre Bisquert was an invited researcher at the University of Amsterdam from May 2015 to Apr. 2016.

- In collaboration with Ulle Endriss (Institute for Logic, Language and Computation), he worked on the link between argumentation theory and social choice. The aim of this work was to study and understand how Arrow's Impossibility Theorem (stating that there is no democratic voting rule) could be avoided thanks to deliberation and argumentation. More precisely, the favored approach was to define a formal framework of the deliberation process predating a vote, and to establish conditions under which deliberation may help to output a democratic and collectively rational choice through the notion of preference structuration, i.e.,the changes in preferences that the agents may undergo after discussion.

Rallou Thomopoulos was invited at Laval University (Québec, Canada) for one year until July 2016. She worked on two projects dealing with decision support:

- An academic project conducted with the Computer Science Division of Laval University. It aimed at conceiving a systematic approach to assess several scenarios in agriculture, by combining a qualitative model based on argumentation and a quantitative simulation technique based on system dynamics.

- The second project was conducted both with a private partner and with the Operation and Decision Division of Laval University. It aimed to provide explanations for automatically-computed instructions, to improve human understanding of the situation. These instructions were the results of a commercial software used for real-time decision support for the flow management of a combined and sanitary wastewater system.

HEPHAISTOS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- CPER project MADORSON for the assistance to elderly people (with the STARS project)
- we have submitted several projects to the local IDEX without success but we are preparing several projects for the next year

9.2. National Initiatives

9.2.1. FHU

- the team has been involved for the FHU *INOVPAIN : Innovative Solutions in Refractory Chronic Pain* that has been labeled in December

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. RAPP

Type: COOPERATION

Instrument: Specific Targeted Research Project

Objective: Robotic Applications for Delivering Smart User Empowering Applications

Duration: December 2013-December 2016

Coordinator: CERTH/ITI

Partner: CERTH/ITI(Greece), Inria, WUT (Poland), ORTELIO (UK), ORMYLIA (Greece), INGEMA (Spain)

Inria contact: David Daney, Jean-Pierre Merlet, Manuel Serrano

Abstract: our societies are affected by a dramatic demographic change, in the near future elderly and people requiring support in their daily life will increase and caregivers will not be enough to assist and support them. Socially interactive robots can help to confront this situation not only by physically assisting people but also functioning as a companion. The increasing sales figures of robots are pointing that we are in front of a trend break for robotics. To lower the cost for developers and to increase their interest on developing robotic applications, the RAPP introduces the idea of robots as platforms. RAPP (Robotic Applications for Delivering Smart User Empowering Applications) will provide a software platform in order to support the creation and delivery of robotics applications (RAPPs) targeted to people at risk of exclusion, especially older people. The open-source software platform will provide an API that contains the functionalities for implementing RAPPs and accessing the robot's sensors and actuators using higher level commands, by adding a middleware stack with added functionalities suitable for different kinds of robots. RAPP will expand the computational and storage capabilities of robots and enable machine learning operations, distributed data collection and processing, and knowledge sharing among robots in order to provide personalized applications based on adaptation to individuals. The use of a common API will assist developers is creating improved applications for different types of robots that target to people with different needs, capabilities and expectations, while at the same time respect their privacy and autonomy, thus the proposed RAPP Store will have a profound effect in the robotic application market. The results of RAPP will be evaluated through the development and benchmarking of social assistive RAPPs, which exploit the innovative features (RAPP API, RAPP Store, knowledge reuse, etc.) introduced by the proposed paradigm.

9.4. International Initiatives

9.4.1. Informal International Partners

We have numerous international collaborations but we mention here only the one with activities that go beyond joint theoretical or experimental works:

- University of Bologna: 2 joint PhD student, publications
- University Innsbruck: joint conference organization
- Fraunhofer IPA, Stuttgart: joint conference organization
- Duisburg-Essen University: joint conference organization
- University of New-Brunswick: 1 joint PhD student
- University Laval, Québec: joint book
- University of Tokyo: joint conference organization
- Tianjin University, China: joint book

9.5. International Research Visitors

9.5.1. Visits of International Scientists

We have received for an extended stay our joint PhD student J. Pickard from University of New Brunswick together with his canadian supervisor J.A Carretero. We have received the Associate Professor Martin Pfurner from Innsbruck University for an extended stay and and Cuong Trinh Duc, PhD student from University Genova while several other scientists from other domains have visited our robotics flat.

<p style="text-align:center; color:red;">**HYBRID Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Labex Cominlabs SUNSET

Participants: Bruno Arnaldi, Guillaume Claude, Gautier Picard, Valérie Gouranton [contact].

SUNSET is a 4-year Labex Cominlabs project (2016-2020). SUNSET partners are MediCIS-LTSI (coordinator), Hybrid, Hycomes (IRISA/Inria), and CHU Rennes. SUNSET aims at developing an innovative training software suite based on immersive and collaborative virtual reality technology for training and evaluating non-technical skills. This approach will be implemented and evaluated in the context of training neurosurgical scrub nurses. We will notably integrate methods and systems developed in the S3PM project (see bellow). By relying on Human Factors approaches, the project also addresses training and evaluation of interpersonal skills. Whereas the developed technologies and approaches will be generic and adaptable to any surgical specialty, the project will evaluate the developed system within training sessions performed with scrub nurses. We ambition to propose novel approaches for surgical non-technical skill learning and assessment, and to install the developed training factory at the University Hospital of Rennes, and evaluate it with real-scale user studies.

9.1.2. Labex Cominlabs S3PM

Participants: Bruno Arnaldi, Guillaume Claude, Valérie Gouranton [contact].

S3PM ("Synthesis and Simulation of Surgical Process Models") is a 4-year Labex Cominlabs project (2013-2017). S3PM partners are MediCIS-LTSI (coordinator), Hybrid, Hycomes (IRISA/Inria), and CHU Rennes. The objective of S3PM is to propose a solution for the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution. The goal of the Hybrid team is to propose and use new models for collaborative and interactive virtual environments for procedural training. The Hybrid team also works on the creation of a surgical training application in virtual reality, exposing the different contributions. Ar

9.1.3. Labex Cominlabs HEMISFER

Participants: Anatole Lécuyer [contact], Marsel Mano, Lorraine Perronnet.

HEMISFER is a 4-year project (2013-2017) funded by Labex CominLabs. It involves 4 Inria/IRISA teams (Hybrid, Visages (lead), Panama, Athena) and 2 medical centers: the Rennes Psychiatric Hospital (CHGR) and the Reeducation Department of Rennes Hospital (CHU Pontchaillou). The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. Clinical applications concern motor, neurological and psychiatric disorders (stroke, attention-deficit disorder, treatment-resistant mood disorders, etc).

9.1.4. Labex Cominlabs SABRE

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Nataliya Kos'Myna.

SABRE is a 3-year project (2014-2017) funded by Labex CominLabs. It involves 1 Inria/IRISA team (Hybrid) and 2 groups from TELECOM BREST engineering school. The goal of SABRE is to improve computational functionnalities and power of current real-time EEG processing pipelines. The project will investigate innovative EEG solution methods empowered and speeded-up by ad-hoc, transistor-level, implementations of their key algorithmic operations. A completely new family of fully-hardware-integrated, new computational EEG imaging methods will be developed that are expected to speed up the imaging process of an EEG device of several orders of magnitude in real case scenarios.

9.1.5. IRT b<>com

Participants: Bruno Arnaldi [contact], Valérie Gouranton, Maud Marchal.

b<>com is a French Institute of Research and Technology (IRT). The main goal of this IRT is to fasten the development and marketing of tools, products and services in the field of digital technologies. Our team has collaborated with b<>com within two 3-year projects: ImData (on "Immersive Interaction") and GestChir (on "Augmented Healthcare") which both ended in 2016. A new 3-year project "NeedleWare" (on "Augmented Healthcare") has been started on October 2016.

9.1.6. CNPAO Project

Participants: Valérie Gouranton [contact], Jean-Baptiste Barreau, Ronan Gaugne.

CNPAO ("Conservatoire Numérique du Patrimoine Archéologique de l'Ouest") is an on-going research project partially funded by the Université Européenne de Bretagne (UEB) and Université de Rennes 1. It involves IRISA/Hybrid and CReAAH. The main objectives are: (i) a sustainable and centralized archiving of 2D/3D data produced by the archaeological community, (ii) a free access to metadata, (iii) a secure access to data for the different actors involved in scientific projects, and (iv) the support and advice for these actors in the 3D data production and exploration through the latest digital technologies, modeling tools and virtual reality systems.
This work was done in collaboration with Quentin Petit (SED Inria Rennes).

9.1.7. Imag'In CNRS IRMA

Participants: Bruno Arnaldi, Jean-Baptiste Barreau, Ronan Gaugne, Valérie Gouranton [contact].

The IRMA project is an Imag'In project funded by CNRS which aims at developing innovative methodologies for research in the field of cultural heritage based on the combination of medical imaging technologies and interactive 3D technologies (virtual reality, augmented reality, haptics, additive manufacturing). It relies on close collaborations with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET. The developed tools are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. We focus on a large number of archeological artefacts of different nature, and various time periods (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We can notably mention the oldest human bones found in Brittany (clavicle Beg Er Vil), a funeral urn from Trebeurden (22), or a Bronze Cauldron from a burial of the Merovingian necropolis "Crassés Saint-Dizier" (51). This project involves a strong collaboration with Théophane Nicolas (Inrap/UMR Trajectoires), Quentin Petit (SED Inria Rennes), and Grégor Marchand (CNRS/UMR CReAAH).

9.2. National Initiatives

9.2.1. ANR MANDARIN

Participants: Adrien Girard, Anatole Lécuyer, Maud Marchal [contact].

MANDARIN ("MANipulation Dextre hAptique pour opéRations INdustrielles en RV") was a 4-year ANR project (2012-2016). MANDARIN partners were CEA-List (coordinator), Inria/Hybrid, UTC, Haption and Renault. It aimed at designing new hardware and software solutions to achieve natural and intuitive mono and bi-manual dextrous interactions, suitable for virtual environments. The objective of Hybrid in MANDARIN was to design novel multimodal 3D interaction techniques and metaphors allowing to deal with haptic gloves limitations (portability, under-actuation) and to assist the user in virtual reality applications requiring dexterous manipulation. The results were evaluated with a representative industrial application: the bi-manual manipulation of complex rigid objects and cables bundles.

9.2.2. ANR HOMO-TEXTILUS

Participants: Anatole Lécuyer [contact], Maud Marchal.

HOMO-TEXTILUS was a 4-year ANR project (2012-2016). Partners of the project were : Inria/Hybrid, CHART, LIP6, TOMORROW LAND, RCP and potential end-user is Hussein Chalayan fashion designer. The objective of HOMO TEXTILUS was to study what could be the next generation of smart and augmented clothes, and their influence and potential impact on behavior and habits of their users. The project was strongly oriented towards human science, with both user studies and sociological studies. The involvement of Hybrid team in the project consisted in studying the design of next-gen prototypes of clothes embedding novel kinds of sensors and actuators. These prototypes were used and tested in various experiments.

9.2.3. FUI Previz

Participants: Bruno Arnaldi [contact], Valérie Gouranton [contact].

Previz was a 3-year project (2013-2016) funded by the competitive cluster "Images et Réseaux". Previz involved 4 Academic partners (Hybrid/INSA Rennes, ENS Louis-Lumière, LIRIS, Gipsa-Lab) and 9 Industrial partners (Technicolor, Ubisoft, SolidAnim, loumasystem, Polymorph). Previz aimed at proposing new previsualization tools for movie directors. The goal of Hybrid in Previz was to introduce new interactions between real and virtual actors so that the actor's actions, no matter his/her real or virtual nature, impact both the real and the virtual environment. The project ended up with a new production pipeline in order to automatically adapt and synchronize the visual effects (VFX), in space and time, to the real performance of an actor.

9.2.4. Ilab CertiViBE

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Charles Garraud, Jérôme Chabrol.

CertiViBE is a 2-year "Inria Innovation Lab" (2015-2017) funded by Inria for supporting the development of OpenViBE software, and notably its evolution in order to enable and fasten the medical transfer and the medical certification of products based on OpenViBE. This joint lab involves two partners: Hybrid and Mensia Technologies startup company. The project aims at setting up a quality environment, and developping a novel version of the software wich should comply with medical certification rules.

9.2.5. IPL BCI-LIFT

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren [contact], Andéol Evain, Lorraine Perronnet, Nataliya Kos'Myna.

BCI-LIFT is a 4-year "Inria Project Lab" initiative (2015-2019) funded by Inria for supporting a national research effort on Brain-Computer Interfaces. This joint lab involves sevearl Inria teams: Hybrid, Potioc, Athena, Neurosys, Mjolnir, Demar; as well as external partners: INSERM-Lyon, and INSA Rouen. This project aims at improving several aspects of Brain-Computer Interfaces : learning and adaptation of BCI systems, user interfaces and feedback, training protocols, etc.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. HAPPINESS

Title: HAptic Printed Patterned INtErfaces for Sensitive Surface

Programm: H2020

Duration: January 2015 - December 2017

Coordinator: CEA

Partners:

Arkema France (France)

Robert Bosch (Germany)

Commissariat A L'Energie Atomique et Aux Energies Alternatives (France)

Fundacion Gaiker (Spain)

Integrated Systems Development S.A. (Greece)

University of Glasgow (United Kingdom)

Walter Pak SL (Spain)

Inria contact: Nicolas Roussel and Anatole Lécuyer

The Automotive HMI (Human Machine Interface) will soon undergo dramatic changes, with large plastic dashboards moving from the 'push-buttons' era to the 'tactile' era. User demand for aesthetically pleasing and seamless interfaces is ever increasing, with touch sensitive interfaces now commonplace. However, these touch interfaces come at the cost of haptic feedback, which raises concerns regarding the safety of eyeless interaction during driving. The HAPPINESS project intends to address these concerns through technological solutions, introducing new capabilities for haptic feedback on these interfaces. The main goal of the HAPPINESS project is to develop a smart conformable surface able to offer different tactile sensations via the development of a Haptic Thin and Organic Large Area Electronic technology (TOLAE), integrating sensing and feedback capabilities, focusing on user requirements and ergonomic designs. To this aim, by gathering all the value chain actors (materials, technology manufacturing, OEM integrator) for application within the automotive market, the HAPPINESS project will offer a new haptic Human-Machine Interface technology, integrating touch sensing and disruptive feedback capabilities directly into an automotive dashboard. Based on the consortium skills, the HAPPINESS project will demonstrate the integration of Electro-Active Polymers (EAP) in a matrix of mechanical actuators on plastic foils. The objectives are to fabricate these actuators with large area and cost effective printing technologies and to integrate them through plastic molding injection into a small-scale dashboard prototype. We will design, implement and evaluate new approaches to Human-Computer Interaction on a fully functional prototype that combines in packaging both sensors and actuator foils, driven by custom electronics, and accessible to end-users via software libraries, allowing for the reproduction of common and accepted sensations such as Roughness, Vibration and Relief. In this project, the role of Hybrid team is to design user studies on tactile perception, and study innovative usages of the technologies developed in HAPPINESS.

9.4. International Research Visitors

9.4.1. *Visits of International Scientists*

Michael Pereira (EPFL, Switzerland) visited Hybrid for a collaboration on Brain-Computer Interfaces and sports in January 2016.

9.4.2. *Visits to International Teams*

Ferran Argelaguet visited the Virtual Reality Lab (Pr. Bernd Frohlich) at the Bauhaus University at Weimar (Germany) in October/November 2016.

ILDA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

ScaleGest. Surface Gestures for Advanced Graphical Interfaces: Which Gesture for What. (2014-2017) Funded by Digiteo. In collaboration with Telecom ParisTech: **109Keuros**. Participants: Caroline Appert (PI), Rafael Morales Gonzalez, Emmanuel Pietriga.

The project aims at designing gesture-based interaction for expert users who navigate and manipulate large datasets. In the context of advanced graphical applications, the number of gestures should be large-enough to cover the set of controls (*i.e.*, commands and parameter settings) but remain simple-enough to avoid exceeding human abilities. Making gesture-based interaction scale with graphical applications' growing complexity can be achieved only by understanding the foundational aspects of this input modality. This project is about characterizing and structuring both the space of application controls and the space of surface gestures in order to establish guidelines for appropriate control-gesture mappings. It is also about the definition of a sound and systematic evaluation methodology that will serve as a reference benchmark for evaluating these mappings. The resulting control-gesture mappings are demonstrated in the specific application domains of cartography and astronomy.

9.2. National Initiatives

9.2.1. ANR

MapMuxing - Multi-dimensional Map Multiplexing. (2014-2018) Funded by the French National Research Agency (ANR). In collaboration with IGN (Institut National de l'Information Géographique et Forestière): **208Keuros**/499Keuros. Participants: Emmanuel Pietriga (PI), Caroline Appert, Olivier Chapuis, María-Jesús Lobo. http://mapmuxing.ign.fr

The project explores novel ways of combining different maps and data layers into a single cartographic representation, and investigates novel interaction techniques for navigating in it. The project aims at going beyond the traditional pan & zoom and overview+detail interface schemes, and at designing and evaluating novel cartographic visualizations that rely on high-quality generalization, *i.e.*, the simplification of geographic data to make it legible at a given map scale, and symbol specification.

9.2.2. Collaborations with other French Research Organizations

CorTextViz. (2015-2016) Funded by INRA (Institut National de la Recherche Agronomique). In collaboration with project-team Aviz at Inria Saclay (Jean-Daniel Fekete) and INRA (Jean-Philippe Cointet, Guy Riba). Interactive visualization of medium-scale multi-level networks, supporting data storytelling on wall displays. Participants: André Spritzer, Emmanuel Pietriga (PI), Anastasia Bezerianos.

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

- European Southern Obseervatory (ESO)
- ALMA Operations Monitoring and Control - design and implementation of state-of-the-art interactive visualization components for the operations monitoring and control software that runs the ALMA radio-observatory in Chile.
- Deutsches Elektronen-Synchrotron (DESY)

- Scientific collaboration on the design and implementation of user interfaces for array operations monitoring and control for the Cherenkov Telescope Array (CTA) project [24], to be built in the Canary Islands (Spain) and in the Atacama desert (Chile).

9.4. International Initiatives

9.4.1. Inria International Labs

Inria Chile / CIRIC. From 2012 to 2015, Emmanuel Pietriga was the scientific leader of the Massive Data team at Inria Chile, working on projects in collaboration with the ALMA radio-telescope and the Millenium Institute of Astrophysics [15]. He is now scientific advisor to Inria Chile's visualization lab.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- University of Konstanz: Daniel Keim and Johannes Fuchs on mapping out the design space for visualization glyphs [14]. Participants: Anastasia Bezerianos.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Shumin Zhai, Google, June 2016
- Iftach Sadeh, DESY/CTA Observatory, April 2016

9.5.1.1. Internships

- María Grazia Prato, Inria Chile, April 2016

<h1 style="color:red; text-align:center">IMAGINE Project-Team</h1>

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. ARC6 PoTAsse (2015 - 2018)

Participants: Pablo Coves, Jean-Claude Léon, Damien Rohmer.

We received a doctoral grant (AdR) from the ARC6 program to generate functional CAD assemblies from scanned data (*PoTAsse*: POint clouds To ASSEmblies) as a collaboration between Imagine team (LJK/Inria) and Geomod team (LIRIS). Our PhD student Pablo Coves is advised by Jean-Claude Léon and Damien Rohmer at Imagine, Raphaëlle Chaine and Julie Digne in Geomod team.

7.2. National Initiatives

7.2.1. FUI Collodi (October 2013 - October 2016)

Participants: Francois Faure, Romain Testylier.

This 3-year contract with two industrial partners: TeamTo and Mercenaries Engineering (software for production rendering), was a follow-up and a generalization of Dynam'it. The goal was to propose an integrated software for the animation and final rendering of high-quality movies, as an alternative to the ever-ageing Maya. It included dynamics similarly to Dynam'it This contract, started in October, funded 2 engineers for 3 years.

This project will be pursued within the new FUI Collodi 2 between 2017 - 2018.

7.3. European Initiatives

7.3.1. ERC Grant Expressive

Title: EXPloring REsponsive Shapes for Seamless desIgn of Virtual Environments.

Programm: ERC Advanced Grant

Duration: 04/2012 - 03/2017

Inria contact: Marie-Paule Cani

To make expressive and creative design possible in virtual environments, the goal is to totally move away from conventional 3D techniques, where sophisticated interfaces are used to edit the degrees of freedom of pre-existing geometric or physical models: this paradigm has failed, since even trained digital artists still create on traditional media and only use the computer to reproduce already designed content. To allow creative design in virtual environments, from early draft to progressive refinement and finalization of an idea, both interaction tools and models for shape and motion need to be revisited from a user-centred perspective. The challenge is to develop reactive 3D shapes – a new paradigm for high-level, animated 3D content – that will take form, refine, move and deform based on user intent, expressed through intuitive interaction gestures inserted in a user-knowledge context. Anchored in Computer Graphics, this work reaches the frontier of other domains, from Geometry, Conceptual Design and Simulation to Human Computer Interaction.

7.3.2. PIPER

Title: Position and Personalize Advanced Human Body Models for Injury Prediction

Programm: FP7

Duration: November 2013 - April 2017

Inria contact: F. Faure

In passive safety, human variability is currently difficult to account for using crash test dummies and regulatory procedures. However, vulnerable populations such as children and elderly need to be considered in the design of safety systems in order to further reduce the fatalities by protecting all users and not only so called averages. Based on the finite element method, advanced Human Body Models for injury prediction have the potential to represent the population variability and to provide more accurate injury predictions than alternatives using global injury criteria. However, these advanced HBM are underutilized in industrial R&D. Reasons include difficulties to position the models – which are typically only available in one posture – in actual vehicle environments, and the lack of model families to represent the population variability (which reduces their interest when compared to dummies). The main objective of the project will be to develop new tools to position and personalize these advanced HBM. Specifications will be agreed upon with future industrial users, and an extensive evaluation in actual applications will take place during the project. The tools will be made available by using an Open Source exploitation strategy and extensive dissemination driven by the industrial partners.Proven approaches will be combined with innovative solutions transferred from computer graphics, statistical shape and ergonomics modeling. The consortium will be balanced between industrial users (with seven European car manufacturers represented), academic users involved in injury bio-mechanics, and partners with different expertise with strong potential for transfer of knowledge. By facilitating the generation of population and subject-specific HBM and their usage in production environments, the tools will enable new applications in industrial R&D for the design of restraint systems as well as new research applications.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Jean-Charles Bazin (ETH Zurich): The convergence space of visual computing.
- Ariel Shamir (Interdisciplinary Center, Israel): Creating visual stories.
- Eugene Fiume (Univ. Toronto, Canada): Procedural Speech Synchronization for Facial Animation.
- Rahul Narain (Univ. Minnesota, USA): Adaptivity and Optimization for Physics-Based Animation.
- Christian Jacquemin (Univ. Paris Sud): Arts and science: examples in computer graphics and image processing, and critical analysis.
- James Gain (Univ. Cape Town, South Africa): Parallel, Realistic and Controllable Terrain Synthesis.
- Nils Thuerey (Technical Univ. of Munich, Germany): Data-driven Fluid Simulation.
- Bernhard Thomaszewski (Disney Research Zurich, ETH Zurich, Switzerland): Computational Design Tools for the Age of Digital Fabrication.

<p style="text-align:center">**LACODAM Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. SePaDec: Declarative approaches for Sequential Pattern mining

Participants: Benjamin Negrevergne, Thomas Guyet, Ahmed Samet, Alexandre Termier.

The SEPADEC project is funded by the Region Bretagne. It aims at exploring the application of declarative pattern mining (more especially ASP) in the field of care pathway analysis. The first objective was to model knowledge from the data to enrich the raw data with medical expert knowledge and to develop a toolbox that smoothly integrates both expert knowledge and declarative pattern mining.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. #DigitAg: Digital agriculture
Participants: Alexandre Termier, Véronique Masson, Christine Largouët, Anne-Isabelle Graux.

#DigitAg is a "Convergence Institute" dedicated to the increasing importance of digital techniques in agriculture. Its goal is twofold: first, make innovative research on the use of digital techniques in agriculture in order to improve competitiveness, preserve environment, and offer correct living conditions to farmers. Second, through education prepare future farmers and agricultural policy makers to successfully exploit such technology.

While #DigitAg is based on Montpellier, Rennes is a satellite of the institute focused on cattle farming. Lacodam is involved in the "data mining" challenge of the institute, that A. Termier co-leads. He is also the representative of Inria in the steering comittee of the institute.

The interest for the team is to design novel methods to analyze and represent agricultural data, which are challenging because they are both heterogeneous and multi-scale (both spatial and temporal).

9.2.2. National Platforms

9.2.2.1. PEPS: Pharmaco-epidemiology for Health Products
Participants: Yann Dauxais, Thomas Guyet, Véronique Masson, René Quiniou, Alexandre Termier.

The PEPS project (Pharmaco-epidemiology des Produits de Santé) is funded by ANSM (national agency for health security). The project leader is E. Oger from the clinical investigation center CIC-1414 INSERM/CHU Rennes. The other partners located in Rennes are the Institute of Research and Technology (IRT) B<>Com, EHESP and the LTSI. The project started in january 2015 and is funded for 4 years.

The PEPS project has two parts: the clinical studies and a research program dedicated to the development of innovative tools for pharmaco-epidemiological studies with medico-administrative databases.

Our contribution to this project will be to propose pattern mining algorithm and reasoning techniques to analyse the typical care pathways of specific groups of insured patients.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

9.3.1.1.1. University of Calgary: Monitoring cattle in big herds with multiple sensors
Participant: René Quiniou.

The state of Alberta produces a significant part of the beef meat in Canada. Big farms feeds up around 40.000 bull calves in feedlots grouping 200-300 animals. Diseases such as Bovine Respiratory Diseases (BRD) are frequent and may propagate quickly in such conditions. So, it is important to detect as soon as possible when an animal is sick. We are collaborating with the Department of Production Animal Health, University of Calgary for designing monitoring systems able to generate early alarms when an animal is sick. Precisely, we are studying the properties of new sensors and their aptitude to provide relevant data for BRD detectors.

9.3.1.1.2. University of Potsdam: preferences in mining with ASP
Participant: Thomas Guyet.

The research group "knowledge processing and information systems" of the University of Potsdam, so called Potascco group, develops a collection of tools and programs for Answer Set Programming such as the clingo solver or the ASPRIN system, developed by J. Romero to handle preferences on ASP models. They have strong expertise in problem encoding with ASP. In addition to T. Schaub Inria position, we initiate some collaborations with other members of the Potascco group in order to strengthen our relationships.

9.4. International Research Visitors

9.4.1. Research Stays Abroad

Thomas Guyet spent a month (may 2016) in the team leaded by Prof. Torsten Schaub in the university of Potsdam.

<p align="center" style="color:red">LAGADIC Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. ARED NavRob

Participants: Suman Raj Bista, Paolo Robuffo Giordano, François Chaumette.

no Inria Rennes 8033, duration: 36 months.

This project funded by the Brittany council ended in October 2016. It supported in part Suman Raj Bista's Ph.D. about visual navigation (see Section 7.4.1).

9.1.2. ARED DeSweep

Participants: Lesley-Ann Duflot, Alexandre Krupa.

no Inria Rennes 8033, duration: 36 months.

This project funded by the Brittany council started in October 2014. It supports in part Lesley-Ann Duflot's Ph.D. about visual servoing based on the shearlet transform (see Section 7.3.3).

9.1.3. ARED Locoflot

Participants: Ide Flore Kenmogne Fokam, Vincent Drevelle, Eric Marchand.

no Inria Rennes 9944, duration: 36 months.

This project funded by the Brittany council started in October 2015. It supports in part Ide Flore Kenmogne Fokam's Ph.D. about cooperative localization in multi-robot fleets using interval analysis (see Section 7.5.3).

9.1.4. ARED Mod4Nav

Participants: Aline Baudry, Marie Babel.

no INSA Rennes 2016/01, duration: 36 months.

This project funded by the Brittany council started in October 2016. It supports in part Aline Baudry's Ph.D. about wheelchair modeling.

9.1.5. "Equipement mi-lourd Rennes Métropole"

Participant: Paolo Robuffo Giordano.

no CNRS Rennes 14C0481, duration: 36 months.

A grant from "Rennes Métropole" has been obtained in June 2014 and supports the activities related to the use of drones (quadrotor UAVs). The platform described in Section 6.9.5 has been purchased in part thanks to this grant.

9.1.6. IRT Jules Verne Mascot

Participant: François Chaumette.

no Inria Rennes 10361, duration: 36 months.

This project started in October 2015. It is managed by IRT Jules Verne in Nantes and realized in cooperation with IRCCyN, Airbus, Renault, Faurecia and Alsthom. Its goal is to perform screwing for various industrial applications.

9.1.7. IRT b<>com NeedleWare

Participants: Hadrien Gurnel, Alexandre Krupa.

no Inria Rennes 9072, duration: 36 months.

This project started in October 2016. It supports Hadrien Gurnel's Ph.D. about the study of a shared control strategy fusing haptic and ultrasound visual control for assisting manual steering of needles for biopsies or therapy purposes in a synergetic way.

9.2. National Initiatives

9.2.1. *France Life Imaging WP3-FLI ANFEET*
Participant: Alexandre Krupa.

duration: 24 months.

This project started in January 2016. Its objective is to initiate collaborative research with the ICube laboratory (Strasbourg) on the control and supervision of flexible endoscopes in the digestive tube using ultrasound images.

9.2.2. *ANR Contint Visioland*
Participants: Noël Mériaux, Patrick Rives, François Chaumette.

no Inria Rennes 8304, duration: 48 months.

This project started in November 2013. It is composed of a consortium managed by Onera in Toulouse with Airbus, Spikenet Technology, IRCCyN, and Lagadic. Its aim is to develop vision-based localization and navigation techniques for autonomous landing on a runway (see Section 7.1.3).

9.2.3. *ANR Contint Entracte*
Participant: Julien Pettré.

no Inria Rennes 8013, duration: 42 months.

This project started in November 2013. It is realized in collaboration with the Gepetto group at Laas, Toulouse, and the Mimetic group at Irisa and Inria Rennes Bretagne Atlantique. It addresses the problem of motion planning for anthropomorphic systems, and more generally, the problem of manipulation path planning. ENTRACTE proposes to study in parallel both the mathematical foundation of artificial motion and the neurocognitive structures used by humans to quickly solve motion problems.

9.2.4. *ANR JCJC Percolation*
Participant: Julien Pettré.

no Inria Rennes 7991, duration: 42 months.

The ANR "Jeune Chercheur" Percolation project started on January 2014. It aims at designing perception-based crowd simulation algorithms. We develop agents which are capable of perceiving their virtual environment through virtual sensors, and which are able to navigate in it, as well as to interact with the other agents.

9.2.5. *ANR JCJC SenseFly*
Participants: Thomas Bellavoir, Muhammad Usman, Riccardo Spica, Paolo Robuffo Giordano.

no Irisa CNRS 50476, duration: 36 months.

The ANR "Jeune Chercheur" SenseFly project started in August 2015. Its goal is to advance the state-of-the-art in multi-UAV in the design and implementation of fully decentralized and sensor-based group behaviors by only resorting to onboard sensing (mainly cameras and IMU) and local communication (e.g., Bluetooth communication, wireless networks). Topics such as individual flight control, formation control robust against sensor limitations (e.g., limited field of view, occlusions), distributed estimation of relative positions/bearings from local sensing, maintenance of architectural properties of a multi-UAV formation will be touched by the project. Part of the platforms described in Section 6.9.5 has been purchased thanks to this grant.

9.2.6. ANR PLaTINUM

Participants: Eduardo Fernandez Moral, Vincent Drevelle, Patrick Rives.

no Inria Sophia 10204, duration: 42 months.

This project started in November 2015. It is composed of a consortium managed by Litis in Rouen with IGN Matis (Paris), Le2i (Le Creusot) and Lagadic group. It aims at proposing novel solutions to robust long-term mapping of urban environments.

9.2.7. BPI Romeo 2

Participants: Giovanni Claudio, Nicolas Cazy, Suman Raj Bista, Fabien Spindler, François Chaumette.

no Inria Rennes 7114, duration: 60 months.

This project started in November 2012. It is composed of a large consortium managed by Softbank Robotics (ex Aldebaran Robotics) with Laas in Toulouse, Isir in Paris, Lirmm in Montpellier, Inria groups Lagadic, Bipop (Pierre-Brice Wieber), Flowers (Pierre-Yves Oudeyer), and many other partners. It aims at developing advanced control and perception functionalities to a humanoid robot. In this project, we are in charge of visual manipulation and navigation with Romeo and Pepper. It supports in part Suman Raj Bista's Ph.D. about visual navigation (see Section 7.4.1), as well as Nicolas Cazy's Ph.D. about model-based predictive control for visual servoing (see Section 7.2.4).

9.2.8. Equipex Robotex

Participants: Fabien Spindler, François Chaumette.

no Inria Rennes 6388, duration: 9 years.

Lagadic is one of the 15 French academic partners involved in the Equipex Robotex network thats started in February 2011. It is devoted to get and manage significative equipment in the main robotics labs in France. In the scope of this project, we have got the humanoid robot Romeo (see Section 6.9.4).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. FP7 Space RemoveDEBRIS

Participants: Aurélien Yol, Eric Marchand, François Chaumette.

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2017

Coordinator: University of Surrey (United Kingdom)

Partners: Surrey Satellite Technology (United Kingdom), Airbus (Toulouse, France and Bremen, Germany), Isis (Delft, The Netherlands), CSEM (Neuchâtel, Switzerland), Stellenbosch University (South Africa).

Inria contact: François Chaumette

Abstract: The goal of this project is to validate model-based tracking algorithms on images acquired during an actual space debris removal mission (see Section 7.1.2).

9.3.1.2. H2020 Comanoid

Participants: Don Joven Agravante, Giovanni Claudio, Souriya Trinh, Fabien Spindler, François Chaumette.

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: CNRS (Lirmm)

Partners: Airbus Group (France), DLR (Germany), Università Degli Studi di Roma La Sapienza (Italy), CNRS (I3S)

Inria contact: Francois Chaumette

COMANOID investigates the deployment of robotic solutions in well-identified Airbus airliner assembly operations that are laborious or tedious for human workers and for which access is impossible for wheeled or rail-ported robotic platforms. As a solution to these constraints a humanoid robot is proposed to achieve the described tasks in real-use cases provided by Airbus Group. At a first glance, a humanoid robotic solution appears extremely risky, since the operations to be conducted are in highly constrained aircraft cavities with non-uniform (cargo) structures. Furthermore, these tight spaces are to be shared with human workers. Recent developments, however, in multi-contact planning and control suggest that this is a much more plausible solution than current alternatives such as a manipulator mounted on multi-legged base. Indeed, if humanoid robots can efficiently exploit their surroundings in order to support themselves during motion and manipulation, they can ensure balance and stability, move in non-gaited (acyclic) ways through narrow passages, and also increase operational forces by creating closed-kinematic chains. Bipedal robots are well suited to narrow environments specifically because they are able to perform manipulation using only small support areas. Moreover, the stability benefits of multi-legged robots that have larger support areas are largely lost when the manipulator must be brought close, or even beyond, the support borders. COMANOID aims at assessing clearly how far the state-of-the-art stands from such novel technologies. In particular the project focuses on implementing a real-world humanoid robotics solution using the best of research and innovation. The main challenge will be to integrate current scientific and technological advances including multi-contact planning and control; advanced visual-haptic servoing; perception and localization; human-robot safety and the operational efficiency of cobotics solutions in airliner manufacturing.

9.3.1.3. H2020 Romans

Participants: Nicolò Pedemonte, Firas Abi Farraj, Fabien Spindler, François Chaumette, Paolo Robuffo Giordano.

Title: Robotic Manipulation for Nuclear Sort and Segregation

Programm: H2020

Duration: May 2015 - April 2018

Coordinator: University of Birmingham

Partners: NLL (UK), CEA (France), Univ. Darmstadt (Germany)

CNRS contact: Paolo Robuffo Giordano

The RoMaNS (Robotic Manipulation for Nuclear Sort and Segregation) project will advance the state of the art in mixed autonomy for tele-manipulation, to solve a challenging and safety-critical "sort and segregate" industrial problem, driven by urgent market and societal needs. Cleaning up the past half century of nuclear waste, in the UK alone (mostly at the Sellafield site), represents the largest environmental remediation project in the whole of Europe. Most EU countries face related challenges. Nuclear waste must be "sorted and segregated", so that low-level waste is placed in low-level storage containers, rather than occupying extremely expensive and resource intensive high-level storage containers and facilities. Many older nuclear sites (>60 years in UK) contain large

numbers of legacy storage containers, some of which have contents of mixed contamination levels, and sometimes unknown contents. Several million of these legacy waste containers must now be cut open, investigated, and their contents sorted. This can only be done remotely using robots, because of the high levels of radioactive material. Current state-of-the-art practice in the industry, consists of simple tele-operation (e.g. by joystick or teach-pendant). Such an approach is not viable in the long-term, because it is prohibitively slow for processing the vast quantity of material required. The project will: 1) Develop novel hardware and software solutions for advanced bi-lateral master-slave tele-operation. 2) Develop advanced autonomy methods for highly adaptive automatic grasping and manipulation actions. 3) Combine autonomy and tele-operation methods using state-of-the-art understanding of mixed initiative planning, variable autonomy and shared control approaches. 4) Deliver a TRL 6 demonstration in an industrial plant-representative environment at the UK National Nuclear Lab Workington test facility.

9.3.2. Collaborations with European Partners

Participants: Fabien Spindler, Alexandre Krupa, François Chaumette.

Project acronym: i-Process

Project title: Innovative and Flexible Food Processing Technology in Norway

Duration: January 2016 - December 2019

Coordinator: Sintef (Norway)

Other partners: Nofima, Univ. of Stavanger, NMBU, NTNU (Norway), DTU (Denmark), KU Leuven (Belgium), and about 10 Norwegian companies.

Abstract: This project is granted by the Norwegian Government. Its main objective is to develop novel concepts and methods for flexible and sustainable food processing in Norway. In the scope of this project, the Lagadic group is involved for visual tracking and visual servoing of generic and potentially deformable objects. Prof. Pal Johan from the Norwegian University of Life Sciences (NMBU), and Ekrem Misimi from Sintef spent a short visit in June and October respectively.

9.4. International Initiatives

9.4.1. Inria Associate Teams

9.4.1.1. SIMS

Title: Realistic and Efficient Simulation of Complex Systems

International Partners:

>   University of North Carolina at Chapel Hill (USA) - GAMMA Group - Ming C. Lin, Dinesh Manocha

>   University of Minnesota (USA) - Motion Lab - Stephen Guy

>   Brown University (USA) - VenLab - William Warren

Start year: 2012

See http://people.rennes.inria.fr/Julien.Pettre/EASIMS/easims.html

The general goal of SIMS is to make significant progress toward realistic and efficient simulation of highly complex systems, which raise combinatory explosive problems. This proposal is focused on human motion and interaction, and covers 3 active topics with wide application range:

1.   Crowd simulation: virtual human interacting with other virtual humans,

2.   Autonomous virtual humans interacting with their environment,

3.   Physical simulation: real humans interacting with virtual environments.

SIMS is orthogonally structured by transversal questions: the evaluation of the level of realism reached by a simulation (which is a problem by itself in the considered topics), considering complex systems at various scales (micro, meso and macroscopic ones), and facing combinatory explosion of simulation algorithms.

9.4.1.2. ISI4NAVE

Title: Innovative Sensors and adapted Interfaces for assistive NAVigation and pathology Evaluation
International Partner:

University College London (United Kingdom) - Aspire CREATe - Tom Carlson

Start year: 2016

See http://www.irisa.fr/lagadic/team/MarieBabel/ISI4NAVE/ISI4NAVE.html

The global ageing population, along with disability compensation constitute major challenging societal and economic issues. In particular, achieving autonomy remains a fundamental need that contributes to the individual's wellness and well-being. In this context, innovative and smart technologies are designed to achieve independence while matching user's individual needs and desires.

Hence, designing a robotic assistive solution related to wheelchair navigation remains of major importance as soon as it compensates partial incapacities. This project will then address the following two issues. First, the idea is to design an indoor / outdoor efficient obstacle avoidance system that respects the user intention, and does not alter user perception. This involves embedding innovative sensors to tackle the outdoor wheelchair navigation problem. The second objective is to take advantage of the proposed assistive tool to enhance the user Quality of Experience by means of biofeedback. Indeed, adapted interfaces should improve the understanding of people that suffer from cognitive and/or visual impairments.

The originality of the project is to continuously integrate medical validation as well as clinical trials during the scientific research work in order to match user needs and acceptation.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- Alexandre Krupa has a collaboration with Prof. Nassir Navab from the Technical University of Munich concerning the joint supervision of Pierre Chatelain's Ph.D. (see Section 7.3.2).

9.4.3. Participation in International Programs

The Lagadic group is one of the few external partners of the Australian Center for Robotic Vision (see http://roboticvision.org). It groups QUT in Brisbane, ANU in Canberra, Monash University and Adelaide University. In the scope of this project, Peter Corke and Ben Upcroft spent a short visit in May 2016 while Jurgen Leitner spent a 1-month visit in October 2016.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Nicolas Alt, senior researcher at Technical University of Munich (TUM) was a visiting scientist at Sophia Antipolis from Jan until Feb 2016. He worked on visuo-haptic environment perception.
- Alejandro Perez Yus, Ph.D. student at Universidad de Zaragoza, spent a 3-month visit in Sophia Antipolis from Sep until Nov 2016. He worked on the calibration of multi-camera RGB-D systems.
- Prof. Denis Wolf, associate professor at Univ. Sao Paulo, Brasil, spends a sabbatical year in Sophia Antipolis from Jul 2016 to Aug 2017. He works on semantic learning applied to intelligent vehicles.
- Nicola Battilani, Ph.D. student at University of Modena and Reggio Emilia, spent a 6-month visit in Rennes from May until Oct 2016. He worked on shared control algorithms for optimal 3D reconstruction from vision.
- Prof. Volkan Isler from University of Minnesota, Phillip Schmidt, Ph.D. student from DLR, Prof. Ivan Petrovic from Univ. of Zagreb, Prof. Purang Abolmaesumi from Univ. of British Columbia, Prof. Nassir Navab from Technical University of Munich, and Prof. Russ Taylor from John Hopkins University spent a short visit in the group in 2016.

<h1 style="text-align:center; color:red;">LARSEN Team</h1>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Project PsyPhINe: Cogitamus ergo sumus

Participant: Amine Boumaza.

This project is financed for two years by the MSH Lorraine (USR3261) gathering researchers from the following institutes: , InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Inria Bordeaux Sud-Ouest, Loria (UMR7503). Refer to sec. 7.1.1 for further information.

8.1.2. AME Satelor

Participants: François Charpillet, Xuan Son Nguyen, Thomas Moinel, Mélanie Lelaure.

Economic mobilisation agency in Lorraine has launched a new project Satelor providing it with 2.5 million Euros of funding over 3 years, out of an estimated total of 4.7 million. The leader of the project is Pharmagest-Diatelic. Pharmagest, in Nancy, is the French leader in computer systems for pharmacies, with a 43.5 % share of the market, 9,800 clients and more than 700 employees. Recently, the Pharmagest Group expanded its activities into e-health and the development of telemedicine applications. The Satelor project will accompany the partners of the project in developing services for maintaining safely elderly people with loss of autonomy at home or people with a chronic illness. Larsen team will play an important role for bringing some research results such as:

- developing a low cost environmental sensor for monitoring the daily activities of elderly people at home
- developing a low cost sensor for fall detection
- developing a low cost companion robot able to interact with people and monitoring their activities while detecting emergency situations.
- developing a general toolbox for data-fusion: Bayesian approach.

8.2. National Initiatives

8.2.1. PIA LAR Living Assistant Robot

Participants: François Charpillet, Abdallah Dib.

Partners : Crédit Agricole, Diatelic, Robosoft
The LAR project has the objective to design an assistant robot to improve the autonomy and quality of life for elderly and fragile persons. The project started at the beginning of 2015. The role of the Larsen Team is to develop a simultaneous localisation and mapping algorithm using a RGB-D camera. The main issue is to develop an algorithm able to deal with a dynamic environment. Another issue is for the robot to be able to behave with acceptable social skills.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. RESIBOTS

Title: Robots with animal-like resilience

Programm: H2020

Type: ERC

Duration: May 2015 - April 2020

Coordinator: Inria

Inria contact: Jean Baptiste Mouret

Despite over 50 years of research in robotics, most existing robots are far from being as resilient as the simplest animals: they are fragile machines that easily stop functioning in difficult conditions. The goal of this proposal is to radically change this situation by providing the algorithmic foundations for low-cost robots that can autonomously recover from unforeseen damage in a few minutes. The current approach to fault tolerance is inherited from safety-critical systems (e.g. spaceships or nuclear plants). It is inappropriate for low-cost autonomous robots because it relies on diagnostic procedures, which require expensive proprioceptive sensors and contingency plans, which cannot cover all the possible situations that an autonomous robot can encounter. It is here contended that trial-and-error learning algorithms provide an alternate approach that does not require diagnostic or pre-defined contingency plans. In this project, we will develop and study a novel family of such learning algorithms that make it possible for autonomous robots to quickly discover compensatory behaviors. We will thus shed a new light on one of the most fundamental questions of robotics: how can a robot be as adaptive as an animal? The techniques developed in this project will substantially increase the lifespan of robots without increasing their cost, and will open new research avenues for adaptive machines.

8.3.1.2. CoDyCo

Participants: Serena Ivaldi, Valerio Modugno, Oriane Dermy.

Title: Whole-body Compliant Dynamical Contacts in Cognitive Humanoids

Program: FP7

Instrument: STREP

Objective: Cognitive Systems and Robotics (b)

Duration: March 2013 - February 2017 (4 years)

Coordinator: Francesco Nori (Italian Institute of Technology)

Partners: TU Darmstadt (Germany), Université Pierre et Marie Curie (France), Josef Stefan Institue (Slovenia), University of Birmingham (UK)

Inria contact: Serena Ivaldi

Abstract: The aim of CoDyCo is to advance the current control and cognitive understanding of robust, goal-directed whole-body motion interaction with multiple contacts. CoDyCo will go beyond traditional approaches by: (1) proposing methodologies for performing coordinated interaction tasks with complex systems; (2) combining planning and compliance to deal with predictable and unpredictable events and contacts; (3) validating theoretical advances in real-world interaction scenarios. First, CoDyCo will advance the state-of-the-art in the way robots coordinate physical interaction and physical mobility. Traditional industrial applications involve robots with limited mobility. Consequently, interaction (e.g., manipulation) has been treated separately from whole-body posture (e.g., balancing), assuming the robot firmly connected to the ground. Foreseen applications involve robots with augmented autonomy and physical mobility. Within this novel context, physical interaction influences stability and balance. To allow robots to surpass barriers between interaction

and posture control, CoDyCo will be grounded in principles governing whole-body coordination with contact dynamics. Second, CoDyCo will go beyond traditional approaches in dealing with all perceptual and motor aspects of physical interaction, unpredictability included. Recent developments in compliant actuation and touch sensing allow safe and robust physical interaction from unexpected contact including humans. The next advancement for cognitive robots, however, is the ability not only to cope with unpredictable contact, but also to exploit predictable contact in ways that will assist in goal achievement. Third, the achievement of the project objectives will be validated in real-world scenarios with the iCub humanoid robot engaged in whole-body goal-directed tasks. The evaluations will show the iCub exploiting rigid supportive contacts, learning to compensate for compliant contacts, and utilizing assistive physical interaction.

8.4. International Initiatives

8.4.1. Participation in Other International Programs

Serena Ivaldi, in collaboration with Prof. Dana Kulic of University of Waterloo, obtained a MITACS-Inria grant for the master student Jamie Waugh for the project "learning gait models".

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Francesco Nori, researcher at the Italian Institute of Technology, and coordinator of the European Project CoDyCo (where we are partners), visited our team for one month. During this visit, we wrote together a proposal for a H2020 project that was submitted in April 2016 and was subsequently accepted: the project, AnDy, will start in January 2017.
- John Rieffel, Associate Professor at Union College (NY, USA), visited our team for a month. During his visit, we used Bayesian optimization to learn gaits for a soft tensegrity robot. A paper has been submitted.

8.5.1.1. Internships

- Jamie Waugh, master student of University of Waterloo, visited our team for 3 months (from September to December) thanks to a MITACS-Inria grant.

<div align="center" style="color:red">LINKMEDIA Project-Team</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *CominLabs Project Linking Media in Acceptable Hypergraphs (LIMAH)*
Participants: Rémi Bois, Vincent Claveau, Guillaume Gravier, Grégoire Jadi, Pascale Sébillot, Arnaud Touboulic.

Duration: 4 years, started in April 2014
Partners: Telecom Bretagne (IODE), Univ. Rennes II (CRPCC, PREFics), Univ. Nantes (LINA/TAL)
URL: http://limah.irisa.fr

LIMAH aims at exploring hypergraph structures for multimedia collections, instantiating actual links reflecting particular content-based proximity—similar content, thematic proximity, opinion expressed, answer to a question, etc. Exploiting and developing further techniques targeting pairwise comparison of multimedia contents from an NLP perspective, LIMAH addresses two key issues: How to automatically build from a collection of documents an hypergraph, i.e., a graph combining edges of different natures, which provides exploitable links in selected use cases? How collections with explicit links modify usage of multimedia data in all aspects, from a technology point of view as well as from a user point of view? LIMAH studies hypergraph authoring and acceptability taking a multidisciplinary approach mixing ICT, law, information and communication science as well as cognitive and ergonomy psychology.

9.1.2. *CominLabs Project BigCLIN*
Participants: Vincent Claveau, Ewa Kijak, Clément Dalloux.

Duration: 3 years, started in September 2016
Partners: STL-CNRS, Inserm/CHU Rennes, Inria Cidre URL: http://www.bigclin.cominlabs.ueb.eu

Data collected or produced during clinical care process can be exploited at different levels and across different domains. Yet, a well-known challenge for secondary use of health big data is that much of detailed patient information is embedded in narrative text, mostly stored as unstructured data. The project proposes to address the essential needs when reusing unstructured clinical data at a large scale. We propose to develop new clinical records representation relying on fine-grained semantic annotation thanks to new NLP tools dedicated to French clinical narratives. To efficiently map this added semantic information to existing structured data for further analysis at big scale, the project also addresses distributed systems issues: scalability, management of uncertain data and privacy, stream processing at runtime, etc.

9.2. National Initiatives

9.2.1. *ANR Project IDFRAud*
Participant: Teddy Furon.

Duration: 3 years, started in Feb. 2015
Partners: AriadNext, IRCGN, École Nationale Supérieure de Police

The IDFRAud project consists in proposing an automatic solution for ID analysis and integrity verification. Our ID analysis goes through three processes: classification, text extraction and ID verification. The three processes rely on a set of rules that are externalized in formal manner in order to allow easy management and evolving capabilities. This leads us to the ID knowledge management module. Finally, IDFRAud addresses the forensic link detection problem and to propose an automatic analysis engine that can be continuously applied on the detected fraud ID database. Cluster analysis methods are used to discover relations between false IDs in their multidimensional feature space. This pattern extraction module will be coupled with a suitable visualization mechanism in order to facilitate the comprehension and the analysis of extracted groups of inter-linked fraud cases.

9.2.2. *FUI 19 NexGenTV*

Participants: Vincent Claveau, Guillaume Gravier, Ewa Kijak, Gabriel Sargent, Ronan Sicre.

Duration: 2.5 years, started in May 2015
Partners: Eurecom, Avisto Telecom, Wildmoka, Envivio-Ericsson

Television is undergoing a revolution, moving from the TV screen to multiple screens. Today's user watches TV and, at the same time, browses the web on a tablet, sends SMS, posts comments on social networks, searches for complementary information on the program, etc. Facing this situation, NexGen-TV aims at developing a generic solution for the enrichment, the linking and the retrieval of video content targeting the cost-cutting edition of second screen and multiscreen applications for broadcast TV. The main outcome of the project will be a software platform to aggregate and distribute video content via a second-screen edition interface connected to social media. The curation interface will primarily make use of multimedia and social media content segmentation, description, linking and retrieval. Multiscreen applications will be developed on various domaine, e.g., sports, news.

9.3. European Initiatives

9.3.1. *Collaborations with Major European Organizations*

> Big Data Value Association (BDVA)
> LINKMEDIA is a co-founder and co-leader of the media group (TF7) within BDVA

9.4. International Initiatives

9.4.1. *Inria Associate Teams Not Involved in an Inria International Labs*

9.4.1.1. MOTIF

> Title: Unsupervised motif discovery in multimedia content

> International Partner (Institution - Laboratory - Researcher):

>> Pontifícia Universidade Católica de Minas Gerais (Brazil) - Audio-Visual Information Processing Laboratory (VIPLAB) - Silvio Jamil Guimarães

>> Universidade Federal Minas Gerais, Brasil - NPDI - Arnaldo Albuquerque de Araújo

> Duration: 2014–2016

> MOTIF aims at studying various approaches to unsupervised motif discovery in multimedia sequences, i.e., to the discovery of repeated sequences with no prior knowledge on the sequences. On the one hand, we will develop symbolic approaches inspired from work on bioinformatics to motif discovery in the multimedia context, investigating symbolic representations of multimedia data and adaptation of existing symbolic motif discovery algorithms. On the other hand, we will further develop cross modal clustering approaches to repeated sequence discovery in video data, building upon previous work.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- National Institute for Informatics, Japan
- University of Amsterdam, The Netherlands
- Czech Technical University, Czech Republic
- Katholieke Universiteit Leuven, Belgium

9.4.3. Participation in Other International Programs

- PICS CNRS MM-Analytics
    - Title: Fouille, visualisation et exploration multidimensionnelle de contenus multimédia ; Multi-Dimensional Multimedia Browsing, Mining, Analytics (num 6382).
    - International Partner (Institution - Laboratory - Researcher):

        Reykjavík University, Iceland - Björn Þór Jónsson
    - Jan. 2014 – Dec. 2016
- CNRS – CONFAP FIGTEM
    - Title: Fine-grained text-mining for clinical trials
    - International Partner (Institution - Laboratory - Researcher): Pontifícia Universidade Católica do Paraná - Health Informatics dept, Claudia Moro

        FIGTEM aims at developing natural language processing methods, including information extraction and indexing, dedicated to the clinical trial domain. The goal is to populate a formal representation of patients (via their electronic patient records) and clinical trial data in different languages (French, English, Portuguese).
    - Jan. 2016 – Dec. 2018

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Claudia Moro, Lucas Oliveira

Date: Oct. 2016 (1 week)

Institution: Pontifícia Universidade Católica do Paraná - Health Informatics dept

Giorgos Tolias

Date: Sept. 2016 (1 week)

Institution: Czech Technical University, Czech Republic

9.5.1.1. Internships

Gabriel B. de Fonseca

Date: Nov. 2016 - Jan. 2017

Institution: PUC Minas, Brazil

9.5.2. Visits to International Teams

Vincent Claveau

Date: 7-17 December 2016

Institution: Helth Informatics dept, Pontifícia Universidade Católica do Paraná, Curitiba, Brazil

Vincent Claveau

Date: 7-13 May 2016

Institution: OLST, Univ. of Montreal, Canada

Guillaume Gravier, Simon Malinowski

Date: Jul. 2016 (1 week)

Institution: PUC Minas, Brazil

Ahmet Iscen

Date: Apr. 2016 - May 2016

Institution: Czech Technical University, Czech Republic

Vedran Vukotić

Date: Sep. 2016 - Dec. 2016

Institution: TU Delft, The Netherlands

<p align="center" style="color:red">LINKS Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

Links participates in the CPER DATA (2015-19)

8.2. National Initiatives

ANR Aggreg (2014-19): Aggregated Queries.

- Particpants: J. Niehren [correspondent], P. Bourhis, A. Lemay, A. Boiret
- The coordinator is J. Niehren and the parteners are the University Paris 7 (A. Durand) including members of the Inria project DAHU (L. Ségoufin), the University of Marseille (N. Creignou) and University of Caen (E. Grandjean).
- Objective: the main goal of the Aggreg project is to develop efficient algorithms and to study the complexity of answering aggregate queries for databases and data streams of various kinds.

ANR Colis (2015-20): Correctness of Linux Scripts.

- Participants: J. Niehren [correspondent], A. Lemay, S. Tison, A. Boiret, V. Hugot.
- The coordinator is R. Treinen from the University of Paris 7 and the other partner is the Tocata project of Inria Saclay (C. Marché).
- Objective: This project aims at verifying the correctness of transformations on data trees defined by shell scripts for Linux software installation. The data trees here are the instance of the file system which are changed by installation scripts.

ANR DataCert (2015-20):

- Participants: I. Boneva [correspondent], S. Tison, J. Lozano.
- Partners: The coordinator is E. Contejean from the University of Paris Sud and the other partner is the University of Lyon.
- Objective: the main goals of the Datacert project are to provide deep specification in Coq of algorithms for data integration and exchange and of algorithms for enforcing security policies, as well as to design data integration methods for data models beyond the relational data model.

ANR Headwork (2016-21):

- Participants: P. Bourhis [correspondant], J. Niehren, M. Sakho.
- Scientific partners: The coordinateur is D. Gross-Amblard from the Druid Team (Rennes 1). Other partners include the Dahu team (Inria Saclay) and Sumo (Inria Bretagne)
- Industrial partners: Spipoll, and Foulefactory.
- Objective: The main object is to develop data-centric workflows for programming crowd sourcing systems in flexible declarative manner. The problem of crowd sourcing systems is to fill a database with knowledge gathered by thousands or more human participants. A particular focus is to be put on the aspects of data uncertainty and for the representation of user expertise.

ANR Delta (2016-21):

- Participants: P. Bourhis [correspondent], D. Gallois.

- Partners: The coordinator is M. Zeitoun from LaBRI, other partners are LIF (Marseille) and IRIF (Paris-Diderot).
- Objective: Delta is focused on the study of logic, transducers and automata. In particular, it aims at extending classical framework to handle input/output, quantities and data.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

AMSud project "Foundations of Graph Databases" (2015-16)

Partners: Chili (C. Riveros), Buenos Aires (Figueira), Bordeaux (G. Puppis).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Domagoj Vrgoc, DCC PUC Chile, From Aug 2016 Until Sep 2016

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Slawek Staworko, University of Edinburgh, 2014-16.

MAGNET Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Participation to the *Data Advanced data science and technologies* project (CPER Data). This project, leaded by DAVID SIMPLOT-RYL, is organized following three axes: internet of things, data science, high performance computing. MAGNET is involved in the data science axis to develop machine learning algorithms for big data, structured data and heterogeneous data.

9.2. National Initiatives

9.2.1. ANR Pamela (2016-2020)

Participants: MARC TOMMASI [correspondent], AURÉLIEN BELLET, RÉMI GILLERON, FABIO VITALE

The Pamela project aims at developing machine learning theories and algorithms in order to learn local and personalized models from data distributed over networked infrastructures. Our project seeks to provide first answers to modern information systems built by interconnecting many personal devices holding private user data in the search of personalized suggestions and recommendations. More precisely, we will focus on learning in a collaborative way with the help of neighbors in a network. We aim to lay the first blocks of a scientific foundation for these new types of systems, in effect moving from graphs of data to graphs of data and learned models. We argue that this shift is necessary in order to address the new constraints arising from the decentralization of information that is inherent to the emergence of big data. We will in particular focus on the question of learning under communication and privacy constraints. A significant asset of the project is the quality of its industrial partners, Snips and Mediego, who bring in their expertise in privacy protection and distributed computing as well as use cases and datasets. They will contribute to translate this fundamental research effort into concrete outcomes by developing personalized and privacy-aware assistants able to provide contextualized recommendations on small devices and smartphones. https://project.inria.fr/pamela/.

9.2.2. ANR JCJC GRASP (2016-2020)

Participants: PASCAL DENIS [correspondent], AURÉLIEN BELLET, RÉMI GILLERON, MIKAELA KELLER, MARC TOMMASI

The GRASP project aims at designing new graph-based Machine Learning algorithms that are better tailored to Natural Language Processing structured output problems. Focusing on semi-supervised learning scenarios, we will extend current graph-based learning approaches along two main directions: (i) the use of structured outputs during inference, and (ii) a graph construction mechanism that is more dependent on the task objective and more closely related to label inference. Combined, these two research strands will provide an important step towards delivering more adaptive (to new domains and languages), more accurate, and ultimately more useful language technologies. We will target semantic and pragmatic tasks such as coreference resolution, temporal chronology prediction, and discourse parsing for which proper Machine Learning solutions are still lacking. https://project.inria.fr/grasp/.

9.2.3. ANR-NFS REM (2016-2020)

With colleagues from the linguistics departments at Lille 3 and Neuchâtel (Switzerland), PASCAL DENIS is a member of another ANR project (REM), funded through the bilateral ANR-NFS Scheme. This project, co-headed by I. Depreatere (Lille 3) and M. Hilpert (Neufchâtel), proposes to reconsider the analysis of English modal constructions from a multidisciplinary perspective, combining insights from theoretical, psycho-linguistic, and computational approaches.

9.2.4. EFL (2010-2020)

Pascal Denis is an associate member of the Laboratoire d'Excellence *Empirical Foundations of Linguistics* (EFL), http://www.labex-efl.org/.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

ERC-PoC 713626 SOM "Statistical modeling for Optimization Mobility": This project aims at bringing to practice results from the project ERC-StG 240186 MiGraNT in the domain of mobility and mobile devices. In particular, a proof of concept will be made of graph mining approaches to learn predictive models and/or recommendation systems from collections of data distributed over a large number of devices (cars, smartphones, ...) while caring about privacy-friendliness.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. Sci-GENERATION (2013-2017)

Program: COST

Project acronym: Sci-GENERATION

Project title: Next Generation of Young Scientist: Towards a Contemporary Spirit of R&I.

Duration: 2013-2017

Coordinator: Jan Ramon is an MC member for belgium and a core group member

Other partners: More information on http://scigeneration.eu/en/participants.html

Abstract: Sci-Generation is a COST targeted network that addresses the challenges faced by next generation of researchers in Europe. We aim to improve the visibility, inclusion and success of excellent young researchers and research teams in European science and policy-making. We study and deliberate how changes in research funding opportunities and career perspectives can facilitate these improvements. We wish to promote new and emergent research topics, methods and management organisations. We are developing recommendations for EU science policy that will foster transformations at national and regional levels to promote scientific excellence and to establish a true European research area. (See http://scigeneration.eu).

9.3.2.2. TextLink (2014-2018)

Program: COST Action

Project acronym: TextLink

Project title: Structuring Discourse in Multilingual Europe

Duration: Apr. 2014 - Apr. 2018

Coordinator: Prof. Liesbeth Degand, Université Catholique de Louvain, Belgium. Pascal Denis is member of the Tools group.

Other partners: 26 EU countries and 3 international partner countries (Argentina, Brazil, Canada)

Abstract: Effective discourse in any language is characterized by clear relations between sentences and coherent structure. But languages vary in how relations and structure are signaled. While monolingual dictionaries and grammars can characterize the words and sentences of a language and bilingual dictionaries can do the same between languages, there is nothing similar for discourse. For discourse, however, discourse-annotated corpora are becoming available in individual languages. The Action will facilitate European multilingualism by (1) identifying and creating a portal into such resources within Europe - including annotation tools, search tools, and discourse-annotated corpora; (2) delineating the dimensions and properties of discourse annotation across corpora; (3) organizing these properties into a sharable taxonomy; (4) encouraging the use of this taxonomy in subsequent discourse annotation and in cross-lingual search and studies of devices that relate and

structure discourse; and (5) promoting use of the portal, its resources and sharable taxonomy. With partners from across Europe, TextLink will unify numerous but scattered linguistic resources on discourse structure. With its resources searchable by form and/or meaning and a source of valuable correspondences, TextLink will enhance the experience and performance of human translators, lexicographers, language technology and language learners alike.

9.3.2.3. STAC (2011-2016)

Program: ERC Advanced Grant

Project acronym: STAC

Project title: Strategic conversation

Duration: Sep. 2011 - Aug. 2016

Coordinator: Nicholas Asher, CNRS, Université Paul Sabatier, IRIT (France)

Other partners: School of Informatics, Edinburgh University; Heriot Watt University, Edinburgh; Inria (PASCAL DENIS)

Abstract: STAC is a five year interdisciplinary project that aims to develop a new, formal and robust model of conversation, drawing from ideas in linguistics, philosophy, computer science and economics. The project brings a state of the art, linguistic theory of discourse interpretation together with a sophisticated view of agent interaction and strategic decision making, taking advantage of work on game theory.

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. RSS

Program: Inria North-European Labs

Project title: Rankings and Similarities in Signed graphs

Duration: late 2015 to late 2017

Partners: Aristides Gionis (Data Mining Group, Aalto University, Finland) and Mark Herbster (Centre for Computational Statistics and Machine Learning, University College London, UK)

Abstract: The project focuses on predictive analysis of networked data represented as signed graphs, where connections can carry either a positive or a negative semantic. The goal of this associate team is to devise novel formal methods and machine learning algorithms towards link classification and link ranking in signed graphs and assess their performance in both theoretical and practical terms.

9.4.1.2. LEGO

Title: LEarning GOod representations for natural language processing

International Partner (Institution - Laboratory - Researcher): University of California, Los Angeles (United States) - TEDS: Research group Theoretical and Empirical Data Science - Fei Sha

Start year: 2016

See also: https://team.inria.fr/lego/

Abstract: LEGO lies in the intersection of Machine Learning and Natural Language Processing (NLP). Its goal is to address the following challenges: what are the right representations for structured data and how to learn them automatically, and how to apply such representations to complex and structured prediction tasks in NLP? In recent years, continuous vectorial embeddings learned from massive unannotated corpora have been increasingly popular, but they remain far too limited to capture the complexity of text data as they are task-agnostic and fall short of modeling complex structures in languages. LEGO strongly relies on the complementary expertise of the two partners in areas such as representation/similarity learning, structured prediction, graph-based learning, and statistical NLP to offer a novel alternative to existing techniques. Specifically, we will

investigate the following three research directions: (a) optimize the embeddings based on annotations so as to minimize structured prediction errors, (b) generate embeddings from rich language contexts represented as graphs, and (c) automatically adapt the context graph to the task/dataset of interest by learning a similarity between nodes to appropriately weigh the edges of the graph. By exploring these complementary research strands, we intend to push the state-of-the-art in several core NLP problems, such as dependency parsing, coreference resolution and discourse parsing.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

We invited Soravit Changpinyo (University of Southern California) in October, collaborating with MATHIEU DEHOUCK, PASCAL DENIS and AURÉLIEN BELLET on multi-task learning and transfer of word embeddings.

JAN RAMON collaborated with WILHELMIINA HAMALAINEN, who visited the magnet lab for 2 weeks. In particular, they worked on multiple hypothesis tests for regression and discretization problems.

MARK HERBSTER from University College London was invited for one week in January and collaborated with FABIO VITALE and MARC TOMMASI on machine learning and similarity prediction in graphs.

Several international researchers have also been invited to give a talk at the MAGNET seminar:

- TIM VANDERCRUYS (Toulouse): "Modeling Meaning with Latent Factorization Models" (April)
- SORAVIT CHANGPINYO (University of Southern California): "Synthesized Classifiers for Zero-Shot Learning" (October)
- THOMAS KIPF (University of Amsterdam): "Deep Learning on Graphs with Graph Convolutional Networks" (December)

9.5.1.1. Local Workshops

- FABIO VITALE organized the workshop Graph-based Learning and Graph Mining.
- PASCAL DENIS organized the Workshop on Argumentation Mining.

9.5.2. Visits to International Teams

In March, April and May FABIO VITALE visited the Department of Computer Science of the University of Milan, collaborating with Prof. NICOLÒ CESA-BIANCHI and Prof. CLAUDIO GENTILE.

In July, AURÉLIEN BELLET and PASCAL DENIS visited the Department of Computer Science of the University of California (Los Angeles), collaborating with Prof FEI SHA.

In September, MATHIEU DEHOUCK visited the Department of Computer Science of the University of California (Los Angeles), collaborating with Prof FEI SHA.

Since September, FABIO VITALE is working at the department of computer science of Aalto University, Helsinki (Finland), in the DMG group (http://research.ics.aalto.fi/dmg/index.shtml) led by Prof. ARISTIDES GIONIS.

<p align="center">MAGRIT Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Lorraine regional project about AR for liver surgery (2015-2018)
  The MAGRIT and the MIMESIS teams have been working for several years on the use of augmented reality for deformable organs and especially on liver surgery. The PhD of Jaime Garcia started in October 2015 and is funded by the Région Lorraine. It follows on from our past works and aims at improving the reliability and the robustness of AR-based clinical procedures.

8.2. National Initiatives

8.2.1. *Projet RAPID EVORA*

Participant: M.-O. Berger, V. Gaudillière, G. Simon.
This 3-year project is supported by DGA/DGE and led by the SBS-Interactive company. The objective is to develop a prototype for location and object recognition in large-scale industrial environments (factories, ships...), with the aim to enrich the operator's field of view with digital information and media. The main issues concern the size of the environment, the nature of the objects (often non textured, highly specular...) and the presence of repeated patterns. Use cases will be provided by industrial partners such as DCNS and Areva. A class of officer cadets and professors of the Merchant Marine School will also be associated to judge the pedagogical interest of such a tool. A PhD student, Vincent Gaudillière, has been recruited to work on this project and his contract started on 1rst December 2016.

8.2.2. *Project funded by GDR ISIS in collaboration with Institut Pascal*

Participant: F. Sur.
Since June 2012, we have been engaged in a collaboration with Pr. Michel Grédiac. The aim is to give a mathematical analysis and to help improving the image processing tools used in experimental mechanics at Institut Pascal.

The TIMEX project (2014-2016) is funded by GDR ISIS ("Appel à projet exploratoire, projet interdisciplinaire"). It aims at investigating image processing tools for enhancing the metrological performances of contactless measurement systems in experimental mechanics.

8.2.3. *Collaboration with the MIMESIS team*

Participants: R. Anxionnat, M.-O. Berger, E. Kerrien.
The SOFA-InterMedS large-scale Inria initiative is a research-oriented collaboration across several Inria project-teams, international research groups and clinical partners. Its main objective is to leverage specific competences available in each team to further develop the multidisciplinary field of Medical Simulation research. Our action within the initiative takes place in close collaboration with both the MIMESIS team and the Department of diagnostic and therapeutic interventional neuroradiology of Nancy University Hospital. We aim at providing in-vivo models of the patient's organs, and in particular a precise geometric model of the arterial wall. Such a model is used by the MIMESIS team to simulate the coil deployment within an intracranial aneurysm. The associated medical team in Nancy, and in particular our external collaborator René Anxionnat, is in charge of validating our results. For three years, we have also been collaborating with the MIMESIS team about real-time augmentation of deformable organs.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Pierre-Frederic Villard has a "Harvard Affiliate" status through his collaboration with the Harvard Biorobotics Lab led by Professor Robert D. Howe. It follows a one year and a half sabbatical years (2014-2016) that Pierre-Frederic Villard spent in Harvard University in Cambridge (USA) working on heart valve modeling.

<p style="text-align:center; color:red; font-weight:bold;">MANAO Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Carer xD: "Caractérisation et restitution du réel xD"

Currently, the characterization and display of the real world are limited to techniques focusing on a subset of the necessary physical phenomena. A lot of work has been done to acquire geometric properties. However, the acquisition of a geometry on an object with complex reflection property or dynamic behavior is still a challenge. Similarly, the characterization of a material is limited to a uniform object for complex material or a diffuse material when one is interested in its spatial variations.

To reach full interaction between real and virtual worlds (augmented reality, mixed reality), it is necessary to acquire the real world in all its aspects (spatial, spectral, temporal) and to return it as in all these dimensions. To achieve this goal, a number of theoretical and practical tools will be developed around the development of mixed reality solutions and the development of some theoretical framework that supports the entire project.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. "Young Researcher" RichShape (2014-2018)

MANAO
Leader G. Guennebaud
This project aims at the development of novel representations for the efficient rendering and manipulation of highly detailed shapes in a multi-resolution context.

9.2.1.2. ALTA (2011-2016)

MAVERICK, REVES
Leader N. Holzschuch (MAVERICK)
The project ALTA aims at analyzing the light transport equations and at using the resulting representations and algorithms for more efficient computation. We target lighting simulations, either off-line, high-quality simulations or interactive simulations.

9.2.1.3. ISAR (2014-2017)

POTIOC, MANAO, LIG-CNRS-UJF, Diotasoft
Leader M. Hachet (POTIOC)
The ISAR project focuses on the design, implementation and evaluation of new interaction paradigms for spatial augmented reality, and to systematically explore the design space.

9.2.1.4. MATERIALS (2015-2019)

MAVERICK, LP2N-CNRS (MANAO), Musée d'Ethnographie de Bordeaux, OCÉ-Print
Leader N. Holzschuch (MAVERICK)
Local Leader R. Pacanowski (LP2N-CNRS)

Museums are operating under conflicting constraints: they have to preserve the artifacts they are storing, while making them available to the public and to researchers. Cultural artifacts are so fragile that simply exposing them to light degrades them. 3D scanning, combined with virtual reality and 3D printing has been used for the preservation and study of sculptures. The approach is limited: it acquires the geometry and the color, but not complex material properties. Current 3D printers are also limited in the range of colors they can reproduce. Our goal in this project is to address the entire chain of material acquisition and restitution. Our idea is to scan complex cultural artifacts, such as silk cloths, capturing all the geometry of their materials at the microscopic level, then reproduce them for study by public and researchers. Reproduction can be either done through 2.5D printing or virtual reality displays.

9.2.1.5. FOLD-Dyn (2016-2020)

IRIT, IMAGINE, MANAO, TeamTo, Mercenaries
Leader L. Barthe (IRIT)
Local Leader G. Guennebaud (Inria)
The FOLD-Dyn project proposes the study of new theoretical approaches for the effective generation of virtual characters deformations, when they are animated. These deformations are two-folds: character skin deformations (skinning) and garment simulations. We propose to explore the possibilities offered by a novel theoretical way of addressing character deformations: the implicit skinning. This method jointly uses meshes and volumetric scalar functions. By improving the theoretical properties of scalar functions, the study of their joint use with meshes, and the introduction of a new approach and its formalism - called multi-layer 3D scalar functions - we aim at finding effective solutions allowing production studios to easily integrate in their pipeline plausible character deformations together with garment simulations.

9.2.2. Competitivity Clusters

9.2.2.1. LabEx CPU

IMB (UPR 5251), LABRI (UMR 5800), Inria (CENTRE BORDEAUX SUD-OUEST), I2M (NEW UMR FROM 2011), IMS (UMR 5218), CEA/DAM
Some members of *MANAO* participate in the local initiative CPU. As it includes many thematics, from fluid mechanics computation to structure safety but also management of timetable, safety of networks and protocols, management of energy consumption, etc., numerical technology can impact a whole industrial sector. In order to address problems in the domain of certification or qualification, we want to develop numerical sciences at such a level that it can be used as a certification tool.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. PRISM

Title: Perceptual Representation of Illumination, Shape and Material

Programm: FP7

Duration: January 2013 - December 2016

Coordinator: JUSTUS-LIEBIG-UNIVERSITAET GIESSEN

Partners:

Justus-Liebig-Universitaet Giessen (Germany)

Katholieke Universiteit Leuven (Belgium)

Next Limit Sl (Spain)

Technische Universiteit Delft (Netherlands)

the Chancellor, Masters and Scholars of The University of Cambridge (United Kingdom)

Bilkent Üniversitesi (Turkey)

Universite Paris Descartes (France)

The University of Birmingham (United Kingdom)

Local Leader: Pascal Barla

Visual perception provides us with a richly detailed representation of the surrounding world, enabling us to make subtle judgements of 1) 3D shape, 2) the material properties of objects, and 3) the flow of illumination within a scene. Together, these three factors determine the intensity of a surface in the image. Estimating scene properties is crucial for guiding action and making decisions like whether food is edible. Visual 'look and feel' also plays a key role in industrial design, computer graphics and other industries. Despite this, little is known about how we visually estimate the physical properties of objects and illumination. Previous research has mainly focussed on one or two of the three causal factors independently, and from the viewpoint of a specific discipline. By contrast, in PRISM we take an integrative approach, to understand how the brain creates a richly detailed representation of the world by looking at how all three factors interact simultaneously. PRISM is radically interdisciplinary, uniting experts from psychology, neuroscience, computer science and physics to understand both the analysis and synthesis of shape, shading and materials. PRISM is intersectoral by uniting researchers from seven leading Universities and two industrial partners, enabling impact in basic research, technology and the creative industries. Through research projects, cross-discipline visits, and structured Course Modules delivered through local and network-wide training events, we will endow PRISM fellows with an unusually broad overview and the cross-sector skills they need to become future leaders in European research and development. Thus, by delivering early-career training embedded in a cutting-edge research programme, we aim to 1) springboard the next generation of interdisciplinary researchers on perceptual representations of 3D scenes and 2) cement long-term collaborations between sectors to enhance European perception research and its applications.

9.4. International Initiatives

9.4.1. International Partners

9.4.1.1. Rainbow Particle Imaging Velocimetry

Partner : KAUST - King Abdullah University of Science & Technology
We propose a new approach for snapshot imaging of time-resolved, non-stationary 3D fluid flows, which we term Rainbow Particle Imaging Velocimetry (RainbowPIV). Using only a single camera, RainbowPIV will be able to track a dense set of particles advected in the flow. This is achieved by illuminating the flow volume with a stack of monochromatic light planes at different wavelengths (a "rainbow"). Particles are tracked in 3D by both following their 2D spatial position and their change in color, depending on which light plane they traverse.

RainbowPIV will provide dense measurements of 3D velocity vectors, thus obtaining a dense 3D representation of a 3D velocity field. This will allow us to accurately image and understand many new types of flow, including turbulent flows within complex 3D geometries and particle trajectories, with limited optical access. After the initial exploration stage covered in this proposal, RainbowPIV could find many applications in science and engineering, for example to help understand combustion processes or flow through catalytic converters, between turbine blades, and inside inlet manifolds.

<div align="center">

MAVERICK Project-Team

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8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR BLANC: ALTA

Participants: Nicolas Holzschuch [contact], Cyril Soler.

We are funded by the ANR research program "Blanc" for a joint research project with two other Inria research teams, REVES in Sophia-Antipolis and Manao in Bordeaux. The goal of this project is studying light transport operators for global illumination, both in terms of frequency analysis and dimensional analysis. The grant started in October 2011, for 54 months.

8.1.2. ANR CONTINT: Galaxy/veRTIGE

Participants: Jean-Dominique Gascuel, Nicolas Holzschuch, Fabrice Neyret [contact].

RTIGE stands for Real-Time and Interactive Galaxy for Edutainment. This is an ANR CONTINT (Contents and Interactions) research program, for a joint research project with the EVASION Inria project-team, the GEPI and LERMA research teams at Paris Observatory, and the RSA Cosmos company. The goal of this project is to simulate the quality multi-spectral real-time exploration of the Galaxy with Hubble-like images, based on simulation data, statistical data coming from observation, star catalogs, and procedural amplification for stars and dust clouds distributions. RSA-Cosmos aims at integrating the results in digital planetariums (See Figures 16 and 17). The grant started in December 2010, for 60 months.

8.1.3. ANR CONTINT: MAPSTYLE

**Participants:** Joëlle Thollot [contact], Hugo Loi.

The MAPSTYLE project aims at exploring the possibilities offered by cartography and expressive rendering to propose original and new cartographic representations. Through this project, we target two types of needs. On the one hand, mapping agencies produce series paper maps with some renderings that are still derived from drawings made by hand 50 years ago: for example, rocky areas in the series TOP25 (to 1/25000) of the French Institut Géographique National (IGN). The rendering of these rocky areas must be automated and its effectiveness retained to meet the requirements of hikers safety. On the other hand, Internet mapping tools allow any user to become a cartographer. However, they provide default styles that cannot be changed (GeoPortal, Google Maps) or they are editable but without any assistance or expertise (CloudMade). In such cases, as in the case of mobile applications, we identify the need to offer users means to design map styles more personalised and more attractive to meet their expectations (decision-making, recreation, etc.) and their tastes. The grant started on October 2012, for 48 months.

8.1.4. ANR: Materials

Participants: Nicolas Holzschuch [contact], Romain Vergne.

Participants: Nicolas Holzschuch [contact], Romain Vergne. We are funded by the ANR for a joint research project on acquisition and restitution of micro-facet based materials. This project is in cooperation with Océ Print Logic technologies, the Museum of Ethnography at the University of Bordeaux and the Manao team at Inria Bordeaux. The grant started in October 2015, for 48 months.
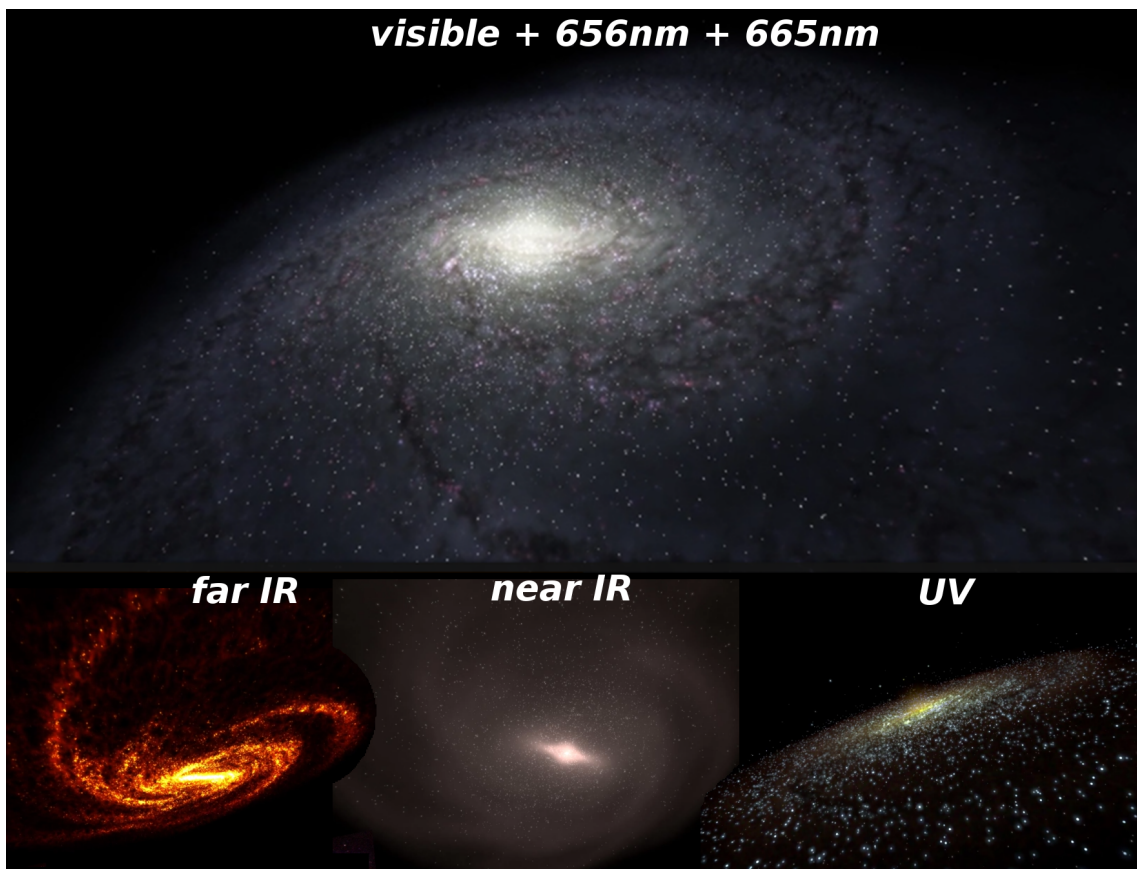
Figure 16. The interactive virtual galaxy integrated in the RSA Cosmos virtual planetarium Sky Explorer, rendered in real-time simulating various Hubble filters in the visible and invisible ranges.
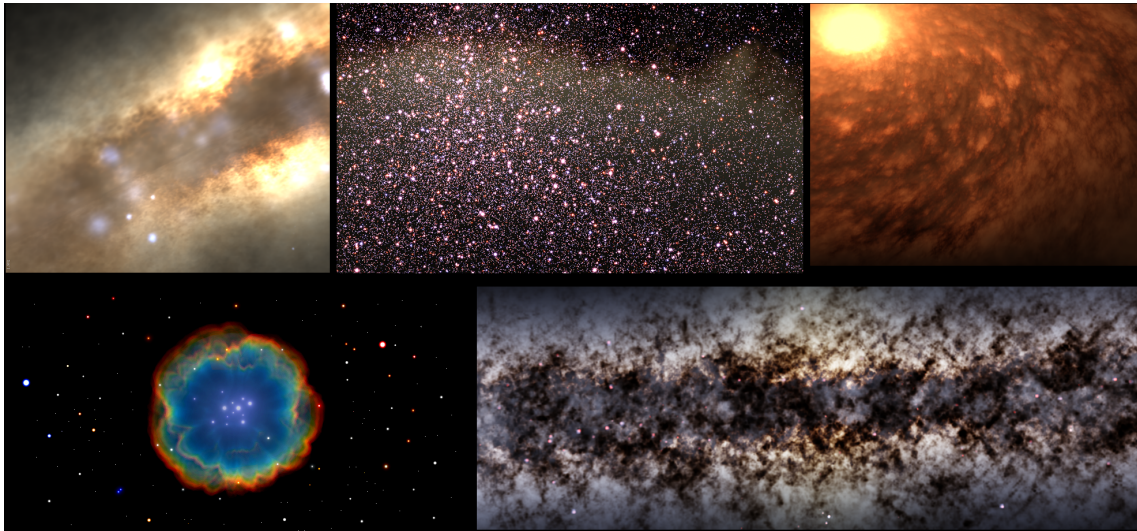
Figure 17. Some detailed views inside the galaxy using the experimental model GigaVoxels-veRTIGE.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Declared Inria International Partners

Title: "MAIS": Mathematical Analysis of Image Synthesis

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada) - Département d'Informatique et Recherche Opérationnelle - Derek Nowrouzezahrai

Duration: 2015 - 2019

Start year: 2015

See also: http://diro.umontreal.ca/accueil/

8.2.1.2. Informal International Partners

We have frequent exchanges and on-going collaborations with Cyril Crassin from nVIDIA-Research, and Eric Heitz, Laurent Belcour and Jonathan Dupuy from Unity-Research.

Maverick is part of the GPU Research Center labeled by nVIDIA at Inria Grenoble. Team contact: Fabrice NEYRET.

8.2.2. Participation in Other International Programs

8.2.2.1. Indo-French Center of Applied Mathematics

Topology-driven Visualization of Scientific Data

Title: Topology-driven Visualization of Scientific Data

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Deptartment of Science and Automation - Vijay Natarajan

Duration: Sept 2016 - Sept 2017

One of the greatest scientific challenges of the 21st century is how to master, organize, and extract useful knowledge from the overwhelming flow of information made available by today's data acquisition systems and computing resources. Visualization is the premium means of taking up this challenge. Topological analysis has recently emerged as a powerful class of methods for visualizing data. From the input data, these methods derive combinatorial structures capturing the essential features of the data. The goal of this project is to design new topological structures, study their properties, and develop efficient algorithms to compute them. In order to solve this challenge, we will combine our expertise in Topology for the Indian partner and in Geometric Modeling for the French partner. We plan to develop new geometric models that accurately and intuitively depict the topological combinatorial structures.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

8.3.1.1. Internships

Nucha Girijanandan

> Date: June 2016 - Jul 2016

> Institution: IIS (India) - Deptartment of Science and Automation

Nucha worked on the project "Topology Driven Visualisation of Scientific Data", along with G-P. Bonneau.

Santiago Montesdeoca

> Date: Oct 1st - Dec 31 2016

> MAGIC - Nanyang Technological University, Singapore.

Santiago is doing research in watercolor rendering of 3D animation and environments, developing new stylization approaches and enforcing direct stylization frameworks in expressive rendering. His research interests include expressive/non-photorealistic rendering, computer animation, real-time rendering and image processing.

8.3.2. Visits to International Teams

8.3.2.1. Sabbatical programme

Soler Cyril

> Date: Aug 2015 - Jul 2016

> Institution: Université de Montréal (Canada)

During his stay in Montreal, C.Soler has worked in Collaboration with D.Nowrouzezahrai and P.Poulin (U.of Montreal) and Guillaume Lavoué (Université Lyon-I), on two projects associated to material appearance capture and characterisation. At the time of writing these two projects are actively followed by all partners and publications will be submitted to ACM Transaction on Graphics within a few months. C.Soler has also presented his work in the seminar of the DIRO in October 2015.

8.3.2.2. Research Stays Abroad

Fabrice Neyret

> Date: Nov 2015 - Mar 2016

> Institution: WETA Digital (New-Zeland)

The content of this collaboration is covered by a NDA.

MIMETIC Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. Cineviz
Participants: Marc Christie [contact], Christophe Lino, Hui-Yin Wu.

Cineviz is a 3-year ANR LabCom project (2016-2019). Amount: 300kE. Parnters: SolidAnim, UR1.

The project is a bilateral collaboration with the SolidAnim company. The objective is to jointly progress on the design and implementation of novel tools for the preproduction in the film industry. The project will address the challenges related to (i) proposing expressive framing tools, (ii) integrating the technical aspects of shooting (how to place the cameras, lights, green sets) directly at the design stage), and (iii) novel interaction metaphors for designing and controlling the staging of lights in preproduction, using an example-based approach.

9.1.1.2. Cinecitta
Participants: Marc Christie [contact], Christophe Lino, Hui-Yin Wu.

Cinecitta is a 3.5 year ANR young researcher project lead by Marc Christie (ANR JCJC 2012-2016). Amount: 208kE.

The main objective of Cinecitta was to propose and evaluate a novel workflow which mixes user interaction using motion-tracked cameras and automated computation aspects for interactive virtual cinematography that will better support user creativity. We designed a novel cinematographic workflow that features a dynamic collaboration of a creative human filmmaker with an automated virtual camera planner. The process enhances the quality and utility of the automated planner's suggestions by adapting and reacting to the creative choices made by the filmmaker. This required three advances in the field. First, the ability to generate relevant viewpoint suggestions following classical cinematic conventions. The formalization of these conventions in a computationally efficient and expressive model is a challenging task in order to select and propose the user with a relevant subset of viewpoints among millions of possibilities. Second, the ability to analyze data from real movies in order to formalize some elements of cinematographic style and genre. Third, the integration of motion-tracked cameras in the workflow. Motion-tracked cameras represent a great potential for cinematographic content creation. However given that tracking spaces are of limited size, there is a need to provide novel interaction metaphors to ease the process of content creation with tracked cameras. Finally we gathered feedback on our prototype by involving professionals (during dedicated workshops) and numerous interactions with the Louis Lumière Film School.

9.1.1.3. Entracte
Participants: Charles Pontonnier [contact], Georges Dumont, Franck Multon, Pierre Plantard, Ana Lucia Cruz Ruiz, Antoine Muller, Anthony Sorel, Nicolas Bideau, Richard Kulpa.

The ANR project ENTRACTE is a collaboration between the Gepetto team in LAAS, Toulouse (head of the project) and the Inria/MimeTIC team. The project started in November 2013 and will end in August 2017. The purpose of the ENTRACTE project is to address the action planning problem, crucial for robots as well as for virtual human avatars, in analyzing human motion at a biomechanical level and in defining from this analysis bio-inspired motor control laws and bio-inspired paradigms for action planning. The project is launched since november 2013 and Ana Lucia Cruz Ruiz, who has been recruited as a PhD student since this date, just defended her thesis on muscle-based control based on synergies.

9.1.2. National scientific collaborations

9.1.2.1. Cavaletic
Participant: Franck Multon.

The Cavaletic collaborative project is leaded by University Bretagne Sud and also involves University Rennes2 (CREAD Lab.). It has been funded by the National IFCE (Institut Français du Cheval et de l'Equitation) in order to develop and evaluate technological assistance in horse riding learning, thanks to a user-centered approach. MimeTIC is involved in measuring expert and non-expert horse riders' motions in standardized situations in order to develop metrics to measure riders' performance. It will be used to develop a technological system embedded on users to evaluate their performance and provide them with real-time feedback to correct potential errors.

9.1.2.2. FFT
Participants: Richard Kulpa, Benoit Bideau, Pierre Touzard.

An exclusive contract has been signed between the M2S laboratory and the French Federation of Tennis for three years. The goal is to perform biomechanical analyses of 3D tennis serves on a population of 40 players of the Pôle France. The objective is to determine the link between injuries and biomechanical constraints on joints and muscles depending on the age and gender of the players. At the end, the goal is to evaluate their load training.

9.1.2.3. gDGA
Participants: Antonio Mucherino, Ludovic Hoyet, Franck Multon.

gDGA (generalization of the Distance Geometry and its Applications) is a INS2I/CNRS PEPS project involving local and national partners. Distance geometry can nowadays be seen as a classical problem in operational research, having a wide range of applications. The main aim of this interdisciplinary project is to extend the definition and the range of applicability of distance geometry. In particular, our main interest is on dynamical problems, motivated by a certain number of applications of interest, including interaction motion adaptation, the simulation of crowd behaviours, and the conception of modern recommender systems. The classical application of distance geometry arising in the biological field is also taken into consideration. The necessity of a strong computational power for the considered applications motivates the need of implementing our algorithms in environments capable of exploiting the resources on GPU cards.

9.1.2.4. IRMA
Participants: Ronan Gaugne [contact], Georges Dumont.

The IRMA project is an Imag'In project funded by CNRS which aims at developing innovative methodologies for research in the field of cultural heritage based on the combination of medical imaging technologies and interactive 3D technologies (virtual reality, augmented reality, haptics, additive manufacturing). It relies on close collaborations with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET. The developed tools are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. We focus on a large number of archeological artefacts of different nature, and various time periods (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We can notably mention the oldest human bones found in Brittany (clavicle Beg Er Vil), a funeral urn from Trebeurden (22), or a Bronze Cauldron from a burial of the Merovingian necropolis "Crassés Saint-Dizier" (51). This project involves a strong collaboration with members of the team Hybrid (Valérie Gouranton, Bruno Arnaldi and Jean-Baptiste Barreau), Théophane Nicolas (Inrap/UMR Trajectoires), Quentin Petit (SED Inria Rennes), and Grégor Marchand (CNRS/UMR CReAAH).

9.1.3. ADT: Immerstar
Participants: Franck Multon, Georges Dumont, Ronan Gaugne.

The ADT-Immerstar is driven by the SED and aims at developing new tools and facilities for the scientific community in order to develop demos and use the two immersive rooms in Rennes: Immersia and Immermove. The engineer (Quentin Petit, SED) has the responsibility of homogenizing the software modules and development facilities in each platform, of installing new upgrades and of developing collaborative applications between the two sites.

9.1.4. PRE

Participants: Franck Multon, Ludovic Hoyet.

The Inria PRE entitled "Smart sensors and novel motion representation breakthrough for human performance analysis" aims at designing a new description for human motion in order to automatically capture, measure and transfer the intrinsic constraints of human motion. Current approaches consist in manually editing the constraints associated with a motion, to use classical skeleton representation with joint angles based on direct or indirect measurements, and then perform inverse kinematics to fulfill these constraints. We aim at designing a new representation to simplify this process pipeline and make it automatic, together with relevant motion sensors that could provide enough information to automatically extract these intrinsic constraints. To this end, this project has been jointly proposed with the Inria CAIRN team, which develops sensors based on joint orientations and distances between sensors. We aim at extending this type of device to measure new types of information that would help to simplify the above mentionned pipeline. Zhiguang Liu started to work as a research fellow on this project since November 2016, working in collaboration with CAIRN. We also involved Hubert Shum from Northumbria University to link this project with our long-term collaboration on this type of problems.

9.2. International Initiatives

9.2.1. Inria Associate Teams Not Involved in an Inria International Labs

9.2.1.1. FORMOSA

> Title: Fostering Research on Models for Storytelling Applications
>
> International Partner (Institution - Laboratory - Researcher):
>
> > NCCU (Taiwan) - Intelligent Media Lab (IML) - Tsai-Yen Li
>
> Start year: 2016
>
> See also: http://www.irisa.fr/mimetic/GENS/mchristi/EA-FORMOSA/
>
> Interactive Storytelling is a new media which allows users to alter the content and outcome of narratives through role-playing and specific actions. With the quality, the availability and reasonable costs of display technologies and 3D interaction devices on one side, and the accessibility of 3D content creation tools on the other, this media is taking a significant share in entertainment (as demonstrated by the success of cinematographic games such as Heavy Rain or Beyond: two souls). These advances push us to re-think the way narratives are traditionally structured, explore new interactive modalities and provide new interactive cinematographic experiences. As a sequel of the first associate team FORMOSA 1, we propose to address new challenges pertained to interactive storytelling such as the use of temporal structures in narratives, interaction modalities and their impact in terms of immersion, and the adaptation of cinematographic real data to 3D environments. To achieve these objectives, the associate team will rely on the complementary skills of its partners and on the co-supervision of students.

9.2.1.2. RE-SIMS

> Title: REal data against crowd SImulation algorithMS
>
> International Partner (Institution - Laboratory - Researcher):
>
> > University of North Carolina at Chapel Hill (United States) - GAMMA Research Group (GAMMA) - Ming LIN

Start year: 2015

See also: http://www.irisa.fr/mimetic/GENS/jpettre/EASIMS/easims.html

RE-SIMS aims at gathering the best international research teams working on crowd simulation to allow significant progresses on the level of realism achieved by crowd simulators. To this end, RE-SIMS aims at improving methods for capturing crowd motion data that describe real crowd behaviors, as well as by improving data assimilation techniques.

In this renewal, RE-SIMS extends the previous SIMS partnership and follows a multidiciplinary direction.

9.2.2. Informal Inria International Partners

Dr. Edouard Auvinet, Imperial College London, UK (collaboration with Franck Multon, visited the team for a wekk in November)

Dr. Douglas S. Gonçalves, Federal University of Santa Catarina, Florianópolis, Brazil (collaboration with Antonio Mucherino, visited the team in December)

Prof. Carlile Lavor, UNICAMP, Campinas, São Paulo, Brazil (collaboration with Antonio Mucherino)

Dr. Rachel McDonnell, Trinity College Dublin, Ireland (collaboration with Ludovic Hoyet, joint paper submission)

Prof. Carol O'Sullivan, Trinity College Dublin, Ireland (collaboration with Ludovic Hoyet, visited the team for a week in June)

Dr. Huber Shum, Northumbria University, Newcastle, UK (collaboration with Franck Multon and Ludovic Hoyet, with joint papers and supervision, visited the team in November)

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Dr. Edouard Auvinet, Imperial College London, UK (one week in November)

Dr. Douglas S. Gonçalves, Federal University of Santa Catarina, Florianópolis, Brazil (one week in December)

Prof. Carol O'Sullivan, Trinity College Dublin, Ireland (one week in June)

Dr. Hubert Shum, Northumbria University, Newcastle, UK (joint supervision, visit for two days in November)

9.3.1.1. Internships

Yihun Shen, Northumbria University, Newcastle, UK (PhD supervisor: Dr. Hubert Shum), 4-month internship on Rennes Metropole incoming mobility funding (Sept. to Dec. 2016).

<p style="color:red; text-align:center;">**MINT Project-Team**</p>

8. Partnerships and Cooperations

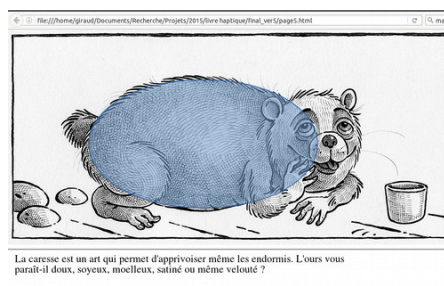## 8.1. Regional Initiatives

8.1.1. StimTac, 2015-2017

Participants: Frédéric Giraud [correspondant], Patricia Plénacoste, Laurent Grisoni, Michel Amberg, Nicolas Bremmard.

The aim of this project is to create the first digital book, enhanced with haptic feedback, in order to anticipate the integration of this technology into everyday products. This project adresses technological issues, like programming haptic content in a multimedia software, and design issues to understand how the haptic feedback is perceived by the users.

Stimtac is a book, and could thus be presented to non-specialists users and to a wide public during presentations, demos and foru. The scenario and the illustrations were made by Dominique Maes, a belgium artist, who did the digital book "bleu de toi" among other things. The Public Library of Lille is a partner of this project and allows us to meet the public.
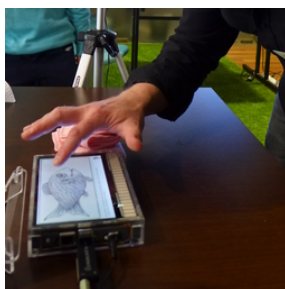
(a)   (b)

Figure 4. Demo session at "La nuit des Bibliothèques (Lille, October 2016), and a page of Stimtac; the ellipse highlights the tactile feedback on E-Vita.

This project has been granted 8Keuros from IRCICA.

8.2. National Initiatives

8.2.1. Touchit (13th FUI, May 2012-2015)

Participants: Michel Amberg, Frédéric Giraud, Betty Lemaire-Semail [correspondant].

The purpose of this project is twofold. It aims at designing and implementing hardware solutions for tactile feedback based on programmable friction. It also aims at developing the knowledge and software tools required to use these new technologies for human-computer interaction. Grant for MINT is balanced on 272 keuro handled at University for L2EP, and 220 Keuros for Inria.

Partners: STMicroelectronics, CEA/LETI, Orange Labs, CNRS, EASii IC, MENAPIC and ALPHAUI.

Competitive clusters involved: Minalogic, Cap Digital and MAUD.

8.2.2. *Equipex IRDIVE (ANR project 2012-2020)*

3 Meuros project, co-funded by ERDF for the developpement of a pluri-disciplinary project on ICT-based tools for understanding human perception of visual contents. Laurent Grisoni is member of the lead group of this project, and animates an axis devoted to art-sciences and technologies collaborations.

8.2.3. *MAUVE CPER ("Contrat de Plan État-Région") 2016-2020 project*

Funds: 4 Meuros (validated at national level, funded by Region), and 1 Meuro additional funding provided by ERDF.
Subject: ICT tools for mediation and access to knowledge.
Lead: University of Lille, University of Artois. Laurent Grisoni is co-lead of this project.

8.2.4. *Projet FUI HID: lead Holusion (2016-2018)*

Participants: Laurent Grisoni [correspondant], Samuel Degrande, Fabrice Aubert.

290 Keuros for MINT. Funding for two 18 months contracts and 24 months of post-doc.
Subject: rationalized process for industrial use of holographic displays.
MINT contribution: anamorphic software tools for holographics displays, and study of interactive aspects, including collaborative activities. This project has been prematurily stopped by french government.

8.2.5. *InriaRT*

Participants: Laurent Grisoni [correspondant], Samuel Degrande, Francesco de Comité.

Art/science Inria internal network gathering projects interested in collaborating with artists.
Inria teams involved: MuTANT (paris), Imagine (grenoble), Flowers, Potioc (Bordeaux), Hybrid, MimeTic (Rennes). This initiative shall take advantage of an agreement between Inria and french ministry of culture, signed early december 2016.

8.2.6. *MATRICE (sept 2015-sept. 2017*

Participant: Laurent Grisoni [correspondant].

This regional project, funded by ERDF, led by lille school of architecture, aims at understanding in which way 3D printing may be interesting for the building economy. partners: école d'architecture de Lille, Inria, ecole centrale de lille, télécome Lille 1, Ecole des mines de douai.

8.3. International Initiatives

8.3.1. *Inria International Partners*

8.3.1.1. *Informal International Partners*

- INESC-ID: collaboration with Joaquim Jorge (Talaria paper, published at ISS'16)
- Collaboration with Mrad UofT (paper published, harvesting energy)

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

- Dr. Luke Dahl (University of Virginia) for the BOEUF project
- Masaya Takasaki and Masayuki Hara (University of Saitama, Japan) 22nd of january
- Masaya Takasaki has also been visiting Professor at University lille1 (April, 18th - April 30th)

8.4.1.1. *Internships*

visiting PhD student from University of Chile: Orlando Errazo (nov 2015-jan 2016). One publication currently on submission.

<div align="center">

Mjolnir Team

</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Mjolnir/UCLIC associate team (Inria Lille, 2015-2017)

Participants: Sylvain Malacria [correspondent], Nicolas Roussel.

The goal of this project is the design and implementation of novel cross-device systems and interaction techniques that minimize the cost of divided attention. Of particular interest are notification systems on smart watches and in distributed computing systems. More precisely, we design cross-device activity and notifications monitor that will intercept external (e.g. new e-mail) and internal (e.g. a video editing software completed an export) notifications and distribute them to the device users are currently wearing/interacting with in order to minimize notification redundancy.

Partner: University College London Interaction Centre (United Kingdom).

9.2. National Initiatives

9.2.1. Turbotouch (ANR, 2014-2018)

Participants: Géry Casiez [correspondent], Nicolas Roussel, Thomas Pietrzak.

Touch-based interactions with computing systems are greatly affected by two interrelated factors: the transfer functions applied on finger movements, and latency. This project aims at transforming the design of touch transfer functions from black art to science to support high-performance interactions. We are working on the precise characterization of the functions used and the latency observed in current touch systems. We are developing a testbed environment to support multidisciplinary research on touch transfer functions and will use this testbed to design latency reduction and compensation techniques, and new transfer functions.

Partners: Inria Lille's NON-A team and the "Perceptual-motor behavior group" from the Institute of Movement Sciences.

Web site: http://mjolnir.lille.inria.fr/turbotouch/

Related publications: [20], [35], [19], [34], [37], [42]

9.2.2. ParkEvolution (Carnot Inria - Carnot STAR, 2015-2017)

Participants: Géry Casiez [correspondent], Sébastien Poulmane.

This project studies the fine motor control of patients with Parkinson disease in an ecological environment, at home, without the presence of experimenters. Through longitudinal studies, we collect raw information from pointing devices to create a large database of pointing behavior data. From the analysis of this big dataset, the project aims at inferring the individual's disease progression and influence of treatments.

Partners: the "Perceptual-motor behavior group" from the Institute of Movement Sciences and Hôpital de la Timone.

Web site: http://parkevolution.org/

9.2.3. BCI-LIFT (Inria Project Lab, 2015-2019)

Participants: Géry Casiez, Nicolas Roussel [correspondent].

The goal of this large-scale initiative is to design a new generation of non-invasive Brain-Computer Interfaces (BCI) that are easier to appropriate, more efficient, and suited for a larger number of people.

Partners: Inria's ATHENA, NEUROSYS, POTIOC, HYBRID & DEMAR teams, *Centre de Recherche en Neurosciences de Lyon* (INSERM) and INSA Rouen.

Web site: https://bci-lift.inria.fr/

Related publications: [38], [15], [14], [41]

9.3. European Initiatives

9.3.1. *Happiness (H2020-ICT-2014-1/ICT-03-2014/RIA, 2015-2018)*

Participants: Christian Frisson, Julien Decaudin, Thomas Pietrzak [correspondent], Nicolas Roussel.

The main objective of this project is to develop and evaluate new types of haptic actuators printed on advanced Thin, Organic and Large Area Electronics (TOLAE) technologies for use in car dashboards. These actuators are embedded in plastic molded dashboard parts. The expected outcome is a marketable solution for haptic feedback on curved interactive surfaces.

Partners: CEA (coordinator), Inria Rennes' HYBRID team, Arkema, Bosch, Glasgow University, ISD, Walter Pack, Fundacion Gaiker.

Web site: http://happiness-project.eu/

Related publication: [29]

9.4. International Initiatives

9.4.1. *MIDWAY (Inria associate team, 2014-2016)*

Participants: Fanny Chevalier, Stéphane Huot [correspondent], Justin Mathew.

The goal of the project is the design and implementation of a musical interaction design workbench to facilitate the exploration and definition of new interactive technologies for both musical creation and performance.

Partner: Inria Saclay's EXSITU team and the Input Devices and Music Interaction Laboratory (IDMIL) from the Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT) at McGill University, Canada.

Web site: http://insitu.lri.fr/MIDWAY/

Related publication: [43]

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Visiting scholars:
- Marcelo Wanderley, Professor at McGill University, Canada (3 one week visits in April, October & December)
- Edward Lank, Associate Professor at the University of Waterloo, Canada (since September)
- Daniel Wigdor, Associate Professor at the University of Toronto, Canada (April 2016)
- Baptiste Caramiaux, Post-Doctoral researcher at McGill University, Canada, & IRCAM (December)

Internships:
- Filipe Calegario, PhD student at McGill University, Canada (January)
- Nicholas Fellion, Master's student at Carleton University, Canada (from January to April)
- Aakar Gupta, PhD student at the University of Toronto, Canada (from June to September)
- Hrim Mehta, PhD student at the Ontario Institute of Technology, Canada (from May to August)
- Anastasia Kuzminykh, PhD student at the University of Waterloo, Canada (from October to December)

<p style="text-align:center; color:red">MORPHEO Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. ARC6 project PADME – Perceptual quality Assessment of Dynamic MEshes and its applications

In this project, we propose to use a new and experimental "bottom-up" approach to study an interdisciplinary problem, namely the objective perceptual quality assessment of 3D dynamic meshes (i.e., shapes in motion with temporal coherence). The objectives of the proposed project are threefold:

1. to understand the HVS (human visual system) features when observing 3D animated meshes, through a series of psychophysical experiments;
2. to develop an efficient and open-source objective quality metric for dynamic meshes based on the results of the above experiments;
3. to apply the learned HVS features and the derived metric to the application of compression and/or watermarking of animated meshes.

This work is funded by the Rhône-Alpes région through an ARC6 grant for the period 2013-2016. The three partners are LIRIS (University Lyon 1, Florent Dupont), GIPSA-Lab (CNRS, Kai Wang) and LJK (University of Grenoble, Franck Hétroy-Wheeler). A PhD student, Georges Nader, is working on this project.

9.2. National Initiatives

9.2.1. Persyval-Lab exploratory project Carambole

The Carambole projects initiates a new collaboration between the Morpheo team and biophysicists from University Paris Diderot. The objectives are to develop hardware and software to help tracking feature points on a leaf of Averrhoa Carambola during its growth with a multi-camera system and to measure their 3D motion. Averrhoa carambola is of special interest because of the distinctive nutation balancing motion of a leaf during its growth.
This exploratory project is funded for 18 months in 2016 and 2017 by the Persyval-Lab LabEx.

9.2.2. ANR

9.2.2.1. ANR project Achmov – Accurate Human Modeling in Videos

The technological advancements made over the past decade now allow the acquisition of vast amounts of visual information through the use of image capturing devices like digital cameras or camcorders. A central subject of interest in video are the humans, their motions, actions or expressions, the way they collaborate and communicate. The goal of ACHMOV is to extract detailed representations of multiple interacting humans in real-world environments in an integrated fashion through a synergy between detection, figure-ground segmentation and body part labeling, accurate 3D geometric methods for kinematic and shape modeling, and large-scale statistical learning techniques. By integrating the complementary expertise of two teams (one French, MORPHEO and one Romanian, CLVP), with solid prior track records in the field, there are considerable opportunities to move towards processing complex real world scenes of multiple interacting people, and be able to extract rich semantic representations with high fidelity. This would enable interpretation, recognition and synthesis at unprecedented levels of accuracy and in considerably more realistic setups than currently considered. This project is currently ongoing with 2 PhDs on the Inria side: Vincent Leroy and Jinlong Yang.

9.2.3. Competitivity Clusters

9.2.3.1. FUI project Creamove

Creamove is a collaboration between the Morpheo team of the Inria Grenoble Rhône-Alpes, the 4D View Solution company specialized in multi-camera acquisition systems, the SIP company specialized in multi-media and interactive applications and a choreographer. The objective is to develop new interactive and artistic applications where humans can interact in 3D with virtual characters built from real videos. Dancer performances will be pre-recorded in 3D and used on-line to design new movement sequences based on inputs coming from human bodies captured in real time. Website: http://www.creamove.fr.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

9.3.1.1.1. Joint projects with the Forestry Commission, UK

A common project with an ecophysiologist from the British Forestry Commission, Eric Casella, is currently carried out. It aims at reconstructing accurate virtual models of forest trees, for biomass measurement purposes. This project is called Digitree and is funded by the University of Grenoble Alpes, through the AGIR framework. A PhD student, Romain Rombourg, is working on it. Two presentations related to this project have been made this year at the FSPMA conference [15], [21].

The long term collaboration with TU Munich and Slobodan Ilic on human motion capture is ongoing with the work of Paul Huang [10] that was published at CVPR this year. The work contributes with an approach that combines detection by learning with traditional generative tracking approaches.

<p style="text-align:center;color:red;font-weight:bold;">MULTISPEECH Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CORExp

Project acronym: CORExp

Project title: Acquisition, Processing and Analysis of a Corpus for the Synthesis of Expressive Audiovisual Speech

Duration: December 2014 - December 2016

Coordinator: Slim Ouni

Cofunded by Inria and Région Lorraine

Abstract: The main objective of this project was the acquisition of a bimodal corpus of a considerable size (several thousand sentences) to study the expressiveness and emotions during speech (for example, how to decode facial expressions that are merged with speech signals). The main purpose was to acquire, process and analyze the corpus and to study the expressiveness; the results will be used for the expressive audiovisual speech synthesis system.

9.1.2. CPER LCHN

Project acronym: CPER LCHN

Project title: CPER "Langues, Connaissances et Humanités Numériques"

Duration: 2015-2020

Coordinator: Bruno Guillaume (LORIA) & Alain Polguère (ATILF)

Abstract: The main goal of the project is related to experimental platforms for supporting research activities in the domain of languages, knowledge and numeric humanities engineering.

MULTISPEECH contributes to automatic speech recognition, speech-text alignment and prosody aspects.

9.1.3. CPER IT2MP

Project acronym: CPER IT2MP

Project title: CPER "Innovation Technologique Modélisation et Médecine Personalisée"

Duration: 2015-2020

Coordinator: Faiez Zannad (Inserm-CHU-UL)

Abstract: The goal of the project is to develop innovative technologies for health, and tools and strategies for personalized medicine.

MULTISPEECH will investigate acoustic monitoring using an array of microphones.

9.1.4. SATT Dynalips

Project title: Control of the movements of the lips in the context of facial animation for an intelligible lipsync.

Duration: May 2016 - December 2017

Coordinator: Slim Ouni

Abstract: We propose in this project the development of tools of lipsync which from recorded speech will provide realistic mechanisms of animating the lips. These tools will be available to be integrated into existing 3D animation software and existing game engines. One objective is that these lipsync tools fit easily into the production pipeline in the field of 3D animation and video games. The goal of this maturation is to propose a product ready to be exploited in the industry whether by the creation of a start-up or by the distribution of licenses.

9.2. National Initiatives

9.2.1. EQUIPEX ORTOLANG

Project acronym: ORTOLANG [0]

Project title: Open Resources and TOols for LANGuage

Duration: September 2012 - December 2016 (phase I)

Coordinator: Jean-Marie Pierrel, ATILF (Nancy)

Other partners: LPL (Aix en Provence), LORIA (Nancy), Modyco (Paris), LLL (Orléans), INIST (Nancy)

Abstract: The aim of ORTOLANG was to propose a network infrastructure offering a repository of language data (corpora, lexicons, dictionaries, etc.) and tools and their treatment that are readily available and well-documented. This will enable a real mutualization of analysis research, of modeling and automatic treatment of the French language. This will also facilitate the use and transfer of resources and tools set up within public laboratories towards industrial partners, in particular towards SME which often cannot develop such resources and tools for language treatment due to the costs of their realization. Moreover, this will promote the French language and local languages of France by sharing knowledge which has been acquired by public laboratories.

Several teams of the LORIA laboratory contribute to this Equipex, mainly with respect to providing tools for speech and language processing. MULTISPEECH contributes with text-speech alignment and speech visualization tools.

9.2.2. E-FRAN METAL

Project acronym: E-FRAN METAL

Project title: Modèles Et Traces au service de l'Apprentissage des Langues

Duration: October 2016 - September 2020

Coordinator: Anne Boyer (LORIA)

Other partners: Interpsy, LISEC, ESPE de Lorraine, D@NTE (Univ. Versailles Saint Quentin), Sailendra SAS, ITOP Education, Rectorat.

Abstract: METAL aims at improving the learning of languages (both written and oral components) through the development of new tools and the analysis of numeric traces associated with students' learning, in order to adapt to the needs and rythm of each learner.

Multispeech is concerned by oral language learning aspects.

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[0] http://www.ortolang.fr

9.2.3. PIA2 ISITE LUE

Project acronym: ISITE LUE

Project title: Lorraine Université d'Excellence

Duration: starting in 2016

Coordinator: Univ. Lorraine

Abstract: The initiative aims at developing and densifying the initial perimeter of excellence, within the scope of the social and economic challenges, so as to build an original model for a leading global engineering university, with a strong emphasis on technological research and education through research. For this, we have designed LUE as an "engine" for the development of excellence, by stimulating an original dialogue between knowledge fields.

MULTISPEECH is mainly concerned with challenge number 6: "Knowledge engineering", i.e., engineering applied to the field of knowledge and language, which represent our immaterial wealth while being a critical factor for the consistency of future choices. In 2016, this project has funded a new PhD thesis.

9.2.4. ANR ContNomina

Project acronym: ContNomina

Project title: Exploitation of context for proper names recognition in diachronic audio documents

Duration: February 2013 - March 2017

Coordinator: Irina Illina

Other partners: LIA, Synalp

Abstract: The ContNomina project focuses on the problem of proper names in automatic audio processing systems by exploiting in the most efficient way the context of the processed documents. To do this, the project addresses the statistical modeling of contexts and of relationships between contexts and proper names; the contextualization of the recognition module (through the dynamic adjustment of the lexicon and of the language model in order to make them more accurate and certainly more relevant in terms of lexical coverage, particularly with respect to proper names); and the detection of proper names (on the one hand, in text documents for building lists of proper names, and on the other hand, in the output of the recognition system to identify spoken proper names in the audio/video data).

9.2.5. ANR ORFEO

Project acronym: ORFEO [0]

Project title: Outils et Ressources pour le Français Écrit et Oral

Duration: February 2013 - February 2016

Coordinator: Jeanne-Marie DEBAISIEUX (Université Paris 3)

Other partners: ATILF, CLLE-ERSS, ICAR, LIF, LORIA, LATTICE, MoDyCo

Abstract: The main objective of the ORFEO project is the constitution of a corpus for the study of contemporary French.

In this project, we were concerned by the automatic speech-text alignment at the word and phoneme levels for audio files from several corpora gathered by the project. These corpora orthographically transcribed with Transcriber contain mainly spontaneous speech, recorded under various conditions with a large SNR range and a lot of overlapping speech and anonymised speech segments. For the forced speech-text alignment phase, we applied our 2-step methodology (the first step uses a detailed acoustic model for finding the pronunciation variants; then, in the second step a more compact model is used to provide more temporally accurate boundaries).

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[0] http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx_lwmsuivibilan_pi2[CODE]=ANR-12-CORP-0005

9.2.6. ANR-DFG IFCASL

Project acronym: IFCASL

Project title: Individualized feedback in computer-assisted spoken language learning

Duration: March 2013 - December 2016

Coordinator: Jürgen Trouvain (Saarland University)

Other partners: Saarland University (COLI department)

Abstract: The main objective of IFCASL is to investigate learning of oral French by German speakers, and oral German by French speakers at the phonetic level.

A French-German learner corpus was designed and recorded. French speakers were recorded in Nancy, whereas German speakers were recorded in Saarbrücken. An automatic speech-text alignment process was applied on all the data. Then, the French speech data (native and non-native) were manually checked and annotated in France, and the German speech data (native and non-native) were manually checked and annotated in Germany. The corpora are currently used for analyzing non-native pronunciations, and studying feedback procedures.

9.2.7. ANR DYCI2

Project acronym: DYCI2 [0]

Project title: Creative Dynamics of Improvised Interaction

Duration: March 2015 - February 2018

Coordinator: Ircam (Paris)

Other partners: Inria (Nancy), University of La Rochelle

Abstract: The goal of this project is to design a music improvisation system which will be able to listen to the other musicians, improvise in their style, and modify its improvisation according to their feedback in real time.

9.2.8. ANR JCJC KAMoulox

Project acronym: KAMoulox

Project title: Kernel additive modelling for the unmixing of large audio archives

Duration: January 2016 - January 2019

Coordinator: Antoine Liutkus

Abstract: Develop the theoretical and applied tools required to embed audio denoising and separation tools in web-based audio archives. The applicative scenario is to deal with large audio archives, and more precisely with the notorious "Archives du CNRS — Musée de l'homme", gathering about 50,000 recordings dating back to the early 1900s.

9.2.9. ANR ArtSpeech

Project acronym: ArtSpeech

Project title: Synthèse articulatoire phonétique

Duration: October 2015 - March 2019

Coordinator: Yves Laprie

Other partners: Gipsa-Lab (Grenoble), IADI (Nancy), LPP (Paris)

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[0]http://repmus.ircam.fr/dyci2/

Abstract: The objective is to synthesize speech from text via the numerical simulation of the human speech production processes, i.e. the articulatory, aerodynamic and acoustic aspects. Corpus based approaches have taken a hegemonic place in text to speech synthesis. They exploit very good acoustic quality speech databases while covering a high number of expressions and of phonetic contexts. This is sufficient to produce intelligible speech. However, these approaches face almost insurmountable obstacles as soon as parameters intimately related to the physical process of speech production have to be modified. On the contrary, an approach which rests on the simulation of the physical speech production process makes explicitly use of source parameters, anatomy and geometry of the vocal tract, and of a temporal supervision strategy. It thus offers direct control on the nature of the synthetic speech.

Measurements of glottis opening during the production of fricatives via EPGG (ElectroPhotoGlottoGraphy), the design of acoustic experiments with a replica of the vocal tract and the design of dynamic acquisition with MRI were the main activities of this first year.

9.2.10. FUI RAPSODIE

Project acronym: RAPSODIE

Project title: Automatic Speech Recognition for Hard of Hearing or Handicapped People

Duration: March 2012 - February 2016

Coordinator: eRocca (Mieussy, Haute-Savoie)

Other partners: CEA (Grenoble), Inria (Nancy), CASTORAMA (France)

Abstract: The goal of the project was to realize a portable device to help a hard-of-hearing person to communicate with other people. To achieve this goal the portable device needs to access a speech recognition system, adapted to this task. Another application of the device is environment vocal control for handicapped persons.

In this project, MULTISPEECH was involved in optimizing the speech recognition models for the envisaged task, and in finding the best way of presenting the speech recognition results in order to maximize the communication efficiency between the hard-of-hearing person and the speaking person.

9.2.11. FUI VoiceHome

Project acronym: VoiceHome

Duration: February 2015 - July 2017

Coordinator: onMobile

Other partners: Orange, Delta Dore, Technicolor Connected Home, eSoftThings, Inria (Nancy), IRISA, LOUSTIC

Abstract: The goal of this project is to design a robust voice control system for smart home and multimedia applications. We are responsible for the robust automatic speech recognition brick.

9.2.12. ADT Plavis

Project acronym: Plavis

Project title: Platform for acquisition and audiovisual speech synthesis

Duration: January 2015 - December 2016

Coordinator: Vincent Colotte

Abstract: The objective of this project was to develop a platform acquisition and audiovisual synthesis system (3D animation of the face synchronously with audio). The main purpose was to build a comprehensive platform for acquisition and processing of audiovisual corpus (selection, acquisition and acoustic processing, 3D visual processing and linguistic processing). The acquisition was performed using a motion-capture system (Kinect-like), a Vicon system, and an electromagnetic articulography (EMA) system.

9.2.13. *LORIA exploratory project*

Project title: Acquisition and processing of multimodal corpus in the context of interactive human communication

Duration: June 2015 - May 2016

Coordinator: Slim Ouni

Abstract: The aim of this project was the study of the various mechanisms involved in multimodal human communication that can be oral, visual, gestural and tactile. This project focused on the identification and acquisition of a very large corpus of multimodal data from multiple information sources and acquired in the context of interaction and communication between two people or more.

9.2.14. *SYNABE*

Project acronym: SYNABE

Project title: Articulatory data synchronization for studying stuttering

Duration: January 2016 - December 2016

Coordinator: Fabrice Hirsch (Praxiling, UMR 5267, Montpellier)

Other partners: S. Ouni

Funding: CNRS DEFI Instrumentation aux limites

Abstract: The objective of this project is to use simultaneously three hardware allowing having information on the subglottic (respiratory belt), glottic (electroglottograph) and supraglottic (articulograph) levels during the production of the speech in order to know the timing of the gestures during speech. This system will be used to study the motor coordination between the three levels mentioned in the stuttering and normo-fluent words. We will propose a new typology of normal and pathological disfluencies.

Our main contribution concerned the articulatory data acquisition using the articulograph AG501.

9.3. European Initiatives

9.3.1. *Collaborations with Major European Organizations*

Jon Barker: University of Sheffield (UK)

Robust speech recognition [11], [55]

9.4. International Initiatives

9.4.1. *Inria International Partners*

9.4.1.1. *Informal International Partners*

Jonathan Le Roux, Shinji Watanabe, John R. Hershey: Mitsubishi Electric Research Labs (MERL, Boston, USA)

Robust speech recognition [11], [55]

Dayana Ribas Gonzalez, Ramón J. Calvo: CENATAV (Habana, Cuba)

Robust speaker recognition [42]

9.4.2. *Participation in Other International Programs*

9.4.2.1. *STIC-AmSud - multimodal communication corpus*

STIC-AmSud: MCC - Multimodal Communication Corpus. A collaboration: Argentina, Chile and France (01/2015-12/2016)

Project acronym: MCC

Project title: Multimodal Communication Corpus

Duration: January 2015 - December 2016

International Coordinator: S. Ouni

National Coordinators: Nancy Hitschfeld (Depto. de Ciencias de la Computación (DCC), Universidad de Chile) - Chile; and, Juan Carlos Gomez (Centro Internacional Franco Argentino de Ciencias de la Información y de Sistemas (CIFASIS), UNR, CONICET) - Argentina

Abstract: The project aims to collect a multimodal speech corpus containing synchronized audio-visual data recorded from talking individuals. The corpus will incorporate several communication modes which appear in the communication among humans, such as the acoustic signal, facial movements and body gestures during speech. During 2016, a complete corpus of 8 speakers (4 French and 4 Spanish) has been acquired and processed. The corpus will be distributed using the Ortolang platform.

9.4.2.2. PHC UTIQUE - HMM-based Arabic speech synthesis

PHC UTIQUE - HMM-based Arabic speech synthesis, with ENIT (Engineer school at Tunis-Tunisia)

Duration: 2015 - 2018.

Coordinators: Vincent Colotte (France) and Noureddine Ellouze (Tunisia).

Abstract: Development of an HMM-based speech synthesis system for the Arabic language. This includes the development of an Arabic speech corpus, the selection of linguistic features relevant to Arabic HMM-based speech synthesis, as well as improving the quality of the speech signal generated by the system.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Sebastian Gonzales Mora

Date: Jan 2016

Faculty de Cs. Físicas y Matemáticas, University of Chile

Benjamin Martinez Elizalde

Date: May 2016 - Aug 2016

Institution: Carnegie Mellon University (USA)

Dayana Ribas Gonzalez

Date: Sep 2016 - Dec 2016

Institution: CENATAV (Cuba)

Ziteng Wang

Date: Sep 2016 - Sep 2017

Institution: Institute of Acoustics, Chinese Academy of Sciences (China)

<p style="text-align:center">**ORPAILLEUR Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Hydreos*

Participant: Jean-François Mari.

Hydreos is a state organization –actually a so-called "Pôle de compétitivité"– aimed at evaluating the delivering and the quality of water (http://www.hydreos.fr/fr). Actually, data about water resources rely on many agronomic variables, including land use successions. The data to be analyzed are obtained by surveys or by satellite images and describe the land use at the level of the agricultural parcel. Then there is a search for detecting changes in land use and for correlating these changes to groundwater quality. Accordingly, one main challenge in our participation in Hydreos is to process and analyze space-time data for reaching a better understanding of the changes in the organization of a territory. The systems ARPEnTAge and CarottAge (see § 6.2.1) are used in this context, especially by agronomists of INRA (ASTER Mirecourt http://www6.nancy.inra.fr/sad-aster).

8.2. National Initiatives

8.2.1. *ANR*

8.2.1.1. *Hybride (2011-2016)*

Participants: Adrien Coulet, Amedeo Napoli, Chedy Raïssi, My Thao Tang, Mohsen Sayed, Yannick Toussaint.

The Hybride research project (http://hybride.loria.fr/) aims at combining Natural Language Processing (NLP) and Knowledge Discovery in Databases (KDD) for text mining. A key idea is to design an interacting and convergent process where NLP methods are used for guiding text mining while KDD methods are used for guiding the analysis of textual documents. NLP methods are mainly based on text analysis and extraction of general and temporal information. KDD methods are based on pattern mining, e.g. patterns and sequences, formal concept analysis and graph mining. In this way, NLP methods applied to texts extract "textual information" that can be used by KDD methods as constraints for focusing the mining of textual data. By contrast, KDD methods extract patterns and sequences to be used for guiding information extraction from texts and text analysis. Experimental and validation parts associated with the Hybride project are provided by an application to the documentation of rare diseases in the context of Orphanet.

The partners of the Hybride consortium are the GREYC Caen laboratory (pattern mining, NLP, text mining), the MoDyCo Paris laboratory (NLP, linguistics), the INSERM Paris laboratory (Orphanet, ontology design), and the Orpailleur team at Inria NGE (FCA, knowledge representation, pattern mining, text mining). The Hybride project ended on 30th November 2016.

8.2.1.2. *ISTEX (2014–2016)*

Participant: Yannick Toussaint.

ISTEX is a so-called "Initiative d'excellence" managed by CNRS and DIST ("Direction de l'Information Scientifique et Technique"). ISTEX aims at giving to the research and teaching community an on-line access to scientific publications in all the domains (http://www.istex.fr/istex-excellence-initiative-of-scientific-and-technical-information/). Thus ISTEX requires a massive acquisition of documents such as journals, proceedings, corpus, databases...ISTEX-R is one research project within ISTEX in which the Orpailleur team is involved, with two other partners, namely ATILF laboratory and INIST Institute (both located in Nancy). ISTEX-R aims at developing new tools for querying full-text documentation, analyzing content and extracting information. A platform is under development to provide robust NLP tools for text processing, as well as methods in text mining and domain conceptualization.

8.2.1.3. PractiKPharma (2016–2020)

Participants: Adrien Coulet, Joël Legrand, Pierre Monnin, Amedeo Napoli, Malika Smaïl-Tabbone, Yannick Toussaint.

The ANR project PractiKPharma (http://practikpharma.loria.fr/) is interested in the validation of domain knowledge in pharmacogenomics. The originality of PractiKPharma is to use "Electronic Health Records" (EHRs) to constitute cohorts of patients, cohorts which are are then mined for validating extracted pharmacogenomics knowledge units after validation w.r.t. literature knowledge. This project involves two other labs, namely LIRMM at Montpellier and CRC Paris.

8.2.1.4. Termith (2014–2016)

Participant: Yannick Toussaint.

Termith (http://www.atilf.fr/ressources/termith/) is an ANR Project involving a series of laboratories, namely ATILF, INIST, Inria Nancy Grand Est, Inria Saclay, LIDILEM, and LINA. It aims at indexing documents belonging to different domain of Humanities. Thus, the project focuses on extracting candidate terms (information extraction) and on disambiguation.

In the Orpailleur team, we are mainly concerned by information extraction using Formal Concept Analysis techniques, but also pattern and sequence mining. The objective is to define contexts introducing terms, i.e. finding textual environments allowing a system to decide whether a textual element is actually a candidate term and its corresponding environment. This disambiguation process was described and published at LREC 2016 [35]. The Termith project ended in April 2016.

8.2.2. FUI POQEMON (2014-2016)

Participants: Chedy Raïssi, Mickaël Zehren.

The publication of transaction data, such as market basket data, medical records, and query logs, serves the public benefit. Mining such data allows the derivation of association rules that connect certain items to others with measurable confidence. Still, this type of data analysis poses a privacy threat; an adversary having partial information on a person's behavior may confidently associate that person to an item deemed to be sensitive. Ideally, an anonymization of such data should lead to an inference-proof version that prevents the association of individuals to sensitive items, while otherwise allowing truthful associations to be derived. The POQEMON project aims at developing new pattern mining methods and tools for supporting privacy preserving knowledge discovery from monitoring purposes on mobile phone networks. The main idea is to develop sound approaches that handle the tradeoff between privacy of data and the power of analysis. Original approaches to this problem were based on value perturbation, damaging data integrity. Recently, value generalization has been proposed as an alternative; still, approaches based on it have assumed either that all items are equally sensitive, or that some are sensitive and can be known to an adversary only by association, while others are non-sensitive and can be known directly. Yet in reality there is a distinction between sensitive and non-sensitive items, but an adversary may possess information on any of them. Most critically, no antecedent method aims at a clear inference-proof privacy guarantee. In this project, we integrated the ρ-uncertainty privacy concept that inherently safeguards against sensitive associations without constraining the nature of an adversary's knowledge and without falsifying data. The project integrates the ρ-uncertainty pattern mining approach with novel data visualization techniques.

The POQEMON research project (https://members.loria.fr/poqemon/) involves the following partners: Altran, DataPublica, GenyMobile, HEC, IP-Label, Next Interactive Media, Orange and Université Paris-Est Créteil, and Inria Nancy Grand Est.

8.2.3. CNRS PEPS and Mastodons projects

8.2.3.1. Mastodons HyQual (2016–2018)

Participants: Miguel Couceiro, Esther Galbrun, Dhouha Grissa, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

The HyQual project was proposed and initiated this year in the framework of the Mastodons CNRS Call about data quality in data mining (see http://www.cnrs.fr/mi/spip.php?article819&lang=fr). This project is interested in the mining of nutritional data for discovering predictive biomarkers of diabetes and metabolic syndrome in elder populations. The data mining methods which are considered here are hybrid, combining symbolic and numerical methods, and are applied to complex and noisy metabolic data [39]. In the HyQual project, we are mainly interested by the quality of the data at hand and the patterns that can be discovered. In particular, we check whether we can find possible definitions within the data (actually double implications) and redescriptions (under the form of different descriptions of the same data). In this way, we can study the definitional power of the data and as well the incompleteness of the data, leading to two original ways of considering data quality. The project involves researchers from the Orpailleur Team, with researchers from LIRIS Lyon, ICube Strasbourg, and INRA Clermont-Ferrand.

8.2.3.2. PEPS Confocal (2015–2016)

Participants: Adrien Coulet, Amedeo Napoli, Chedy Raïssi, Malika Smaïl-Tabbone.

The Confocal Project (see http://www.cnrs.fr/ins2i/spip.php?article1183) is interested in the design of new methods in bioinformatics for analyzing and classifying heterogeneous omics data w.r.t. biological domain knowledge. We are working on the adaption of FCA and pattern structures for discovering patterns and associations in gene data with the help of domain ontologies. One important objective of the project is to check whether such a line of research could be reused on so-called "discrete models in molecular biology".

8.2.3.3. PEPS Prefute (2015–2016)

Participants: Quentin Brabant, Adrien Coulet, Miguel Couceiro, Esther Galbrun, Amedeo Napoli, Chedy Raïssi, Justine Reynaud, Mohsen Sayed, Malika Smaïl-Tabbone, My Thao Tang, Yannick Toussaint.

The PEPS Prefute project is mainly interested in interaction and iteration in the knowledge discovery (KD) process. Usually the KD process is organized around three main steps which are (i) selection and preparation of the data, (ii) data mining, and (iii) interpretation of (selected) resulting patterns. An analyst, most of the time an expert of the data domain, is present for leading the KD process. Accordingly, the PEPS Prefute project is interested in the study of interactions between the analyst and the KD process, i.e. pushing constraints, preferences and domain knowledge, for guiding and improving the KD process. One possible way is to discover initial patterns acting as seeds for searching farther the pattern space w.r.t. this initial seeds possibly linked to preferences of the analyst. In this way, the interesting pattern space is much more concise and of much lower size.

Then, the importance of preferences and domain knowledge in interaction with KD, and as well, visualization tools, have to be improved for allowing work with large and complex datasets (see https://www.greyc.fr/fr/node/2207).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. CrossCult (H2020 Project, 2016-2020)

Participants: Miguel Couceiro, Nyoman Juniarta, Amedeo Napoli, Chedy Raïssi.

CrossCult (http://www.crosscult.eu/) aims to make reflective history a reality in the European cultural context, by enabling the re-interpretation of European (hi)stories through cross-border interconnections among cultural digital resources, citizen viewpoints and physical venues. The project has two main goals. The first goal is to lower cultural EU barriers and create unique cross-border perspectives, by connecting existing digital historical resources and by creating new ones through the participation of the public. The second goal is to provide long-lasting experiences of social learning and entertainment that will help towards the better understanding and re-interpretation of European history. To achieve these goals, CrossCult will use cutting-edge technology to connect existing digital cultural assets and to combine them with interactive experiences that all together are intended to increase retention, stimulate reflection and help European citizens appreciate their past and present in a holistic manner. CrossCult will be implemented on 4 real-world flagship pilots involving a total of 8 sites across Europe.

The role of the Orpailleur Team (in conjunction with the Kiwi Team of LORIA) is mainly to work on the recommendation aspects, with a focus on defining an extended profile of the users and connecting these profiles with domain knowledge for leading the recommendation process [42].

The partners of the Orpailleur team in the CrossCult project are the following: Luxembourg Institute for Science and Technology and Centre Virtuel de la Connaissance sur l'Europe (Luxembourg, leader of the project), University College London (England), University of Malta (Malta), University of Peloponnese and Technological Educational Institute of Athens (Greece), Università degli Studi di Padova (Italy), University of Vigo (Spain), National Gallery (London, England), and GVAM Guìas Interactivas (Spain).

8.4. International Initiatives

8.4.1. Inria Associate Teams:SNOWFLAKE

8.4.1.1. SNOWFLAKE

Participants: Adrien Coulet, Joël Legrand, Pierre Monnin, Malika Smaïl-Tabbone.

Title: Knowledge Discovery from Linked Data and Clinical Notes

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Medicine, Stanford Center for Biomedical Informatics Research (BMIR) - Nigam Shah

Start year: 2014

Web site: http://snowflake.loria.fr/

Snowflake is an Inria Associate Team which started in 2014. It is aimed at facilitating the collaboration between researchers from the Inria Orpailleur team and the Stanford Center for Biomedical Informatics Research, Stanford University, USA. The main objective of Snowflake is to improve biomedical knowledge discovery by connecting Electronic Health Records (EHRs) with domain knowledge either in the form of ontologies or of Linked Open Data (LOD). Such a connection should help to complete domain knowledge w.r.t. EHRs. The initial focus of Snowflake is the identification and characterization of groups of patients w.r.t. (adverse) reactions to drugs. Identified features associated with such groups of patients could be used as predictors of over- or under-reactions to some drugs.

8.4.2. Participation in Other International Programs

8.4.2.1. A stay at NASA Frontier Development Lab

Participant: Chedy Raïssi.

In 2013, NASA presented the "Asteroid Grand Challenge", a White House supported initiative to supplement the NEO (Near-Earth Object) Program, with a mission: "Find all asteroid threats to human populations and to know what to do about them." There remain a number of unresolved gaps in this challenge, both in terms of discovery, characterization and eventual mitigation strategies, should a potentially hazardous asteroid (PHA) be discovered. By bringing new approaches in computer science, such as deep learning and data mining to tackle specific parts of the problem, solutions may be revealed that, combined with existing processes, significantly benefit the community as a whole.

In July 2016, Chedy Raïssi visited NASA Ames and SETI Institute as part of the Frontier Development Lab. He worked there on developing meaningful research opportunities, as well as support the work of the planetary defense community and show the potential of this kind of applied research methodology to deliver breakthrough of significant value. The work was over a period of six weeks, focusing on Delay-Doppler radar imaging. Delay-Doppler radar imaging is a powerful technique to characterize the trajectories, shapes, and spin states of near-Earth asteroids and has yielded detailed models of dozens of objects. Since the 1990s, Delay-Doppler data has been analyzed using the SHAPE software developed originally by Steven J. Ostro. SHAPE performs sequential single-parameter fitting, and requires considerable computation runtime and human intervention. Reconstructing asteroid shapes and spins from Delay-Doppler data is, like many inverse problems, computationally intensive and requires extensive human oversight of the shape modeling process. Chedy Raïssi has explored two new techniques to better automate Delay-Doppler shape modeling: Bayesian optimization and deep generative models.

8.4.2.2. Ciência Sem Fronteiras (2014–2016)
Participant: Amedeo Napoli.

Program "Ciência Sem Fronteiras" is a Brazilian research fellowship which provides a funding for the stay of a visiting French researcher in Brazil at Universidade Federal Pernambuco Recife for three years. The on-going project is called "Formal Concept Analysis as a Support for Knowledge Discovery" and is aimed at combining FCA methods with numerical clustering methods used by Brazilian colleagues. This project is supervised in Brazil by Professor Francisco de A.T. de Carvalho (CIn/UFPE).

The project aims at developing and comparing classification and clustering algorithms for complex data (especially interval and multi-valued data). Two families of algorithms are studied, namely "clustering algorithms" based on the use of a similarity or a distance for comparing the objects, and "classification algorithms in Formal Concept Analysis (FCA)" based on attribute sharing between objects. The objectives here are to combine the facilities of both families of algorithms for improving the potential of each family in dealing with more complex and voluminous datasets.

8.4.2.3. STIC AmSud: Autonomic Knowledge Discovery (AKD, 2015–2016)
Participants: Miguel Couceiro, Esther Galbrun, Amedeo Napoli, Chedy Raïssi.

This research project involves researchers with different specialties, from Brazil (Universidade Federal Rio Grande do Sul), from Chile (UFSM Santiago and Valparaiso), from Uruguay (Universidad de la Repùblica), and the Orpailleur Team. The project is interested in the design of solutions able to proactively understand the behavior of systems and networks in order to prevent vulnerable states. Accordingly, we aim at integrating knowledge discovery techniques within autonomic systems in order to provide intelligent self-configuration and self-protection mechanisms. The results of this project may not only benefit to end-users but also highly contribute to the scientific community by providing solid foundations for the development of more secure, scalable, and reliable management approaches.

8.4.2.4. LEA STRUCO
Participant: Jean-Sébastien Sereni.

LEA STRUCO is an "Associated International Laboratory" of CNRS between IÚUK, Prague, and LIAFA, Paris. It focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work. Jean-Sébastien Sereni is the contact person for LEA STRUCO which was initiated when Jean-Sébastien was a member of LIAFA.

8.4.2.5. Research Collaboration with HSE Moscow
Participants: Miguel Couceiro, Adrien Coulet, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

An on-going collaboration involves the Orpailleur team and Sergei O. Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory several times while Sergei O. Kuznetsov visited Inria Nancy Grand Est several times too. The collaboration is materialized by the joint supervision of students (such as for example the thesis of Aleksey Buzmakov defended at the end of 2015), and the the organization of scientific events, as in particular the workshop FCA4AI whose fifth edition was organized this year in August at ECAI 2016 (see http://www.fca4ai.hse.ru) [53]. A special session about Knowledge Discovery and Formal Concept Analysis will be supervised by Sergei O. Kuznetsov and Amedeo Napoli at the next ISMIS Conference in Warsaw (Poland) next June 2017 (http://ismis2017.ii.pw.edu.pl/s_kd_fca.php).

<p style="text-align: center; color: red; font-weight: bold;">PANAMA Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Labex Comin Labs projects

CominLabs is a Laboratoire d'Excellence funded by the PIA (Programme Investissements d'Avenir) in the broad area of telecommunications.

9.1.1.1. HEMISFER

Participant: Rémi Gribonval.

Acronym: HYBRID (Hybrid Eeg-MrI and Simultaneous neuro-feedback for brain Rehabilitation)

http://www.hemisfer.cominlabs.ueb.eu/

Research axis: 3.1

CominLabs partners : EPI VISAGES; EPI HYBRID; EPI PANAMA

External partners : EA 4712 team from University of Rennes I; EPI ATHENA, Sophia-Antipolis;

Coordinator: Christian Barillot, EPI VISAGES

Description: The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. We propose to combine advanced instrumental devices (Hybrid EEG and MRI platforms), with new man-machine interface paradigms (Brain computer interface and serious gaming) and new computational models (source separation, sparse representations and machine learning) to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major neurological and psychiatric disorders of the developmental and the aging brain (stroke, attention-deficit disorder, language disorders, treatment-resistant mood disorders, Ã¢ÂÂ¦).

Contribution of PANAMA: PANAMA, in close cooperation with the VISAGES team, contributes to a coupling model between EEG and fMRI considered as a joint inverse problem addressed with sparse regularization. By combining both modalities, one expects to achieve a good reconstruction both in time and space. This new imaging technique will then be used for improving neurofeedback paradigms in the context of rehabilitation and psychiatric disorders, which is the final purpose of the HEMISFER project.

9.1.1.2. TEPN

Participant: Rémi Gribonval.

Acronym: TEPN (Toward Energy Proportional Networks)

http://www.tepn.cominlabs.ueb.eu/

Research axis: 3.1

CominLabs partners : IRISA OCIF - Telecom Bretagne; IETR SCN; IETR SCEE; EPI PANAMA

Coordinator: Nicolas Montavont, IRISA OCIF - Telecom Bretagne

Description: As in almost all areas of engineering in the past several decades, the design of computer and network systems has been aimed at delivering maximal performance without regarding to the energy efficiency or the percentage of resource utilization. The only places where this tendency was questioned were battery-operated devices (such as laptops and smartphones) for which the users accept limited (but reasonable) performance in exchange for longer use periods. Even though the end users make such decisions on a daily basis by checking their own devices, they have no way of minimizing their energy footprint (or conversely, optimize the network resource usage) in the supporting infrastructure. Thus, the current way of dimensioning and operating the infrastructure supporting the user services, such as cellular networks and data centers, is to dimension for peak usage. The problem with this approach is that usage is rarely at its peak. The overprovisioned systems are also aimed at delivering maximal performance, with energy efficiency being considered as something desired, but non-essential. This project aims at making the network energy consumption proportional to the actual charge of this network (in terms of number of served users, or requested bandwidth). An energy proportional network can be designed by taking intelligent decisions (based on various constraints and metrics) into the network such as switching on and off network components in order to adapt the energy consumption to the user needs. This concept can be summarized under the general term of Green Cognitive Network Approach.

Contribution of PANAMA: PANAMA, in close cooperation with the SCEE team at IETR (thesis of Marwa Chafii), focuses on the design of new waveforms for multi carrier systems with reduced Peak to Average Power Ratio (PAPR).

9.1.2. ANR INVATE project with IRT b<>com France

Participants: Rémi Gribonval, Nancy Bertin, Mohamed Hafsati.

Thesis on 3D audio scene decomposition for interactive navigation

Duration: 3 years (2016-2019)

Research axis: 3.2.2

Partners: IRT b<>com, Inria-Rennes, IRISA

Funding: ANR INVATE project (PIA)

The objective of this thesis is to develop tools to analyze audio scenes in order to identify, locate, and extract the sources present in the scene to re-spatialize them according to the user head orientation and the movement of the user in the targeted virtual scene.

9.1.3. OSEO-FUI: voiceHome

Participants: Nancy Bertin, Frédéric Bimbot, Romain Lebarbenchon, Ewen Camberlein.

Duration: 3 years (2015-2017)

Research axis: 3.2

Partners: onMobile, Delta Dore, eSoftThings, Orange, Technicolor, LOUSTIC, Inria Nancy

Coordinator: onMobile

Description: The goal of the project is to design and implement a multi-channel voice interface for smart home and multimedia (set-top-box) appliances.

Contributions of PANAMA are focused on (i) audio activity monitoring and wake-up word detection and (ii) audio source localization and separation. In both cases, the issue of energy frugality is central and strongly constrains the available resources. We expect from this cooperation to make progress towards operational low-resource audio source separation schemes and we intend to investigate compressive sensing for the characterization of audio and voice activity.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. ERC-StG: PLEASE (Projections, Learning, and Sparsity for Efficient Data Processing)
Participants: Rémi Gribonval, Srdan Kitic, Luc Le Magoarou, Nancy Bertin, Nicolas Keriven, Yann Traonmilin, Gilles Puy, Adrien Leman, Nicolas Bellot.

> *Duration: January 2012 - December 2016*
>
> *Research axis: 3.1*
>
> *Principal investigator: Rémi Gribonval*
>
> *Program: ERC Starting Grant*
>
> *Project acronym: PLEASE*
>
> *Project title: Projections, Learning and Sparsity for Efficient data processing*
>
> *Abstract: The Please ERC is focused on the extension of the sparse representation paradigm towards that of sparse modeling, with the challenge of establishing, strengthening and clarifying connections between sparse representations and machine learning*
>
> *Web site: https://team.inria.fr/panama/projects/please/*

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

PANAMA has strong recurrent collaborations with the LTS2 lab at EPFL, the Center for Digital Music at Queen Mary University of London, the Institute for Digital Communications at the University of Edimburgh, and the Institute for Mathematics of the Postdam University.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Pierre Vandergheynst, in June-July, Professor of Signal and Image Processing, EPFL (Chaire Internationale Inria)
- Gilles Blanchard, in September, Professor, University of Potsdam
- Laurent Jacques, in October, Professor, Catholic University of Louvain
- Mike Davies, in November, Professor, University of Edimburgh

<p style="color:red; text-align:center;">**PERCEPTION Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. MIXCAM

Type: ANR BLANC

Duration: March 2014 - February 2016

Coordinator: Radu Horaud

Partners: 4D View Solutions SAS

Abstract: Humans have an extraordinary ability to see in three dimensions, thanks to their sophisticated binocular vision system. While both biological and computational stereopsis have been thoroughly studied for the last fifty years, the film and TV methodologies and technologies have exclusively used 2D image sequences, including the very recent 3D movie productions that use two image sequences, one for each eye. This state of affairs is due to two fundamental limitations: it is difficult to obtain 3D reconstructions of complex scenes and glass-free multi-view 3D displays, which are likely to need real 3D content, are still under development. The objective of MIXCAM is to develop novel scientific concepts and associated methods and software for producing live 3D content for glass-free multi-view 3D displays. MIXCAM will combine (i) theoretical principles underlying computational stereopsis, (ii) multiple-camera reconstruction methodologies, and (iii) active-light sensor technology in order to develop a complete content-production and -visualization methodological pipeline, as well as an associated proof-of-concept demonstrator implemented on a multiple-sensor/multiple-PC platform supporting real-time distributed processing. MIXCAM plans to develop an original approach based on methods that combine color cameras with time-of-flight (TOF) cameras: TOF-stereo robust matching, accurate and efficient 3D reconstruction, realistic photometric rendering, real-time distributed processing, and the development of an advanced mixed-camera platform. The MIXCAM consortium is composed of two French partners (Inria and 4D View Solutions). The MIXCAM partners will develop scientific software that will be demonstrated using a prototype of a novel platform, developed by 4D Views Solutions, and which will be available at Inria, thus facilitating scientific and industrial exploitation.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. EARS

Title: Embodied Audition for RobotS

Program: FP7

Duration: January 2014 - December 2016

Coordinator: Friedrich Alexander Universität Erlangen-Nünberg

Partners:

Aldebaran Robotics (France)

Ben-Gurion University of the Negev (Israel)

Friedrich Alexander Universität Erlangen-Nünberg (Germany)

Imperial College of Science, Technology and Medicine (United Kingdom)

Humboldt-Universitat Zu Berlin (Germany)

Inria contact: Radu Horaud

The success of future natural intuitive human-robot interaction (HRI) will critically depend on how responsive the robot will be to all forms of human expressions and how well it will be aware of its environment. With acoustic signals distinctively characterizing physical environments and speech being the most effective means of communication among humans, truly humanoid robots must be able to fully extract the rich auditory information from their environment and to use voice communication as much as humans do. While vision-based HRI is well developed, current limitations in robot audition do not allow for such an effective, natural acoustic human-robot communication in real-world environments, mainly because of the severe degradation of the desired acoustic signals due to noise, interference and reverberation when captured by the robot's microphones. To overcome these limitations, EARS will provide intelligent 'ears' with close-to-human auditory capabilities and use it for HRI in complex real-world environments. Novel microphone arrays and powerful signal processing algorithms shall be able to localise and track multiple sound sources of interest and to extract and recognize the desired signals. After fusion with robot vision, embodied robot cognition will then derive HRI actions and knowledge on the entire scenario, and feed this back to the acoustic interface for further auditory scene analysis. As a prototypical application, EARS will consider a welcoming robot in a hotel lobby offering all the above challenges. Representing a large class of generic applications, this scenario is of key interest to industry and, thus, a leading European robot manufacturer will integrate EARS's results into a robot platform for the consumer market and validate it. In addition, the provision of open-source software and an advisory board with key players from the relevant robot industry should help to make EARS a turnkey project for promoting audition in the robotics world.

8.2.1.2. VHIA

Title: Vision and Hearing in Action

Program: FP7

Type: ERC

Duration: February 2014 - January 2019

Coordinator: Inria

Inria contact: Radu Horaud

The objective of VHIA is to elaborate a holistic computational paradigm of perception and of perception-action loops. We plan to develop a completely novel twofold approach: (i) learn from mappings between auditory/visual inputs and structured outputs, and from sensorimotor contingencies, and (ii) execute perception-action interaction cycles in the real world with a humanoid robot. VHIA will achieve a unique fine coupling between methodological findings and proof-of-concept implementations using the consumer humanoid NAO manufactured in Europe. The proposed multi-modal approach is in strong contrast with current computational paradigms influenced by unimodal biological theories. These theories have hypothesized a modular view, postulating quasi-independent and parallel perceptual pathways in the brain. VHIA will also take a radically different view than today's audiovisual fusion models that rely on clean-speech signals and on accurate frontal-images of faces; These models assume that videos and sounds are recorded with hand-held or head-mounted sensors, and hence there is a human in the loop who intentionally supervises perception and inter-action. Our approach deeply contradicts the belief that complex and expensive humanoids (often manufactured in Japan) are required to implement research ideas. VHIA's methodological program addresses extremely difficult issues: how to build a joint audiovisual space from heterogeneous, noisy, ambiguous and physically different visual and auditory stimuli, how to model seamless in-teraction, how to deal with high-dimensional input data, and how to achieve robust and efficient human-humanoid communication tasks through a well-thought tradeoff between offline training and online execution. VHIA bets on the high-risk idea that in the next decades, social robots will have a considerable economical impact, and there will be millions of humanoids, in our homes, schools and offices, which will be able to naturally communicate with us.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- Professor Sharon Gannot, Bar Ilan University, Tel Aviv, Israel,
- Dr. Miles Hansard, Queen Mary University London, UK,
- Professor Nicu Sebe, University of Trento, Trento, Italy,
- Professor Adrian Raftery, University of Washington, Seattle, USA,
- Dr. Rafael Munoz-Salinas, University of Cordoba, Spain,
- Dr. Noam Shabatai, Ben Gourion University of the Negev, Israel.
- Dr. Christine Evers, Imperial College of Science and Medecine, UK.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Professor Sharon Gannot, Bar Ilan University, Tel Aviv, Israel,
- Yuval Dorfan, Bar Ilan University, Tel Aviv, Israel,
- Dr. Rafael Munoz-Salinas, University of Cordoba, Spain,
- Dr. Noam Shabatai, Ben Gourion University of the Negev, Israel.
- Dr. Christine Evers, Imperial College of Science and Medecine, UK.

PERVASIVE INTERACTION Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Project Involved

Participants: Amr Alyafi, Patrick Reignier.

Other Partners: UMR G-SCOP, UMR LIG (Persuasive Interaction, IIHM), CEA Liten, PACTE, Vesta Systems and Elithis.

Dates: Jan 2015 to Dec 2018

The ANR project Involved focuses on bringing solutions to building actors for upcoming challenges in energy management in residential buildings. The project explores a user centric energy management system, where user needs and tacit knowledge drive the search of solutions. These are calculated using a flexible energy model of the living areas. The system is personified by energy consultants with which building actors such as building owners, building managers, technical operators but also occupants, can interact with in order to co-define energy strategies, benefiting of both assets: tacit knowledge of human actors, and measurement with computation capabilities of calculators. Putting actors in the loop, i.e. making energy not only visible but also controllable is the needed step before large deployment of energy management solutions. It is proposed to develop interactive energy consultants for all the actors, which are energy management aided systems embedding models in order to support the decision making processes. MIRROR (interactive monitoring), WHAT-IF (interactive quantitative simulation), EXPLAIN (interactive qualitative simulation), SUGGEST-AND-ADJUST (interactive management) and RECOMMEND (interactive diagnosis) functionalities will be developed.

8.1.2. ANR Project CEEGE: Chess Expertise from Eye Gaze and Emotion

Participants: James Crowley, Dominique Vaufreydaz, Rafaellea Balzarini

Other Partners: Dept of NeuroCognition, CITEN, Bielefeld University

Dates: Jan 2016 to Dec 2019

CEEGE is a multidisciplinary scientific research project conducted by the Inria PRIMA team in cooperation with the Dept of Cognitive Neuroscience at the University of Bielefeld. The primary impacts will be improved scientific understanding in the disciplines of Computer Science and Cognitive NeuroScience. The aim of this project is to experimentally evaluate and compare current theories for mental modelling for problem solving and attention, as well as to refine and evaluate techniques for observing the physiological reactions of humans to situation that inspire pleasure, displeasure, arousal, dominance and fear.

In this project, we will observe the visual attention, physiological responses and mental states of subject with different levels of expertise solving classic chess problems, and participating in chess matches. We will observe chess players using eye-tracking, sustained and instantaneous face-expressions (micro-expressions), skin conductivity, blood flow (BVP), respiration, posture and other information extracted from audio-visual recordings and sensor readings of players. We will use the recorded information to estimate the mental constructs with which the players understand the game situation. Information from visual attention as well as physiological reactions will be used to determine and model the degree to which a player understands the game situation in terms of abstract configurations of chess pieces. This will provide a structured environment that we will use for experimental evaluation of current theories of mental modeling and emotional response during problem solving and social interaction.

The project is organized in three phases. During the first phase, we will observe individual players of different levels of chess expertise solving known chess problems. We will correlate scan-path from eye tracking and other information about visual attention to established configurations of pieces and known solutions to chess problems. This will allow us to construct a labeled corpus of chess play that can be used to evaluate competing techniques for estimating mental models and physiological responses. In a second phase, we will observe the attention and face expressions of pairs of players of different levels of chess ability during game play. In particular, we will seek to annotate and segment recordings with respect to the difficulty of the game situation as well as situations that elicit particularly strong physiological reactions. In the final phase, we will use these recordings to evaluate the effectiveness of competing techniques for mental modeling and observation of emotions in terms of their abilities to predict the chess abilities of players, game outcomes and individual moves and player self reports. Results of our work will be published in scientific conferences and journals concerned with cognitive science and cognitive neuroscience as well as computer vision, multimodal interaction, affective computing and pervasive computing. Possible applications include construction of systems that can monitor the cognitive abilities and emotional reactions of users of interactive systems to provide assistance that is appropriate but not excessive, companion systems that can aid with active healthy ageing, and tutoring systems that can assist users in developing skills in a variety of domains including chess.

8.2. European Initiatives

8.2.1. ICT FET Bambi (FET Open FP7-ICT-2013-C)

Participants: Emmanuel Mazer, Marvin Faix

Partners: Hebrew University of Jerusalem, Probayes, Universit√© de Liege, Instituto de Sistemas e Robotica (Portugal),CNRS (LIG,ISIR,IEF,UMIPhi)

Dates January 2014 to December 2016

FET Open BAMBI explores a theory and a hardware implementation of probabilistic computation inspired by biochemical cell signalling. The project studies probabilistic computation following three axes: algebra, biology, and hardware. In each case, we will develop a bottom-up hierarchical approach starting from the elementary components, and study how to combine them to build more complex systems. It proposes a Bayesian Gate operating on probability distributions on binary variables as the building blocks of our probabilistic algebra. These Bayesian gates can be seen as a generalization of logical operators in Boolean algebra. The consortium interprets elementary cell signalling pathways as biological implementation of these probabilistic gates. In turn, the key features of biochemical processes give new insights for new probabilistic hardware implementation. They associate conventional electronics and novel stochastic nano-devices to build the required hardware elements. Combining these will lead to new artificial information processing systems, which could, in the future, outperform classical computers in tasks involving a direct interaction with the physical world. For this purpose, this project associates research in Bayesian probability theory, molecular biology, nanophysics, computer science and electronics.

<p style="text-align:center">**POTIOC Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

HOBIT: Hybrid Optical Bench for Innovative Teaching:

Duration: 2015-2017

Funding: Idex CPU & LAPHIA, and Inria ADT

Partners: Université de Bordeaux (IUT mesures physiques) & Université de Lorraine

The goal of the Hobit project (Hybrid Optical Bench for Innovative Teaching) is to design a hybrid optical bench that benefits from both the physical and the virtual worlds to enhance teaching and training in the field of optics and photonics (See Section 7.1).

website: https://project.inria.fr/hobit

OpenStreetMap

Collaboration with Marina Duféal (Assistant Professor in Geography at PASSAGES, UMR 5319, Univ. Bordeaux Montaigne) and Vincent Bergeot (Num&Lib) regarding contribution to OpenStreetMap. We have jointly organized a cartopartie for "Fête de la Science2016" at Inria Bordeaux.

9.2. National Initiatives

eTAC: Tangible and Augmented Interfaces for Collaborative Learning:

Funding: EFRAN

Duration: 2017-2021

Coordinator: Université de Lorraine

Local coordinator: Martin Hachet

Partners: Université de Lorraine, Inria, ESPE, Canopé, OpenEdge,

the e-TAC project proposes to investigate the potential of technologies "beyond the mouse" in order to promote collaborative learning in a school context. In particular, we will explore augmented reality and tangible interfaces, which supports active learning and favors social interaction.

ANR Rebel:

Duration: 2016-2019

Coordinator: Fabien Lotte

Funding: ANR Jeune Chercheur Jeune Chercheuse Project

Partners: Disabilities and Nervous Systems Laboratory Bordeaux

Brain-Computer Interfaces (BCI) are communication systems that enable their users to send commands to computers through brain activity only. While BCI are very promising for assistive technologies or human-computer interaction (HCI), they are barely used outside laboratories, due to a poor reliability. Designing a BCI requires 1) its user to learn to produce distinct brain activity patterns and 2) the machine to recognize these patterns using signal processing. Most research efforts focused on signal processing. However, BCI user training is as essential but is only scarcely studied and based on heuristics that do not satisfy human learning principles. Thus, currently poor BCI reliability is probably due to suboptimal user training. Thus, we propose to create a new generation of BCI that apply human learning principles in their design to ensure the users can learn high quality control skills, hence making BCI reliable. This could change HCI as BCI have promised but failed to do so far.

ANR Project ISAR:

>Duration: 2014-2017
>Coordinator: Martin Hachet
>Partners: LIG-CNRS (Grenoble), Diotasoft (Paris)
>Acronym: Interaction en Réalité Augmentée Spatiale / Interacting with Spatial Augmented Reality
>The ISAR project (Interaction with Spatial Augmented Reality) focuses on the design, implementation, and evaluation of new paradigms to improve interaction with the digital world when digital content is directly projected onto physical objects. It opens new perspectives for exciting tomorrow's applications, beyond traditional screen-based applications.
>website: https://team.inria.fr/potioc/scientific-subjects/papart/

Inria ADT Artik:

>Duration: 2014-2016
>Coordinator: Jérémy Laviole & Martin Hachet
>The Artik projet is focused on the development of Papart (Paper Augmented Reality Toolkit). Papart is a toolkit that enables projector/cameras (ProCam) and depth camera to work together to create interactive surfaces. It works with comsumer-available hardware and enables tabletop interactions, although high-end cameras and projectors are also well supported. Here are the major advances of the developments of 2015: The hardware is now managed with a dedicated application, each Papart application is now hardware agnostic. Extrinsic calibration of projector / color and depth cameras can be done with any application running, the calibration processing is now below 2 minutes. The touch detection can be tweaked to fit any suface: it has been tested on a table, wall, and floor with respectively finger, hand, and foot interaction. This project relies on open source software, we also maintain the support of Maven distribution for the Processing project.
>website: https://project.inria.fr/papart/

Inria ADT OpenViBE-X:

>Duration: 2014-2016
>Partners: Inria teams Hybrid and Athena
>Coordinator: Maureen Clerc (Inria Sophia Antipolis)
>This is the follow-up project of OpenViBE-NT
>website: http://openvibe.inria.fr

Inria Project Lab BCI-LIFT:

>Duration: 2015-2018
>Partners: Inria team Athena (Inria Sophia-Antipolis), Inria team Hybrid (Inria Rennes), Inria team Neurosys (Inria Nancy), LITIS (Université de Rouen), Inria team DEMAR (Inria Sophia-Antipolis), Inria team MINT (Inria Lille), DyCOG (INSERM Lyon)
>Coordinator: Maureen Clerc (Inria Sophia Antipolis)
>The aim is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. With this concern of usability as our driving objective, we will build non-invasive systems that benefit from advanced signal processing and machine learning methods, from smart interface design, and where the user immediately receives supportive feedback. What drives this project is the concern that a substantial proportion of human participants is currently categorized "BCI-illiterate" because of their apparent inability to communicate through BCI. Through this project we aim at making it easier for people to learn to use the BCI, by implementing appropriate machine learning methods and developping user training scenarios.
>website: http://bci-lift.inria.fr/

Helios:

Duration: 2015-2016

Partners: Université de Lorraine

Funding: SATT Nancy Grand Est

Coordinator: Stéphanie Fleck (Université de Lorraine)

The Helios project aims to provide a methodology and innovative media for the improvement of learning of basic astronomical phenomena for school groups (8-11 years). As part of this project, Potioc has focused on the development of the final application for augmented reality based and 3D manipulation, for providing a high-fidelity prototype.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: ERC Starting Grant

Project acronym: BrainConquest

Project title: Boosting Brain-Computer Communication with High Quality User Training

Duration: 2017-2021

Coordinator: Fabien Lotte

Abstract: Brain-Computer Interfaces (BCIs) are communication systems that enable users to send commands to computers through brain signals only, by measuring and processing these signals. Making computer control possible without any physical activity, BCIs have promised to revolutionize many application areas, notably assistive technologies, e.g., for wheelchair control, and man-machine interaction. Despite this promising potential, BCIs are still barely used outside laboratories, due to their current poor reliability. For instance, BCIs only using two imagined hand movements as mental commands decode, on average, less than 80A BCI should be considered a co-adaptive communication system: its users learn to encode commands in their brain signals (with mental imagery) that the machine learns to decode using signal processing. Most research efforts so far have been dedicated to decoding the commands. However, BCI control is a skill that users have to learn too. Unfortunately how BCI users learn to encode the commands is essential but is barely studied, i.e., fundamental knowledge about how users learn BCI control is lacking. Moreover standard training approaches are only based on heuristics, without satisfying human learning principles. Thus, poor BCI reliability is probably largely due to highly suboptimal user training. In order to obtain a truly reliable BCI we need to completely redefine user training approaches. To do so, I propose to study and statistically model how users learn to encode BCI commands. Then, based on human learning principles and this model, I propose to create a new generation of BCIs which ensure that users learn how to successfully encode commands with high signal-to-noise ratio in their brain signals, hence making BCIs dramatically more reliable. Such a reliable BCI could positively change man-machine interaction as BCIs have promised but failed to do so far.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: ERASMUS+

Project acronym: VISTE

Project title: Empowering spatial thinking of students with visual impairment

Duration: 2016-2019

Coordinator: National Technical University of Athens (Greece)

Other partners: Intrasoft International SA (Greece), Casa Corpolui Didatic Cluj (Romania), Liceul Special pentru Deficienti de Vedere Cluj-Napoca (Romania), Eidiko Dimotiko Sxolio Tiflon Kallitheas (Greece)

Abstract: VISTE addresses inclusion and diversity through an innovative, integrated approach for enhancing spatial thinking focusing on the unique needs of students with blindness or visual impairment. However, since spatial thinking is a critical competence for all students, the VISTE framework and associated resources and tools will focus on cultivating this competence through collaborative learning of spatial concepts and skills both for sighted and visually impaired students to foster inclusion within mainstream education. The VISTE project will introduce innovative educational practices for empowering students with blindness or visual impairment with spatial skills through specially designed educational scenarios and learning activities as well as through a spatial augmented reality prototype to support collaborative learning of spatial skills both for sighted and visually impaired students.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Prof. James Landay and Dr. Jessica Cauchard at the Stanford HCI Group (USA) on interaction with maps projected from drones

Prof. Niels Henze (University Stuttgart,Germany) and Prof. Katrin Wolf (Hamburg University of Applied Science, Germany) on mobile applications for visually impaired people

Prof. Pierre Dillenbourg (EPFL, Switzerland) on HCI for Education

9.4.2. Participation in Other International Programs

DGA-DSTL Project with UK, "Assessing and Optimising Human-Machine Symbiosis through Neural signals for Big Data Analytics", 2014-2018

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Andreas Meinel, University of Freiburg, Germany, Apr. and Dec. 2016

Katrin Wolf, University of Art and Design, Berlin, Germany, Jul. 2016

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Fabien Lotte - Visting scientist At RIKEN Brain Science Institute, Cichocki's advanced Brain Signal Processing Laboratory, Wakoshi, Japan, October-November 2016

Camille Jeunet - Uniersity of Sussex (Brigthon - UK) 01/11/2015 - 30/01/2016

Camille Jeunet - UQAM (Montréal - CA) 10/06/2016 - 10/07/2016

<p style="text-align:center;color:red;font-weight:bold;">RITS Project-Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. COCOVEA

Title: Coopération Conducteur-Véhicule Automatisé

Instrument: ANR

Duration: November 2013 - April 2017

Coordinator: Jean-Christophe Popieul (LAMIH - University of Valenciennes)

Partners: LAMIH, IFSTTAR, Inria, University of Caen, COMETE, PSA, CONTINENTAL, VALEO, AKKA Technologies, SPIROPS

Inria contact: Fawzi Nashashibi

Abstract: CoCoVeA project aims at demonstrating the need to integrate from the design of the system, the problem of interaction with the driver in resolving the problems of sharing the driving process and the degree of freedom, authority, level of automation, prioritizing information and managing the operation of the various systems. This approach requires the ability to know at any moment the state of the driver, the driving situation in which he finds himself, the operating limits of the various assistance systems and from these data, a decision regarding activation or not the arbitration system and the level of response.

8.1.1.2. VALET

Title: Redistribution automatique d'une flotte de véhicules en partage et valet de parking

Instrument: ANR

Duration: January 2016 - December 2018

Coordinator: Fawzi Nashashibi

Partners: Inria, Ecole Centrale de Nantes (IRCCyN), AKKA Technologies

Inria contact: Fawzi Nashashibi

Abstract: The VALET project proposes a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers. An optimal routing algorithm is in charge of defining platoons drivers' routes to the parking areas where the followers are parked in a complete automated mode. The main idea of VALET is to retrieve vehicles parked randomly on the urban parking network by users. These parking spaces may be in electric charging stations, parking for car sharing vehicles or in regular parking places. Once the vehicles are collected and guided in a platooning mode, the objective is then to guide them to their allocated parking area or to their respective parking lots. Then each vehicle is assigned a parking place into which it has to park in an automated mode.

8.1.2. FUI

8.1.2.1. Sinetic

Title: Système Intégré Numérique pour les Transports Intelligents Coopératifs

Instrument: FUI

Duration: December 2014 - May 2017

Coordinator: Thomas Nguyen (Oktal)

Partners: Oktal, ALL4TEC, CIVITEC, Dynalogic, Inria, EURECOM, Renault, Armines, IFSTTAR, VEDECOM

Inria contact: Jean-Marc Lasgouttes

Abstract: The purpose of the project SINETIC is to create a complete simulation environment for designing cooperative intelligent transport systems with two levels of granularity: the system level, integrating all the components of the system (vehicles, infrastructure management centers, etc.) and its realities (terrain, traffic, etc.) and the component-level, modeling the characteristics and behavior of the individual components (vehicles, sensors, communications and positioning systems, etc.) on limited geographical areas, but described in detail.

8.1.2.2. PAC V2X

Title: Perception augmentée par coopération véhicule avec l'infrastructure routière

Instrument: FUI

Duration: September 2016 - August 2019

Coordinator: SIGNATURE Group (SVMS)

Partners: DigiMobee, LOGIROAD, MABEN PRODUCTS, SANEF, SVMS, VICI, Inria, VEDE-COM

Inria contact: Raoul de Charette

Abstract: The objective of the project is to integrate two technologies currently being deployed in order to significantly increase the time for an automated vehicle to evolve autonomously on European road networks. It is the integration of technologies for the detection of fixed and mobile objects such as radars, lidars, cameras ... etc. And local telecommunication technologies for the development of ad hoc local networks as used in cooperative systems.

8.1.3. Competitivity Clusters

RITS team is a very active partner in the competitivity clusters, especially MOV'EO and System@tic. We are involved in several technical committees like the DAS SUR of MOV'EO for example.

RITS is also the main Inria contributor in the VEDECOM institute (IEED). VEDECOM is financing the PhD theses of Mr. Fernando Garrido Carpio and Mr. Zayed Alsayed.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CityMobil2

Type: COOPERATION (TRANSPORTS)

Instrument: Large-scale integrating project

Objectif: NC

Duration: September 2012 - August 2016

Coordinator: University of Rome La Sapienza, CTL (Italy)

Partners: Inria (France), DLR (Germany), GEA Chanard (Switzerland), POLIS (Belgium), ERT (Belgium), EPFL (Switzerland),...(45 partners!)

Inria contact: Fawzi Nashashibi

Abstract: The CityMobil2 goal is to address and to remove three barriers to the deployment of automated road vehicles: the implementation framework, the legal framework and the unknown wider economic effect. CityMobil2 features 12 cities which will revise their mobility plans and adopt wherever they will prove effective automated transport systems. Then CityMobil2 will select the best 5 cases (among the 12 cities) to organize demonstrators. The project will procure two sets of automated vehicles and deliver them to the five most motivated cities for a 6 to 8 months demonstration in each city. CityMobil2 will establish a workgroup that will deliver a proposal for a European Directive to set a common legal framework to certify automated transport systems.

See also: http://www.citymobil2.eu/en/

8.2.1.2. AutoNet2030

Title: Co-operative Systems in Support of Networked Automated Driving by 2030

Objectif: NC

Duration: November 2013 - October 2016

Coordinator: Andras KOVACS – BROADBIT (Hungary)

Partners: BROADBIT (Hungary), BASELABS (Germany), CRF (Italy), Armines (France), VOLVO (Sueden), HITACHI EUROPE (France), EPFL (Switzerland), ICCS (Greece), TECHNISCHE UNIVERSITAET DRESDEN (Germany) (9 partners)

Inria contact: Fawzi Nashashibi

AutoNet2030 shall develop and test a co-operative automated driving technology, based on a decentralized decision-making strategy which is enabled by mutual information sharing among nearby vehicles. The project is aiming for a 2020-2030 deployment time horizon, taking into account the expected preceding introduction of co-operative communication systems and sensor based lane-keeping/cruise-control technologies. By taking this approach, a strategy can be worked out for the gradual introduction of fully automated driving systems, which makes the best use of the widespread existence of co-operative systems in the near-term and makes the deployment of fully automated driving systems beneficial for all drivers already from its initial stages.

See also: http://www.autonet2030.eu

8.2.1.3. AUTOCITS

Title: AUTOCITS Regulation Study for Interoperability in the Adoption of Autonomous Driving in European Urban Nodes

Program: CEF- TRANSPORT Atlantic corridor

Duration: November 2016 - December 2018

Coordinator: Indra Sistemas S.A. (Spain)

Partners: Indra Sistemas S.A. (Spain); Universidad Politécnica de Madrid (UPM), Spain; Dirección General de Tráfico (DGT), Spain; Inria (France); Instituto Pedro Nunes (IPN), Portugal; Autoridade Nacional de Segurança Rodoviária (ANSR), Portugal; Universidade de Coimbra (UC), Portugal.

Inria contact: Fawzi Nashashibi

Abstract: The aim of the Study is to contribute to the deployment of C-ITS in Europe by enhancing interoperability for autonomous vehicles as well as to boost the role of C-ITS as catalyst for the implementation of autonomous driving. Pilots will be implemented in 3 major Core Urban nodes (Paris, Madrid, Lisbon) located along the Core network Atlantic Corridor in 3 different Member States. The Action consists of Analysis and design, Pilots deployment and assessment, Dissemination and communication as well as Project Management and Coordination.

8.2.2. Collaborations with Major European Organizations

RITS is member of the **euRobotics AISBL** and the Leader of "People transport" Topic. This makes from Inria one of the rare French robotics representatives at the European level. See also: http://www.eu-robotics.net/

RITS is a full partner of **VRA – Vehicle and Road Automation**, a support action funded by the European Union to create a collaboration network of experts and stakeholders working on deployment of automated vehicles and its related infrastructure. VRA project is considered as the cooperation interface between EC funded projects, international relations and national activities on the topic of vehicle and road automation. It is financed by the European Commission DG CONNECT and coordinated by ERTICO – ITS Europe. See also: http://vra-net.eu/

RITS is member of the Working Group on Automation: **iMobility**. This group has been created and is animated by ERTICO ITS Europe. The Automation Working Group was formed under the iMobility Forum, with the initial high level aims of exploring and promoting the potential of highly automated vehicles and applications and working towards the development of a roadmap for the deployment of automated systems.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. International Academics Partners

NAIST – Japan: RITS has a close cooperation with NAIST (Nara institute of Science and Technology), Japan since 2009. Based on this collaboration NAIST and Inria established the MoU agreement to accelerate and strengthen future research collaborations and the exchange of researchers and students. During the period February 2015 - March 2016 RITS hosted Sakriani Watiasri Sakti, assistant professor at NAIST.

Seoul National University - S. Korea: An International Cooperation Agreement has been signed between RITS team of Inria and the Vehicle Dynamics and Control Laboratory (VDCL) of Seoul National University (SNU). RITS and VDCL recognize the value of educational, cultural, and scientific exchanges between international research laboratories, and have determined that sufficient interest exists to establish an academic and research partnership for collaborative research and education in the area of future intelligent vehicle systems for sustainable safety and environment.

International Chaire "Drive4U": Inria-RITS, Mines ParisTech, EPFL, Univ. of Berkeley (PATH Program) and Shanghai Jiao Tong Univ. (SJTU) are the academic partners of the international Chaire GAT, funded and supported by: VALEO Group, SAFRAN Group and MPSA Group (Peugeot-Citroën). A recent NDA has been signed recently. This Chaire will promote and fund academic activities related to Ground Automated Transportation and autonomous driving.

8.3.2. Participation in Other International Programs

8.3.2.1. ICT-Asia

 SIM-Cities

Title: "Sustainable and Intelligent Mobility for Smart Cities"

International Partner (Institution - Laboratory - Researcher):

- Nanyang Technical University (NTU), School of Electrical and Electronic Engineering – Singapore. Prof. Dan Wei Wang

- National University of Singapore (NUS), Department of Mechanical Engineering – Singapore. Dr. Marcelo Ang

- Kumamotoo University - Japan. Intelligent Transportation Systems Lab, Graduate School of Science and Technology, Prof. James Hu / Prof. Ogata

- Shanghai Jiao-Tong University (SJTU), Department of Automation – China. Prof. Ming Yang

- Hanoi University of Science and Technology, International Center MICA Institute – Vietnam. Prof. Eric Castelli

- Inria, RITS Project-Team – France. Dr. Fawzi Nashashibi

- Inria, e-Motion/CHROMA Project-Team – France. Dr. Christian Laugier

- Ecole Centrale de Nantes, IRCCyN – France. Prof. Philippe Martinet

Duration: Jan. 2015 - May 2017

Start year: 2015

This project aims at conducting common research and development activities in the field of sustainable transportation and advanced mobility of people and goods in order to move in the direction of smart, clean and sustainable cities.

RITS and MICA lab have obtained from the Vietnamese Program 911 the financing of the joint PhD thesis of Dinh-Van Nguyen (co-directed by Eric Castelli from MICA lab and Fawzi Nashashibi).

8.3.2.2. ECOS Nord – Venezuela

ECOS Nord

Title: "Les Techniques de l'Information et de la Communication pour la Conception de Systèmes Avancés de Mobilité durable en Milieu Urbain."

International Partner (Institution - Laboratory - Researcher):

- Simon Bolivar University, Department of Mecatronics – Venezuela. Dr. Gerardo Fernandez

- Inria, RITS Project-Team – France. Dr. Fawzi Nashashibi

Duration: Jan. 2014 - Dec. 2017

Start year: 2014

The main objective of this project is to contribute scientifically and technically to the design of advanced sustainable mobility systems in urban areas, particularly in dense cities where mobility, comfort and safety needs are more important than in other types of cities. In this project, we will focus on the contribution of advanced systems of perception, communication and control for the realization of intelligent transport systems capable of gradually integrating into the urban landscape. These systems require the development of advanced dedicated urban infrastructures as well as the development and integration of on-board intelligence in individual vehicles or mass transport.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Sakriani Watiasri Sakti, assistant professor at NAIST, from February 2015 until March 2016. A part of the work done during her stay has been published in [51].

Aidos Ibrayev, PhD student, from Kazakhstan.

Pablo Marin Plaza, PhD student, from Universidad Carlos III de Madrid, Spain.

8.4.1.1. Internships

Rafael Colmenares Prieto, Juan Jose Larez Urdaneta, Daniel Sanchez Aranguren from Simon Bolivar University, Venezuela.

Aitor Gomez Torres, Alfredo Valle Barrio and Myriam Vaca Recalde from Universidad Politécnica de Madrid, Spain.

Jose Emilio Traver Becerra from Universidad de Extremadura, Spain.

Kenneth Martinez Torres from Universidad del Turabo, Porto Rico.

Alexis Meyer from Télécom SudParis.

SEMAGRAMME Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Projets Région*

7.1.1.1. SLAM
Participants: Maxime Amblard [coordinator], Philippe de Groote, Sylvain Pogodalla.

Schizophrenia is well-known among mental illnesses for the strength of the thought disorders it involves, and for their widespread and spectacular manifestations: from deviant social behavior to delusion, not to speak about affective and sensitive distortions. It aims at exploring a specific manifestation, namely disorders in conversational speech. This is an interdisciplinary research, both empirical and theoretical from several domains, namely psychology, philosophy, linguistic and computer science.

The first transcriptions of pathological interviews are analyses. The management chain was implemented for disfluences and POS. Moreover, we have focused on implementing the treatment of lexicography issues and proposed an interface for SDRT-annotations. This year, we have developed a new interaction with the Centre Médical d'Aix-en-Provence in order to collect new interviews. The protocol started at the very end of the year. Moreover we have started the reimplementation of the tool SLAMtk.

The SLAM project was supported by the MSH–Lorraine, USR 3261, the region Grand-Est and the University of Lorraine. We organise the fourth workshop (In)Coherence of Discourse which gather linguists, psychologists and computer scientists in march 2017 : http://discours.loria.fr.

7.1.2. *CPER*

7.1.2.1. ITL-DI-Oeil
Participant: Maxime Amblard.

Interrelation troubles du langage, discours et processus oculomoteurs

This project is part of another research project about eye-tracking of schizophrenics. It is really close to the SLAM project. One of the main issue is how to collect the data. In order to simplify this clue, the two projects share the same corpus. SLAM is concerned by the transcription of the interviews whereas ITL-DI-Oeil analyses the eye-tracking records.

7.2. National Initiatives

7.2.1. *ANR*

7.2.1.1. *Polymnie: Parsing and synthesis with abstract categorial grammars. From lexicon to discourse*
Participants: Maxime Amblard, Philippe de Groote, Aleksandre Maskharashvili, Sylvain Pogodalla [coordinator].

POLYMNIE[0] is a research project funded by the French national research agency (ANR) from September 2012 to February 2016. It relies on the grammatical framework of Abstract Categorial Grammars (ACG). A feature of this formalism is to provide the same mathematical perspective both on the surface forms and on the more abstract forms the latter correspond to. As a consequence:

- ACG allows for the encoding of a large variety of grammatical formalisms such as context-free grammars, Tree Adjoining grammars (TAG), etc.
- ACG defines two languages: an abstract language for the abstract forms, and an object language for the surface forms.

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[0]http://semagramme.loria.fr/doku.php?id=projects:polymnie

Importantly, the notions of object language and abstract language are relative to each other. If we can naturally see surface forms as strings for instance and abstract forms as the associated syntactic trees, we can also consider to associate this abstract form to a first order logical formula as surface (object) form. This property is central in our project as it offers a unified approach to text analysis and text generation, in particular considering the underlying algorithms and their complexity.

ACG definition uses type-theory and lambda-calculus. From this point of view, they smoothly integrate formal semantics models issuing from Montague's proposal. Theories that extend to the discourse level such as Discourse Representation Theory (DRT) and Dynamic Predicate Logic (DPL) were not initially formulated using lambda-calculus. But such formulations have been proposed. In particular, a formulation based on continuation semantics allows them to be expressed quite naturally in the ACG architecture. Dynamic effects of discourse, in particular those related to anaphora resolution or rhetorical relation inference, have then to be expressed by lexical semantics or computed from the syntactic rules as studied in the Inria Collaborative Research Project (ARC) CAuLD [0].

It has been shown that the discourse structure of texts plays a key role in their understanding. This is the case for both human readers and automatic processing systems. For instance, it can enhance text transformation systems such as the ones performing automatic summarization.

POLYMNIE focuses on studying and implementing the modeling of sentences and discourses in a compositional paradigm that takes into account their dynamics and their structures, both in parsing and in generation. To that end, we rely on the ACG framework. The kind of processing we are interested in relates to the automatic construction of summaries or to text simplification. This has to be considered in the limits of the modeling of the linguistic processes (as opposed to inferential processes for instance) these tasks involve.

Partners:

- Sémagramme people,

- Alpage (Paris 7 university & Inria Paris-Rocquencourt): Laurence Danlos (local coordinator), C. Braud, C. Roze, Éric Villemonte de la Clergerie,

- MELODI (IRIT, CNRS): Stergos Afantenos, Nicholas Asher (local coordinator), Juliette Conrath, Philippe Muller,

- Signes (LaBRI, CNRS): Jérôme Kirman, Richard Moot, Christian Retoré (local coordinator), Sylvain Salvati, Noémie-Fleur Sandillon-Rezer.

The project has been presented during the *journés du numérique de l'ANR* [23]. A demonstration of the ACGtk software has been given during the TALN conference 2016 [22].

7.2.2. DGLFLF (Délégation générale à la langue française et aux langues de France)

7.2.2.1. ZombiLingo
Participants: Bruno Guillaume [coordinator], Nicolas Lefebvre.

The goal of the ZombiLingo project is to develop an online GWAP (Game With A Purpose) to help the construction of linguistic resources. See 6.3.1 for more information.

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[0] https://members.loria.fr/SPogodalla/files/cauld

<p style="text-align:center">**SIROCCO Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *CominLabs/InterCom project*

Participants: Aline Roumy, Thomas Maugey.

- Title : Interactive Communication (INTERCOM): Massive random access to subsets of compressed correlated data .
- Research axis : 7.4.1
- Partners : Inria-Rennes (Sirocco team and i4S team); LabSTICC, Telecom Bretagne, Signal & Communications Department; External partner: Kieffer L2S, CentraleSupelec, Univ. Paris Sud.
- Funding : Labex CominLabs.
- Period : Oct. 2016 - Nov. 2019.

This project aims to develop novel compression techniques allowing massive random access to large databases. Indeed, we consider a database that is so large that, to be stored on a single server, the data have to be compressed efficiently, meaning that the redundancy/correlation between the data have to be exploited. The dataset is then stored on a server and made available to users that may want to access only a subset of the data. Such a request for a subset of the data is indeed random, since the choice of the subset is user-dependent. Finally, massive requests are made, meaning that, upon request, the server can only perform low complexity operations (such as bit extraction but no decompression/compression). Algorithms for two emerging applications of this problem will be developed: Free-viewpoint Television (FTV) and massive requests to a database collecting data from a large-scale sensor network (such as Smart Cities).

9.2. European Initiatives

9.2.1. *FP7 & H2020 Projects*

9.2.1.1. *ERC-CLIM*

Participants: Pierre David, Elian Dib, Christine Guillemot, Xin Su.

Light fields yield a rich description of the scene ideally suited for advanced image creation capabilities from a single capture, such as simulating a capture with a different focus and a different depth of field, simulating lenses with different apertures, for creating images with different artistic intents or for producing 3D views. Light fields technology holds great promises for a number of application sectors, such as photography, augmented reality, light field microscopy, but also surveillance, to name only a few.

The goal of the ERC-CLIM project is to develop algorithms for the entire static and video light fields processing chain, going from compact sparse and low rank representations and compression to restoration, high quality rendering and editing.

9.3. International Initiatives

9.3.1. *Informal International Partners*

- Reuben Farrugia, Prof. at the University of Malta has been one sabbatical year Sept. 2015-Aug. 2016) within the team, working on inverse problems (super-resolution, inpainting) for several applications.
- The study on guided image inpainting is carried out in collaboration with Prof. Pascal Frossard from EPFL (Ecole Polytechique Federal de Lausanne).

9.4. International Research Visitors

9.4.1. *Visits of International Scientists*

Sheila Hemami, Prof. at Northeastern University, Boston, has visited the team during three months (May 2016-July 2016), working on the problem of demultiplexing and decoding of micro-lenses based light fields.

<p style="text-align:center; color:red;">**SMIS Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR PerSoCloud (Jan. 2017 - Jan. 2020)

Partners: Orange Labs (coordinator), Inria-SMIS, Cozy Cloud, Univ. of Versailles.
SMIS funding: 170k€.

The objective of PerSoCloud is to design, implement and validate a fullfledged Privacy-by-Design Personal Cloud Sharing Platform. One of the major difficulties linked to the concept of personal cloud lies in organizing and enforcing the security of the data sharing while the data is no longer under the control of a central server. We identify three dimensions to this problem. Devices-sharing: assuming that the primary copy of user U1's personal data is hosted in a secure place, how to share and synchronize it with U1's multiple (mobile) devices without compromising security? Peers-sharing: how user U1 could exchange a subset of his-her data with an identified user U2 while providing to U1 tangible guarantees about the usage made by U2 of this data? Community-sharing: how user U1 could exchange a subset of his-her data with a large community of users and contribute to personal big data analytics while providing to U1 tangible guarantees about the preservation of his-her anonymity? In addition to tackling these three scientific and technical issues, a legal analysis will guarantee compliance of this platform with the security and privacy French and UE regulation, which firmly promotes the Privacy by Design principle, including the current reforms of personal data regulation.

8.1.2. ANR KISS (Dec. 2011 - Feb. 2016)

Partners: Inria-SMIS (coordinator), Inria-SECRET, LIRIS, Univ. of Versailles, CryptoExperts, Gemalto, Yvelines district.
SMIS funding: 230k€.

The idea promoted in KISS is to embed, in trusted devices, software components capable of acquiring, storing and managing securely various forms of personal data (e.g., salary forms, invoices, banking statements, geolocation data, depending on the applications). These software components form a Personal Data Server which can remain under the holder's control. The scientific challenges include: embedded data management issues tackling regular, streaming and spatio-temporal data (e.g., geolocation data), data provenance-based privacy models, crypto-protected distributed protocols to implement private communications and secure global computations.

8.1.3. PIA - PDP SECSi (May. 2016 - Dec. 2017)

Partners: Cozy Cloud (coordinator), Qwant, Inria-SMIS, FING.
SMIS funding: 149k€.

The objective of this PIA-PDP (Programme Investissement d'Avenir - Protection des Données Personnelles) SECSi project is to build a concrete Personal Cloud platform which can support a large scale deployment of Self Data services. Three major difficulties are identified and will be tackled in this project: (1) how to implement and enforce a fine control of the data flow when personal data are exploited by third party applications, (2) how to protect these same applications when processing is delegated to the personal cloud platform itself and (3) how to implement personalized search on the web without hurting user's privacy.

8.1.4. CAPPRIS Project-Lab (Dec. 2011 - Dec. 2016)

Inria Partners: PRIVATICS (coordinator), SMIS, PLANETE, CIDRE, COMETE.
External partners: Univ. of Namur, Eurecom, LAAS.
Funding: not associated to individual project-teams.

An Inria Project Lab (IPL) is a long-term multi-disciplinary project launched by Inria to sustain large scale risky research actions in line with its own strategic plan. CAPPRIS stands for "Collaborative Action on the Protection of Privacy Rights in the Information Society". The key issues that are addressed are: (1) the identification of existing and future threats to privacy, (2) the definition of formally grounded measures to assess and quantify privacy, (3) the definition of the fundamental principles underlying privacy by design and methods to apply them in concrete situations and (4) The integration of the social and legal dimensions. To assess the relevance and significance of the research results, they are confronted to three classes of case studies CAPPRIS partners are involved in: namely Online Social Networks, Location Based Services and Electronic Health Record Systems.

8.1.5. CityLab@Inria, Inria Project Lab (May 2014 -).

Inria Partners: CLIME, DICE, FUN, MIMOVE, MYRIADS, SMIS, URBANET, WILLOW.
External partners: UC Berkeley.
Funding: not associated to individual project teams.

CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. SMIS contributes to Privacy-by-Design architectures for trusted smart objects so as to ensure privacy to citizens, which is critical for ensuring that urbanscale sensing contributes to social sustainability and does not become a threat. https://citylab.inria.fr/

8.1.6. VALDO (Valorisation et monétisation des données personnelles à l'ère du Big Data), Digital Society Institute (DSI) (May 2015 - Sept. 2016).

Partners: DANTE and SMIS (co-organizers), CERDI, RITM.
SMIS funding: 50K€.

The objective of this project is to study with a multidisciplinary approach (i.e., computer science, law and economics) the impact of putting a certain (e.g., monetary) value on personal data, over the behavior of individuals (that are the rightful owners of the data) and market companies (that make usage of the personal data) in terms of data protection practices and data usage.

<p style="text-align:center">STARS Project-Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. MOVEMENT

Program: ANR CSOSG

Project acronym: MOVEMENT

Project title: AutoMatic BiOmetric Verification and PersonnEl Tracking for SeaMless Airport ArEas Security MaNagemenT

Duration: January 2014-June 2017

Coordinator: MORPHO (FR)

Other partners: SAGEM (FR), Inria Sophia-Antipolis (FR), EGIDIUM (FR), EVITECH (FR) and CERAPS (FR)

Abstract: MOVEMENT is focusing on the management of security zones in the non public airport areas. These areas, with a restricted access, are dedicated to service activities such as maintenance, aircraft ground handling, airfreight activities, etc. In these areas, personnel movements tracking and traceability have to be improved in order to facilitate their passage through the different areas, while insuring a high level of security to prevent any unauthorized access. MOVEMENT aims at proposing a new concept for the airport's non public security zones (e.g. customs control rooms or luggage loading/unloading areas) management along with the development of an innovative supervision system prototype.

8.1.1.2. SafEE

Program: ANR TESCAN

Project acronym: SafEE

Project title: Safe & Easy Environment for Alzheimer Disease and related disorders

Duration: December 2013-May 2017

Coordinator: CHU Nice

Other partners: Nice Hospital(FR), Nice University (CobTeck FR), Inria Sophia-Antipolis (FR), Aromatherapeutics (FR), SolarGames(FR), Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW), BDE (TW)

Abstract: SafEE project aims at investigating technologies for stimulation and intervention for Alzheimer patients. More precisely, the main goals are: (1) to focus on specific clinical targets in three domains behavior, motricity and cognition (2) to merge assessment and non pharmacological help/intervention and (3) to propose easy ICT device solutions for the end users. In this project, experimental studies will be conducted both in France (at Hospital and Nursery Home) and in Taiwan.

8.1.2. FUI

8.1.2.1. Visionum

Program: FUI

Project acronym: Visionum

Project title: Visonium.

Duration: January 2015- December 2018

Coordinator: Groupe Genious

Other partners: Inria(Stars), StreetLab, Fondation Ophtalmologique Rothschild, Fondation Hospitaliere Sainte-Marie.

Abstract: This French project from Industry Minister aims at designing a platform to re-educate at home people with visual impairment.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CENTAUR

Title: Crowded ENvironments moniToring for Activity Understanding and Recognition

Programm: FP7

Duration: January 2013 - December 2016

Coordinator: Honeywell

Partners:

Ecole Polytechnique Federale de Lausanne (Switzerland)

"honeywell, Spol. S.R.O" (Czech Republic)

Neovision Sro (Czech Republic)

Queen Mary University of London (United Kingdom)

Inria contact: François Bremond

'We aim to develop a network of scientific excellence addressing research topics in computer vision and advancing the state of the art in video surveillance. The cross fertilization of ideas and technology between academia, research institutions and industry will lay the foundations to new methodologies and commercial solutions for monitoring crowded scenes. Research activities will be driven by specific sets of scenarios, requirements and datasets that reflect security operators' needs for guaranteeing the safety of EU citizens. CENTAUR gives a unique opportunity to academia to be exposed to real life dataset, while enabling the validation of state-of-the-art video surveillance methodology developed at academia on data that illustrate real operational scenarios. The research agenda is motivated by ongoing advanced research activities in the participating entities. With Honeywell as a multi-industry partner, with security technologies developed and deployed in both its Automation and Control Solutions and Aerospace businesses, we have multiple global channels to exploit the developed technologies. With Neovison as a SME, we address small fast paced local markets, where the quick assimilation of new technologies is crucial. Three thrusts identified will enable the monitoring of crowded scenes, each led by an academic partner in collaboration with scientists from Honeywell: a) multi camera, multicoverage tracking of objects of interest, b) Anomaly detection and fusion of multimodal sensors, c) activity recognition and behavior analysis in crowded environments. We expect a long term impact on the field of video surveillance by: contributions to the state-of-the-art in the field, dissemination of results within the scientific and practitioners community, and establishing long term scientific exchanges between academia and industry, for a forum of scientific and industrial partners to collaborate on addressing technical challenges faced by scientists and the industry.'

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. Informal International Partners

- **Collaborations with Asia:** Stars has been cooperating with the Multimedia Research Center in Hanoi MICA on semantics extraction from multimedia data. Stars also collaborates with the National Cheng Kung University in Taiwan and I2R in Singapore.
- **Collaboration with U.S.A.:** Stars collaborates with the University of Southern California.
- **Collaboration with Europe:** Stars collaborates with Multitel in Belgium, the University of Kingston upon Thames UK, and the University of Bergen in Norway.

8.3.1.2. Other IIL projects

The ANR SafEE (see section 8.1.1.2) collaborates with international partners such as Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW) and BDE (TW).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

This year, Stars has been visited by the following international scientists:
- Salwa Baabou, Ecole Nationale d'Ingénieurs de Gabès, Tunisia;
- Siyuan Chen, University of New South Wales, Australia;
- Adlen Kerboua, University of Skikda, Algeria;
- Karel Krehnac, Neovision, Praha, Czech Republic;
- Jana Trojnova, Honeywell, Praha, Czech Republic;
- Luis Emiliano Sanchez, Rosario University, Argentina.

8.4.1.1. Internships

Seongro Yoon
>   Date: Apr 2016-Dec 2016
>   Institution: Korea Advanced Institute of Science and Technology, Daejeon, Korea
>   Supervisor: François Brémond

Yashas Annadani
>   Date: May2016-June 2016
>   Institution: National Institute Of Technology Karnataka, India
>   Supervisor: Carlos Fernando Crispim Junior

Chandraja Dharmana
>   Date: May 2016-June 2016
>   Institution: Birla Institute of Technology and Science, Pilani, Hyderbrad
>   Supervisor: Carlos Fernando Crispim Junior

Shanu Vashistha
>   Date: May 2016-June 2016
>   Institution: Indian Institute of Technology, Kanpur, India
>   Supervisor: Carlos Fernando Crispim Junior

Nairouz Mrabah
>   Date: Apr 2016-Sep 2016
>   Institution: National School of Computer Science (ENSI), Tunisia
>   Supervisor: Inès Sarray

Isabel Rayas
>   Date: June 2016-Dec 2016
>   Institution: Massachusetts Institute of Technology, USA
>   Supervisor: Farhood Negin

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THOTH Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. DeCore (Deep Convolutional and Recurrent networks for image, speech, and text)
Participants: Jakob Verbeek, Maha Elbayad.

DeCore is a project-team funded by the Persyval Lab for 3.5 years (september 2016 - February 2020), coordinated by Jakob Verbeek. It unites experts from Grenoble's applied-math and computer science labs LJK, GIPSA-LAB and LIG in the areas of computer vision, machine learning, speech, natural language processing, and information retrieval. The purpose of DeCore is to stimulate collaborative interdisciplinary research on deep learning in the Grenoble area, which is likely to underpin future advances in machine perception (vision, speech, text) over the next decade. It provides funding for two full PhD students. Maha Elbayad is one of them, supervised by Jakob Verbeek and Laurant Besacier (UGA).

9.2. National Initiatives

9.2.1. ANR Project Physionomie
Participants: Jakob Verbeek, Shreyas Saxena, Guosheng Hu.

Face recognition is nowadays an important technology in many applications ranging from tagging people in photo albums, to surveillance, and law enforcement. In this 3-year project (2013–2016) the goal is to broaden the scope of usefulness of face recognition to situations where high quality images are available in a dataset of known individuals, which have to be identified in relatively poor quality surveillance footage. To this end we will develop methods that can compare faces despite an asymmetry in the imaging conditions, as well as methods that can help searching for people based on facial attributes (old/young, male/female, etc.). The tools will be evaluated by law-enforcement professionals. The participants of this project are: Morpho, SensorIT, Université de Caen, Université de Strasbourg, Fondation pour la Recherche Stratégique, Préfecture de Police, Service des Technologies et des Systèmes d'Information de la Sécurité Intérieure, and Thoth. The project ended in June 2016.

9.2.2. ANR Project Macaron
Participants: Julien Mairal, Zaid Harchaoui [University of Washington], Laurent Jacob [CNRS, LBBE Laboratory], Michael Blum [CNRS, TIMC Laboratory], Joseph Salmon [Telecom ParisTech].

The project MACARON is an endeavor to develop new mathematical and algorithmic tools for making machine learning more scalable. Our ultimate goal is to use data for solving scientific problems and automatically converting data into scientific knowledge by using machine learning techniques. Therefore, our project has two different axes, a methodological one, and an applied one driven by explicit problems. The methodological axis addresses the limitations of current machine learning for simultaneously dealing with large-scale data and huge models. The second axis addresses open scientific problems in bioinformatics, computer vision, image processing, and neuroscience, where a massive amount of data is currently produced, and where huge-dimensional models yield similar computational problems.

This is a 3 years and half project, funded by ANR under the program "Jeunes chercheurs, jeunes chercheuses", which started in October 2014. The principal investigator is Julien Mairal.

9.2.3. ANR Project DeepInFrance
Participant: Jakob Verbeek.

DeepInFrance (Machine learning with deep neural networks) project also aims at bringing together complementary machine learning, computer vision and machine listening research groups working on deep learning with GPUs in order to provide the community with the knowledge, the visibility and the tools that brings France among the key players in deep learning. The long-term vision of Deep in France is to open new frontiers and foster research towards algorithms capable of discovering sense in data in an automatic manner, a stepping stone before the more ambitious far-end goal of machine reasoning. The project partners are: INSA Rouen, Univ. Caen, Inria, UPMC, Aix-Marseille Univ., Univ. Nice Sophia Antipolis.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERC Advanced grant Allegro
Participants: Cordelia Schmid, Pavel Tokmakov, Nicolas Chesneau, Vicky Kalogeiton, Konstantin Shmelkov, Daan Wynen, Xiaojiang Peng.

The ERC advanced grant ALLEGRO started in April 2013 for a duration of five years. The aim of ALLEGRO is to automatically learn from large quantities of data with weak labels. A massive and ever growing amount of digital image and video content is available today. It often comes with additional information, such as text, audio or other meta-data, that forms a rather sparse and noisy, yet rich and diverse source of annotation, ideally suited to emerging weakly supervised and active machine learning technology. The ALLEGRO project will take visual recognition to the next level by using this largely untapped source of data to automatically learn visual models. We will develop approaches capable of autonomously exploring evolving data collections, selecting the relevant information, and determining the visual models most appropriate for different object, scene, and activity categories. An emphasis will be put on learning visual models from video, a particularly rich source of information, and on the representation of human activities, one of today's most challenging problems in computer vision.

9.3.1.2. EU Marie Curie project: Egovision4health
Participants: Grégory Rogez, Cordelia Schmid.

After the 2-year outgoing phase hosted by the University of California, Irvine, G. Rogez spent the return (and final) phase of the project in the team. In 2015, he analyzed functional object manipulations focusing on fine-grained hand-object interactions and created a large dataset of 12000 RGB-D images covering 71 everyday grasps in natural interactions. This Grasp UNderstanding dataset (GUN-71) has been made publicly available in 2016 (http://www.gregrogez.net/research/egovision4health/gun-71/). In the last period of the fellowship, G. Rogez and C. Schmid addressed the more general problem of full-body 3D pose estimation in third-person images. They developed a new data synthesis technique to generate large-scale (2 millions images) training data that were later used to train Deep Convolutional Neural Networks. The collaboration resulted in a publication [19]. Dataset, code and models will be released soon.

9.4. International Initiatives

9.4.1. *Inria Associate Teams Not Involved in an Inria International Labs*

9.4.1.1. GAYA: Semantic and Geometric Models for Video Interpretation

We have formed an associate team GAYA, with the primary goal of interpreting videos in terms of recognizing actions, understanding the human-human and human-object interactions. Despite several years of research, it is yet unclear what is an efficient and robust video representation to attack this challenge. In order to address this, GAYA will focus on building semantic models, wherein we learn the video feature representation with limited supervision, and also geometric models, where we study the geometric properties of object shapes to better recognize them. The team consists of researchers from two Inria project-teams (Thoth and WILLOW) and a US university (Carnegie Mellon University [CMU]). It will allow the three teams to effectively combine their respective strengths in areas such as inference and machine learning approaches for vision tasks, feature

representation, large-scale learning, geometric reasoning. The main expected outcomes of this collaboration are: effective learnt representations of video content, new machine learning algorithms for handling minimally annotated data, large-scale public datasets for benchmarking, theoretical analysis of objects shapes and contours. Cordelia Schmid and Karteek Alahari are involved in this associate team.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- **University of Edinburgh:** C. Schmid collaborates with V. Ferrari, associate professor at university of Edinburgh. Vicky Kalogeiton started a co-supervised PhD in September 2013; she is bi-localized between Uni. Edinburgh and Inria. Her subject is the automatic learning of object representations in videos. The collaboration resulted in a joint publication in IEEE PAMI [7]

- **MPI Tübingen:** C. Schmid collaborates with M. Black, a research director at MPI, starting in 2013. She spent one month at MPI in May 2016. End of 2015 she was award a Humbolt research award funding a long-term research project with colleagues at MPI. In 2016 the project resulted in the development of a large-scale synthetic human action dataset.

- **Technion:** J. Mairal started a collaboration with Yonina Eldar (Technion) and Andreas Tillmann (Darmstadt university) to develop dictionary learning techniques for phase retrieval. Their collaboration resulted in a paper accepted to the ICASSP'16 conference [22] and a paper accepted to IEEE Transaction on signal processing [12].

- **UC Berkeley:** This collaboration between Bin Yu, Jack Gallant, Yuval Benjamini, Adam Bloniarz, Yuansi Chen (UC Berkeley), and Julien Mairal (Inria Thoth) aims to discover the functionalities of areas of the visual cortex. We have introduced an image representation for area V4, adapting tools from computer vision to neuroscience data. The collaboration started when Julien Mairal was a post-doctoral researcher at UC Berkeley and is still ongoing.

9.4.3. Participation in Other International Programs

- **Indo-French project EVEREST** with IIIT Hyderabad, India, funded by CEFIPRA (Centre Franco-Indien pour la Promotion de la Recherche Avancee). The aim of this project between Cordelia Schmid, Karteek Alahari and C. V. Jawahar (IIIT Hyderabad) is to enable the use of rich, complex models that are required to address the challenges of high-level computer vision. The work plan for the project will follow three directions. First, we will develop a learning framework that can handle weak annotations. Second, we will build formulations to solve the non-convex optimization problem resulting from the learning framework. Third, we will develop efficient and accurate energy minimization algorithms, in order to make the optimization computationally feasible.

- **France-Berkeley fund:** Julien Mairal was awarded in 2014 a grant from the France-Berkeley fund for a project with Pr. Bin Yu (statistics department, UC Berkeley) on "Invariant image representations and high dimensional sparse estimation for neurosciences". The award amounts to 10,000 USD, from November 2014 to April 2016. The funds are meant to support scientific and scholarly exchanges and collaboration between the two teams.

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Research Stays Abroad

- H. Lin visited Microsoft Research at New York from September to December 2016, as part of the MSR-Inria joint centre collaboration.

- G. Chéron visited Microsoft Research at Cambridge from April to July 2016, as part of the MSR-Inria joint centre collaboration.

<center>**TITANE Project-Team**</center>

9. Partnerships and Cooperations

9.1. European Initiatives

9.1.1. FP7 & H2020 Projects

9.1.1.1. TITANIUM - Software Components for Robust Geometry Processing

> Type: IDEAS
>
> Instrument: ERC Proof of concept
>
> Duration: 18 months
>
> Coordinator: Pierre Alliez
>
> Inria contact: Pierre Alliez
>
> Abstract: The TITANIUM project aims to develop a software demonstrator for geometry processing and 3D urban modeling, in order to facilitate the pre-commercialization of novel software components for the Computational Geometry Algorithms Library. The demonstrator will include novel approaches resulting from the ERC-funded IRON project (Robust Geometry Processing, StG-2010-257474), which are illustrated by publications presented at premier conferences in our field and a patent submitted in 2015. The expected outcomes of TITANIUM will be versatile methods for 3D reconstruction and simplification of data gathered from geometric measurements, as well as related methods specifically tailored to urban modeling. These methods represent a significant step forward by offering unrivaled levels of robustness, and automated generation of levels of detail that are semantically meaningful. The acronym TITANIUM, a robust and lightweight material, conveys our wish to streamline the geometric modeling pipeline through robust algorithms and lightweight representations. This Proof of Concept project will also implement the steps required for pre-commercialization. In view of this goal, we have included an industrial partner, GeometryFactory, a spinoff from Inria. We have already established preliminary contacts in the fields of metrology and geographic information systems. These contacts will provide real-world industrial case studies.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Declared Inria International Partners

We have a long standing collaboration with Prof. Mathieu Desbrun from Caltech.

9.2.1.2. Informal International Partners

We collaborate with researchers from RWTH Aachen.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Prof. Mathieu Desbrun visited us for 3 months between August and November, within the framework of the Inria international chair.

9.3.1.1. Internships

Chunlin Xiao (University of Nice Sophia-Antipolis and University of L'Aquila): large-scale remote sensing image segmentation and classification.

<p style="text-align:center"><strong style="color:red">TYREX Project-Team</p>

7. Partnerships and Cooperations

7.1. Regional Initiatives

AGIR

>Title: Data-CILE
>
>Call: Appel à projet Grenoble Innovation Recherche (AGIR-Pole)
>
>Duration: 2016-2018
>
>Coordinator: Nabil Layaïda
>
>Abstract: The goal of this project is to contribute to foundational and algorithmic challenges introduced by increasingly popular data-centric paradigms for programming on distributed architectures such as spark and the massive production of big linked open data. The focus of the project is on building robust and more efficient workflows of transformations of rich web data. We will investigate effective programming models and compilation techniques for producing specialised language runtimes. We will focus on high-level specifications of pipelines of data transformations and extraction for producing valuable knowledge from rich web data. We will study how to synthesise code which is correct and optimised for execution on distributed platforms. The overall expected outcome is to make the development of rich-data-intensive applications less error-prone and more efficient.

7.2. National Initiatives

7.2.1. Investissements d'avenir

Datalyse

>Title: Entrepôt Intelligent pour Big Data hétérogènes. Investissements d'Avenir Développement de l'Economie Numérique.
>
>Call: Cloud Computing, num 3 – Big Data.
>
>Duration: May 2013 - November 2016
>
>Coordinator: Business & Decision Eolas
>
>Others partners: Groupement des Mousquetaires, Inria Saclay (OAK EPC), LIG (Hadas and Erods teams), LIRMM (Montpellier), LIFL (Lille).
>
>See also: http://www.datalyse.fr/
>
>Abstract: Project Datalyse aims at designing and deploying an infrastructure for big data storage, collection, certification, integration, categorisation, enrichment and sharing over very large heterogeneous data sets. It relies on an industrial platform, to be made available on the cloud, and focuses on three flagship applications, showcasing three uses of big data over different data sets:
>
>- Data-Center Monitoring: The goal of this application is to provide features such as traceability, reporting, optimisation and analysis of abnormal behaviour regarding energy efficiency and security issues. The application will be built with an existing application called ScopeBR (Eolas) and will be deployed in two different green data centers, those of Eolas and GDF SUEZ.
>- 'Territoire de données ouvertes et liées': This application aims at extracting and provisioning public open data collected from the city of Grenoble and its suburbs. The goal is to make public data available to third-party application developers and to federate local actors around a single platform.
>- Real-time Business Intelligence for the management and processing of points of sale: this application will focus on real-time data analytics and will be deployed within 'Groupement des Mousquetaires' in support of their business intelligence platforms.

7.2.2. ANR

CLEAR

Title: Compilation of intermediate Languages into Efficient big dAta Runtimes

Call: Appel à projets générique 2016 défi 'Société de l'information et de la communication' – JCJC

Duration: October 2016 – September 2020

Coordinator: Pierre Genevès

See also: http://tyrex.inria.fr/clear

Abstract: This project addresses one fundamental challenge of our time: the construction of effective programming models and compilation techniques for the correct and efficient exploitation of big and linked data. We study high-level specifications of pipelines of data transformations and extraction for producing valuable knowledge from rich and heterogeneous data. We investigate how to synthesize code which is correct and optimized for execution on distributed infrastructures.

7.2.3. PERSYVAL-lab LabEx

Title: Mobile Augmented Reality Applications for Smart Cities

Call: Persyval Labex ('Laboratoire d'excellence').

Duration: 2014 – 2017

Coordinators: Pierre Genevès and Nabil Layaïda

Others partners: NeCS team at GIPSA-Lab laboratory.

Abstract: The goal of this project is to increase the relevance and reliability of augmented reality (AR) applications, through three main objectives:

1. Finding and developing appropriate representations for describing the physical world (3D maps, indoor buildings, ways...), integrated advanced media types (3D, 3D audio, precisely geo-tagged pictures with lat., long. and orientation, video...)

2. Integrating the different abstraction levels of these data streams (ranging from sensors data to high level rich content such as 3D maps) and bridging the gap with Open Linked Data (the semantic World). This includes opening the way to query the environment (filtering), and adapt AR browsers to users' capabilities (e.g. blind people). The objective here is to provide an open and scalable platform for mobile-based AR systems (just like the web represents).

3. Increasing the reliability and accuracy of localization technologies. Robust and high-accuracy localization technologies play a key role in AR applications. Combined with geographical data, they can also be used to identify user-activity patterns, such as walking, running or being in an elevator. The interpretation of sensor values, coupled with different walking models, allows one to ensure the continuity of the localization, both indoor and outdoor. However, dead reckoning based on Inertial Navigation Systems (INS) or Step-and-Heading Systems (SHS) is subject to cumulative errors due to many factors (sensor drift (accelerometers, gyroscopes, etc.), missed steps, bad estimation of the length of each stride, etc.). One objective is to reduce such errors by merging and mixing these approaches with various external signals such as GPS and Wi-Fi or relying on the analyses of user trajectories with the help of a structured map of the environment. Some filtering methods (Kalman Filter, observer, etc.) will be useful to achieve this task.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: BETTY

Project title: Behavioural Types for Reliable Large-Scale Software Systems

Duration: October 2012 – October 2016

Coordinator: Professor Simon Gay, University of Glasgow, UK

Other partners: Bosnia and Herzegovina, Croatia, Cyprus, Denmark, Estonia, fYR Macedonia, Germany, Greece, Ireland, Italy, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Spain, Sweden, United Kingdom

Abstract: Modern society is increasingly dependent on large-scale software systems that are distributed, collaborative and communication-centred. Correctness and reliability of such systems depend on compatibility between components and services that are newly developed or may already exist. The consequences of failure are severe, including security breaches and unavailability of essential services. Current software development technology is not well suited to producing these large-scale systems, because of the lack of high-level structuring abstractions for complex communication behaviour.

This Action will use behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreography. As a unifying structural principle it will transform the theory and practice of distributed software development.

The significance of behavioural types has been recognised world-wide during the last five years. European researchers are internationally leading. There is an urgent need for European co-ordination to avoid duplication of effort, facilitate interactions among research groups, and ensure that the field proceeds efficiently from academic research to industrial practice. This Action will provide the co-ordination layer and leverage the efforts of European researchers, to increase the competitiveness of the European software industry.

See also: http://behavioural-types.eu

7.4. International Research Visitors

7.4.1. Internships

Jakob Zietsch from Technische Universität München visited the team from March to July to work on geolocalization with smartphones based on fingerprinting.

<p align="center">**WILLOW Project-Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. *Agence Nationale de la Recherche (ANR): SEMAPOLIS*
Participants: Mathieu Aubry, Josef Sivic.

The goal of the SEMAPOLIS project is to develop advanced large-scale image analysis and learning techniques to semantize city images and produce semantized 3D reconstructions of urban environments, including proper rendering. Geometric 3D models of existing cities have a wide range of applications, such as navigation in virtual environments and realistic sceneries for video games and movies. A number of players (Google, Microsoft, Apple) have started to produce such data. However, the models feature only plain surfaces, textured from available pictures. This limits their use in urban studies and in the construction industry, excluding in practice applications to diagnosis and simulation. Besides, geometry and texturing are often wrong when there are invisible or discontinuous parts, e.g., with occluding foreground objects such as trees, cars or lampposts, which are pervasive in urban scenes. This project will go beyond the plain geometric models by producing semantized 3D models, i.e., models which are not bare surfaces but which identify architectural elements such as windows, walls, roofs, doors, etc. Semantic information is useful in a larger number of scenarios, including diagnosis and simulation for building renovation projects, accurate shadow impact taking into account actual window location, and more general urban planning and studies such as solar cell deployment. Another line of applications concerns improved virtual cities for navigation, with object-specific rendering, e.g., specular surfaces for windows. Models can also be made more compact, encoding object repetition (e.g., windows) rather than instances and replacing actual textures with more generic ones according to semantics; it allows cheap and fast transmission over low- bandwidth mobile phone networks, and efficient storage in GPS navigation devices.

This is a collaborative effort with LIGM / ENPC (R. Marlet), University of Caen (F. Jurie), Inria Sophia Antipolis (G. Drettakis) and Acute3D (R. Keriven).

9.2. European Initiatives

9.2.1. *European Research Council (ERC) Advanced Grant: "VideoWorld" - Jean Ponce*
Participants: Jean Ponce, Ivan Laptev, Josef Sivic.

WILLOW will be funded in part from 2011 to 2016 by the ERC Advanced Grant "VideoWorld" awarded to Jean Ponce by the European Research Council.

'Digital video is everywhere, at home, at work, and on the Internet. Yet, effective technology for organizing, retrieving, improving, and editing its content is nowhere to be found. Models for video content, interpretation and manipulation inherited from still imagery are obsolete, and new ones must be invented. With a new convergence between computer vision, machine learning, and signal processing, the time is right for such an endeavor. Concretely, we will develop novel spatio-temporal models of video content learned from training data and capturing both the local appearance and nonrigid motion of the elements—persons and their surroundings—that make up a dynamic scene. We will also develop formal models of the video interpretation process that leave behind the architectures inherited from the world of still images to capture the complex interactions between these elements, yet can be learned effectively despite the sparse annotations typical of video understanding scenarios. Finally, we will propose a unified model for video restoration and editing that builds on recent advances in sparse coding and dictionary learning, and will allow for unprecedented control of the video stream. This project addresses fundamental research issues, but its results are expected to serve as a basis for groundbreaking technological advances for applications as varied as film post-production, video archival, and smart camera phones.'

9.2.2. *European Research Council (ERC) Starting Grant: "Activia" - Ivan Laptev*

Participant: Ivan Laptev.

WILLOW will be funded in part from 2013 to 2017 by the ERC Starting Grant "Activia" awarded to Ivan Laptev by the European Research Council.

'Computer vision is concerned with the automated interpretation of images and video streams. Today's research is (mostly) aimed at answering queries such as 'Is this a picture of a dog?', (classification) or sometimes 'Find the dog in this photo' (detection). While categorisation and detection are useful for many tasks, inferring correct class labels is not the final answer to visual recognition. The categories and locations of objects do not provide direct understanding of their function i.e., how things work, what they can be used for, or how they can act and react. Such an understanding, however, would be highly desirable to answer currently unsolvable queries such as 'Am I in danger?' or 'What can happen in this scene?'. Solving such queries is the aim of this proposal. My goal is to uncover the functional properties of objects and the purpose of actions by addressing visual recognition from a different and yet unexplored perspective. The main novelty of this proposal is to leverage observations of people, i.e., their actions and interactions to automatically learn the use, the purpose and the function of objects and scenes from visual data. The project is timely as it builds upon the two key recent technological advances: (a) the immense progress in visual recognition of objects, scenes and human actions achieved in the last ten years, as well as (b) the emergence of a massive amount of public image and video data now available to train visual models. ACTIVIA addresses fundamental research issues in automated interpretation of dynamic visual scenes, but its results are expected to serve as a basis for ground-breaking technological advances in practical applications. The recognition of functional properties and intentions as explored in this project will directly support high-impact applications such as detection of abnormal events, which are likely to revolutionise today's approaches to crime protection, hazard prevention, elderly care, and many others.'

9.2.3. *European Research Council (ERC) Starting Grant: "Leap" - Josef Sivic*

Participant: Josef Sivic.

The contract has begun on Nov 1st 2014. WILLOW will be funded in part from 2014 to 2018 by the ERC Starting Grant "Leap" awarded to Josef Sivic by the European Research Council.

'People constantly draw on past visual experiences to anticipate future events and better understand, navigate, and interact with their environment, for example, when seeing an angry dog or a quickly approaching car. Currently there is no artificial system with a similar level of visual analysis and prediction capabilities. LEAP is a first step in that direction, leveraging the emerging collective visual memory formed by the unprecedented amount of visual data available in public archives, on the Internet and from surveillance or personal cameras - a complex evolving net of dynamic scenes, distributed across many different data sources, and equipped with plentiful but noisy and incomplete metadata. The goal of this project is to analyze dynamic patterns in this shared visual experience in order (i) to find and quantify their trends; and (ii) learn to predict future events in dynamic scenes. With ever expanding computational resources and this extraordinary data, the main scientific challenge is now to invent new and powerful models adapted to its scale and its spatio-temporal, distributed and dynamic nature. To address this challenge, we will first design new models that generalize across different data sources, where scenes are captured under vastly different imaging conditions such as camera viewpoint, temporal sampling, illumination or resolution. Next, we will develop a framework for finding, describing and quantifying trends that involve measuring long-term changes in many related scenes. Finally, we will develop a methodology and tools for synthesizing complex future predictions from aligned past visual experiences. Our models will be automatically learnt from large-scale, distributed, and asynchronous visual data, coming from different sources and with different forms of readily-available but noisy and incomplete metadata such as text, speech, geotags, scene depth (stereo sensors), or gaze and body motion (wearable sensors). Breakthrough progress on these problems would have profound implications on our everyday lives as well as science and commerce, with safer cars that anticipate the behavior of pedestrians on streets; tools that help doctors monitor, diagnose and predict patients' health; and smart glasses that help people react in unfamiliar situations enabled by the advances from this project.'

9.3. International Initiatives

9.3.1. IARPA FINDER Visual geo-localization (Inria)

Participants: Josef Sivic, Petr Gronat, Relja Arandjelovic.

Finder is an IARPA funded project aiming to develop technology to geo-localize images and videos that do not have geolocation tag. It is common today for even consumer-grade cameras to tag the images that they capture with the location of the image on the earth's surface ("geolocation"). However, some imagery does not have a geolocation tag and it can be important to know the location of the camera, image, or objects in the scene. Finder aims to develop technology to automatically or semi-automatically geo-localize images and video that do not have the geolocation tag using reference data from many sources, including overhead and ground-based images, digital elevation data, existing well-understood image collections, surface geology, geography, and cultural information.

Partners: ObjectVideo, DigitalGlobe, UC Berkeley, CMU, Brown Univ., Cornell Univ., Univ. of Kentucky, GMU, Indiana Univ., and Washington Univ.

9.3.2. Inria CityLab initiative

Participants: Josef Sivic, Jean Ponce, Ivan Laptev, Alexei Efros [UC Berkeley].

Willow participates in the ongoing CityLab@Inria initiative (co-ordinated by V. Issarny), which aims to leverage Inria research results towards developing "smart cities" by enabling radically new ways of living in, regulating, operating and managing cities. The activity of Willow focuses on urban-scale quantitative visual analysis and is pursued in collaboration with A. Efros (UC Berkeley).

Currently, map-based street-level imagery, such as Google Street-view provides a comprehensive visual record of many cities worldwide. Additional visual sensors are likely to be wide-spread in near future: cameras will be built in most manufactured cars and (some) people will continuously capture their daily visual experience using wearable mobile devices such as Google Glass. All this data will provide large-scale, comprehensive and dynamically updated visual record of urban environments.

The goal of this project is to develop automatic data analytic tools for large-scale quantitative analysis of such dynamic visual data. The aim is to provide quantitative answers to questions like: What are the typical architectural elements (e.g., different types of windows or balconies) characterizing a visual style of a city district? What is their geo-spatial distribution (see figure 1)? How does the visual style of a geo-spatial area evolve over time? What are the boundaries between visually coherent areas in a city? Other types of interesting questions concern distribution of people and their activities: How do the number of people and their activities at particular places evolve during a day, over different seasons or years? Are there tourists sightseeing, urban dwellers shopping, elderly walking dogs, or children playing on the street? What are the major causes for bicycle accidents?

Break-through progress on these goals would open-up completely new ways smart cities are visualized, modeled, planned and simulated, taking into account large-scale dynamic visual input from a range of visual sensors (e.g., cameras on cars, visual data from citizens, or static surveillance cameras).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Prof. Alexei Efros (UC Berkeley, USA) visited Willow during May-June with his postdoc Phillip Isola and Phd student Richard Zhang. Prof. John Canny (UC Berkeley) has visited Willow in 2016 within the framework of Inria's International Chair program.

9.4.1.1. Internships

P. Trutman and O. Rybkin have visited Willow from Czech Technical University in Prague.

WIMMICS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. SPARKS Team (I3S)

Wimmics is member of the I3S SPARKS team (Scalable and Pervasive softwARe and Knowledge Systems). It is structured according to three axes: FORUM, ELK and S3.

9.1.1.1. SPARKS ELK Axis

Wimmics contributes to the SPARKS ELK research axis (Knwoledge Extraction and Learning). Andrea Tettamanzi is co-animator of this axis together with Frédéric Precioso (I3S).

9.1.1.2. SPARKS FORUM Axis

Wimmics contributes to the SPARKS FORUM research axis (FORmalizing with Users and Models). Catherine Faron-Zucker and Alain Giboin are co-animators of FORUM. This year, three seminars were organized: (1) Visualisation des données liées (Emilie Palagi, Erwan Demairy, Raphaël Boyer, Olivier Corby); (2) Agents BDI possibilistes (Célia Da Costa-Pereira, Serena Villata, Andrea Tettamanzi); (3) Adaptation Dynamique : des processus métiers à l'environnement opérationnel. Application à la continuité de services ambiants (Jean-Yves Tigli, Isabelle Mirbel).

9.1.1.3. SPARKS S3 Axis

Wimmics contributes to the SPARKS S3 research group (Scalable Software Systems). Olivier Corby, Fuqi Song and Erwan Demairy contribute with federated distributed query processing in Corese with Johan Montagnat and Abdoul Macina. Catherine Faron-Zucker and Franck Michel contribute on it with Johan Montagnat on heterogeneous databases federation.

9.1.1.4. SPARKS HCI Group

The HCI Group brings together researchers from the SPARKS team conducting or wishing to conduct research related to Human-Computer Interaction. The group specifically addresses the issues of how to conduct user experiments to evaluate the UIs of the software developed in GLC. The group establishes collaborations between researchers in the design and implementation of experiments. The HCI group is animated by Anne-Marie Dery (I3S).

9.1.1.5. MSHS Axis-2: ICT, Usage and Communities
Participants: Alain Giboin, Alexandre Monnin, Fabien Gandon, Emilie Palagi.

Axis-2 of the *Maison des Sciences Humaines et Sociales (MSHS) du Sud-Est (Nice)* aims to federate interdisciplinary research on the relationships between ICT, Practices and Communities. Wimmics is mainly involved in one of the Axis-2 groups-projects, "Artifacts and Coordination." This group-project studies the impact of cognitive technologies on the social and cognitive coordination between individuals in organizational and community contexts. Alain Giboin is member of the Axis-2 scientific committee and co-animator (with Lise Arena, GREDEG, until September 2016; and Evelyne Rouby, GREDEG, from October 2016) of the "Artifacts and Coordination" group-project. He is also co-animator (with Pierre Thérouanne (Lapcos), Lise Arena and Agnès Festré (GREDEG)) of the project "Acceptabilitity of digital devices: an interdisciplinary perspective". This group is animated by Alain Giboin, Alexandre Monnin, Fabien Gandon and Emilie Palagi.

9.1.2. TCP-IP + Blockchain UCA Idex Submission
Participant: Alexandre Monnin.

We submitted a project proposal around the "TCP-IP + Blockchain (Transdisciplinary Collaborative Plaform for Internet of things and Platformcooperativism)" platform, launched and coordinated by Alexandre Monnin inside the UCA Jedi Idex (Wimmics, LEAT, Aoste, Indes, I3S, GREDEG, LAPCOS, SKEMA, Sustainable Design School, Villa Arson, module D, club Cap EF, SCITIAM, Fabrique des Mobilités, Mnémotix, etc.). A host of projects were submitted inside this platform:

- ACCEPT by Lise Arena and Alain Giboin (Idex Academy 5)

- SMART by François Verdier (Idex Academy 1)

- Polisthelia by Alexandre Monnin (ANR, PCRI with Luxemburg)

- SMARTIOT by François Verdier (ANR project on Smart Contracts)

among which ValueModels submitted by Alexandre Monnin (Idex Academy 1) was accepted.

9.2. National Initiatives

9.2.1. *NiceCampus Research Lab*
Participant: Nhan Le Thanh.

NiceCampus Research Lab (from training to/and through research to a Joint International Laboratory) is a framework for cooperation for research training. This framework is proposed by the University of Nice Sophia Antipolis to support the 911 Vietnamese research training program that aims to support the development of Vietnamese universities. The NiceCampus Lab Project was a winner of the AUF Call for Proposals 2016-2017. In this context, the MIRE (Maison de l'innovation et de la recherche NiceCampus) was created at University of Da Nang (Vietnam).

9.2.2. *DILPROSPECT*
Participant: Andrea Tettamanzi.

We participated in the interdisciplinary DILPROSPECT CNRS Project, with researchers of many other research units, including the UMR 7300 ESPACE and INRA on the study of the interface between constructed and natural land on the French Riviera.

9.2.3. *AZKAR*
Participants: Alain Giboin, Thierry Bergeron, Michel Buffa, Catherine Faron-Zucker.

AZKAR is a two years French project funded by BPI (Banque Publique d'Investissement), focused on *Fast Control of Mobile Robots over the Internet*.

The project started in September 2014. The first step of the project has been the evaluation and benchmarking of video and data solutions over Internet, based on the WebRTC technology. The second step consists in implementing these solutions on a real mobile robot that has been deployed in museums or in homes for helping seniors in their daily tasks. Semantic Web technologies, have been used in the project for describing the services, the context of the application domain, the content transmitted, etc. We got a best demo award at ISWC this year, for a demo that shown a robot located in France that has been remote controlled from Kobe in Japan during the conference [32].

9.2.4. *ANR WASABI*
Participants: Michel Buffa, Elena Cabrio.

We will be project leader of this 42 month ANR project that starts in January 2017. Partners are IRCAM, Deezer, Radio France and a french startup named Parisson. WASABI aims to build the biggest song metadata semantic database, mixing audio and cultural content analysis. Client applications target music school, sound engineer schools, composers and musicians, journalists, radios and streaming services.

9.2.5. ANR LabCom SMILK

Participants: Elena Cabrio, Catherine Faron-Zucker, Fabien Gandon, Zide Meng, Oscar Rodríguez Rocha, Molka Tounsi.

SMILK (Social Media Intelligence and Linked Knowledge) is a joint laboratory (LabCom, 2013-2016) between the Wimmics team and the Research and Innovation unit of VISEO (Grenoble). Natural Language Processing, Linked Open Data and Social Networks as well as the links between them are at the core of this LabCom. The purpose of SMILK is both to develop research and technologies in order to retrieve, analyze, and reason on textual data coming from Web sources, and to make use of LOD, social networks structures and interaction in order to improve the analysis and understanding of textual resources. Topics covered by SMILK include: use of data and vocabularies published on the Web in order to search, analyze, disambiguate and structure textual knowledge in a smart way, but also to feed internal information sources; reasoning on the combination of internal and public data and schemes, query and presentation of data and inferences in natural formats.

9.2.6. Inria LabCom EduMICS

Participants: Catherine Faron-Zucker, Fabien Gandon, Chihabeddine Bouchenaki, Olivier Corby.

EduMICS (Educative Models Interactions Communities with Semantics) is a joint laboratory (LabCom, 2016-2018) between the Wimmics team and the Educlaver company. Adaptive Learning, Social Learning and Linked Open Data and links between them are at the core of this LabCom. The purpose of EduMICS is both to develop research and technologies with the ultimate goal to adapt educational progressions and pedagogical resource recommendation to learner profiles. Topics covered by EduMICS include: ontology-based modeling of educational resources; ontology-based integration of heterogenous data sources; ontology-based reasoning; semantic analysis of a social network of learners; pedagogical resource recommendation adpated to learner profiles.

9.2.7. Ministry of Culture: DBpedia.fr

Participants: Raphaël Boyer, Fabien Gandon.

This DBpedia.fr project proposes the creation of a French chapter of the DBpedia database. This project was the first project of the Semanticpedia convention signed by the Ministry of Culture, the Wikimedia foundation and Inria.

Web site: http://dbpedia.fr

9.2.8. Ministry of Culture: GT 6 for a convention between Inria and the Ministry of Culture

Participant: Fabien Gandon.

We supervised the working group GT6 Ministry of Culture on the creation of a research convention to foster research and development at the crossroad of culture and digital sciences. This convention signed between Inria and the Ministry of Culture the 12 December 2016 will provide a framework to support projects at the cross-road of the cultural domain and the digital sciences.

9.2.9. ANR OCKTOPUS

Participants: Fabien Gandon, Catherine Faron-Zucker, Zide Meng.

OCKTOPUS is an ANR project (2012-2016) which ended during this year. Its general objective was to increase the potential social and economic benefit of the large and quickly growing amounts of user-generated content, by transforming it into useful knowledge. We showed how it is possible to considerably improve upon existing generic Information Retrieval techniques by exploiting the specific structure of this content and of the online communities which produce it. Specifically, we focused on a multi-disciplinary approach in order to address the problem of finding relevant answers to questions within forums and question-answer sites. To create metrics and predictors of content quality and use them to improve the search experience of a user, we took advantage of:

- the experience of the CRG (the management research institute of Ecole Polytechnique and CNRS) to understand better the incentives of, and interactions between individuals who produce online content within large communities;

- the experience of the Wimmics research team to analyze the structural and temporal aspects of the complex typed social graphs found within these communities;

- the ability of Alcméon (a start-up developing a search application dedicated to user-generated content) to integrate and test the results of OCKTOPUS within a common demonstration framework, in order to assess their practical usefulness when applied to concrete large-scale datasets.

Partners: Alcméon, CRG, Inria Wimmics.

Web site: http://ocktopus.alcmeon.com

9.2.10. GDRI Zoomathia

Participants: Olivier Corby, Catherine Faron-Zucker, Alexandre Monnin, Andrea Tettamanzi.

Wimmics is partner of the International Research Group (GDRI) Zoomathia funded by two CNRS institutes: INEE and INSHS. It aims at studying transmission of zoological knowledge from Antiquity to Middle-Age through material resources (bio residues, artefacts), iconography and texts.

One of the goals of the project is to design a thesaurus and semantically annotate resources, capturing different types of knowledge: zoonyme, historical period, zoological speciality (ethology, anatomy, physiology, psychology, zootechnique, etc.), litterary genre or iconography.

We collaboratively work with MNHN and CEPAM researchers on the construction of a SKOS thesaurus of zoonyms and a SKOS thesaurus of animal specialties the automatic and on the automatic semantic categorization of text fragments. The ultimate goal is the exploitation of these semantic metadata to help historians in their studies of knowledge transmission through these texts.

Web site: http://www.cepam.cnrs.fr/zoomathia/

9.2.11. FUI PadDOC

Participants: Patrice Pena, Alain Giboin.

PadDOC goal is to contribute to accelerating the digital transition of citizen, local and regional authorities, administrations and enterprises, by : (1) developing an open standard and innovative software and hardware resources to facilitate nearby or distant administrative formalities and procedures; (2) improving the security of the holder's personal data by putting these data under the exclusive control of the holder; (3) by exploiting unmarked communicating supports (such as smartphones or tablets) for all chain actors. PadDOC partners are: Docapost BPO, Anyces, ABC SmartCard and the teams Rainbow, Media-Coding and Wimmics.Wimmics will contribute to: (1) the analysis, design and evaluation of the PadDOC security-oriented user interfaces; (2) the impact assessment of the chain of actors participating in the experiment to validate the viability of the PadDOC social system. The PadDOC project officially began in November 2014.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. MIREL RISE
Participants: Serena Villata, Elena Cabrio, Oscar Rodríguez Rocha, Raphaël Gazzotti, Fabien Gandon.

Program: Research and Innovation Staff Exchange (RISE) project, funding under Marie Skłodowska-Curie grant.

Project acronym: MIREL

Project title: MIning and REasoning with legal text

Duration: 2016-2019

Coordinator: Leendert van der Torre, University of Luxembourg

Other partners: University of Bologna (Italy), University of Torino (Italy), University of Huddersfield (UK), Inria (France), APIS (Bulgaria), Nomotika s.r.l. (Italy), DLVSystem s.r.l. (Italy), Zhejiang University (China), Research Organization of Information and Systems (Japan), University of Cape Town (South Africa), National University of La Plata (Argentina), National University of Córdoba (Argentina), Universidad Nacional del Sur in Bahía Blanca (Argentina), National ICT Australia Ltd (Australia), Stanford University (USA).

Abstract: The MIREL project will create an international and inter-sectorial network to define a formal framework and to develop tools for MIning and REasoning with Legal texts, with the aim of translating these legal texts into formal representations that can be used for querying norms, compliance checking, and decision support. MIREL addresses both conceptual challenges, such as the role of legal interpretation in mining and reasoning, and computational challenges, such as the handling of big legal data, and the complexity of regulatory compliance. It bridges the gap between the community working on legal ontologies and NLP parsers and the community working on reasoning methods and formal logic. Moreover, it is the first project of its kind to involve industrial partners in the future development of innovative products and services in legal reasoning and their deployment in the market. MIREL promotes mobility and staff exchange between SMEs to academies in order to create an inter-continental interdisciplinary consortium in Law and Artificial Intelligence areas including Natural Language Processing, Computational Ontologies, Argumentation, and Logic & Reasoning.

Web site: http://www.mirelproject.eu/

9.3.1.2. ALOOF CHIST-ERA
Participants: Valerio Basile, Elena Cabrio, Fabien Gandon.

ALOOF (Autonomous Learning of the Meaning of Objects) is a European project (CHIST-ERA 2015-2018) to enable robots to use the ever-growing amount of knowledge available on the Web, by learning from there about the meaning of previously unseen objects, expressed in a form that makes them applicable when acting in situated environments. Partners include: University of Rome La Sapienza (Italy), University of Birmingham (United Kingdom), Technische Universität Wien (Austria), Inria Sophia Antipolis Méditerranée (France).

Web site: https://project.inria.fr/aloof/

9.4. International Initiatives

9.4.1. MoReWAIS
Participants: Papa Fary Diallo, Mahamadou Toure, Olivier Corby, Isabelle Mirbel, Fabien Gandon.

Title: Mobile Read Write Access and Intermittent to Semantic Web

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LANI - Moussa Lo, Seydina Ndiaye

Start year: 2016

See also: https://project.inria.fr/morewais/

MoReWAIS proposes to explore the specificities (advantages and constraints) of mobile knowledge sharing. The mobile application targeted in MoReWAIS must allow communities and their users to enrich and access more easily the knowledge base using the user's context with its richness (e.g. location, other users close-by) and addressing its limitations (e.g. intermittent access, limited resources).

We will design and develop algorithms, methods and tools for mobile devices allowing users to:

- co-construct locally and on the road the Semantic Web of Data RDF triple stores representing the sociocultural shared knowledge.
- Access and visualize in context relevant data from the knowledge platform. This requires a complete rethinking of RDF storage and SPARQL querying in a mobile and unreliable network environment. This will also require dedicated interaction design to ease and encourage access and contribution.

9.4.2. SEEMPAD

Title: Social Exchanges and Emotions in Mediated Polemics - Analysis and Data

International Partner (Institution - Laboratory - Researcher):

University of Montréal (Canada) - Higher Educational Research ON tutoring systems (Heron) - Claude Frasson

Start year: 2014

See also: https://project.inria.fr/seempad/

Generating, annotating and analyzing a dataset that documents a debate. We aim at synchronizing several dimensions: social links (intensity, alliances, etc.); interactions happening (who talks to whom); textual content of the exchanged messages; social-based semantic relations among the arguments; emotions, polarity, opinions detected from the text; emotions, physical state detected from sensors.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

Hatim Aouzal

Date: May – September

Institution: MIAGE UNS & EMSI Casablanca, Morocco

Title: Intelligent System for Mobile Robot Museum Visit.

Supervisor: Michel Buffa

Lautaro Petaccio

Date: July – December

Institution: Universidad de Buenos Aires (Argentina)

Title: Design and development of a Fact-Checking Framework Based on Argumentation Theory and Natural Language Processing Techniques.

Supervisors: Elena Cabrio, Serena Villata

Konstantina Poulida

Date: until January

Institution: University of Patras, Computer Engineering and Informatics Department

Title: Semantic Categorization of Segments of Ancient and Mediaeval Zoological Texts

Supervisors: Catherine Faron-Zucker, Andrea Tettamanzi

Avijit Shah

Date: September – December

Institution: NITK, National Institute of Technology Karnataka, Surathkal (India).

Title: Bootstrapping the Construction of a Knowledge Base of Objects

Supervisors: Valerio Basile and Elena Cabrio

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Tuan Anh Pham

Date: October 2016 to July 2017.

Erasmus Mundus Scholarship Exchange at University of Danang, Vietnam for 7 months to deploy the result of the PhD in a common project with UNS.

Serena Villata

Date: February-March.

Visit of the Nomotika startup in Turin, Italia, for two months as a secondment of the MIREL H2020 Project.

Topic: This secondment was in the context of WP2, and more specifically it addressed Task 2.2 (Develop NLP systems for mining named entities and concepts, in order to populate the ontology). Serena Villata worked in the past on the topic of ontology-based information extraction from licensing information applying machine learning techniques. The results of her work have been exploited to define the two tools called NLL2RDF [0] and Licentia [0].

During this secondment, she studied together with the Nomotika personnel how to generalize the approach proposed in NLL2RDF and Licentia in such a way that this kind of processing is applicable to legal texts in general, and not only to licenses. More precisely, the collaboration has been concentrated on the investigation of the following open issues: (i) find and refine (if needed) existing computational ontologies for normative reasoning, and (ii) mine legal texts to extract the main deontic components (i.e., obligations, permissions, and prohibitions) and returning a machine-readable semantic representation of such information extracted from the texts exploiting a distributional semantics approach where the meaning of a word is represented by the set of contexts in which it occurs in texts. The collaboration is still ongoing and results are expected soon (i.e., publications).

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[0] http://www.airpedia.org/nll2rdf/
[0] http://licentia.inria.fr/

ZENITH Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Labex NUMEV, Montpellier
URL: http://www.lirmm.fr/numev

We participate in the Laboratory of Excellence (labex) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences) headed by University of Montpellier in partnership with CNRS, and Inria. NUMEV seeks to harmonize the approaches of hard sciences and life and environmental sciences in order to pave the way for an emerging interdisciplinary group with an international profile. The project is decomposed in four complementary research themes: Modeling, Algorithms and computation, Scientific data (processing, integration, security), Model-Systems and measurements. Florent Masseglia co-heads the theme on scientific data.

9.1.2. Institute of Computational Biology (IBC), Montpellier
URL: http://www.ibc-montpellier.fr

IBC is a 5 year project (2012-2017) with a funding of 2Meuros by the MENRT (PIA program) to develop innovative methods and software to integrate and analyze biological data at large scale in health, agronomy and environment. Patrick Valduriez heads the workpackage on integration of biological data and knowledge.

9.2. National Initiatives

9.2.1. PIA (Projets Investissements d'Avenir

9.2.1.1. PIA Floris'Tic (2015-2018), 430Keuro.
Participants: Julien Champ, Alexis Joly.

Floris'tic aims at promoting the scientific and technical culture of plant sciences through innovative pedagogic methods, including participatory initiatives and the use of IT tools such as the one built within the Pl@ntNet project. A. Joly heads the work package on the development of the IT tools. This is a joint project with the AMAP laboratory, the TelaBotanica social network and the Agropolis foundation.

9.2.2. Others

9.2.2.1. CIFRE INA/Inria (2013-2016), 100Keuros
Participants: Alexis Joly, Valentin Leveau, Patrick Valduriez.

This contract with INA allows funding a 3-years PhD (Valentin Leveau). This PhD addresses research challenges related to large-scale supervised content-based retrieval in distributed environments.

9.2.2.2. INRA/Inria PhD program, 100Keuros
Participant: Alexis Joly.

This contract between INRA and Inria allows funding a 3-years PhD student (Christophe Botella). The addressed challenge is the large-scale analysis of Pl@ntNet data with the objective to model species distribution (a big data approach to species distribution modeling). The PhD student is supervised by Alexis Joly with François Munoz (ecologist, IRD) and Pascal Monestiez (statistician, INRA).

9.3. European Initiatives

9.3.1. FP7 Projects

9.3.1.1. CoherentPaaS

Participants: Carlyna Bondiombouy, Boyan Kolev, Oleksandra Levchenko, Patrick Valduriez.

Project title: A Coherent and Rich Platform as a Service with a Common Programming Model
Instrument: Integrated Project
Duration: 2013 - 2016
Total funding: 5 Meuros (Zenith: 500Keuros)
Coordinator: U. Madrid, Spain
Partner: FORTH (Greece), ICCS (Greece), INESC (Portugal) and the companies MonetDB (Netherlands), QuartetFS (France), Sparsity (Spain), Neurocom (Greece), Portugal Telecom (Portugal).
Inria contact: Patrick Valduriez

CoherentPaaS has been developing a PaaS that incorporates a rich and diverse set of cloud data management technologies, including NoSQL data stores, such as key-value data stores and graph databases, SQL data stores, such as in-memory and column-oriented databases, hybrid systems, such as SQL engines on top on key-value data stores, and complex event processing data management systems. It uses a common query language to unify the programming models of all systems under a single paradigm and provides holistic coherence across data stores using a scalable, transactional management system. CoherentPaaS will dramatically reduce the effort required to build and the quality of the resulting cloud applications using multiple cloud data management technologies via a single query language, a uniform programming model, and ACID-based global transactional semantics. CoherentPaaS will design and build a working prototype and will validate the proposed technology with real-life use cases. In this project, Zenith is in charge of designing the CloudMdsQL language and implementing its compiler/optimizer and query engine.

9.3.1.2. HPC4E

Participants: Reza Akbarinia, Florent Masseglia, Esther Pacitti, Patrick Valduriez.

Project title: High Performance Computing for Energy
Instrument: H2020
Duration: 2015 - 2017
Total funding: 2 Meuros
Coordinator: Barcelona Supercomputing Center (BSC), Spain
Partner: Europe: Inria, Lancaster University, Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, Repsol S.A., Iberdrola Renovables Energía S.A., Total S.A. Brazil: COPPE/Universidade Federal de Rio de Janeiro, LNCC, Instituto Tecnológico de Aeronáutica (ITA), Universidade Federal do Rio Grande do Sul, Universidade Federal de Pernambuco, Petrobras.
Inria contact: Patrick Valduriez

The main objective is to develop high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using HPC systems. The project also aims at improving the usage of energy using HPC tools by acting at many levels of the energy chain for different energy sources. Another objective is to improve the cooperation between energy industries from EU and Brazil. The project includes relevant energy industral partners from Brazil (Petrobras) and EU (Repsol and Total as O&G industries), which benefit from the project's results. A last objective is to improve the cooperation between the leading research centres in EU and Brazil in HPC applied to energy. This includes sharing supercomputing infrastructures between Brazil and EU. In this project, Zenith is working on Big Data management and analysis of numerical simulations.

9.3.1.3. CloudDBAppliance

Participants: Reza Akbarinia, Boyan Kolev, Florent Masseglia, Esther Pacitti, Patrick Valduriez.

Project title: CloudDBAppliance

Instrument: H2020
Duration: 2016 - 2019
Total funding: 5 Meuros (Zenith: 500Keuros)
Coordinator: Bull/Atos, France
Partner: Europe: Inria Zenith, U. Madrid, INESC and the companies LeanXcale, QuartetFS, Nordea, BTO, H3G, IKEA, CloudBiz, and Singular Logic.
Inria contact: Florent Masseglia, Patrick Valduriez

The project aims at producing a European Cloud Database Appliance for providing a Database as a Service able to match the predictable performance, robustness and trustworthiness of on premise architectures such as those based on mainframes. The cloud database appliance features: (1) a scalable operational database able to process high update workloads such as the ones processed by banks or telcos, combined with a fast analytical engine able to answer analytical queries in an online manner; (2) an operational Hadoop data lake that integrates an operational database with Hadoop, so operational data is stored in Hadoop that will cover the needs from companies on big data; (3) a cloud hardware appliance leveraging the next generation of hardware to be produced by Bull, the main European hardware provider. This hardware is a scale-up hardware similar to the one of mainframes but with a more modern architecture. Both the operational database and the in-memory analytics engine will be optimized to fully exploit this hardware and deliver predictable performance. Additionally, CloudDBAppliance will tolerate catastrophic cloud data centres failures (e.g. a fire or natural disaster) providing data redundancy across cloud data centres. In this project, Zenith is in charge of designing and implementing the components for analytics and parallel query processing.

9.4. International Initiatives

9.4.1. MUSIC

Title: MUltiSite Cloud (MUSIC) data management
Inria principal investigator: Esther Pacitti
International Partner):

> Laboratorio Nacional de Computaçao Cientifica, Petropolis (Brazil) - Fabio Porto

> Universidade Federal do Rio de Janeiro (Brazil) - Alvaro Coutinho and Marta Mattoso

> Universidade Federal Fluminense, Niteroi (Brazil) - Daniel Oliveira

> Centro Federal de Educa cao Tecnologica, Rio de Janeiro (Brazil) - Eduardo Ogasawara

Duration: 2014 - 2016
See also: https://team.inria.fr/zenith/projects/international-projects/music/

By centralizing all data in a large-scale data center, the cloud significantly simplifies the task of system administration. But for scientific data, where different organizations may have their own data centers, a distributed (multisite) cloud model where each site is visible from outside, is needed. The main objective of this research and scientific collaboration is to develop a multisite cloud architecture for managing and analyzing scientific data, including support for heterogeneous data; distributed scientific workflows, and complex big data analysis. The resulting architecture will enable scalable data management infrastructures that can be used to host a variety of scientific applications that benefit from computing, storage, and networking resources that span multiple data centers.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

We have regular scientific relationships with research laboratories in

- North America: Univ. of Waterloo (Tamer Özsu), UCSB Santa Barbara (Divy Agrawal and Amr El Abbadi)
- Asia: National Univ. of Singapore (Beng Chin Ooi, Stéphane Bressan), Wonkwang University, Korea (Kwangjin Park)
- Europe: Univ. of Madrid (Ricardo Jiménez-Periz), UPC Barcelona (Josep Lluis Larriba Pey), HES-SO (Henning Müller), University of Catania (Concetto Spampinatto), The Open University (Stefan Rüger)
- North Africa: Univ. of Tunis (Sadok Ben-Yahia)
- Australia: Australian National University (Peter Christen)
- Central America: Technologico de Costa-Rica (Erick Mata, former director of the US initiative Encyclopedia of Life)

9.4.3. Participation In other International Programs

We are involved in LifeCLEF lab, a self-organized research platform whose main mission is to promote research, innovation, and development of computer-assisted identification of living organisms. It was initiated by Alexis Joly in 2014 in collaboration with several European colleagues: Henning Müller (CH), Robert B Fisher (UK), Andreas Rauber (AU), Concetto Spampinato (IT), Hervé Glotin (FR). Each year, LifeCLEF releases large-scale experimental data covering tens of thousands of species (plants images, birds audio recordings and fish sub-marine videos). About 100-150 research groups register each year to get access to it and tens of them submit reports describing their conducted research (published in CEUR-WS proceedings). Results are then synthesized and further analyzed in joint research papers.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Marta Mattoso (UFRJ, Brazil) gave a seminar on '"Exploratory Analysis of Raw Data Files through Dataflows" in march.

Jose Mario Carranza Rojas (PhD student, Technologico de Costa-Rica) spent two days per week in the team in the context of a 4 months internship at the Montpellier research lab AMAP in the context of the Floris'Tic project).