Activity Report 2015

Section Partnerships and Cooperations

ABS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *Projets Exploratoires Pluridisciplinaires from CNRS/Inria/INSERM*

Title: Novel approaches to characterizing flexible macromolecular systems in biology

Modeling Large Protein Assemblies with Toleranced Models

Type: Projet Exploratoire Pluri-disciplinaire (PEPS) CNRS / Inria / INSERM

Duration: one year

Coordinator: C. Robert (IBPC / CNRS)

Other partner(s): F. Cazals (Inria Sophia Antipolis Méditerranée)

Abstract: A central problem in structural biology consists of modeling the dynamics and thermody-namics of macro-molecular assemblies involving a large number of atoms (thousands to hundreds of thousands). This requires understanding the structure of the potential and free energy landscapes (PEL and FEL) of the system. A number of approaches have been developed from the physical per-spective, in particular to sample the PEL of the systems scrutinized (molecular dynamics, Monte Carlo based methods). The goal of this project is orthogonal, since our aim is to enhance the pro-cessing of samplings generated by the aforementioned approaches. Our methods aim at analyzing and comparing sampled PEL and FEL, using novel methods from computational geometry, compu-tational topology, and optimization. These methods should foster our understanding of the behavior of macro-molecular assemblies, and in the long run, they should also trigger the development of more efficient sampling algorithms.

7.2. International Research Visitors

7.2.1. *Visits of International Scientists*

7.2.1.1. Internships

- N. Gayraud, from the MSc program *Computational biology and biomedicine* from the Univ. of Nice, completed his MSc internship under the guidance of F. Cazals, on the topic *Modeling cryo-electron microscopy maps*. Nathalie is now following-up as a PhD student in the Athena project team.

- S. Lundy (Supélec, Gif-sur-Yvette), completed a 3 months internship under the joint supervision of Dorian Mazauric and Jean-Daniel Boissonnat (Geometrica, Inria Sophia Antipolis Méditerranée) on the topic *Representation of simplicial complexes by directed graphs*.

ACUMES Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Project BOUM

G. Costeseque holds a BOUM (SMAI) project on *"Homogeneization mathematical methods for traffic flow models"* with W. Salazar and M. Zaydan (LMI, INSA Rouen) and J.A. Firozaly (CERMICS, Ecole des Ponts ParisTech and LAMA, Univeristé Paris-Est Créteil).

7.1.2. Project SOKA

R. Duvigneau is coordinator of the project SOKA, funded by INSEP for 2014-2015. The objective is the modeling and optimization of racing canoes in the perspective of 2016 Olympic Games in Rio. Other partners are the Ecole Centrale de Nantes and FFCK (French Federation of Canoe-Kayak).

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. 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

7.3. International Initiatives

7.3.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

7.3.1.1. 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.

LIRIMA

Associate Team involved in the IIL :

7.3.1.2. ANO

The LIRIMA team ANO : Numerical analysis of PDEs and Optimization is a partnership between Opale project and the EMI engineering college, Rabat / National Centre for Scientific and Technical Research (CNRST) Morocco. The Team leader is Prof. Rajae Aboulaïch, EMI. Other french participants are the Project Commands at Saclay, Palaiseau and the team-project DRACULA at Inria Lyon.

The ANO team is composed of ten senior researchers from Morocco and ten senior researchers from France and more than fifteen PhD students.

The themes investigated are biomathematics (Models for plants growth, cardiovascular and cerebral diseases, cardio image segmentation), mathematical finance (optimal portfolio, risk management, Islamic finance), and multiobjective optimization in structural mechanics.

7.3.2. Participation In other International Programs

- PHC PROCOPE Team *Transport Networks Modeling and Analysis*
  Duration : Jan. 2014- Dec. 2015
  Coordinator: P. Goatin (France), S. Göttlich (Germany)
  Other partner: University of Mannheim (Germany)
  Abstract: The proposed research cooperation focuses on the development and analysis of methods for time-dependent transport phenomena in complex systems. Such systems are given for example by traffic flow networks, production lines, gas and water networks, or chemical reactions. Our particular importance is to model physical processes according to their scale by suitable mathematical means. To this end a model hierarchy using a discrete description for the small scale effects and a continuous model to describe large scale phenomena is investigated. These novel and nonstandard approaches allow to incorporate detailed nonlinear dynamic behavior, which is currently not possible with the widely used classical mixed?integer linear approaches. Through the coupling of discrete and continuous models, both on the theoretical and the applied level, we will contribute to the quantification of uncertainty as well as on control problems for these systems. The modeling is achieved by first considering transport phenomena such as traffic, production, gas and water before controlling the systems. We analyze system properties and derive and implement efficient numerical algorithms for simulation and optimization purposes. In this setting, the proposed project yields a significant contribution for tackling large dynamical problems not only restricted to traffic management but also in other engineering areas.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

- H. Yoldas (May 2015, L'Aquila University): numerical study of a non-local version of Hughes' model for pedestrian flows.

- M. Pfirsching (September 2015): numerical schemes for non-local conservation laws.

- S. Villa (March-June 2015, Milano - Bicocca): moving bottlenecks in traffic flow.

- Z. Tabbakh (15 november- 15 december, EMI, Rabat) Modeling and optimization of lakes aeration process.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Clémentine Prieur is a member of the project "Soutien à l'Excellence et à l'Innovation Grenoble INP MEPIERA (MEthodologies innovantes Pour l'Ingénierie de l'Eau et des Risques Associés) leaded by A.- C. Favre (LTHE).
- N. Feyeux PhD is sponsored by the action ARC3 Environment of the Region Rhone-Alpes.

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) 7.1.2

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 6.3 .
- C. Prieur chairs GdR MASCOT NUM, in which are also involved M. Nodet, E. Blayo, C. Helbert, E. Arnaud, L. Viry, S. Nanty, L. Gilquin. 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.
- E.Kazantsev, E.Blayo, F. Lemarié participate in the project "PACO - Vers une meilleure paramétrisation de la côte et des conditions limites dans les modèles d'océan" supported by LEFE-GMMC and LEFE-MANU .

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

C. Prieur collaborates with Jose R. Leon (UCV, Central University of Caracas).

C. Prieur is leader of a project ECOS Nord with Venezuela (2012-2015).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Jose-Raphael Leon-Ramos, Caracas University, has been granted by the Inria international chair.

Victor Shutyaev, Russian Academy of Sciences, 2 weeks.

Pierre Ngnepieba, Florida Agricultural & Mechanical University, 2 weeks.

9.5.2. Visits to International Teams

F.-X Le Dimet has been invited two times by the Department of Mathematics at Florida State University (one week in April and 2 weeks in october). In USA he was also invited at NASA Stennis Space center (Mississipi) by NRL (Navy Resarch lab) He delivered seminars in this place.

F.-X Le Dimet has been invited by Nanjing University (Department of Meteoroly) , one week in May 2015 to give a 6 -hours tutorial on Variational Data Assimilation.

F.-X. Le Dimet and E.Kazantsev were invited by the Institute of Numerical Mathematics of the Russian Academy of Sciences to present a communication at the G.Marchuk's memorial jubilee [34].

F.-X. Le Dimet has presented a communication at the SIAM meetng on Scientific Computing held in Salt Lake city in April 2015

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.

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 ar Work, Dassault Aviation, Eurocopter, MBDA, ProbaYes, IRIT, Onera, Verimag, Inria, Irisa, Tima and Armines.

9.1.2. *Inria Project Lab: Multicore 2013-2016*
Participants: Erven Rohou, Nabil Hallou.

The Inria Project Lab (formerly *Action d'Envergure*) started in 2013. It is entitled "Large scale multicore virtualization for performance scaling and portability". Partner project-teams include: ALF, 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. *ADT IPBS 2013-2015*
Participants: Sylvain Collange, Erven Rohou, André Seznec, Thibault Person.

As multi-core CPUs and parallel accelerators become pervasive, all execution platforms are now parallel. Research on architecture, compilers and systems now focuses on parallel platforms. New contributions need to be validated against parallel applications that are expected to be representative of current or future workloads. The research community relies today on a few benchmarks sets (SPLASH, PARSEC ...) Existing parallel benchmarks are scarce, and some of them have issues such as aging workloads or non-representative input sets. The IPBS initiative aims at leveraging the diversity of parallel applications developed within Inria to provide a set of benchmarks, named the Inria Parallel Benchmark Suite http://parasuite.inria.fr/, to the research community.

9.1.4. *ANR Continuum 2015–2019*
Participant: Erven Rohou.

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.

9.1.5. ANR CHIST-ERA SECODE 2016-2018

Participants: Damien Hardy, Erven Rohou.

SECODE (Secure Codes to thwart Cyber-physical Attacks) was accepted, and will start on January 1st 2016.

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).

9.1.6. ANR W-SEPT 2012-2015

Participants: Hanbing Li, 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.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. ANTAREX

Participant: Erven Rohou.

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)

Dompe Farmaceutici Spa (Italy)

Eidgenoessische Technische Hochschule Zuerich (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)
>
> Ecole Polytechnique Federale de Lausanne (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 (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, Bharath Narasimha Swamy, Sylvain Collange, Erven Rohou, André Seznec, Arthur Perais, Surya Khizakanchery Natarajan, Sajith Kalathingal, Tao Sun, 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.

9.2.2. Collaborations in European Programs, except FP7 & H2020

9.2.2.1. COST Action TACLe - Timing Analysis on Code-Level (http://www.tacle.eu) 10-2012/09-2016
Participants: Damien Hardy, Isabelle Puaut.

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. HiPEAC3 NoE
Participants: Pierre Michaud, Erven Rohou, André Seznec.

P. Michaud, A. Seznec and E. Rohou are members of the European Network of Excellence HiPEAC3. HiPEAC3 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. Inria Associate Teams not involved in an Inria International Labs

9.3.1.1. PROSPIEL

Title: Profiling and specialization for locality

International Partner (Institution - Laboratory - Researcher):

Universidade Federal de Minas Gerais (Brazil) - Dpt of Computer Science - Fernando Magno Quintao 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.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

The ALF 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 Upsalla (Pr Hagersten), University of Cyprus (Pr Sazeides), the Egyptian-Japanese University of Science and Technology (Pr Ahmed El-Mahdy).

9.3.3. Participation In other International Programs

9.3.3.1. UFMG Chair (Brazil)

Program: Cátedras Francesas UFMG

Title: A language runtime with fault-resiliency for approximate computing

Inria principal investigator: Sylvain Collange

International Partner (Institution - Laboratory - Researcher):

Universidade Federal de Minas Gerais (UFMG) - Computer Science Department - Fernando Pereira

Duration: Sep 2015 - Oct 2015

In this project we propose to implement fault tolerance at the runtime level within a virtual machine for a managed language. Our approach consists in developing a just-in-time compiler analysis that identifies and extracts side-effect free computations, such as pure functions, within the code. For each of these computations, an approximate implementation will be generated in addition to the regular native code. When the computation is invoked during execution, the runtime will first execute the approximate implementation. In case the quality or accuracy of the result is not sufficient at the time it is needed, the runtime will transparently re-execute the computation in exact mode.

9.4. International Research Visitors

9.4.1. Visits to International Teams

9.4.1.1. Explorer programme

Perais Arthur

Date: Jan 2015 - Apr 2015

Institution: Carnegie Mellon University (United States)

9.4.1.2. Research stays abroad

Sylvain Collange has been invited on a professor chair at Universidade Federal de Minas Gerais, Brazil (September-October 2015).

<div align="center">

ALICE Project-Team

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8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. 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.

8.1.2. 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

The SHAPEFORGE project (ERC Starting Grant, FP7, 2012–2017) aims at developing new methods for creating objects from examples, with 3D printers. The main challenge with this project is combining approaches that are very different in nature: algorithms from computer graphics which are used to build forms and textures using examples are combined with digital optimization methods which make sure that the real object complies with the function it is assigned. Thus, to produce a Louis XV bench, on the basis of a Louis XV chair, you need to not only capture the appearance of the example but also formalize the characteristics of a bench as well as its mechanical properties to ensure that it is solid enough. You then need to find, from among all the shapes that can be produced from a single example, the one that best complies with the various criteria. The project is led by Sylvain Lefebvre.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

We have continued our informal collaboration with Wenping Wang and Li-Yi Wei from Hong Kong University, both on geometry processing and by-example techniques. We published two joint papers this year [7], [12].

Bruno Lévy and Nicolas Ray collaborated with Gilles-Philippe Paillé, Pierre Poulin (U. Montréal, Canada) and Alla Sheffer (UBC). The result of this collaboration was published in Transactions on Graphics [17].

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*

Connelly Barnes visited our team for four weeks in June 2015. We initiated a collaboration on 3D printing, which is ongoing.

Gilles-Philippe Paillé (U. Montréal, Canada) visited us (2 months) to develop "dihedral angle-based maps")

Wenping Wang (Hong-Kong U.) visited us (2 days) to discuss/launch new cooperation projects on Voronoi diagrams and on 3D printing.

8.5.1.1. Internships

Bolun Zhang is an undergraduate student from the mechanical engineering department of Hong Kong University. He visited us for three months as a summer intern, and worked on FEM simulation of infilling patterns within 3D printed parts. He was co-supervised by Jonas Martínez Bayona and Sylvain Lefebvre.

ALPAGE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. *LabEx EFL (Empirical Foundations of Linguistics) (2011 – 2021)*

Participants: Laurence Danlos, Benoît Sagot, Chloé Braud, Marie Candito, Benoit Crabbé, Pierre Magistry, Djamé Seddah, Sarah Beniamine, 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" (see Section 4.6). 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 2015,Benoît Sagot, Marie Candito and Benoit Crabbé were respectively deputy-head of strand 6 on "Language Resources", strands 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.

9.1.2. *ANR*

9.1.2.1. *ANR project PARSEME-FR (2016 - 2019)*

Participants: Marie Candito, Mathieu Constant [principal investigator], Benoit 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 will be participate 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.

9.1.2.2. ANR project ASFALDA (2012 – 2016)

Participants: Marie Candito [principal investigator], Marianne Djemaa, Benoît Sagot, Éric Villemonte de La Clergerie, Laurence Danlos, Virginie Mouilleron, Vanessa Combet Meunier.

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 [45] 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.

9.1.2.3. 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 [65], [66], [67]. As regards discursive analysis, D-STAG formalism created by Laurence Danlos in the 00's has also been rewritten in ACG in 2015 [24] and enhanced with some preliminary linguistic work on attributions [39].

9.1.3. Other national initiatives

9.1.3.1. "Investissements d'Avenir" project PACTE (2012 – 2015)
   Participants: Benoît Sagot, Kata Gábor, Pierre Magistry.

PACTE (*Projet d'Amélioration de la Capture TExtuelle*) is an "Investissements d'Avenir" project sumbitted within the call "Technologies de numérisation et de valorisation des contenus culturels, scientifiques et éducatifs". It started in November 2012, although the associated fundings only arrived at Alpage in July 2013.

PACTE's aims was the improvement of performance of textual capture processes (OCR, manual script recognition, manual capture, direct typing), using NLP tools relying on both statistical (n-gram-based, with scalability issues) and hybrid techniques (involving lexical knowledge and POS-tagging models). It was more specifically targeted to the application domain of written heritage. The project takes place in a multilingual context, and therefore aims at developing as language-independant techniques as possible.

PACTE involved 3 companies (Numen, formerly Diadeis, main partner, as well as A2IA and Isako) as well as Alpage and the LIUM (University of Le Mans). It brings together business specialists, large-scale corpora, lexical resources, as well as the scientific and technical expertise required.

9.1.3.2. FUI project COMBI (2014-2016)
   Participants: Laurence Danlos, Vanessa Combet Meunier, Jacques Steinlin.

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.

9.1.3.3. Institut de Linguistique Française and Consortium Corpus Écrits 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 *Corpus Écrits* consortium, which is dedicated 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 Corpus Écrits 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).

9.2. European Initiatives

9.2.1. H2020 PARTHENOS

Participants: Laurent Romary, Charles Riondet.

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.

9.2.2. H2020 EHRI

Participants: Laurent Romary, 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.

9.2.3. H2020 Iperion

Participant: Laurent Romary.

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.

9.2.4. 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.

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

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. 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.

9.1.1.3. 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 CO_2 and N_2O 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 Labs

Inria@SiliconValley
Associate Team involved in the International Lab:

9.3.1.1. COALA

Title: Communication Optimal Algoritms for Linear Algebra

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science (EECS) - James Demmel

Start year: 2010

See also: https://who.rocq.inria.fr/Laura.Grigori/COALA2010/coala.html

Our goal is to continue COALA associated team that focuses on the design and implementation of numerical algorithms for today's large supercomputers formed by thousands of multicore processors, possibly with accelerators. We focus on operations that are at the heart of many scientific applications as solving linear systems of equations or least squares problems. The algorithms belong to a new class referred to as communication avoiding that provably minimize communication, where communication means the data transferred between levels of memory hierarchy or between processors in a parallel computer. This research is motivated by studies showing that communication costs can already exceed arithmetic costs by orders of magnitude, and the gap is growing exponentially over time. An important aspect that we consider here is the validation of the algorithms in real applications through our collaborations. COALA is an Inria associate team that focuses on the design and implementation of numerical algorithms for today's large supercomputers formed by thousands of multicore processors, possibly with accelerators. We focus on operations that are at the heart of

many scientific applications as solving linear systems of equations or least squares problems. The algorithms belong to a new class referred to as communication avoiding that provably minimize communication, where communication means the data transferred between levels of memory hierarchy or between processors in a parallel computer. This research is motivated by studies showing that communication costs can already exceed arithmetic costs by orders of magnitude, and the gap is growing exponentially over time. An important aspect that we consider here is the validation of the algorithms in real applications through our collaborations.

9.4. International Research Visitors

9.4.1. Visits to International Teams

9.4.1.1. Sabbatical programme

Grigori Laura

Date: Aug 2014 - June 2015

Institution: University of California Berkeley (United States)

9.4.1.2. Research stays abroad

- Laura Grigori: long term mission at UC Berkeley, Computer Science Department, from September 2015 to June 2016.
- Xavier Claeys: Seminar of Applied Mathematics, ETH Zürich, Switzerland, June. 7th - 20th, 2015.
- Frédéric Hecht: Cours FreeFem++, Maths departement, Universty of Oxford, England, march 16th - 20th, 2015.
- Frédéric Hecht: FreeFem++, Cimpa Summer School on Current Research in FEM at IIT Bombay, India 6-17 July , 2015.

AMIB Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. FRM

Y. 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
- Y. Ponty, A. Denise, M. Regnier, A. Saaidi (PhD funded by FRM)
- B. Sargueil (Paris V – Experimental partner), J. Waldispuhl (Univ. McGill)

7.2. European Initiatives

Y. 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).

ANR International Program

- Fast and efficient sampling of structures in RNA folding landscapes
- RNALANDS (ANR-14-CE34-0011)
- 01/10/2014–30/09/2018
- Y. Ponty (PI), M. Régnier
- EPI BONSAI/INRIA Lille - Nord Europe, Vienna University (Austria)
- LRI, Université Paris-Sud (France)

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Declared Inria International Partners

AMAVI

Title: Combinatorics and Algorithms for the Genomic sequences

International Partners (Institution - Laboratory - Researcher):

Vavilov Institute of General Genetics (Russia (Russian Federation)) - Department of Computational Biology - Vsevolod Makeev

Start year: 2013

See also: https://team.inria.fr/amib/carnage/

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 Inrai-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.

7.3.1.2. Informal International Partners

A long-term cooperation exists with Teheran University (Iran).

7.3.2. Participation In other International Programs

CONSEIL FRANCO-QUÉBÉCOIS DE COOPÉRATION UNIVERSITAIRE EXCHANGE PROGRAM

- Title: Réseau franco-québecois de recherche sur l'ARN
- International Partners (Institution - Laboratory - Researcher):

    Univ. McGill (Canada) - CS Dept - J. Waldispühl, M. Blanchette

    Univ. Montréal (Canada) - Biology Dept & IRIC - E. Lecuyer, F. Major

- Start year: 2012
- The partners have developped complementary expertise on RNA : bioinformatics, combinatorics and algorithms. machine learning, physics and genomics. Methodologies will be developed that combine theoretical simulations and new (high throughput) experimental data. A common high level training at Master and PhD level is organized.

PHC GERMAINE DE STAEL EXCHANGE PROGRAM

- Title: Random constrained permutations
- International Partners (Institution - Laboratory - Researcher):

    Univ. Zürich (Swiss) - Institut für Mathematik - M. Bouvel, V. Féray

- Start year: 2015
- The partners wish to develop new technique for the enumeration, analysis and random generation of constrained permutations.

CNRS UMI PIMS-VANCOUVER EXCHANGE PROGRAM

- Title: Extended research stay of Y. Ponty at the Simon Fraser University

    Simon Fraser University - Maths Dept - C. Chauve, M. Mishna, L. Stacho

    Univ. British Columbia - CS Dept - J. Manuch

- Start year: 2013
- Extended research stay in Vancouver to foster new collaborations between EPI Amib and colleagues at SFU on comparative genomics, RNA structures, and enumerative combinatorics.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Mark Ward

    Date: 23/11/2015- 05/12/2015

    Institution: Purdue University (USA)

Can Alkan

    Date: 24/11/2015- 30/11/2015

    Institution: Bilkent University (Turkey)

Evgenia Furletova

    Date: 22/11/2015- 28/11/2015

    Institution: IMPB (Russia)

7.4.1.1. Internships

Indrajit Saha

    Date: 20/02/2015- 28/02/2015

    Institution:ERCIM fellowship (Wroclaw)

    Supervisor: M. Régnier

Doris Taining

Date: 01/05/2015- 07/08/2015

Institution:Singapore University (Singapore)

Supervisor: M. Régnier

7.4.2. Visits to International Teams

7.4.2.1. Sabbatical programme

Bernauer Julie

Date: Feb 2014 - Jan 2015

Institution: Stanford (United States)

7.4.2.2. Research stays abroad

Yann Ponty

Date: Sept 2013 - Sept 2015

Institution: Simon Fraser (Canada)

Amelie Héliou

Date:June 2015 -Aug 2015

Institution: HKUST (Hong Kong)

Antoine Soulé

Date: Jan 2015 - Sept 2015

Institution: McGill (Canada)

Pauline Pommeret

Date: May 2015 - Aug 2015

Institution: Vancouver (Canada)

ANGE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Instabilities in Hydrodynamics (2011-2015)*
Participant: Nicolas Seguin.

The Emergence project (Ville de Paris and FSMP) "Instabilities in Hydrodynamics" is related to theoretical, applied, and numerical mathematics for the study of hydrodynamical turbulence phenomena.

9.1.2. *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.

9.1.3. *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: Martin Parisot, Jacques Sainte-Marie, Julien Salomon.

Appel à projets ANR : Energies marines renouvelables

Project acronym: Hyflo-Eflu

Project title: Hydroliennes flottantes et énergie fluviale

Coordinator: Julien Salomon

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. Thanks to the collaboration between a team of mathematician specialist of free surface flow and optimization and the industrial developers of the turbine. 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. 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.

9.2.4. ANR LANDQUAKES (2012–2016)

> 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".

9.2.5. 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.

9.2.6. Inria Project Lab "Algae in Silico" (2015-2018)

Participants: Nora Aïssiouene, Marie-Odile Bristeau, David Froger, Raouf Hamouda, Jacques Sainte-Marie.

In the framework of the ADT Inlgae (2013–2015), we developed in collaboration with the BIOCORE Inria project-team a simulation tool for microalgae culture. An Inria Project Lab "Algae in Silico" has started in collaboration with several Inria teams, many 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 project HJnet (2013–2015)*

Participant: Edwige Godlewski.

This research project consists in studying Hamilton-Jacobi equations on networks, and more generally on heterogeneous structures. This theoretical problem has several potential applications, in particular to traffic flow theory.

9.2.8. *Hydraulics for environment and sustainable development (HED^2)*

The scienfitic group (GIS in French), which includes Inria and the ANGE team, brings together scientists and engineers involved in hydraulics, risk management and sustainable development. It results in a continuum between fundamental research, applied research and engineering. On the one hand, the ANGE team can be provided with experimental measurements (erosion, long waves, fluid structure interactions,...) thanks to this collaboration; on the other hand, the GIS can favor the transfer of numerical tools and scientific results.

9.3. European Initiatives

9.3.1. *ERC Consolidator Grant (2013-2018)*

Participant: Anne Mangeney.

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 Research Visitors

9.4.1. *Visits of International Scientists*

Spanish collaborators – Enrique Fernández-Nieto (Univ. Sevilla) and Tomás Morales de Luna (Univ. Córdoba) – spent one week in Paris (UPMC and Inria) in September.

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

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. 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.

7.1.1.2. VerAsCo

Title: Formally-verified static analyzers and compilers

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: Septembre 2011 - September 2015

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 VERASCOadvocates 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.

7.1.1.3. AstréeA

Title: Static Analysis of Embedded Asynchronous Real-Time Software

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: January 2012 - December 2015

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.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. MemCad

Type: IDEAS

Defi: Design Composite Memory Abstract Domains

Instrument: ERC Starting Grant

Objectif: Design Composite Memory Abstract Domains

Duration: October 2011 - September 2016

Coordinator: Inria (France)

Inria contact: Xavier Rival

Abstract: The MemCAD project aims at setting up a library of abstract domains in order to express and infer complex memory properties. It is based on the abstract interpretation frameworks, which allows to combine simple abstract domains into complex, composite abstract domains and static analyzers. While other families of abstract domains (such as numeric abstract domains) can be easily combined (making the design of very powerful static analyses for numeric intensive applications possible), current tools for the analysis of programs manipulating complex abstract domains usually rely on a monolithic design, which makes their design harder, and limits their efficiency. The purpose of the MemCAD project is to overcome this limitation.

Our proposal is based on the observation that the complex memory properties that need to be reasoned about should be decomposed in combinations of simpler properties. Therefore, in static analysis, a complex memory abstract domain could be designed by combining many simpler domains, specific to common memory usage patterns. The benefit of this approach is twofold: first it would make it possible to simplify drastically the design of complex abstract domains required to reason about complex softwares, hereby allowing certification of complex memory intensive softwares by automatic static analysis; second, it would enable to split down and better control the cost of the analyses, thus significantly helping scalability. As part of this project, we propose to build a static analysis framework for reasoning about memory properties, and put it to work on important classes of applications, including large softwares.

7.3. International Initiatives

7.3.1. EXEcutable Knowledge

Title: EXEcutable Knowledge

Type: DARPA

Instrument: DARPA Program

Program: Big Mechanism

Duration: July 2014 - December 2017

Coordinator: Harvard Medical School (Boston, USA)

Partner: Inria Paris-Rocquencourt, École normale supérieure de Lyon Université Paris-Diderot,

Inria contact: Jérôme Feret

Abstract: Our overarching objective is Executable Knowledge: to make modeling and knowledge representation twin sides of biological reasoning. This requires the definition of a formal language with a clear operational semantics for representing proteins and their interaction capabilities in terms of agents and rules informed by, but not exposing, biochemical and biophysical detail. Yet, to achieve Executable Knowledge we need to go further:

- Bridge the gap between rich data and their formal representation as executable model elements. Specifically, we seek an intermediate, but already formal, knowledge representation (meta-language) to express granular data germane to interaction mechanisms; a protocol defining which and how data are to be expressed in that language; and a translation procedure from it into the executable format.

- Implement mathematically sound, fast, and scalable tools for analyzing and executing arbitrary collections of rules.
- Develop a theory of causality and attendant tools to extract and analyze the unfolding of causal lineages to observations in model simulations.

We drive these technical goals with the biological objective of assembling rule-based models germane to Wnt signaling in order to understand the role of combinatorial complexity in robustness and control.

7.3.2. Active Context

Title: Active Context
Type: DARPA
Instrument: DARPA Program
Program: Communicating with Computers
Duration: July 2015 - December 2018
Coordinator: Harvard Medical School (Boston, USA)
Partner: University of California, (San Diego, USA), Inria Paris-Rocquencourt, École normale supérieure de Lyon Université Paris-Diderot,
Inria contact: Jérôme Feret

Abstract: The traditional approach to the curation of biological information follows a philatelic paradigm, in which epistemic units based on raw or processed data are sorted, compared and catalogued in a slow and all too often insufficiently coordinated process aimed at capturing the meaning of each specimen in isolation. The swelling bounty of data generated by a systematic approach to biology founded on high-throughput technologies appears to have only intensified a sense of disconnected facts, despite their rendering as networks. This is all the more frustrating as the tide of static data (sequences, structures) is giving way to a tide of dynamic data about (protein-protein) interaction that want to be interconnected and understood (think annotated) in terms of process, i.e. a systemic approach.

The barrier is the complexity of studying systems of numerous heterogeneously interacting components in a rapidly evolving field of science. The complexity comes from two kinds of dynamically changing context: the internal dynamics of a biological system, which provide the context for assessing the meaning of a protein-protein interaction datum, and the external dynamics of the very fact base used to define the system in the first place. We propose the integration of dynamic modeling into the practice of bioinformatics to address these two dynamics by coupling them. The external dynamics is at first handled by a novel kind of two-layered knowledge representation (KR). One layer contextualizes proteins and their interactions in a structure that incrementally constructs, in an open-ended dialogue with the user, its own semantics by piecing together fragments of knowledge from a variety of sources tapped by the Big Mechanism program. The other layer is a model representation (MR) that handles and prioritizes the many executable abstractions compatible with the KR. The internal dynamics is handled not only by execution but also by addressing the impedance mismatch between the unwieldy formal language(s) required for execution and the more heuristic, high-level concepts that structure the modeling discourse with which biologists reason about molecular signaling systems. To the extent that we are successful on both ends, users will be able to effectively deploy modeling for curating the very fact base it rests upon, hopefully achieving self-consistency.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Josef Widder, associate professor at TU Wien, Embedded Computing Systems group, visited Cezara Drăgoi for a week, from Oct 12 to Oct 17.

7.4.1.1. Internships

Jérôme Feret is supervizing the Internships of Ken Chanseau Germain (M2 student), on "approximated model reduction of differential semantics", since november 2015.

AOSTE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CIM PACA Design Platform
Participant: Robert de Simone.

The objective of this platform, run by a French association under the same name, is to provide mutualized equipments and tools for the design of embedded connected objects, and in our case mostly EDA software for hardware and SoC synthesis at high-level. We collaborate to the definition of the user needs and the choice of purchases, mostly to promote the construction of collaborative R&D projects using those resources. ANR HOPE project is a good example of such project.

CIM PACA also runs the eSAME yearly forum, a meeting point for various partners in the field aroud Sophia-Antipolis, with our active contribution. Further moves towards embedded software and IoT design form the upcoming roadmap.

9.2. National Initiatives

9.2.1. ANR

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

The ANR HOPE project focuses on hierarchical aspects for the high-level modeling and early estimation of power management techniques, with potential synthesis in the end if feasible.
Although this project was officially started in November 2013, it was in part postponed due to the replacement of a major partner (Texas Instruments) by another one (Intel). Current partners are CNRS/UNS UMR LEAT, Intel, Synopsys, Docea Power, Magillem, and ourselves. A publication on multiview modeling (including performance, power, and temperature) was presented at eSAME'2014, reflecting Ameni Khecharem ongoing PhD work.

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

This project is admistratively handled by CNRS for our joint team, on the UMR I3S side. Partners are Inria (Triskell EPI), ENSTA-Bretagne, IRIT, Obeo, Thales TRT.
The project focuses on the modeling of heterogeneous systems using Models of Computation and Communication for embedded and real-time systems, described using generic means of MDE techniques (and in our case the MARTE profile, and most specifically its Time Model, which allows to specify precise timely constraints for operational semantic definition).

As part of the project dissemination purpose we organize a community-building international workshop [47], whose third edition gathered a growing number of participants.

9.2.2. FUI

9.2.2.1. FUI P
Participants: Abderraouf Benyahia, Dumitru Potop Butucaru, Yves Sorel.

The goal of project P is to support the model-driven engineering of high-integrity embedded real-time systems by providing an open code generation framework able to verify the semantic consistency of systems described using safe subsets of heterogeneous modeling languages, then to generate optimized source code for multiple programming (Ada, C/C++) and synthesis (VHDL, SystemC) languages, and finally to support a multi-domain (avionics, space, and automotive) certification process by providing open qualification material. Modeling languages range from behavioural to architectural languages and present a synchronous and asynchronous semantics (Simulink/Matlab, Scicos, Xcos, SysML, MARTE, UML),

See also: http://www.open-do.org/projects/p/

Partners of the project are: industrial partners (Airbus, Astrium, Continental, Rockwell Collins, Safran, Thales), SMEs (AdaCore, Altair, Scilab Enterprise, STI), service companies (ACG, Aboard Engineering, Atos Origins) and research centers (CNRS, ENPC, Inria, ONERA).

9.2.2.2. *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.

9.2.2.3. *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.

9.2.3. *Investissements d'Avenir*

9.2.3.1. *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.

9.2.3.2. *CLARITY*

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

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 7.2 .

9.2.3.3. *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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. FP7 PROXIMA
Participants: Liliana Cucu, Adriana Gogonel, Walid Talaboulma, Dorin Maxim, Cristian Maxim.

PROXIMA is a Integrated Project (IP) of the Seventh framework programme for research and technological development (FP7). The PROXIMA project provides industry ready software timing analysis using probabilistic analysis for many-core and multi-core critical real-time embedded systems and will enable cost-effective verification of software timing analysis including worst case execution time. Our technical results in this project are described in 7.13 .

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. ITEA3 Assume

Project title: Affordable Safe And Secure Mobility Evolution

Duration: Oct. 2015 - Sept. 2018

Coordinator: Daimler AG (Germany)

Other partners: Airbus, Thales, Safran, Ansys/Esterel Technologies, Kalray, Sagem, UPMC, ENS Ulm, Inria (France). AbsInt, BTC, FZI. Kalrsruhe IT, Kiel U. Offis, Bosch, TU Muenchen (Germany), NXP, Recore, VDL, Verum, TU Eindhoven, U. Twente (Netherlands), Arcelik, Ericsson, Ford, Havelsan, KocSistem, Unit, Koc University (Turkey), Arcticus, FindOut, Scania, KTH, Malardalen U. (Sweden)

Abstract: ASSUME aims at providing a seamless engineering methodology for affordable, safe multi-core development that allows industry to deliver new trustworthy functions at competitive prices. The project started on September 1st, 2015, and the kick-off meeting was held on October 1-2. The project coordinator is Daimler AG. The expected constributions of the Aoste team-project include the improvement of the Lopht tool, with the definition of a back-end targeting the Kalray MPPA256 many-core, and the proof of its scheduling algorithms.

9.4. International Initiatives

9.4.1. Inria International Labs

LIAMA
Associate Team involved in the International Lab:

9.4.1.1. 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/

The FM4CPS Associated team is tighly linked to the SACCADES LIAMA project. It is also involved in the International Key Laboratory on Trustworthy Computing by ECNU Shanghai on the Chinese side.

FM4CPS addresses 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.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

9.5.1.1. Invited Professor

Qingguo XU

Date: July 2014 to June 2015

Institution: Shanghai University (China)

9.5.1.2. Internships

Nieto Luis Agustin

Date: Sep 2015 - Feb 2016

Institution: Universidad de Buenos Aires (Argentina)

9.5.2. *Visits to International Teams*

9.5.2.1. Sabbatical programme

Mallet Frédéric

Date: Sep 2014 - Aug 2015

Institution: ECNU (China)

APICS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Contract Provence Alpes Côte d'Azur (PACA) Region - Inria, BDO (no. 2014-05764) funding the research grant of C. Papageorgakis, see Sections 6.1.1 , 7.3 .

8.2. National Initiatives

8.2.1. 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 represent a perfect training ground to test, apply and adapt our work on matching problems (see Section 6.2).

8.2.2. 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 6.1 are instrumental for this purpose.

8.3. European Initiatives

8.3.1. 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.

8.4. International Initiatives

8.4.1. Inria Associate Teams not involved in an Inria International Labs

8.4.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

International Partner (Institution - Laboratory - Researcher):

MIT - Department of Earth, Atmospheric and Planetary Sciences (United States) - Benjamin Weiss

Start year: 2013

See also: http://www-sop.inria.fr/apics/IMPINGE/

The purpose of the associate team IMPINGE is to develop efficient algorithms to recover the magnetization distribution of rock slabs from measurements of the magnetic field above the slab using a SQUID microscope (developed at MIT). The US team also involves a group of Mathematicians at Vanderbilt Univ.

8.4.2. Inria International Partners

8.4.2.1. 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).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Andrea Gombani (IEIIT-CNR, Padova, Italy, February 16-27).
- Michael Northington (Vanderbilt University, Nashville, Tennessee, USA, July 21-30).
- Vladimir Peller (Michigan State Univ., East Lansing, USA, September 2-30).
- Eduardo Lima (MIT, Boston, Massachusetts, USA, September 6-12).
- Isabella Sanders (MIT, Boston, Massachusetts, USA, September 6-12).

8.5.1.1. Internships

- Konstantinos Mavreas, Master 2 Computational Biology - UNSA (5 months), Dipole localization in Moon rocks from sparse magnetic data.

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

L. Baratchart was a visiting scientist at Indiana University-Purdue University at Indianapolis (IUPUI), November 2015.

8.6. 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 (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).

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. 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.

9.1.2. 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: 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.

9.1.2.3. 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

Founded 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

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

Founded 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
Participants: Stefan Thurner, Vito Latora, Albert Diaz-Guilera, Maxi San Miguel, Cecilia Mascolo, Mirco Murolesi, Mario Chavez [Correspondant].

Project acronym: LASAGNE

Project title: multi-LAyer SpAtiotemporal Generalized NEtworks

Dates: 2012-2015

Amount: 1.6M€

Coordinator: Stefan Thurner

Other partners: Medical University of Vienna, Queen Mary University of London, Universitat de Barcelona, Universitat de les Illes Balears,University of Cambridge, University of Birmingham.

Abstract: The aim of the LASAGNE project is to provide a novel and coherent theoretical framework for analyzing and modelling dynamic and multi-layer networks in terms of multi-graphs embedded in space and time. To do this, we will treat time, space and the nature of interactions not as additional dimensions of the problem, but as natural, inherent components of the very same generalized network description. The theory will be validated on real-world applications involving large and heterogeneous data sets of brain networks, on- and off-line social systems, healthcare systems, and transportation flows in cities. The LASAGNE project will provide new quantitative opportunities in different fields, ranging from the prediction of pathologies to the diffusion of ideas and trends in societies, and for the management of socio-technological systems.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

S. Durrleman has an enduring collaboration with the Scientific Computing and Imaging (SCI) Institute at the University of Utah (USA). He is consultant for NIH Grant "4D shape analysis for modeling spatiotemporal change trajectories in Huntington's Disease "predict-HD". He is part of the PhD committees of J. Fishbaugh and A. Sharma supervised by professor Guido Gerig.

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 a 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).

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

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

9.2. National Initiatives

9.2.1. ANR HPAC Project

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

"High-performance Algebraic Computing" (HPAC) is a four year ANR project that started in January 2012. The Web page of the project is http://hpac.gforge.inria.fr/. HPAC is headed by Jean-Guillaume Dumas (CASYS team, LJK laboratory, Grenoble); it involves 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 is 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 is 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 conducts 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.

9.2.2. 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 http://www.liafa.univ-paris-diderot.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.

9.2.3. ANR FastRelax Project

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

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.

9.2.4. 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.

9.3. European Initiatives

9.3.1. 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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Visiting Scientists

- Jung Hee Cheon from July to August;
- Arnold Neumaier from August to December;
- Khoa Ta Toa Nguyen until October;
- Peter Tang, from June to July;
- Yong Sue Song from July to August.

9.4.1.2. Internships

Fabrice Mouhartem

Date: February 2015–July 2015

Institution: ENS de Lyon

Supervisor: Benoît Libert

Alice Pellet-Mary

>   Date: February 2015–July 2015
>
>   Institution: ENS de Lyon
>
>   Supervisor: Damien Stehlé

Andrada Popa

>   Date: July 2015–September 2015
>
>   Institution: Technical University of Cluj-Napoca (Roumanie)
>
>   Supervisor: Nicolas Brisebarre

Pablo Rotondo

>   Date: March 2015–June 2015
>
>   Institution: Universidad de la Republica Uruguay (Uruguay)
>
>   Supervisor: Bruno Salvy

Weiqiang Wen

>   Date: February 2015–July 2015
>
>   Institution: SCNU, China
>
>   Supervisor: Damien Stehlé

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR project SocioPlug

Participants: Davide Frey, Anne-Marie Kermarrec, Pierre-Louis Roman, François Taïani.

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, François Taïani.

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 Oct 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.

8.2. International Initiatives

8.2.1. Inria International Labs

Anne-Marie Kermarrec has been scientific collaborator at EPFL, Lausanne, since February 2014.

Anne-Marie Kermarrec has been the scientific coordinator of the EPFL/Inria International Lab since February 2015.

Anne-Marie Kermarrec organized the *First EPFL/Inria Workshop*, Lausanne, January 2015.

8.2.2. Inria Associate Teams not involved in an Inria International Labs

8.2.2.1. RADCON

Title: Randomized Algorithms for Distributed Computing and Networks

International Partner (Institution - Laboratory - Researcher):

University of Calgary (Canada) - Computer Science (cpsc) - Philipp Woelfel

Start year: 2013

See also: http://www.irisa.fr/asap/radcon

Over recent years, computing systems have seen a massive increase in parallelism and interconnectivity. Peer-to-peer systems, ad-hoc networks, sensor networks, or the "cloud" are based on highly connected and volatile networks. Individual nodes such as cell phones, desktop computers or high performance computing systems rely on parallel processing power achieved through multiple processing units. To exploit the power of massive networks or multiple processors, algorithms must cope with the scale and asynchrony of these systems, and their inherent instability, e.g., due to node, link, or processor failures. In this research project we explore randomized algorithms for large-scale networks of distributed systems, and for shared memory multi-processor systems.

For large-scale networks, decentralized gossip protocols have emerged as a standard approach to achieving fault-tolerant communication between nodes with simple and scalable algorithms. We will devise new gossip protocols for various complex distributed tasks, and we will explore the power and limits of gossip protocols in various settings.

For shared memory systems, randomized algorithms have proved extremely useful to deal with asynchrony and failures. Sometimes probabilistic algorithms provide the only solution to a problem; sometimes they are more efficient; sometimes they are simply easier to implement. We will devise efficient algorithms for some of the fundamental problems of shared memory computing, such as mutual exclusion, renaming, and consensus.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Shlomi Dolev, Jan 21-24

Frederic Mallmann-Trenn Feb 11-18, 2015

Emmanuel Godard April 23-24, 2015

Hamouma Moumen, June 1-30, 2015

Stevens Le Blond, July 14, 2015

Raluca Halalai Aug 1-15, 2015

Diogo Lima Aug 3-28, 2015

Damien Imbs, Oct 11-24, 2015

8.3.1.1. Internships

Tom Ferragut; May 18 to June 27. *Study and evaluation of effective recommendation algorithms* Supervised by Anne-Marie

Nominoe Kervadec; from June 1 to Aug 31 2015. *Non-blocking I/O in YALPS* Supervised by Davide Frey.

Yasamin Nazari. *Asynchronous vs. Synchronous Rumor Spreading* Sep 1 - Dec 15 2015 Supervised by George Giakkoupis.

8.3.2. Visits to International Teams

8.3.2.1. Research stays abroad

George Giakkoupis visited University of Calgary, Canada, 1-8 Mar, 18 Jun - 10 Jul, and 5-21 Dec, Simon Fraser University, Canada, 22 Feb - 1 Mar, and University of Cambridge, UK, 22-30 Jul.

8.3.2.2. Internships

Nupur Mittal did an internship at NICTA, Sydney from March 30, 2015 to July 1, 2015 under the supervision of Dr. Dali Kaafar. She also received Ecole Doctorale Mobility grant for the same.

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

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 (N. Ayache serves as Chief Scientific Officer), 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 build an XMR interventional room equipped with a medInria 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 International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

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

Starting year: 2015

See also: http://www-sop.inria.fr/asclepios/projects/GeomStats/

The scientific goal of this associated team is to develop the field of geometric statistics that have key applications in computational anatomy. Computational anatomy is an emerging discipline at the interface of geometry, statistics, image analysis and medicine, which aim is to analyze and model 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.

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 assume 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. This will, for example, help determine the impact location 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. 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. Research visits abroad

In the context of the Associated team GeomStats, part of the Inria International Lab Inria@SiliconValley, there were two research visits in 2015 at the Stanford Statistics Department:

- Xavier Pennec: 3 months (April to June 2015)
- Nina Miolane: 8 months (April to June and August to December 2015)

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Competitiveness cluster Images-et-Reseaux*

8.1.1.1. EcoCloud
Participant: Jean-Marc Menaud.

The project EcoCloud is a cooperative research project running for 2 years. Three other partners collaborate within the project that is coordinated by the company EasyVirt: the Ascola team and another company Pentasonic. The partners aim at developing an economically-valid and ecologic cloud platform in the context of micro and mono-site data centers (all resources are in the same physical location). A high SLA level must be provided with a specific focus on high availability satisfying strong redundancy and placement constraints.

8.2. National Initiatives

8.2.1. *CominLabs laboratory of excellence*

8.2.1.1. EPOC
Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux, Md Sabbir Hasan, Yunbo Li.

The project EPOC (Energy Proportional and Opportunistic Computing system) is an (academic) Labex CominLabs 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.

8.2.1.2. 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 investigated how to extend real-world Javascript environments, such as Narcissus in a modular way.

8.2.2. ANR

8.2.2.1. 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.

8.2.3. FSN

8.2.3.1. 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.

8.2.3.2. 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.

8.2.4. CPER

8.2.4.1. 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.

8.2.5. *Inria Project Labs*

8.2.5.1. DISCOVERY
Participants: Adrien Lebre [coordinator], 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 [40] 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.

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 LUC Operating System 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.

8.3. European Initiatives

8.3.1. *FP7 & H2020 Projects*

8.3.1.1. ERC Starting Grant: The CoqHoTT project
Participant: Nicolas Tabareau [coordinator].

CoqHoTT stands for Coq for Homotopy Type Theory. The goal of this project is to go further in the correspondence between proofs and programs which has allowed in the last 20 years the development of useful proof assistants, such as Coq (developed by Inria). This project starts from the recent discovery by field medal Vladimir Voevosdky, of the strong link between homotopy theory (which studies the notion of continuous deformation in topology) and type theory (which is at the heart of the Coq proof assistant). The main goal of the CoqHoTT project is to provide a new generation of proof assistants based on this fascinating connection.

The CoqHoTT project has started in June 2015 with a budget of 1,5M€.

8.3.1.2. A4Cloud (IP)

Participants: Mario Südholt [coordinator], Walid Benghabrit, Ronan-Alexandre Cherrueau, Rémi Douence, Hervé Grall, Jean-Claude Royer.

The integrated project "Accountability for the Cloud" (A4Cloud) is coordinated by HP Labs, UK, and fosters cooperation of a consortium of five industrial and eight academic partners. It has been started in Oct. 2012 for a duration of 42 months.

A4Cloud focuses on accountability properties for the cloud and other future internet services as the most critical prerequisite for effective governance and control of corporate and private data processed by cloud-based IT services. The research being conducted in the project will increase trust in cloud computing by devising methods and tools, through which cloud stakeholders can be made accountable for the privacy and confidentiality of information held in the cloud. These methods and tools will combine risk analysis, policy enforcement, monitoring and compliance auditing. They will contribute to the governance of cloud activities, providing transparency and assisting legal, regulatory and socio-economic policy enforcement. For further information, see http://www.a4cloud.eu. ASCOLA, whose financial support consists of 550 K€, is mainly involved in the sub-projects on the enforcement of accountability and security policies, as well as tool validation efforts.

This year we have proposed new logic-based and language-level means for the formal specification and implementation of accountability properties and have proposed a new composition approach for distributed systems that enforces privacy-properties through statically-verified types (see 6.3).

8.3.1.3. BigStorage (MSCA-ETN)

Participants: Adrien Lebre [coordinator], Linh-Thuy Nguyen, Mario Südholt.

BigStorage is a European Training Network (ETN) whose main goal is to 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.

Nowadays there is a lack of professionals who know how to deal with storage, management and analysis of Big Data. Indeed, there is a gap between infrastructures for dealing with Big Data and applications using these volumes of data. In 2011, the McKinsey Global Institute published a study that found that, by 2018, there could be a shortage of up to 190,000 data scientists in the United States, representing a 50 percent to 60 percent gap between supply and demand. Similarly, European officials estimate that 300,000 data scientists will be needed in Europe in the forthcoming years. Other reports, such as those from PRACE and ETP4HPC, have also emphasized the need of skills in HPC, Cloud, Storage, Energy, or Big Data to maintain Europe's economy. In this context, a major goal of this project is to bring a substantial contribution to the training process of these future experts.

Within this project, ASCOLA leads the WP 3 that deals with the convergence between HPC and Cloud storage backends.

8.3.1.4. GRACeFUl (FETPROACT)

Participant: Rémi Douence [coordinator].

The GRACeFUl project is coordinated by Universitat Politecnica de Catalunya, Spain, and fosters cooperation of a consortium of two institutes and five academic partners. It has been started in Feb. 2015 for a duration of 36 months. For information, see https://www.graceful-project.eu.

Global Systems Science is a FET Proactive initiative under Horizon 2020 that seeks to improve the way scientific knowledge can help inform and evaluate policy and societal responses to global challenges like climate change and global financial crises.

The GRACeFUL project strives for a base for domain-specific languages aimed at building scalable rapid assessment tools for collective policy making in global systems. It involves several different disciplines. ASCOLA is involved in WP5 in order to provide expertise in functional programming . In this context Rémi Douence codirects the PhD thesis of Ekaterina Arafailova. This work has already produced a generalization of automata-based constraints [12].

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. REAL

Title: Reasoning about Effects in Aspect Languages

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (CHILI)

Duration: 2010 - 2015

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

During the period 2013-2015, REAL has studied means to reason about aspect interference, providing foundations for secure aspects, and the link of secure aspects with security aspects. This last year has been devoted to developing a general mechanism for modular composition of session types, applying our ideas on modular instrumentation of interpreters to Narcissus and information flow analyses, and exploring ideas for future collaboration, in particular in the area of gradual certification.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Apart from the Inria associate team rapids with the Pleiad group (Prof. Éric Tanter) at U. Chile, the Ascola team has formalized cooperations, notably in the context of co-financed and co-supervised PhD theses with the PROG group (Prof. Wofgang de Meuter) at VU Brussel, Belgium, and the Software Technology group (Prof. Mira Mezini) at TU Darmstadt, Germany.

Furthermore, the Ascola team has long-term cooperations that resulted in common results in 2015, typically joint publications or common software artifacts, with partners from the AIST research institute (Dr. Takahiro Hirofuchi) and U. of Bogota, Colombia (Prof. Rubby Casallas).

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

7. Partnerships and Cooperations

7.1. Regional initiatives

7.1.1. *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.

7.2. National initiatives

7.2.1. *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.

7.2.2. 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.

7.3. International research visitors

7.3.1. Visits to international teams

François Le Gland has been invited by Joaquín Míguez to visit the department of signal theory and communications of Universidad Carlos III de Madrid, in February 2015.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Master Software Engineering

ATEAMS is a core partner in the Master Software Engineering at Universiteit van Amsterdam. This master is a collaboration between SWAT/ATEAMS, Universiteit van Amsterdam, Vrije Universiteit and Hogeschool van Amsterdam.

8.1.2. Early Quality Assurance in Software Production

The EQUA project is a collaboration among Hogeschool van Amsterdam (main partner) Centrum Wiskunde & Informatica (CWI), Technisch Universiteit Delft, Laboratory for Quality of Software (LaQuSo), Info Support, Software Improvement Group (SIG), and Fontys Hogeschool Eindhoven.

8.1.3. Next Generation Auditing: Data-assurance as a service

This project is a collaboration between Centrum Wiskunde & Informatica (CWI) PriceWaterhouseCoopers (PWC), Belastingdienst (National Tax Office), and Computational Auditing, is to enable research in the field of computational auditing.

8.1.4. Domain-Specific Languages: A Big Future for Small Programs

Software and programming have a brilliant past that has brought us the automation of many expected and unexpected human and societal activities ranging from banking and consumer electronics to mobile networking, search engines and social networks. The present of software is overwhelming: many software systems have sizes in the range of 10–100 million lines of source code and contain tens of thousands of errors that are yet to be discovered. We claim that software will only have a big future if software itself becomes smaller. Smaller software leads to higher software productivity (we have to write less) and higher software quality (quality guarantees become part of the language and not of the program).

This project is funded by NWO (the Dutch national science foundation).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- FP7 STREP "OSSMETER — Automated Measurement and Analysis of Open Source Software" (ended in 2015)

8.2.2. Collaborations with Major European Organizations

Centrum Wiskunde & Informatica (CWI): Software Analysis & Transformation (Netherlands)
CWI SWAT is the research team associated directly with ATEAMS.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

ATEAMS collaborates with the following research teams:
- Eindhoven Technical University - SET (Eindhoven, The Netherlands)
- Universiteit van Amsterdam - Systems and Network Engineering (Amsterdam, The Netherlands)
- Royal Holloway University of London - Dept. of Computer Science
- The University of Hong Kong (China) - Computer Science
- Delft Technical University (The Netherlands)
- University of Texas at Austin (USA)
- TU Darmstadt (Germany)

8.3.1.2. Research stays abroad

- Michael Steindorfer stayed for 3 months at Oracle Labs in Austria to study efficient data-structures and data-structure optimisations on the JVM.

ATHENA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. 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).

8.1.1.2. 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.

8.1.1.3. 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.

8.1.2. ADT

8.1.2.1. ADT BOLIS
Participants: Nicolas Schnitzler, Théodore Papadopoulo, Juliette Leblond [APICS], 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).

8.1.2.2. 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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. 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.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. 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 source localisation.
- CRM, Centre de Recherche Mathématiques, Montréal, Canada.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Maxime Descoteaux (Sherbrooke University, CA) visited ATHENA from March 13 to April 3, 2015
- Gabriel Girard (Sherbrooke University, CA) visited ATHENA from March 13 to April 3, 2015
- Mauro Zuccheli (Verona University, It) visited ATHENA from March 23 to 27, 2015
- Dalila Cherifi (Boumerdes University, Algers) visited ATHENA from April 24 to 27, 2015
- Mouloud Kachouane (USTHB, Algiers) visited ATHENA from November 2015 to October 2016.

8.4.1.1. Internships

Guillermo Alejandro Gallardo Diez

    Date: June 2015 - August 2015

    Institution: Universidad de Buenos Aires (Argentina)

Etienne Guerlais

    Date: October 2015 - February 2016

    Institution: Ecole d'ingénieurs informatique CESI, eXia

Jelena Mladenovic

    Date: April 2015 - September 2015

    Institution: Université de Nice-Sophia Antipolis

Siobhan Powell

    Date: May 2015 - Jul 2015

    Institution: Queens Univeristy, Ontario (Canada)

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. FUI

Program: FUI - AAP 15

Project acronym: MoNoGe

Project title: Atelier de Modélisation de Nouvelle Génération

Duration: 2013 - 2016

Coordinator: Softeam

Other partners: Industry (DCNS), Research and University (ARMINES AtlanMod, LIP6) and Vendors and service providers (Softeam, Soft-Maint, Mia-Software)

Abstract: There is currently in companies a wide diversity of models and modeling tools according to the application domains, services or contexts which are concerned. This implies different problems forbidding their plain exploitation: traceability, global coherence, continuity between works, knowledge management, etc. All are largely penalized by this situation that harms the mastering of the complexity of the related systems and software. The MoNoGe project has for objective to bring innovative solutions allowing to ensure the agility of the models and modeling tools. The term agility is here referring to the properties of interoperability, extensibility and evolution of models. The dynamic extension mechanism to be developed in MoNoGe, potentially inspiring from the OMG MEF standard currently under definition, is intended to preserve the original metamodel which can be conserved, partially hidden or extended. Thus, the legacy data and models can stay operational with the extended metamodel. The user does not have to deal with heavy migration or conversion operations, and can this way focus on its modeling activities while continuously exploiting past models. Our focus within the project is on defining conceptually such a (meta)model extension solution and proposing an implementing prototype based on Eclipse/EMF. To this intent, we are already studying the potential reuse (and improvement) of our EMF Views prototype in this given context.

Program: FUI - AAP 13

Project acronym: TEAP

Project title: TOGAF Entreprise Architecture Platform

Duration: 2012 - 2014

Coordinator: Obeo

Other partners: Industry (DCNS), Research and University (Inria AtlanMod) and Vendors and service providers (Obeo, Capgemini)

Abstract: The fast evolution of technologies (SOA, Cloud, mobile environments), the systems complexity and the growing need for agility require to be able to represent information systems as a whole. The high-level approach promoted by Enterprise Architecture (EA) is a key element in this context and intends to address all the systems dimensions: software components, associated physical resources, relationships with the companies requirements and business processes, implied actors/roles/structures, etc. The objective of the TEAP project was to specify and implement an EA platform based on the Open Group international standard named TOGAF and on the SmartEA technical solution. In addition to its base modeling capabilities, this platform now allows data federation from different existing sources (e.g. for reverse engineering purposes such as retro-cartography) as well as the definition of possible transformation chains (for governance and modernization). As part of this project, we have been notably using in practice (and improving accordingly) some of our works and corresponding prototypes such as EMF Views, ATL or some MoDisco components.

Program: FUI - AAP 13

Project acronym: ITM Factory

Project title: Information Technology Modernisation Factory

Duration: 04/2012 - 10/2014

Coordinator: Soft-Maint (Groupe SODIFRANCE)

Other partners: Mia-Software (Groupe SODIFRANCE), ACAPNOS, MMA and Inria AtlanMod.

Abstract: Application maintenance represents about 80 per cent of the computer market (at the French and global level). The challenge of software maintenance is to keep running applications with technologies that are no longer required to be maintained and with changing development teams and whose skills are not always validated on ancient languages. The main goal of the ITM Factory is to propose a software modernization framework, based on the ModDisco project and including: (i) an integrated workbench for software modernization engineers and (ii) a set of ready to use modernization cartirdges, i.e., a solution brick that meets a business challenge level, as opposed to a technical bricks that provides technical solutions that are integrated into a business solution.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Program: FP7 - COOPERATION (ICT)

Project acronym: MONDO

Project title: Scalable Modelling and Model Management on the Cloud

Duration: November 2013 - May 2016

Coordinator: The Open Group - X/Open Company

Other partners: The Open Group - X/Open Company (United Kingdom), University of York (United Kingdom), Universidad Autonoma de Madrid (Spain), Budapest University of Technology and Economics (Hungary), IKERLAN (Spain), Soft-Maint (France), SoftTeam (France), UNINOVA (Portugal)

Abstract: As Model Driven Engineering (MDE) is increasingly applied to larger and more complex systems, the current generation of modelling and model management technologies are being pushed to their limits in terms of capacity and efficiency, and as such, additional research is imperative in order to enable MDE to remain relevant with industrial practice and continue delivering its widely recognised productivity, quality, and maintainability benefits. The aim of MONDO is to tackle the increasingly important challenge of scalability in MDE in a comprehensive manner. Achieving scalability in modelling and MDE involves being able to construct large models and domain specific languages in a systematic manner, enabling teams of modellers to construct and refine large models in a collaborative manner, advancing the state-of-the-art in model querying and transformations tools so that they can cope with large models (of the scale of millions of model elements), and providing an infrastructure for efficient storage, indexing and retrieval of large models. To address these challenges, MONDO brings together partners with a long track record in performing internationally-leading research on software modelling and MDE, and delivering research results in the form of robust, widely-used and sustainable open-source software, with industrial partners active in the fields of reverse engineering and systems integration, and a global consortium including more than 400 organisations from all sectors of IT.

Program: FP7 - Research For SMEs

Project acronym: AutoMobile

Project title: Automated Mobile App Development Type: Research For SMEs

Duration: November 2013 - October 2015

Coordinator: WebRatio s.r.l. (Italy)

Other partners: Politecnico di Milano (Italy), AtlanMod-Armines, Moon Submarine (UK), Forward-Software (Rumania).

Abstract: The AutoMobile project aims at designing and bringing to the market innovative methodologies, software tools, and vertical applications for the cost-effective implementation of cross-platform, multi-device mobile applications, i.e. business applications that can be accessed by users on a variety of devices and operating systems, including PC, cellular / smart phones and tablets. Cross-platform and multi-device design, implementation and deployment is a barrier for today's IT solution providers, especially SME providers, due to the high cost and technical complexity of targeting development to a wide spectrum of devices, which differ in format, interaction paradigm, and software architecture. AutoMobile will exploit the modern paradigm of Model-Driven Engineering and code generation to dramatically simplify multi-device development, reducing substantially cost and development times, so as to increase the profit of SME solution providers and at the same time reduce the price and total cost of ownership for end-customers. AutoMobile will rely on modeling languages such as IFML (Interaction Flow Modeling Languages) and on tools like WebRatio.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

The six main research partners of the team are:

- Politecnico di Milano (Italy) - DB Group, especially Marco Brambilla
- TU Wien (Austria) - BiG Group, especially Manuel Wimmer
- Politecnica de Catalunya (Spain) - GESSI Group, especially Xavier Franch
- Universitat Poliècnica de València (Spain) - ISSI Group, especially José H. Canós
- ICREA (Spain)- SOM Group, especially Jordi Cabot
- National Institute of Informatics in Tokyo - BiG group, especially Soichiro Hidaka

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- In March, Soichiro Hidaka, from the National Institute of Informatics (NII) in Tokyo, Japan, visited AtlanModels for one month, in the frame of a collaboration on bidirectionalization of model-transformation languages.

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PIA

9.1.1.1. PIA ELCI, Environnement Logiciel pour le Calcul Intensif, 2014-2017
Participants: Hélène Coullon, Thierry Gautier, Laurent Lefèvre, 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 programming and execution environment. It also aims to validate the relevance of these development 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.

9.1.2. French National Research Agency Projects (ANR)

9.1.2.1. ANR EMERGENCE CloudPower, Cloud Service providing HPC on-demand to innovative SME's, 35 months, ANR-12-EMMA-0038
Participant: Gilles Fedak.

High performance computing (HPC) allows scientists and industries to run large numerical application on huge data volumes. The HPC is a key factor in knowledge and innovation in many fields of industry and service, with high economic and social issues: aerospace, finance and business intelligence, energy and environment, chemicals and materials, medicine and biology , digital art and games, Web and social networks, ... Today, acquiring HPC supercomputer is very expensive, making HPC unreachable to SMIs / SMEs for their research and development. The CloudPower project results from the XtremWeb research and development project. Its goal is to offer a low cost Cloud HPC service for small and medium-sized innovative companies. With CloudPower, companies and scientists will run their simulations to design and develop new products on a powerful, scalable, economical, reliable and secure infrastructure.

The project will lead the creation of a new and innovative company operating the platform implemented in the framework of the ANR Emergence. CloudPower will implement SaaS / PaaS portal for customers and develop extensions to allow commercial exploitation of unused resources. Building on the network of SMIs from the competitiveness clusters System@tic and LyonBiopole, we will implement scenarios and/or demonstrators which illustrate the ability of CloudPower to increase competitiveness, research and marketing of innovative SMEs.

9.1.2.2. ANR INFRA MOEBUS, Multi-objective scheduling for large computing platforms, 4 years, ANR-13-INFR-000, 2013-2016
Participants: Christian Perez, Laurent Lefèvre, 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.

9.1.2.3. 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 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.

9.1.3. Inria Large Scale Initiative

9.1.3.1. C2S@Exa, Computer and Computational Sciences at Exascale, 4 years, 2013-2017
Participants: Hélène Coullon, Christian Perez, Laurent Lefèvre, 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.

9.1.3.2. DISCOVERY, DIstributed and COoperative management of Virtual Environments autonomousLY, 4 years, 2015-2019
Participants: Christian Perez, Gilles Fedak.

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.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. PaaSage
Participants: Christian Perez, Laurent Pouilloux.

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.

9.2.2. Collaborations in European Programs, except FP7 & H2020

9.2.2.1. CHIST-ERA STAR

Participants: Marcos Dias de Assunçao, Radu Carpa, Laurent Lefèvre, Olivier Glück.

Title: SwiTching And tRansmission project

Type: CHIST-ERA (European Coordinated Research on Long-term Challenges in Information and Communication Sciences & Technologies ERA-Net)

Duration: 2013-2015

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 prove 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 overprovisioning 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 can be realised through this project with significant potential for resulting impact on how core photonic networks are designed and implemented.

9.2.2.2. COST IC1305 : Nesus

Participants: Laurent Lefèvre, Marcos Dias de Assunçao, 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). In 2015, Violaine Villebonnet has been involved in a shirt term scientific mission with Universtity of La Lagune (Spain) on the topic of energy proportionality and profiling of HPC systems (May 18-29, 2015).

9.2.2.3. SEED4C

Program: Celtic-Plus

Project acronym: SEED4C

Project title: Security Embedded Element and Data privacy for the Cloud.

Duration: 2012-2015

Coordinator: Stéphane Betge-Brezetz (Alcatel-Lucent lab)

Other partners: Gemalto, ENSI Bourges, Inria, Wallix, VTT Technical Research centre of Finland, Mikkelin Puhelin Oyj, Cygate, Nokia Siemens Networks, Finceptum OY (Novell), Solacia, Innovalia Association, Nextel, Software Quality Systems, Ikusi, Vicomtech, Biscaytik

Abstract: SEED4C is a Celtic-Plus project: an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications and services focusing on a new "Smart Connected World" paradigm. Celtic-Plus is a EUREKA ICT cluster and is part of the inter-governmental EUREKA network.

The cloud security challenge not only reflects on the secure running of software on one single machine, but rather on managing and guaranteeing security of a computer group or cluster seen as a single entity. Seed4C focus is to evolve from cloud security with an isolated point or centralized points of enforcement for security to cloud security with cooperative points of enforcement for security.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. Inria-UIUC-NCSA Joint Laboratory for Petascale Computing
Participants: Eddy Caron, Hélène Coullon, Olivier Glück, Vincent Lanore, Laurent Lefèvre, Christian Perez.

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.

9.3.1.2. Informal International Partners
- Université Gaston Berger, Saint Louis, Sénégal. Contact: Pr. Ousmane Thiaré.
- École Centrale Mahindra, Hyderabad, India. Contact: Dr. Arya Kumar Bhattacharya.

9.3.2. Participation In other International Programs

9.3.2.1. GreenTouch
Participants: Jean-Patrick Gelas, Laurent Lefèvre.

GreenTouch is a consortium of leading Information and Communications Technology (ICT) industry, academic and non-governmental research experts dedicated to fundamentally transforming communications and data networks, including the Internet, and significantly reducing the carbon footprint of ICT devices, platforms and networks. The GreenTouch project has ended in June 2015 through the dissemination and demonstration of main results during a final celebration in New York. Our activities on designing virtual home gateway at large scale have been demonstrated.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Dr Dan Emanoil Grigoras. University College Cork (UK). September 16-18 2015.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

9.4.2.1.1. Gilles Fedak visited CAS, Beijing, China

Dates: 15/8/15 - 15/9/15

Local contact: Pr Haiwu He

Gilles Fedak hase been awarded the President's International Fellowship Initiative (PIFI) from the Chinese Academy of Sciences. He visited the CSNET institute in Beijing for one month, working with Pr. Haiwu He on D^3 MapReduce.

9.4.2.1.2. Daniel Balouek Thomert visited Mahindra Ecole Centrale, India

Dates: 10/5/15 - 12/19/15

Local contact: Dr Arya K. Bhattacharya (Arya.Bhattacharya@mechyd.ac.in)

Other avalon researcher involved: Eddy Caron and Laurent Lefevre.

Abstract: Our work synergizes two state-of- the-art technologies by combining Multi-Objective Evolutionary Algorithms (MOEA) with trade-off mechanisms using the DIET toolkit, in a context of cloud computing workflow placement. Evaluation of the proposed solution under different scheduling policies shows significant gains of energy consumption with some improvement on the overall workflow completion time. Following this work, a paper has been submitted.

<h1 style="text-align:center; color:red">AVIZ Project-Team</h1>

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.

The project addresses fundamental problems of technological infrastructure and the design of data representation and interaction to build a bridge between individual and team work for visual data analysis. In collaboration with the University of Magdeburg we have begun to tackle this challenge through the design of tangible widgets that help to bridge the gap between individual and collaborative information seeking.

8.1.2. ANR EASEA-Cloud

Participants: Evelyne Lutton [correspondant], Waldo Cancino, Hugo Gilbert, Pierre Collet.

The aim of the EASEA-CLOUD project is to exploit the massively parallel resources that are offered by clusters or a grid of modern GPU-equipped machines in order to find solutions to inverse problems whose evaluation function can be intrinsically sequential. Massive parallelization of generic sequential problems can be achieved by evolutionary computation, that can efficiently exploit the parallel evaluation of thousands of potential solutions (a population) for optimization or machine-learning purposes. The project consists in turning the existing EASEA (EAsy Specification of Evolutionary Algorithms, http://easea.unistra.fr/) research platform into an industrial-grade platform that could be exploited by running in "cloud" mode, on a large grid of computers (ISC-PIF/CREA is the current manager of the French National Grid). The necessary steps are to develop:

- a professional-grade API, development environment and human-computer interface for the existing academic EASEA platform,
- cloud-management tools (in order to launch an experiment on a grid of computers, monitor the experiment and bill the laboratories or companies that will be using EASEA-CLOUD for intensive computation,
- novel visualisation tools, in order to monitor an evolutionary run, potentially launched on several hundred heterogeneous GPU machines.

The consortium is made of thee partners: LSIIT/UDS (which is developing the EASEA platform), ISCPIR/CREA (for its experience in grid and cloud computing), AVIZ/Inria (for its experience in visualization tools for evolutionary computation) and two subcontractors: LogXLabs (a software development company in order to create industrial-grade code and interfaces) an BIOEMERGENCE-IMAGIF, the "valorisation" department of CNRS Gif s/Yvette. Valorisation will take place in strong collaboration with UNISTRA VALO, the valorisation structure of Université de Strasbourg. The project started on October 1st, 2012, for 2 years. AVIZ is in charge of developing new visualisation tools adapted to the monitoring of the optimization process.

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 & Scholars of The College of The Holy and Undivided Trinity of Queen Elizabeth Near Dublin (Ireland)

Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (Germany)

Universitaet Stuttgart (Germany)

The University of Birmingham (United Kingdom)

Universita Degli Studi di Cassino E Del Lazio Meridionale (Italy)

Inria contact: Jean-Daniel Fekete & Lauerent 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.'

8.2.2. Collaborations with Major European Organizations

We collaborate with several larger european research organizations, such as:

Fraunhofer Institute, IGD (DE)

We are collaborating on visual analytics, setting up European projects and coordinating European initiatives on the subject.

University of Stuttgart, Visualization Center (DE)

We are collaborating on the development of a comprehensive visualization publication dataset

Technical University of Vienna, Visualization Research Group (AT)

We are collaborating on a project to derive major visualization domain keywords and collaborating on projects and workshops related to the evaluation of visualization.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

- We hosted a visiting PhD student as part of the Inria-Mitacs collaboration.
- AVIZ collaborates with several researchers from Microsoft Research Redmond, in particular on the topic of new interactions for information visualization and brain connectivity visualization.

8.3.1.2. Informal International Partners

- Arizona State University, USA
- University of Groningen, the Netherlands
- University of Granada, Spain
- New York University, USA
- Harvard University, USA
- Google, USA

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Teresa Onorati, PostDoc at the University of Madrid visited us for three months.

8.4.1.1. Internships

- Paul Lapides and Alice Thudt visited from the University of Calgary, Canada.

8.4.2. Visits to International Teams

8.4.2.1. Sabbatical programme

Fekete Jean-Daniel

Date: Jan 2015 - Dec 2015

Institution: NYU (United States) and Harvard University (United States)

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Seong-Gyun Jeong, Nazre Batool and Josiane Zerubia have been in contact with image processing experts for early clinical evaluation at Galderma R&D in Sophia Antipolis [http://www.galderma.com/About-Galderma/Worldwide-presence/R-D-Locations] to discuss AYIN's research on wrinkle detection.
- Zhao Liu and Josiane Zerubia discussed several times with Dr Catherine Queille-Roussel, CPCAD managing director at CHU Nice (Faculty of Medicine, Dermatology department, at l'Archet 2 hospital in Nice) about AYIN's research on semi-automatic acne detection.
- Josiane Zerubia have 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 on remote sensing.

9.2. International Initiatives

9.2.1. Inria International Partners

- Josiane Zerubia has been working for more than 20 years with MTA SZTAKI (Hungarian Academy of Sciences) in Budapest, Hungary, and with University of Szeged, Hungary.
- Josiane Zerubia has also a strong collaboration with University of Genoa, Italy, for more than 20 years.
- Finally, another collaboration with Mc Master University, Hamilton, Canada, started in 2012.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- 2 young researchers visited AYIN team during one week each: Ganchi Zhang, PhD student, working with Prof. Nick Kingsbury at University of Cambridge, UK, in March and Dr. Vladimir Krylov, post-doc researcher, working with Prof. Sebastiano Serpico and Prof. Gabriele Moser at University of Genoa, Italy in Nov.
- several senior researchers visited AYIN team during a few days this year: Prof. Qiyin Fang, Mc Master University, Hamilton, Canada, in June; Prof. Hassan Foroosh, University of Central Florida, Orlando, USA, in July; Prof. Rozen Dayhiot, Trinity College Dublin, Ireland, in October; Prof. Freddy Buckstein, Technion, Haifa, Israel, in November; Prof. Pascal Fua, EPFL, Lausanne, Switzerland, in November; Prof. Daniela Zaharie, West University of Timioara, Romania, in November and Prof. Tamas Sziranyi, MTA Sztaki and Univ. of Technology and Economics Budapest, Hungary in November.

9.3.1.1. Internships

- Ali Madooei, PhD student, supervised by Prof. Joseph Hayward from Simon Fraser University, Burnaby, Canada, got a Mitacs/Inria internship fellowship (Mitacs Globalink Research Award [https://www.mitacs.ca/en/programs/globalink/globalink-research-award-inria]) to work in AYIN team during 3 months (June to August) in collaboration with Josiane Zerubia and the research group of Prof. Qiyin Fang at Mc Master University and Juravinsky Cancer Center, Hamilton, Canada.

9.3.2. Visits to International Teams

- Seong-Gyun Jeong was invited in January to visit the Institute of Space and Earth Information Science (ISEIS, [http://www.iseis.cuhk.edu.hk/eng/]) at the Chinese University of Hong Kong (CUHK), China.
- Josiane Zerubia was invited during a few days in April at Trinity College Dublin, Ireland, to visit the School of Computer Science and Statistics [https://www.cs.tcd.ie/] and the School of Engineering [http://www.tcd.ie/Engineering/].

BEAGLE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Intracell X Evo, projet LABEX ECOFECT. Leaders: Thomas Henry, CIRI, Lyon, and Eric Tannier, Beagle. Other partner : Dominique Schneider, laboratoire Adaptation et pathogénie des Microorganismes, Grenoble. Duration: 3 years The objective of the project is to understand the host-pathogen interactions in the cytosol by an experimental evolution approach. Funding: 120 000 Euros.

8.2. National Initiatives

8.2.1. ANR

- Ancestrome: phylogenetic reconstruction of ancestral "-omes", a five-year project (2012-2017), 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 (2013-2016) 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: Dopamine modulation of calcium influx underlying synaptic plasticity, a 4-year project (2014-2017) 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

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. EvoEvo

Title: Evolution of Evolution

Programm: FP7

Duration: November 2013 - October 2016

Coordinator: Inria

Partners:

Agencia Estatal Consejo Superior de Investigaciones Científicas (Spain)

Institut National des Sciences Appliquees de Lyon (France)

Universite Lyon 1 Claude Bernard (France)

Universite Joseph Fourier Grenoble 1 (France)

Universiteit Utrecht (Netherlands)

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).

8.3.1.2. Neuron-Astro-Nets

Title: Neuron-Astro-Nets

Programm: Marie-Curie International Outgoing Fellowship (IOF) grant FP7

Duration: 2013 - October 2017

Coordinator: Inria

Partners:

Inria (France)

Dept Statistics and Neurobiology, University of Chicago (USA)

Inria contact: Hugues 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 Pitta' s postdoc for 4 years (June 2013- May 2017). M. De Pitta has first spent one year in Beagle, Lyon funded by an EU ERCIM grant (06/2013-05/2014) then two years in N. Brunel's Lab in Chicago (06/2014-05/2016) and one year back in Beagle in Lyon (06/2016-05/2017). The IOF grant funds the last three years.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

Beagle collaborates with two american laboratories: the Theunissen Lab (UC Berkeley, CA, http://theunissen.berkeley.edu/publications.html) and the Blackwell lab (George Mason Univ., VA, http://krasnow1.gmu.edu/CENlab/index.html). Those labs are the partners of the two ANR-NSF-NIH grants we were awarded (cf "ANR" section above).

8.4.2. Participation In other International Programs

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 team (UJF, LAPM, UMR CNRS 5163, France), Rich Lenski team (Michigan State University, Beacon center, US) and the Beagle team.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Priscila Biller did a one year doctoral internship in Beagle, ending in April 2015
- Jaap Rutten started his internship in the Beagle team in December 2015. Jaap Rutten is a M2 student from the Utrecht University (NL).

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

Eric Tannier has spent one month in July 2015 at Simon Fraser University in Vancouver, Canada.

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

9. Partnerships and Cooperations

9.1. National Initiatives

- *PhotoBrain* (2015-17), AGuIX® theranostic nanoparticles for vascular-targeted interstitial photo-dynamic therapy of brain tumors, Funding organism: EuroNanoMed II, Leader: M. Barberi-Heyob (CRAN), Thierry Bastogne

- (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. International Research Visitors

9.2.1. *Visits of International Scientists*

S. Roelly, University of Postdam visited P. Vallois in 2015 September.

9.2.1.1. *Internships*

A. Gégout-Petit and P. Vallois supervised an internship of a master IMOI student at the startup SD-Innovation, http://www.sd-innovation.fr/. The subject was the parametrization of curves issued from the aggregation of cells.

9.2.2. *Visits to International Teams*

9.2.2.1. *Research stays abroad*

- P. Vallois visited S. Roelly in Postdam (Germany), March 2015
- P. Vallois visited P. Salminien in Turku (Turkey), March 2015
- P. Vallois visited the Finance department in New York, April 2015

<div align="center" style="color:red">**BIOCORE Project-Team**</div>

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.

- **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.

- **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 Université Nice Sophia Antipolis.
- **OPTIBIO:** This project is devoted to the analysis of optimal control problems related to bioprocesses. The project is funded by Programme Gaspard Monge pour L'Optimisation et la Recherche Opérationnelle and coordinated by T. Bayen (U. Montpellier 2).
- **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 [66]).

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 Stuttgart, Institute for Systems Theory and Automatic Control (D):

Identification of gene networks

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 CO_2 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 expertises 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

GRIMCAPE, Université de Douala, Cameroon. Epidemiology.

National Institute of Technology Meghalaya, India. Modelling of augmentative biological control.

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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Samuel Bowong (Université de Douala, Cameroon), 1 week;
- Daniel Figueriedo (University of Aveiro, Portugal), 3 weeks;
- Benoît Chachuat (Imperial College, Department of chemical engineering, UK), 1 week
- Claude Aflalo (Ben Gurion University of the Neguev, Israel), 1 week;
- Andrei Akhmetzhanov (Université Montpellier II), 2 weeks.

9.5. Project-team seminar

BIOCORE organized a 4-day seminar in November in Peyresq. On this occasion, every member of the project-team presented his/her recent results and brainstorming sessions were organised. Claude Lobry (Univ. Nice and Modemic) was invited as a guest speaker.

BIPOP Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project eBacuss from the Persyval Labex, with C. Prieur (GIPSA Lab), B. Bidegarray (LJK Grenoble), L. Fesquet (TIMA Grenoble).

8.2. National Initiatives

8.2.1. ANR

- CHASLIM Chattering Free Sliding Mode Control: ANR BLAN 2011 BS03 007 01 (octobre 2011–octobre 2015), coordinator B. Brogliato.
- SLOFADYBIO Slow-fast dynamics applied to the biosciences (january 2015 – december 2016), coordinateur: Mathieu Desroches (Inria Rocquencourt).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. GEM

Title: from GEometry to Motion, inverse modeling of complex mechanical structures

Programm: H2020

Type: ERC

Duration: September 2015 - September 2020

Coordinator: Inria

Inria contact: Florence Bertails-Descoubes

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.

8.3.1.2. COMANOID

   Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

   Programm: H2020

   Duration: January 2015 - January 2019

   Coordinator: CNRS (Lirmm)

   Partners:

   Airbus Groups (France)

   Centre national de la recherche scientifique (France)

   Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

   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.

8.4. International Initiatives

8.4.1. Inria International Labs

   Vincent Acary is on leave at Inria Chile from September 2014 to August 2016.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

   We lead collaborations with several foreigh colleagues:

   - Prof. Ryo Kikuuwe from Kyushu University, Japan.
   - Prof. C. Liu from Peking University (PKU), Beijing, China [34].
   - Prof. Thorsten Schindler from Munich Technical University.
   - Prof. Nathan Krislock from North Illinois University [51].
   - Prof. Yuli Starosvetsky, Technion Israel Institute of Technology.

8.4.3. Participation In other International Programs

Y. Starosvetsky (Technion, PI) and G. James (Co-PI) have been awarded a grant from the Pazi Foundation (Israel) on a 4-years project (2015-19) entitled *Experimental, computational and analytical study of wave propagation in 1D and 2D granular crystals mounted on the non-uniform elastic foundation with spatially and temporarily varying properties*.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Professor Ryo Kikuuwe from Kyushu University (Japan) visited BIPOP from 01 September 2014 to 31 March 2016.
- Professor Nathan Krislock from North Illinois University visited BIPOP in June/July 2015.

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

Acary Vincent

Date: Sep 2014 - Aug 2016

Institution: CMM (Chile)

<center>BONSAI Project-Team</center>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- 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 increase 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 the installation, administration and usability. This will make the software well suited for a daily clinical use. The software is already used in test on our own web server (more than 1,000 samples processed by now). Our goal is that several labs use Vidjil on a daily basis by the end of the ADT, and that they all have their own Vidjil server.

9.1.3. Others

- PEPS Gen-CoV: *Global bioinformatics analysis of coronavirus strain 229E in hospital outbreak.* The goal of this PEPS is to provide with a better characterization of coronavirus infections and to understand underlying mecanisms that lead to the high diversity of coronaviruses. To achieve this goal, we will sequence and analyze a number of coronavirus 229E genomes in order to characterize their diversity, identify features that influence pathogenicity and propose a model of evolution. All those results will be correlated with epidemiologic data thanks to a partnership with Lille hospital.

- PEPS JCJC: *Frugal algorithms for third-generation DNA sequencing.* The goal of this PEPS is to develop lightweight algorithms and data structures for the analysis of third-generation sequencing data. Among third-generation technologies, the MinION sequencer is a new, portable USB device that can perform DNA sequencing using only common lab equipment and a laptop computer. However, analysis of the data produced by the MinION can only be carried by uploading data to a cloud server. Indeed, all algorithms and data structures that are currently known require large computational resources to process such data. This is unfortunate for at least two reasons: analysis of the data now takes more time than its production, and confidential data needs to be processed on potentially insecure cloud servers. We seek to design methods that would enable analysis of sequenced data on the same machine as the one that performed sequencing.

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*). The subject is 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.

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, informatique et mathématique (LaCIM) - Anne Bergeron

Start year: 2014

See also: http://thales.math.uqam.ca/~cgalcode/

The aim of this Associated Team is the development of comparative genomics models and methods for the analysis of eukaryotes gene structure evolution. The goal of the project 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 meetings of CG-ALCODE researchers took place in 2015. First, Samuel Blanquart, Anne Bergeron and Krister Swenson met each other in Montpellier, from 27th to 30th of April. Second, Samuel Blanquart, Jean Stéphane Varré spent two weeks in Montréal, from 1st to 11th November, to work with Anne Bergeron.

9.3.1.2. Informal International Partners

- *Astrid Lindgrens Hospital, Stockholm University:* Collaboration with Anna Nilsson and Shanie Saghafian-Hedengren on RNA sequencing of stromal cells.
- *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.
- *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.
- *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 and Markus Mueller on nonribosomal peptides.
- *School of Social and Community Medicine, University of Bristol:* Collaboration with John Moppett on leukemia follow-up.
- *Science for Life Laboratory, Stockholm University:* Collaboration with Lars Arvestad and Kristoffer Sahlin on genome scaffolding of contaminated libraries.
- *Theoretical Biochemistry Group, Universität Wien:* Collaboration with Andrea Tanzer and Ronny Lorenz on RNA folding and RNA kinetics.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Kristina Heyn, PhD student, Institut für Biophysik und physikalische Biochemie, University of Regensburg (from 6th to 11th of July)
- Burkhard Morgenstern, professeur, Universität Gottingen (from 20th to 23th of April)
- Samarth Rangavittal, PhD student, The Pennsylvania State University (from October 18th to December 6th)
- Gabriele Valiente, professeur, Universitat Politècnica de Catalunya (from 25th to 29th of May)
- Tilmann Weber, senior researcher, Novo Nordisk Foundation Center for Biosustainability, Technical University of Denmark (from 18th of October to 31st of October)

CAGIRE Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Predicting pressure losses in aeronautical fuel injectors

This is a 3-year programme, funded by Conseil Régional d'Aquitaine (call 2014) and two small-size companies, AD Industrie (Gurmençon, France) and GDTECH (Bordes, France). A one-year post-doc [YM] started in May 2015. 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.

9.2. National Initiatives

9.2.1. GIS Success

We are members of the CNRS GIS Success (Groupement d'Intérêt Scientifique) organised around the two major codes employed by the Safran group, namely AVBP and Yales 2. Apart our participation in the annual meeting of the GIS technical comittee, no specific technical activity has been devoted around those codes during 2015.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

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

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.

9.4. International Initiatives

- April-June 2015: A. Javadi (PhD student) from Chalmers University, Gothenburg, Sweden (3 months).

9.4.1. Informal International Partners

- Collaboration [PB, VP, YM] with E. Dick (University of Ghent, Belgium) on the development of schemes for the simulation of unsteady low Mach number flows.

- Collaboration [PB] with A. Allouhi, A. Jamil, Y. Mourad (Ecole Supérieure de Technologie of Fès, Marocco) related to solar driven cooling systems.

- Collaboration [PB] with A. Beketaeva and A. Naïmanova (Institute of Mathematics, Almaty, Kazakhstan) related to the simulation of supersonic flows.

- Collaboration [RM] with H. Nilsson and A. Javadi (University of Chalmers, Gothenburg, Sweden) on the development of RANS and hybrid RANS/LES for the turbomachinery computations.

- Collaboration [RM] with E. Juntasaro (King Mongkut's TU, Bangkok, Thailand) about the modeling of bypass transition.

- Collaboration [RM] with Tran Thanh Tinh and Anh Thi NGuyen (TU Ho Chi Minh City, Viet Nam) on temporal hybrid RANS/LES.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- April-June 2015: A. Javadi (PhD student) from Chalmers University, Gothenburg, Sweden (3 months).

- November 2015: Prof. Erik Dick from Ghent University (Belgium) (4 days).

- November 2015: Dr. A. Naïmanova from the Institute of Mathematics (Ministry of Education), Almaty, Kazakhstan (4 weeks).

- November-December 2015: N. Shakhan (PhD student) from Al Farabi University, Almaty, Kazakhstan (7 weeks).

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 CAIRNand 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. CAIRNgoal is the technological transfer of the methods proposed by the team that enable the rapid prototyping of digital radios.

8.2. National Initiatives

The CAIRNteam mainly collaborates with the following laboratories: CEA List, CEA Leti, LEAT Nice, Lab-Sticc (Lorient, Brest), LIRMM (Montpellier, Perpignan), LIP6 Paris, IETR Rennes, DTIM-ONERA Toulouse, LAAS Toulouse, IRIT Toulouse, Inria Socrate.

The team participates in the activities of the following research organization of CNRS (GdR for in French *"Groupe de Recherche"*):

- GdR SOC-SIP (*System On Chip & System In Package*), working groups on reconfigurable architectures, embedded software for SoC, low power issues. E. Casseau is in charge of the architecture topic of the reconfigurable platform working group.

- GdR ISIS (*Information Signal ImageS*), working group on *Algorithms Architectures Adequation*.

- GdR ASR (*Architectures Systèmes et Réseaux*)

- GdR IM (*Informatique Mathématiques*), C2 working group on Codes and Cryptography and ARITH working group on Computer Arithmetic

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

Participants: Arnaud Tisserand, Emmanuel Casseau, Philippe Quémerais, Jérémie Métairie, Nicolas Veyrat-Charvillon, Karim Bigou, Pierre Guilloux.

PAVOIS (in French: *Protections Arithmétiques Vis à vis des attaques physiques pour la cryptOgraphIe basée sur les courbeS elliptiques*) is a project on Arithmetic Protections Against Physical Attacks for Elliptic Curve based Cryptography. It involves IRISA-CAIRN(Lannion) and LIRMM (Perpignan and Montpellier). This project will provide novel implementations of curve based cryptographic algorithms on custom hardware platforms. A specific focus will be placed on trade-offs between efficiency and robustness against physical attacks. One of our goal is to theoretically study and practically measure the impact of various protection schemes on the performance (speed, silicon cost and power consumption). Theoretical aspects will 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 will design innovative cryptographic hardware architectures of a specific processor based on the theoretical advancements described above to implement curve based protocols. We will target efficient and secure implementations for both FPGA an ASIC circuits. For more details see http://pavois.irisa.fr.

8.2.2. *ANR INFRA 2011 - FAON (2012-2015)*

Participants: Raphaël Bardoux, Arnaud Carer.

The FAON (Frequency based Access Optical Networks) project objectives are to demonstrate the technology and feasibility of a new type of Passive Optical Network (PON) for broadband access which uses a Frequency based shared access technique known as Frequency Division Multiplexing (FDM). These goals completely fall into the line of the expected capacity increase in PON which is today forecasted to go from 100 Mbps per user to 1 Gbps. Faon involves Orange Labs, CEA-LETI, University of South Brittany (Lab-STICC laboratory) and Univ. Rennes I (Foton laboratory and CAIRNteam). CAIRNdeveloped a high-rate architecture at the receiver side. Specific receiver algorithms (synchronization and equalization) and FPGA implementation are the key issues that were addressed. This project ended in 2015.

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

Participants: Arnaud Tisserand, Philippe Quémerais.

ARDyT (in French: *Architecture Reconfigurable Dynamiquement Tolérante aux fautes*) 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. The ARDyT platform will provide a European alternative to import ITAR constraints for fault-tolerant reconfigurable architectures. For more details see http://ardyt.irisa.fr.

8.2.4. *ANR Ingénérie Numérique et Sécurité - COMPA (2011-2015)*

Participants: Emmanuel Casseau, Steven Derrien, Yaset Oliva Venegas.

COMPA (model oriented design of embedded and adaptive multiprocessor) is a project which involves CAIRN, IETR (Rennes) and Lab-STICC (Lorient). The aim of the project was to design adaptive multiprocessor embedded systems for executing dataflow programs. The use case is the Reconfigurable Video Coding (RVC) standard. More specifically, we focus on the portable and platform-independent RVC-CAL language to describe the applications. We use transformations to refine, increase parallelism and translate the application model into software and hardware components. Specific scheduling and actor's mapping are also investigated for runtime execution. For more details see http://www.compa-project.org. This project ended in 2015.

8.2.5. *ANR Ingénérie Numérique et Sécurité - DEFIS (2011-2015)*

Participants: Olivier Sentieys, Nicolas Simon.

DEFIS (Design of fixed-point embedded systems) is a project which involves CAIRN, LIP6 (University of Paris 6), LIRMM (University of Perpignan), CEA LIST, Thales, Inpixal. The main objectives of the project were to propose new approaches to improve the efficiency of the floating-point to fixed-point conversion process and to provide a complete design flow for fixed-point refinement of complex applications. This infrastructure reduces the time-to-market by automating the fixed-point conversion and by mastering the trade-off between application quality and implementation cost. Moreover, this flow guarantees and validates the numerical behavior of the resulting implementation. The proposed infrastructure was validated on two real applications provided by the industrial partners. For more details see http://defis.lip6.fr. This project ended in 2015.

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

Participants: Olivier Sentieys, Arnaud Carer.

The BoWi project (Body Wold Interactions) aims at designing an accurate gesture and body movement estimation using very-small and low-power wearable sensor nodes. It initially stems from a proposal of the CominLabs think thank focused on the society challenge called Digital Environment for the Citizen. It is also related to the social challenge ICT for Personalized Medicine and to the research track Energy Efficiency in ICT. The main objective of the project is to propose pioneer interfaces for an emerging interacting world based on smart environments (house, media, information and entertainment systems...). Basically the

project relies on Wireless Body Areas Sensor Networks; the aim is the accurate Gesture and Body Movement estimation with extremely severe constraints in terms of footprint and power consumption according to on-body energy harvesting perspectives. The BoWI geolocation approach will combine radio communication distance measurement and inertial sensors and it will also strongly benefit from cooperative techniques based on multiple observations and distributed computation. Different types of applications, as health care, activity monitoring and environment control, will be considered and evaluated along with a human-machine interface expertise.

The scientific challenge is global and deals with the solution to be interactively invented by all partners: a short-range geolocation method based on distributed and coopering devices processing multisource data issued from radio-communication distance estimation and integrated inertial sensors. It includes several specific contributions:

- Dynamic and cooperative communication coding and protocol for inter-nodes communications. This includes cooperative communications and protocols such as cooperative MIMO, relaying, error coding, network coding and MAC and wake-up radio protocols.

- Node hardware/software architecture design and self-adaptive distributed processing for geolocation with aggressive low-power run-time optimisation.

- Channel models and antennas for short-range communications. This study will be performed for various radio standards from upcoming BAN 802.15.6, 802.15.4a technologies to future UWB solutions.

- Channel models and antennas for WBASN at millimeter waves. This is a promising perspective for antenna miniaturization, however no front-ends are yet available.

- In depth and specific analysis of human-machine interactions to set system constrains and define user requirement according to various application perspectives.

In practice the BoWi partners aim to deliver the design of basic components, a prototype based on available radio front-ends and energy harvesting devices as well as a system simulator including mm-wave models. Results will also concern the specification of future radio-front ends. The BoWI involves CAIRN, IRISA Granit (Lannion), IETR (Rennes), and Lab-STICC (Brest, Lorient, Vannes). For more details see http://www.bowi.cominlabs.ueb.eu/fr.

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

Participants: Olivier Sentieys, Daniel Chillet, Cédric Killian, Jiating Luo, Van Dung Pham.

3DCORE (3D Many-Core Architectures based on Optical Network on Chip) is a project which involves CAIRN, FOTON (Rennes, Lannion) and Institut des Nanotechnologies de Lyon. 3D integration in the ultra deep submicron domain means the implementation of billions of transistors or of hundreds of cores on a single chip with the need to ensure a large number of exchanges between cores, and the obligation to limit the power consumption. Focusing on system integration rather than transistor density, allows for both functional and technological diversification in integrated systems. The functional diversification allows for non-digital functionalities to migrate from the board level into the (on-)chip level. This allows for integration of new technologies that enable high performance, low power, high reliability, low cost, and high design productivity. The use of Optical Network-on-Chip (ONoC) promises to deliver significantly increased bandwidth, increased immunity to electromagnetic noise, decreased latency, and decreased power consumption while wavelength routing and Wavelength Division Multiplexing (WDM) contributes to the valuable properties of optical interconnect by permitting low contention or even contention free routing. WDM allows for multiple signals to be transmitted simultaneously, facilitating higher throughput. Individual realization of CMOS compatible optical components, such as, waveguides, modulators, and detectors lets the community foresee that such integration may be possible in the next ten years. The aim of the project is therefore to investigate new optical interconnect solutions 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 targeting both embedded and high-performance computing. Moreover, we envisage taking advantage of 3D technologies for designing a specific photonics layer suitable for a flexible and energy efficient high-speed optical network on chip (ONoC).

8.2.8. Labex CominLabs - RELIASIC (2014-2018)

Participants: Emmanuel Casseau, Arnaud Tisserand.

RELIASIC (Reliable Asic) is a project which involves CAIRN, Lab-STICC (University of Bretagne Sud) and IETR (Institut d'Electronique et de Télécommunications de Rennes). One of the most critical challenges of the next design technologies will be fault-tolerant computation. The increase in integration density and the requirement of low-energy consumption can only be sustained through low-powered components, with the drawback of a looser robustness against transient errors. In the near future, electronic gates to process information will be inherently unreliable. New techniques will be required to increase the reliability of operators and components. The aim of the project is to address this problem 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.

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

Participants: Arnaud Tisserand, Nicolas Veyrat-Charvillon, Karim Bigou, Gabriel Gallin.

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 involves IRISA-CAIRN(Lannion) and IRMAR (Rennes).

Arithmetic has an important role to play in providing algorithms robust against physical attacks (e.g., analysis of the power consumption, electromagnetic radiations or computation timings). Currently, there are only a very few hardware implementations of HECC (without any open source availability). This project will provide novel implementations of HECC based cryptographic algorithms on custom hardware platforms. For more details see http://h-a-h.inria.fr/.

8.3. European Initiatives

8.3.1. FP7 FLEXTILES

Participants: Olivier Sentieys, Emmanuel Casseau, Daniel Chillet, Philippe Quémerais, Christophe Huriaux.

> Program: FP7-ICT-2011-7
>
> Project acronym: Flextiles
>
> Duration: Oct. 2011 - Mar. 2015
>
> Coordinator: Thales
>
> Other partners: Thales (FR), UR1 (FR), KIT (GE), TU/e (NL), CSEM (SW), CEA LETI (FR), Sundance (UK)
>
> Project title: Self Adaptive Heterogeneous Manycore Based on Flexible Tiles

A major challenge in computing is to leverage multi-core technology to develop energy-efficient high performance systems. This is critical for embedded systems with a very limited energy budget as well as for supercomputers in terms of sustainability. Moreover the efficient programming of multi-core architectures, as we move towards manycores with more than a thousand cores predicted by 2020, remains an unresolved issue. The FlexTiles project defined and developed an energy-efficient yet programmable heterogeneous manycore platform with self-adaptive capabilities. The manycore is associated with an innovative virtualisation layer and a dedicated tool-flow to improve programming efficiency, reduce the impact on time to market and reduce the development cost by 20 to 50%. FlexTiles raised the accessibility of the manycore technology to industry - from small SMEs to large companies - thanks to its programming efficiency and its ability to adapt to the targeted domain using embedded reconfigurable technologies. This project ended in 2015.

8.3.2. FP7 ALMA

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

> Program: FP7-ICT-2011-7
>
> Project acronym: Alma
>
> Project title: Architecture oriented paraLlelization for high performance embedded Multicore systems using scilAb
>
> Duration: Sep. 2011 - Nov. 2014
>
> Coordinator: KIT
>
> Other partners: KIT (GE), UR1 (FR), Recore Systems (NL), Univ. of Peloponnese (GR), TEI-MES (GR), Intracom SA (GR), Fraunhofer (GE)

The mapping process of high performance embedded applications to today's multiprocessor system on chip devices suffers from a complex toolchain and programming process. The problem here is the expression of parallelism with a pure imperative programming language which is commonly C. This traditional approach limits the mapping, partitioning and the generation of optimized parallel code, and consequently the achievable performance and power consumption of applications from different domains. The Architecture oriented paraLlelization for high performance embedded Multicore systems using scilAb (ALMA) project aimed to bridge these hurdles through the introduction and exploitation of a Scilab-based toolchain which enables the efficient mapping of applications on multiprocessor platforms from high-level abstraction descriptions. This holistic solution of the toolchain allows the complexity of both the application and the architecture to be hidden, which leads to a better acceptance, reduced development cost and shorter time-to-market. Driven by the technology restrictions in chip design, the end of Moore's law and an unavoidable increasing request of computing performance, ALMA was a fundamental step forward in the necessary introduction of novel computing paradigms and methodologies. This project ended in 2015.

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) - Department of Electrical and Computer Engineering - Prof. Russel Tessier and Prof. Maciej Ciesielski
>
> 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 will 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. DAVIAP

> Title: From DAtaflow-based VIdeo Appications to embedded multicore Platforms
>
> International Partner (Institution - Laboratory - Researcher):
>
>> Tampere University of Technology (Finland) - Department of Pervasive Computing - Prof. Jarmo Takala

8.4.2.1.3. HARAMCOP

> Title: Hardware accelerators modeling using constraint-based programming
>
> International Partner (Institution - Laboratory - Researcher):
>
>> Lund University (Sweden) - Department of Computer Science - Prof. Krzysztof Kuchcinski

8.4.2.1.4. 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), Optimization of embedded systems using fixed-point arithmetic, fault-tolerant computing architectures.
>
> Ecole Polytechnique Fédérale de Lausanne - EPFL (Switzerland), Optimization of embedded systems using fixed-point arithmetic.
>
> 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, Data Merging, 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. Liam Marnane, Dept. of Electrical and Electronic Engineering, University College, Cork, Ireland, for two weeks in October. This visit was founded by ENSSAT.

Prof. Emanuel Popovici, Dept. of Electrical and Electronic Engineering, University College, Cork, Ireland, for two weeks in July. This visit was founded by Enssat.

Dr. Michele Magno, Integrated Systems Laboratory, ETH Zurich, Switzerland, for two weeks in June. This visit was founded by Enssat.

Prof. Guy Lemieux, Department of Electrical and Computer Engineering, University of British Columbia, Vancouver, Canada, for two weeks in December. This visit was founded by HARDIESSE Inria Associate Team.

Prof. Russel Tessier, University of Massachusetts, Amherst, US, for one week in December. This visit was founded by HARDIESSE Inria Associate Team.

Porf. Renato J. Cintra, TDepartment of Statistics, Universidade Federal de Pernambuco, Recife, Brazil, for six months from January 2015.

8.5.1.1. Internships

Minh Thanh Cong, Master ICT, University of Science and Technology of Hanoi, Vietnam, from Apr 2015 until Sep 2015.

Soumitr Dubey, B.Tech./M.Sc. in Electronics and Communication, Indian Institute of Technology (IIT) Hyderabad, India, from May 2015 until Jul 2015.

Chi Dinh Ma, Master ICT, University of Science and Technology of Hanoi, Vietnam, from Apr 2015 until Sep 2015.

Prannoy Pilligundla, B.Eng. Electronics & Instrumentation Engineering, Birla Institute of Technology & Science, Pilani, India, from May 2015 until Jul 2015.

Madhav Singh, B.Tech. in Electrical Engineering, Indian Institute of Technology (IIT) Patna, India, from May 2015 until Jul 2015.

8.5.2. *Visits to International Teams*

Simon Rockiki visited University of Massachusetts, Amherst, US, for 6 months from January to July 2015. This visit was founded by HARDIESSE Inria Associate Team.

CAMUS Team

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 ALF, 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
- Intel, Santa Clara, CA, USA
- UPMARC, University of Uppsala, Sweden
- University of Batna, Algeria
- Ohio State University, Colombus, USA
- Louisiana State University, Baton Rouge, USA
- Indian Institute of Science (IIIS) Bangalore, India
- University of Delaware, DE, USA

9.3. International Research Visitors

9.3.1. *Visits of International Scientists*

Professor P. Sadayappan from Ohio State University, USA, has been visiting the CAMUS team from November the 4th to November the 7th. He took part of Aravind Sukumaran-Rajam's PhD jury as a reviewer and made several presentations of his research work.

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

<center>**CAPSID Project-Team**</center>

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

Participants: Marie-Dominique Devignes [contact person], Jérémie Bourseau.

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. IFB

Participant: Marie-Dominique Devignes [contact person].

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.

8.2.2.2. 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 choc 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 of International Scientists

8.4.1.1. Doctoral Students

In the frame of a collaboration with the University of Brasilia, Dr. A. Abadio and three doctoral students (A. Souza, J. Ribeiro, P. Alves) visited in July 2015.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

In the context of the research grant "CPER Cyberentreprises", involving the French ministry of research, Région Lorraine, Inria, CNRS, and the European fund FEDER, we solicited and obtained funding for a new computer equipment dedicated to the computation of large polynomial systems. The corresponding machine has been delivered in November 2015, and will be put into service in the first weeks of 2016.

9.2. National Initiatives

The team participates in the "Calcul formel, arithmétique, protection de l'information" research pole of the GDR-IM (CNRS Research Group on Mathematical Computer Science). The team is a member of the "Arithmétique", "Calcul formel" and "Codage et Cryptographie" working groups.

9.2.1. ANR CATREL (Cribles: Améliorations Théoriques et Résolution Effective du Logarithme discret)

Participants: Cyril Bouvier, Nicholas Coxon, Jérémie Detrey, Pierrick Gaudry, Laurent Grémy, Hamza Jeljeli, Emmanuel Thomé [contact], Marion Videau, Paul Zimmermann.

The CATREL proposal has been accepted in ANR "programme Blanc" in 2012. This project involves CARAMEL as a leading team, in cooperation with two other partners which are INRIA project-team GRACE (INRIA Saclay, LIX, École Polytechnique), and the ARITH team of the LIRMM Laboratory (Montpellier). The project targets algorithms for solving the discrete logarithm problem in finite fields, using the Number Field Sieve and the Function Field Sieve algorithms. Actual work on the CATREL project started in January 2013. According to the schedule, the project ended on Dec. 31st, 2015. Two project meetings were held in 2015: in Nancy on January 13-14, 2015, and in Palaiseau on October 1-2, 2015. The last project meeting was attached to an international workshop which brought together international experts on the Discrete Logarithm Problem to discuss the massive advances on this topic during the last years. A mid-term project review of the CATREL project was conducted by ANR in March 2015. The review outcome was very positive.

9.2.2. PEPS JCJC INSII RiCoRé (Résolution de systèmes polynomiaux pour les codes correcteurs et la robotique)

Participant: Pierre-Jean Spaenlehauer.

The RiCoRé proposal has been accepted in the PEPS JCJC INSII program in 2015. This project is coordinated by Romain Lebreton (Maître de Conférence, Univ. Montpellier). The other participants are Salih Abdelaziz (Maître de Conférence, Univ. Montpellier) and Eleonora Guerrini (Maître de Conférence, Univ. Montpellier). The aim of this project is to study the interactions of symbolic algorithms for polynomial system solving with some problems arising in coding theory and robotics.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Masahiro Ishii, a PhD student from the Nara Institute of Science and Technology, Nara (Japan), visited us from February 2014 until February 2015. His PhD supervisors are Atsuo Inomata and Kazutoshi Fujikawa. Locally, he was supervised by Jérémie Detrey and Pierrick Gaudry.

  During his stay here, he worked on implementing the elliptic curve factorization method (ECM) on the Kalray MPPA-256 manycore processor. A paper is currently in progress.
- Nadia Heninger, Assistant Professor at the University of Pennsylvania, visited us from June 22 to June 26.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

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 sruface 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.

9.2. National Initiatives

9.2.1. 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.

9.2.2. 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.

9.2.3. FUI Rodin

Title: Robust structural Optimization for Design in Industry (Rodin)

Type: FUI

Duration: July 2012 - July 2015

Coordinator: ALBERTELLI Marc (Renault)

Abstract: From the research point of view, the RODIN project will focus on: (1) extending level set methods to nonlinear mechanical or multiphysics models and to complex geometrical constraints, (2) developing algorithms for moving meshes with a possible change of topology, (3) adapting in a level-set framework second-order optimization algorithms having the ability of handling a large number of design variables and constraints.

The project will last 3 years and will be supported by a consortium of 7 partners: (1) 2 significant end-users, Renault and EADS, who will provide use-cases reflecting industrial complexity; (2) 3 academics partners, CMAP, J.-L. Lions laboratory and Inria of Bordeaux, who will bring expertise in applied mathematics, structural optimization and mesh deformation; (3) A software editor, ESI Group, who will provide mechanical software package and will pave the way of an industrialization; (4) A SME, Eurodecision, specialized in large-scale optimization.

9.2.4. 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 oxidization. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. STORM

Type: COOPERATION

Defi: NC

Instrument: Specific Targeted Research Project

Objectif: NC

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.

9.3.2. 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.

9.4. International Initiatives

9.4.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

9.4.1.1. 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.

9.4.1.2. 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.

9.4.1.3. 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

University of Nottingham, Department of Mathematics : Dr. M.E. Hubbard. Collaboration on high order schemes for time dependent shallow water flows

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 ;

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

From april 2015 (up to april 2016), Tatsuya Watanabe (Department of Mathematics, Faculty of Science, Kyoto Sangyo University Motoyama,Kamigamo,Kita-Ku,Kyoto-City 603-8555,Japan) comes to visit Mathieu Colin. During his stay, T. Watanabe is funded by a JSPS-grant.
From 09/04/2015 to 24/04/2015 F. Morency () has visited us to work with H. Beaugendre on the construction of penalization methods for the analysis of de-anti icing systems.
From 01/06/2015 to 08/06/2015, T. Magin (von Karman Institute for Fluid Dynamics) has visited us to work with P.M. Congedo on the robust analysis of Reentry flows.
From 01/07/2015 to 28/07/2015 Prof. A. Kurganov (Tulane University, New Orleans) has visited us to work with M. Ricchiuto on semi-implicit time integration methods and adaptive mesh deformation techniques.

9.5.2. *Visits to International Teams*

In May 2015, P.M. Congedo visited the Uncertainty Quantification Laboratory in Stanford University. Andrea Cortesi visited NASA-Ames (California) in November-December 2015.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. IHU LIRYC

Our work is partially funded by the LIRYC project (ANR 10-IAHU 04).

- For 2015: the salary of M. Potse, member of Carmen, is paid by LIRYC..
- For 2012-2015: 1/2 PhD thesis associated to the project *Modélisation pour les données multimodales* (see section Regional Initiaves).

8.1.2. ANR HR-CEM

In 2014, we are supported for the project "High Resolution Cardiac Electrophysiology Models: HR-CEM" within the call for project « Modèles Numériques » of the ANR.

The scientific start of the project was on November 4th, 2013.

It is an international project that involves three partners: Inria (coordinator), IHU LIRYC, and UMI-CRM at Montréal (Canada). The project has some 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.

8.1.3. AMIES – Medic Activ

We were granted by the Agency AMIES a financial support to complete the one obtained from the Région Aquitaine for the Medic Activ project (see above). The objective of this support is to developp reduced order models of cardiac electrophysiology that might enter the MedicActiv framework. The difficulty is to define qualitatively realistic but fast numerical simulations of the ECG and cardiac function, for educational purpose.

8.1.4. ANR Labcom CardioXcomp

We are participant in the ANR Labcom project between Inria and the society Notocord (www.notocord.com). At Inria, the proejct is leaded by J.-F. Gerbeau from the Reo team and we participate to the study and developpment of cardiac electrophysiology models suited to the context of the proejct.

The aim of CarioXcomp is to code human induced pluripotent cardiomyocyte cells and drug/hiPS-CMs interaction. N. Zemzemi works on this project with E. Abbate (PhD thesis until october 2015) for th coupling between human induced pluripotent cardiomyocyte cells and the measurement tool multi-electrode array (MEA). In this project, some different tests on drug models and selection of the most suitable for the hiPS-CMs. In the same time, N. Zemzemi with collaborators N. Fikal, R. Aboulaich and EL.M. El Guarmah worked on the quantification of the effect of uncertainty in the conductivity values on the Electrocardiography imaging (ECGI) inverse solution. N. Zemzemi and J. Lassoued C. Corrado and M. Mahjoub worked on the stability analyssis of the reduced order model for the bidomain equation using proper orthogonal decomposition and on the estimation of the location of cardiac isquemia in a 3D geometry with inverse problem tools with C. Chavez F. Alonso-Atienz, D. Alvarez and Y. Coudière.

8.1.5. REO

The CARMEN team is a partner with the REO team at Inria Paris Rocquencourt and the NOTOCORD company in the CardioXcomp project.

8.1.6. MedicActiv

The CARMEN team cooperates in interaction with the MedicActiV project.

8.1.7. GENCI

GENCI – grand équipement national de calcul intensif – is the agency that grants access to 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 [37].

8.2. International Initiatives

8.2.1. Inria International Labs

LIRIMA: Associate Team involved in the International Lab:

8.2.1.1. EPICARD (https://team.inria.fr/carmen/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 in Bordeaux headed by Professor Michel Haissaguerre. We would like to non-invasively construct the electrical potential on the heart surface only from measurements of the electrical potential on the the chest of the patient. This helps the medical doctor to visualise an image of the electrical potential of the heart of the patient. It is known 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 works in the literature have been carried * out in order to solve this Cauchy problem, but have never been used for solving the ECGI problem. Our goal from the associate team is to develop an experimental platform allowing to test various methods and compare their performance on real life experimental data.

8.2.2. Inria International Partners

8.2.2.1. Informal International Partners

Applied work on atrial fibrillation is performed in collaboration with the experimental and clinical groups of professors U. Schotten and H. Crijns at Maastricht University [36].

M. Potse collaborates on several projects with the Institute of Computational Science at the *Università della Svizzera italiana* in Lugano, Switzerland, and the Department of electronics, informatics, and bioengineering of the *Politecnico di Milano*, Milan, Italy.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

8.3.1.1. Internships

- B. Mostafa
    - The Faculty of Mathematics and Natural Sciences, University of Oslo, Norway
    - Johann Radon Institute for Computational and Applied Mathematics (RICAM) Austrian Academy of Sciences, Linz, Austria.
    - CI^{2}MA y Departamento de Ingenieria Matemática, Universidad de Concepcion, Concepcion, Chile.
    - Departamento de Matemática Aplicada e Estatistica, Instituto de Ciências Matemáticas e de Computação – USP, São Carlos, Brazil

CARTE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Simon Perdrix is the principal investigator of the project "measurement-based quantum computing" funded by Région Lorraine and Université de Lorraine.

8.2. National Initiatives

8.2.1. 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.
- The team is a funding partner in ANR Binsec (2013-2017), whose aim is to fill part of the gap between formal methods over executable code, and binary-level security analyses currently used in the security industry. Two main applicative domains are targeted: vulnerability analysis and virus detection. Two other closely related applications will also be investigated: crash analysis and program deobfuscation.

8.3. International Initiatives

8.3.1. Inria Associate Teams not involved in an Inria International Labs

- Submission of an Inria associate team proposal ACRA (Applications of Complexity to Resource Analysis) in collaboration with Computer Science and Engineering department, State University New York, Buffalo. The french principal investigator is Romain Péchoux, the US principal investigator is Marco Gaboardi.

8.3.2. 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 study topics such as parallelism, probabilistic systems, isomorphisms, etc. 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Walid Gomaa, associate professor at Alexandria E-Just University, was invited during two months (April and November) in the team.
- Daniel Leivant, professor at Indiana University in Bloomington, was invited in June and July.
- Mizuhito Ogawa was invited in the group to discuss about models of self-modifying code based on pushdown automata. He came back in October for further collaboration.

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

7. Partnerships and Cooperations

7.1. National Initiatives with Industrials

7.1.1. PRINCE

Title: Proven Resilience against Information leakage in Cryptographic Engineering

Program: ANR ARPEGE

Duration: December 2010 – May 2015

Coordinator: Tranef

Partners:

- ENS
- UVSQ
- Oberthur Technologies
- Ingenico
- Gemalto
- Tranef

Local coordinator: Michel Abdalla

We aim to undertake research in the field of leakage-resilient cryptography with a practical point of view. Our goal is to design efficient leakage-resilient cryptographic algorithms and invent new countermeasures for non-leakage-resilient cryptographic standards. These outcomes shall realize a provable level of security against side-channel attacks and come with a formally verified implementation. For this every practical aspect of the secure implementation of cryptographic schemes must be taken into account, ranging from the high-level security protocols to the cryptographic algorithms and from these algorithms to their implementation on specific devices which hardware design may feature different leakage models.

7.1.2. 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.

7.1.3. CryptoComp

Program: FUI

Duration: October 2014 – September 2017

Coordinator: CryptoExperts

Partners:

> CEA
>
> CNRS
>
> Kalray
>
> Inria
>
> Dictao
>
> Université de Limoges
>
> VIACESS
>
> Bertin technologies
>
> GEMALTO

Local coordinator: Vadim Lyubashevsky (until July 2015) and David Pointcheval (from August 2015)

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:

> 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. CLE

Title: Cryptography from Learning with Errors

Program: ANR JCJC

Duration: October 2013 – December 2015

PI: Vadim Lyubashevsky

Partners:

> UVSQ
>
> Univ. Paris 8

Inria/SECRET

The main objective of this project is to explore the potential practical implications of the Learning with Errors problem and its variants. The plan is to focus on the constructions of essential primitives whose use is prevalent in the real world. Toward the end of the project, the hope is to propose and standardize several public key and symmetric key schemes that have specific advantages over ones that are currently deployed.

7.2.3. 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.

7.3. European Initiatives

7.3.1. CryptoAction

Title: Cryptography for Secure Digital Interaction

Program: H2020 ICT COST

Duration: April 2014 – April 2018

Local coordinator: Vadim Lyubashevsky (until July 2015) and Michel Abdalla (from August 2015)

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)

Local coordinator: Vadim Lyubashevsky (until July 2015) and Michel Abdalla (from August 2015)

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. Other Grants

- **Google: Google Research Award.**
  Participant: Hoeteck Wee.

  On the security of TLS. The goal of this project is to initiate a formal cryptographic treatment of new mechanisms and proposals for reducing the latency in the TLS Handshake Protocol and to enhance our cryptographic understanding of the TLS Handshake Protocol.

7.5. International Research Visitors

- Dennis Hofheinz (KIT, Germany)
- Melissa Chase (MSR Redmond)
- Mariana Raykova (Yale University)
- Phil Rogaway (UC Davis)
- Alexandra Boldyreva (Georgia Tech)

CASSIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR SEQUOIA *Security properties, process equivalences and automated verification*, duration: 4 years, starting in 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.

9.1.2. 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, it is a question 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 Cassis (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. This long-term project aims at developing 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, we foresee three main tasks. First, we plan to 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 will consider the cryptographic part of the primitives that are used in such protocols (encryption, signatures, ...), obtaining higher security guarantees. Third, we aim at proposing 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.

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[0]http://www.loria.fr/~cortier/ProSecure.html
[0]http://www.loria.fr/~skremer/spooc/index.html

Steve Kremer is the leader of the project.

9.3. International Initiatives

9.3.1. Inria International Partners

- 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 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

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

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). Elms are disruptive instabilities occurring in the edge region (SOL) of a tokamak plasma. The development of Elms poses a major challenge in magnetic fusion research with tokamaks, as these instabilities can damage plasma-facing components, particularly divertor plates. The mitigation or suppression of large Elms is a critical issue for successful operation of ITER. Goal for ANEMOS is to develop and improve numerical tools in order to simulate physical mechanisms of Elms and to qualify some strategies for their control. We then need to design efficient numerical strategies on the most advanced computers available to contribute to the science base underlying of proposed burning plasma tokamak experiments such as ITER.

- LIVE-CAMS: Till September 30 th 2015, R. Pasquetti was involved in the ANR project LIVE-CAMS.

- MEDIMAX: In 2015 R. Pasquetti and F. Rappeti were involved in in the ANR project MEDIMAX.

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

The current rate of fossil fuel usage and its serious adverse environmental impacts (pollution, greenhouse gas emissions, ...) leads to an energy crisis accompanied by potentially disastrous global climate changes. The research of alternative energy sources is thus of crucial importance. Controlled fusion is one of the most promising alternatives to the use of fossil resources, potentially with a unlimited source of fuel. Controlled nuclear fusion can be considered as an example of grand challenge in many fields of computational sciences from physical modeling, 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 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 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

- EUROfusion Grant agreement number 633053. Enabling Research program.
    - CfP-WP14-ER-01/CEA-01; JOREK, BOUT++ non-linear MHD modelling of MHD in-stabilities and their control in existing tokamaks and ITER (PI: Matthias Hoelzl, IPP)
    - CfP-WP14-ER-01; Synergetic numerical-experimental approach to fundamental aspects of turbulent transport in the tokamak edge (PI: Paolo Ricci, École Polytechnique Fédérale de Lausanne).
- EUROfusion WPCD (Working Package Code Development)
    - ACT1: Extended equilibrium and stability chain (participation)
    - ACT2: Free boundary equilibrium and control (participation and coordination)
- The team also participates in the EoCoE European project. Grant Agreement number: 676629 — EoCoE — H2020-EINFRA-2014-2015/H2020-EINFRA-2015-1.

6.3. International Initiatives

6.3.1. Inria Associate Teams not involved in an Inria International Labs

6.3.1.1. AMOSS

Title: Advanced Modeling 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 modeling 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.

6.3.1.2. 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.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

- D. Balsara of the Notre Dame University (USA), as invited professor for one month at the university of Nice (June/July 2015).
- Key-Ming Shyue of the National Taiwan University, as invited professor for one month at the university of Marseille (September 2015)
- Chih-Yu Kuo, Associate Research Fellow, Research Center for Applied Sciences, Academia Sinica, Taipei, Taiwan, and Yih-Chin Tai, Professor, National Cheng Kung University, Tainan, Taiwan. Visit at Inria Sophia in July 2015.

6.4.1.1. Internships

- J. Llobell, March-June 2015, T. Goudon, S. Minjeaud, M. Ribot.
- L. Drescher, TU Berlin, September-October 2015, H. Heumann
- P. Wang, June-September 2015, J. Blum, C.Boulbe

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

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *The ANR VERASCO project*

Participants: Sandrine Blazy, Delphine Demange, Vincent Laporte, David Pichardie.

Static program analysis, Certified static analysis

The VERASCO project (2012–2015) 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.

7.1.2. *The ANR AnaStaSec project*

Participants: Frédéric Besson, Sandrine Blazy, Thomas Jensen.

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.

7.1.3. *The ANR Binsec project*

Participants: Frédéric Besson, Sandrine Blazy, Pierre Wilke.

Binary code, Static program analysis

The Binsec project (2013–2017) is founded 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.

7.1.4. *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 (Estasys and Celtique), Inria Saclay (MAXPLUS) and VISEO/Object Direct.

7.1.5. *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.

7.1.6. *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.

7.1.7. *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.

7.2. International Initiatives

7.2.1. *Inria Associate Teams not involved in an Inria International Labs*

7.2.1.1. *JCERT*

Title: Verified Compilation of Concurrent Managed Languages

International Partner (Institution - Laboratory - Researcher):

Purdue University (United States) - Suresh Jagannathan

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#.

7.2.2. Inria International Partners

7.2.2.1. Declared Inria International Partners

Professor Philippa Gardner, Imperial College, UK, since December 2015.

7.2.2.2. Informal International Partners

Alan Schmitt is part of a Polonium Hubert Curien Partnership (PHC) with the University of Wrocław. This partnership is lead by Sergueï Lenglet, from Loria, Nancy, France.

7.3. International Research Visitors

7.3.1. Visits to International Teams

7.3.1.1. Sabbatical programme

Jensen Thomas

Date: Sep 2014 - Aug 2015

Institution: University of Copenhagen (Denmark)

7.3.1.2. Research stays abroad

Martin Bodin visited the Department of Computing at Imperial College London for three months.

Chroma Team

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".

9.2. 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, [42]) 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 7.1.1 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 will start on february 2016 and will be codirected 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 in European Programs, except FP7 & H2020

Program: PHC (Barande) French-Czech bilateral project

Project acronym: MUROTEX

Project title: Multi-Agent Coordination in Robotic Exploration and Reconnaissance Missions

Duration: Jan. 2014 - Dec. 2015

Coordinator: O. Simonin & J. Faigl (Prague Univ.)

Other partners: CTU (Czech Republic), Inria Larsen team.

Abstract: The main objective of the project is to develop a distributed planning framework for efficient task-allocation planning in exploration and reconnaissance missions by a group of mobile robots operating in an unknown environment with considering communication constraints and uncertainty in localization of the individual team members. One main challenge is to decentralize the decision, in order to scaling up with large fleet of robots (existing solutions are centralized or depend on full communication).

9.3.3. 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).
- Czech Technical University CTU in Prague (Czech Republic)

Subject: Distributed algoritms for multi-robot cooperation (PHC "Murotex" 2013-15 and renewal).

- 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.

- SAMPEN
  Title: self adaptive mobile perception and navigation
  International Partner (Institution - Laboratory - Researcher):
      NTU (TAIWAN)
  Duration: 2014 - 2016
  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.

9.4.1.1. 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.

9.4.2. 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 style="text-align:center">**CIDRE Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **Région Bretagne ARED grant:** the PhD of Regina Marin on privacy protection in distributed social networks (defended in Sep 2015) was supported by a grant from the Région Bretagne.

- **Labex COMINLAB contract (2012-2015): "POSEIDON" -** http://www.poseidon.cominlabs.ueb.eu/fr/

  POSEIDON deals with the protection of data in outsourced or shared systems such as cloud computing and peer-to-peer networks. While these approaches are very promising solutions to outsourced storage space, contents, data and services, they also raise serious security and privacy issues since users lose their sovereignty on their own data, services and systems. Instead of trying to prevent the bad effects of the cloud and of peer-to-peer systems, the main objective of the POSEIDON project is to turn benefit from their main characteristics (distribution, decentralization, multiple authorities, etc.) to improve the security and the privacy of the users' data, contents and services.

  This project is conducted in cooperation with Télécom Bretagne and Université de Rennes I. The PhD of Julien Lolive (co-supervised by Sébastien Gambs and Caroline Fontaine), which deals with the entwining of identification and privacy mechanisms, is funded by the POSEIDON project. The postdoctoral research of Wei Pan (co-supervised by Gouenou Coatrieux and Nicolas Prigent) that deals with a distributed system to ensure patients' privacy in the context of medical imaging is also funded by this project.

  POSEIDON will be over at the end of this year. It has received very positive feedback during the COMINLAB review meeting.

- **Labex COMINLAB contract (2012-2015): "SecCloud" -** http://www.seccloud.cominlabs.ueb.eu

  Nowadays attacks targeting the end-user and especially its web browser constitute a major threat. Indeed web browsers complexity has been continuously increasing leading to a very large attack surface. Among all possible threats, we tackle in the context of the SecCloud project those induced by client-side code execution (for example javascript, flash or HTML5).

  Existing security mechanisms such as OS-level access control often only rely on users identity to enforce the security policy. Such mechanisms are not sufficient to prevent client-side browser attacks as the web browser is granted the same privileges as the user. Consequently, a malicious code can perform every actions that are allowed to the user. For instance, it can read and leak user private data (credit cart numbers, registered passwords, email contacts, etc.) or download and install malware.

  One possible approach to deal with such threats 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 information flow rules between user data and distant web sites.

  Dynamically monitoring information flow at the web browser level may dramatically impact runtime performances of executed codes. Consequently, an important aspect of this work will be to benefit as far as possible from static analysis of application code. This static-dynamic hydride approach should reduce the number of verifications performed at run time.

  This study is 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 programming 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 challenge, intuitive data structures for plug programming, arises from the need by programmers for intuitive 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 INS Project: AMORES (2011-2015) - http://amores-project.org/**

  Situated in the mobiquitous context characterized by a high mobility of individuals, most of them wearing devices capable of geolocation (smartphones or GPS-equipped cars), the AMORES project is built around three use-cases related to mobility, namely (1) dynamic carpooling, (2) real-time computation of multi-modal transportation itineraries and (3) mobile social networking. For these three use cases, the main objective of the AMORES project is to define and develop geo-communication primitives at the middleware level that can offer the required geo-located services, while at the same time preserving the privacy of users, in particular with respect to their location (notion of geo-privacy). Within this context, we study in particular the problem of anonymous routing and the design of a key generation protocol tied to a particular geographical location. Each of these services can only work through cooperation of the different entities composing the mobile network. Therefore, we also work on the development of mechanisms encouraging entities to cooperate together in a privacy-preserving manner. The envisioned approach consists in the definition of generic primitives such as the management of trust and the incentive to cooperation. This project is joint between the Université de Rennes I, Supélec, LAAS-CNRS, Mobigis and Tisséo. The research project AMORES received the Innovation Award at the Toulouse Space Show in June 2013. Simon Boche and Paul Lajoie-Mazenc are doing their PhD in the context of this project. Paul has defended successfully his thesis in September [13] just after the final closing workshop of the project (http://www.irisa.fr/prive/sgambs/journee_AMORES.html).

- **ANR INS Project: LYRICS (2011-2015) - http://projet.lyrics.orange-labs.fr/**

  With the fast emergence of the contactless technology such as NFC, mobile phones will soon be able to play the role of e-tickets, credit cards, transit pass, loyalty cards, access control badges, e-voting tokens, e-cash wallets, etc. In such a context, protecting the privacy of an individual becomes a particularly challenging task, especially when this individual is engaged during her daily life in contactless services that may be associated with his identity. If an unauthorized entity is technically able to follow all the digital traces left behind during these interactions then that third party could efficiently build a complete profile of this individual, thus causing a privacy breach. Most importantly, this entity can freely use this information for some undesired or fraudulent purposes ranging from targeted spam to identity theft. The objective of LYRICS (ANR INS 2011) is to enable end users to securely access and operate contactless services in a privacy-preserving manner that is, without having to disclose their identity or any other unnecessary information related to personal data. Within this project, we work mainly on the privacy analysis of the risks incurred by users of mobile contactless services as well as on the development of the architecture enabling the development of privacy-preserving mobile contactless services. The project is joint between France Télécom, Atos Wordline, CryptoExperts, ENSI Bourges, ENSI Caen, MoDyCo, Oberthur Technologies, NEC Corporation, Microsoft and Université de Rennes I.

  The project was originally suppose to end in 2014 but an extension was granted until May 2015. The final closing workshop of the project was held during this month (http://www.irisa.fr/prive/sgambs/journees_LYRICS.html). The project has finished to develop a first prototype that illustrates how can be used privacy preserving protocols for the transport use case. The prototype implements a transportation pass (similar to the Navigo pass) embedded in the SIM card. This transport pass can be interact with a gate at the entrance of the transportation network in order to check the validity of the pass and answers wirelessly, in less than 300ms, without revealing any information about the user. This result has been presented in "Salon Cartes 2012". During the last year of the project, the partners of the LYRICS projects have also worked on two new use cases and their corresponding prototypes: digital surveys and e-cash solutions that respect the privacy of users. The outcomes of the project have been presented at the RESSI conference [49].

- **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. For instance at the end of November, Sébastien Gambs was co-organizer with Daniel Le Métayer of a joint French-Canadian workshop titled "La vie privée à travers les cultures. Convergences et divergences dans un monde globalisé" (http://www.centrejacquescartier.com/les-entretiens/entretiens-2015lescolloques/3-la-vie-privee-a-travers-les-cultures-convergences-et-divergences-dans-un-monde-globalise/) that had approximately 80 attendees coming either from a law or computer science background.

9.2.3. Competitivity Clusters

The AMORES project (ANR INS 2011, http://www.images-et-reseaux.com/en/content/amores) is recognized by the Images & Réseaux cluster.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The **PANOPTESEC** project (http://www.panoptesec.eu) started on the 1st of November 2013. 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),
- Alcatel-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. Most of our work focused on WP5 and WP6, that deal with the IDS event correlation system and the visualization system. Two prototypes have been produced and a publication was made to VizSec 2015. Next year, we will be entering in the integration phase.

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 2015, one in DEBS [44] and the other one in SRDS [29]. Emmanuelle Anceaume is actively working with James Aspens from Yale University, USA, on population protocols. Their collaboration gave rise to one article published in NCA [43]. Emmanuelle Anceaume is actively working with Ernst Schulte-Geers from the Federal Office for Information Security, Germany. Their collaboration gave rise to one publication in the Journal of Applied Probability [15].

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 [42].

Following the Inria explorer visit of last year, Sébastien Gambs is actively working with Stan Matwin from Dalhousie University (Canada) on the sanitization of location data through non-interactive differentially-private methods, which has lead to a first publication on this subject [26].

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

> Sackmann Mario Julián
>
> > Date: Sep 2014 - Jan 2015
> >
> > Institution: Universidad de Buenos Aires (Argentina)
> >
> > Supervisor: Guillaume Piolle

9.5.2. Visits to International Teams

9.5.2.1. Research stays abroad

Thanks to the support of CentraleSupélec, Christophe Bidan has joined the ETS (École Supérieure de Technologie) of Montréal from july 2014 to july 2015 for working with Prof. Jean-Marc Robert. This stay results from a collaboration that has been initiated 2 years ago when Prof. Jean-Marc Robert has spent 4 months (from september to december 2012) in the CIDRE research group. The conducted research has focused on the use of secure multi-party computation to ensure privacy. Specifically, under the co-supervision of Aurélien Dupin, master student at ETS, we focused on the use of secure multi-party computation to provide proof of localization while ensuring privacy of the participants. An article is being written, and a co-supervised thesis should begin shortly.

From September 2014 to May 2015, Antoine Guellier has joined the "Securing Cyberspace" team leaded by Prof. Batten, at Deakin University (Melbourne, Australia). This stay is possible thanks to the international outgoing fellowships of Rennes Métropole and of the UEB (Université Européenne de Bretagne). This doctoral mobility was the opportunity to start a collaboration with personnel from Deakin University, as well as Radboud University (The Netherlands). Research outputs include a paper submitted to the SPT-IOT workshop (IEEE PERCOM venue). Additionally, by participating in the life of the laboratory and in several academic and information security events based in Melbourne, Antoine Guellier was able to build a network abroad. Through discussion and interactions, he was able to confront the contributions in his thesis with people of different horizons, and start new ones.

In March 2015, Deepak Subramanian has joined, as a Visiting Scholar, the "Faculty of Engineering Science" at KU Leuven in Belgian. During this stay, Deepak Subramanian worked on the topic of WebRTC security analysis with Prof. Frank Piessens, Willem De Greof, and Dr. Lieven Desmet. The objectives was to perform a practical analysis of the current WebRTC framework with the motivation of identifying the various shortcomings. The initial results showed that WebRTC is quite robust and built on strong foundations (based on legacy protocols that also form the foundations of the SIP telephony stack). However, the study also showed that some key modules were made optional in the draft and the implementations are quite ambiguous presently. These results were resumed in a paper that has been submitted and accepted to the ACM SEC@SAC 2016.

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

8. Partnerships and Cooperations

8.1. 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 will be generated using a dynamic traffic assignment model. Ensembles of traffic assignments will be 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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Program: e-Infrastructures

Project acronym: EoCoE

Project title: Energy oriented Centre of Excellence for computer applications

Duration: 3 years

Coordinator: CEA (Commissariat à l'énergie atomique et aux énergies alternatives)

Other partners: Forschungzentrum Jülich GMBH and 11 other partners. Inria is third-linked party of CEA.

Abstract: the aim of the project 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.

8.2.2. Collaborations with Major European Organizations

Partner: ERCIM working group "Environmental Modeling".

The working group gathers laboratories of ERCIM working on developing models, processing environmental data or data assimilation.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Partner: Marine Hydrophysical Institute, Sevastopol.

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.

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

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. FSN OpenPaaS (2012–2015)

Participants: Olivier Perrin [contact], Ahmed Bouchami.

Partners: SAMOVAR team (Telecom SudParis), COAST project-team (Université de Lorraine, LORIA), ARMINES (Ecole des Mines d'Albi), Brake France, Linagora.

Website: http://www.open-paas.org/

The OpenPaaS project aims at developing a PaaS (Platform as a Service) technology dedicated to enterprise collaborative applications deployed on hybrid clouds (private/public). OpenPaaS is a platform that allows to design and deploy applications based on proven technologies provided by partners such as collaborative messaging systems, integration and workflow technologies that will be extended in order to address Cloud Computing requirements. Available as an open-source Enterprise Social Network, the OpenPaaS project innovates both at the collaborative level and by its capacity to leverage heterogeneous cloud technologies at the IaaS level (Infrastructure as a Service). This project is funded under the French FSN umbrella (Fond National pour la société Numérique).

7.1.2. OpenPaas NG (2015–2018)

Participants: Claudia-Lavinia Ignat, François Charoy [contact], Gérald Oster, Olivier Perrin.

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 Enterprise Social Network concept 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.

7.1.3. Inria ADT PLM (2014-2016)

Participants: Gérald Oster [contact], Matthieu Nicolas.

Partners: COAST project-team, VERIDIS 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.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. 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 its consistency is relatively simple in a centralised cloud, but no longer possible due to increased scalability requirements. Instead, data must replicated across several distributed data centres, requiring new principled approaches to consistency that will be explored by the SyncFree project. http://syncfree.lip6.fr/

7.3. International Initiatives

7.3.1. *Inria Associate Teams not involved in an Inria International Labs*

7.3.1.1. USCOAST

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

Wright State University (USA) - Department of Psychology - Valerie Shalin

Start year: 2013

See also: http://uscoast.loria.fr

USCoast has as main objective the validation of trustworthy collaborative systems using experimental user studies. This type of validation requires the expertise of both computer scientists that designed the systems and social scientists for conceptualizing and measuring human behaviour in collaborative work. The project focuses on the real-time requirements and trust policies in collaborative editing, resulting in a theory for the effect of real-time constraints in collaborative editing and awareness management for the coordination of work in the presence of conflict and disruption. The project also proposes light security mechanisms for decentralised collaboration, based on measures of voluntary compliance with data sharing restrictions. New methods will be developed for the cost-effective evaluation of collaborative work to compensate for otherwise unrealistic sample sizes and costly engineering, using game theory to inspire task analogues and simulated users along with human users.

7.4. International Research Visitors

7.4.1. *Visits of International Scientists*

Valerie Shalin

Date: October 10, 2015 - November 5, 2015

Institution: Wright State University (USA)

Valerie Shalin worked on the validation of trust-based collaboration, specifically on the design and analysis of the experiments with users on the trust game.

7.4.2. Visits to International Teams

7.4.2.1. Research stays abroad

François Charoy spend 7 weeks at Wright State University, OH, in the Knoesis Team lead by Prof. Amit Sheth as part of the USCOAST associated team.

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

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: Algorithm for large and Dynamic Networks

Inria principal investigator: Nicolas Nisse

International Partner (Institution - Laboratory - Researcher):

Universidad Adolfo Ibañez, Santiago, Chile
Facultad de Ingeniería y Ciencias
Karol Suchan

Duration: 2013 - 2015

See also: https://team.inria.fr/coati/projects/aldynet/

The main goal of this Associate Team is to study the structure of networks (modeled by graphs) to design both efficient distributed algorithms and reliable network topologies suitable to applications. We are interested both in large-scale (Facebook, Internet, etc.) and in smaller networks (e.g., WDM) that handle heavy traffic. More precisely, we aim at designing new techniques of distributed and localized computing to test structural properties of networks and to compute structures (e.g., decompositions) to be used in applications. Concerning the applications, we will first focus on routing and subgraph packing problems.

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

Action ECOS-SUD: ALgorithmes Distribués pour le calcul de la structure des réseaux, with Chile, 2013-2015.

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

Jorgen Bang Jensen : Jan 31 - June 13, Univ. of Southern Denmark

Sylvain Leguay : Feb 2 - March 27, Univ. Paris XI, LRI, Orsay, France

Mauricio Abel Soto Gomez : Feb 23 - March 20, Univ. Adolfo Ibáñez, Santiago, Chile

Takako Kodate : March 23 - Apr 4, Tokyo Woman's Christian Univ., Japan

Min-Li (Joseph) Yu : March 3 - Apr 8, Univ. of the Fraser valley, Abbotsford, (BC), Canada

Medji Kaddour : May 4 - 15, Univ. d'Oran, Algérie

Nicolas De Almeida Martins : May 20 - July 30, Univ. Federal do Ceará, Fortaleza, Brazil

Samuel Nascimiento de Araujo : June - July, Univ. Federal do Ceará, Fortaleza, Brazil

Esteban H. Roman Catafau : Oct 1 - 10, Univ. Adolfo Ibáñez, Santiago, Chile

Arunabha Sen : Oct 12 - 17, Arizona State Univ., USA

Fabricio Benevides : Oct 19 - 31, Univ. Federal do Ceará, Fortaleza, Brazil

Victor Campos : Oct 19 - 31, Univ. Federal do Ceará, Fortaleza, Brazil

Eduardo Moreno : Nov 1 - 7, Univ. Adolfo Ibáñez, Santiago, Chile

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

David Coudert

Univ. Adolfo Ibañez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AlDyNet, April 3-19 and November 21-December 5, 2015;

Department of Information Engineering at University of Florence, Italy, June 23-30, 2015;

Department of Informatics and Telecommunications of the National and Kapodistrian University of Athens, Greece, September 7-11, 2015.

Guillaume Ducoffe

Univ. Adolfo Ibañez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AlDyNet, November 21-December 6, 2015.

Frédéric Giroire

Univ. Adolfo Ibañez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AlDyNet, November 13-29, 2015.

Frédéric Havet

Univ. Federal do Ceará, Fortaleza, Brazil, May 5-10, 2015;

Univ. Orléans - LIFO, July 6-10 2015.

Nicolas Nisse

Univ. Federal do Ceará, Fortaleza, Brazil, May 4-17, 2015;

Univ. Aix-Marseille, June 29-July 2015;

Univ. Adolfo Ibañez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AlDyNet, November 13-29, 2015.

<p align="center">**COFFEE Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

The ANR-project Monumentalg, led by M. Ribot, is devoted to the modeling and simulation of biological damage on monuments and algae proliferation.

7.1.2. National and European networks

- GdR MoMas.

  The research group MoMaS (Mathematical Modeling and Numerical Simulation for Nuclear Waste Management Problems) 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".

7.2. Regional Initiatives

The team is involved in the recently granted project UCA-JEDI.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. 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.

7.3.1.2. 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.

7.4. International Research Visitors

7.4.1. *Visits of International Scientists*

Kazuo Aoki, Satushi Taguchi, Takeru Yano, Shingo Kosuge from Kyoto and Osaka University.

7.4.1.1. *Internships*

Luis Urrutia from Granada

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Large-scale initiatives

Project acronym: CAPPRIS

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

Duration: September 2013 - September 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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. MEALS

Program: FP7-PEOPLE-2011-IRSES

Project acronym: MEALS

Project title: Mobility between Europe and Argentina applying Logic to Systems

Duration: October 2011 - September 2015

URL: http://www.meals-project.eu/

Coordinator: Holger Hermans, Saarland University, Germany

Coordinator for the Inria sites: Catuscia Palamidessi, Inria Saclay

Other partner institutions: Rheinisch-Westfälische Technische Hochschule Aachen, Germany. Technische Universität Dresden, Germany. Inria, France. Imperial College of Science, Technology and Medicine, UK, University of Leicester, UK. Technische Universiteit Eindhoven, NL. Universidad Nacional de Cordoba, AR. Universidad de Buenos Aires, AR. Instituto Tecnologico de Buenos Aires, AR. Universidad Nacional de Rio Cuarto, AR.

Abstract: In this project we focus on three aspects of formal methods: specification, verification, and synthesis. We consider the study of both qualitative behavior and quantitative behavior (extended with probabilistic information). We aim to study formal methods in all their aspects: foundations (their mathematical and logical basis), algorithmic advances (the conceptual basis for software tool support) and practical considerations (tool construction and case studies).

8.3. International Initiatives

8.3.1. Inria-MSR joint lab

8.3.1.1. 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.

8.3.2. Inria Associate Teams

8.3.2.1. PRINCESS

Title: Protecting privacy while preserving data access

Inria principal investigator: Catuscia Palamidessi

International Partners:

Geoffrey Smith, Florida International University (United States)

Carroll Morgan, NICTA (Australia)

Annabelle McIver, Maquarie University (Australia)

Duration: 2013 - 2015

URL: http://www.lix.polytechnique.fr/comete/Projects/Princess/

Abstract: PRINCESS is an Inria associated team focusing on the protection of privacy and confidential information. In particular, we study the issues related to the leakage of confidential information through public observables.

We aim at developing a meaningful notion of measure in order to quantify the leakage of information, and to design mechanisms to limit the amount of leakage, without interfering too severely with the utility of the information that is meant to be disclosed.

The main topics currently investigated are quantitative information flow, where we are developing a decision-theoretic approach, and differential privacy, where we are developing an extension which lifts the basic notion of privacy meant for databases to arbitrary domains.

8.3.3. Inria International Partners

8.3.3.1. Informal International Partners

Moreno Falaschi, Professor, University of Siena, Italy

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

Charles Carroll Morgan, Professor, University of New South Wales, Australia

Daniel Gebler, PhD student at the Free University of Amsterdam, The Netherlands

Camilo Rueda, Professor, Universidad Javeriana Cali, Colombia

8.3.4. Participation In other International Programs

8.3.4.1. 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. 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.

8.3.4.2. 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.

8.3.4.3. 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Santiago Quintero, Undergraduate Student, Universidad Javeriana Cali, Colombia, Nov 2015 to Dec 2015

Camilo Rueda, Professor, Universidad Javeriana Cali, Colombia, Nov 2015 to Dec 2015

Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil, Dec 2015

Annabelle McIver, Associate Professor, Macquarie University, Australia, Dec 2015

Carroll Morgan, Professor, University of New South Wales and NICTA, Australia, Dec 2015

Geoffrey Smith, Professor, Florida International University, USA, Dec 2014

8.4.2. Visits to International Teams

Frank Valencia visited the team of Camilo Rueda (AVISPA) at Pontifical Universidad Javeriana Cali, from Feb 2015 until Feb 2015

Frank Valencia visited the team of Camilo Rueda (AVISPA) at Pontifical Universidad Javeriana Cali, from July 2015 until July 2015

COMMANDS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Axel Kröner, Frederic Bonnans: "Optimal control of partial differential equations using parameterizing manifolds, model reduction, and dynamic programming". Foundation Mathematique Jacques Hadamard/PGMO

9.2. International Initiatives

9.2.1. Inria International Labs

Participation to the Inria Chile laboratory.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

9.3.1.1. Internships

- Justina Jianatti (PhD student, U. Rosario, Argentina). Numerical algorithms for stochastic control problems. Supervised by F. Bonnans.
- Mandy Huo (now PhD at Caltech, USA): International internship of École Polytechnique on aspects of optimal control of bilinear equation. Supervised by A. Kroener.

9.3.2. Visits to International Teams

9.3.2.1. Explorer programme

Kröner Axel

Date: Jul 2015 - Aug 2015

Institution: University of California, Los Angeles (United States)

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *In Relation with the LYONCALCUL Initiative*

Compsys follows or participates 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 organized in 2013 a thematic quarter on compilation (http://labexcompilation.ens-lyon.fr). A new thematic quarter on high performance computing (HPC) is in preparation for 2016, initiated by Violaine Louvet (Institute Camille Jordan), with the participation of the LIP teams Aric, Avalon, Compsys, and Roma. It will include, in particular, an inter-disciplinary spring school, following the polyhedral school organized in 2013, connecting mathematics (HPC numerical analysis) and computer science (polyhedral optimizations for HPC).

Alain Darte, Alexandre Isoard, and Tomofumi Yuki have also regular 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.

9.1.2. *Collaboration with the Verimag lab*

Laure Gonnord, who did her PhD in abstract interpretation at Verimag, re-activated her connection with this group, in particular with N. Halbwachs and D. Monniaux. This led to several joint results, exposed in Sections 7.3 and 7.4 . The theme of termination through affine ranking functions was first brought to the attention of Compsys when studying loop transformations for HLS, in the context of the S2S4HLS project with STMicroelectronics. The techniques of Compsys [15] were then extended by Laure Gonnord with D. Monniaux. Conversely, the idea of using Handelman and Schweighofer's theorems to deal with polynomial constraints, as exploited in Section 7.11), was first suggested by D. Monniaux through discussions with Paul Feautrier and some visits at ENS-Lyon.

9.1.3. *"PEPS local" with the MMI*

Alain Darte and Laure Gonnord participated to the creation of EMI (Education, Musique et Informatique), an educative inter-disciplinary project ("PEPS de site", coordinated by Natacha Portier, from the MC2 team at LIP, and Yann Orlarey from the Grame laboratory) concerning an experience of musical programming with Faust (a functional audio stream language, with its compiler), in the context of the MMI (Maison des mathématiques et de l'informatique), a place for dissemination.

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 10th event has been organized in Sep. 2015). The community is animated by Laure Gonnord and Fabrice Rastello since 2010, and now also by Florian Brandner (ex-Compsys too). Alain Darte, Alexandre Isoard, and Tomofumi Yuki participated to the 10th edition, with talks on "Static Analysis of OpenStream Programs", "Liveness Analysis in the Polyhedral Model", and "PolyApps: Case Study of Polyhedral Compilers using Real Applications" respectively.

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 one-day lecture at the 2015 edition.

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 Section 8.1). The results of Sections 7.10 and 7.11 are related to this collaboration.

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 7.14 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) on several subjects connected to the analysis and transformations of X10 programs (see Section 7.8).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Compsys participated to a H2020 proposal (project Verde) on the convergence of compiler tools for hardware accelerators on one side (HLS tools) and programmable accelerators (multicores, GPUs) on the other side. But the project was not selected.

9.3.2. 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 9.4.2.2), 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. Inria Associate Teams not Involved in an Inria International Labs

Laure Gonnord and Maroua Maleej are involved in the PROSPIEL Associate Team (Inria/Brazil, https://team.inria.fr/alf/prospiel/), led by Sylvain Collange (Inria Alf), in a collaboration with Fernando Pereira's group in UFMG (Brazil). The PROSPIEL project aims at optimizing parallel applications for high performance on new throughput-oriented architectures: GPUs and many-core processors. Specifically, Laure Gonnord and Maroua Maalej are in charge of designing static analyses for GPUs. Maroua Maleej visited the group of Fernando Pereira in Aug. 2015.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

- Christophe Alias is co-adviser, with Sanjay Rajopadhye from Colorado State University (USA), of the PhD thesis of Guillaume Iooss. The results described in Section 7.6 are part of this collaboration.

- Tomofumi Yuki, who did his PhD with Sanjay Rajopadhye, then a post-doc in the Cairn team in Rennes, continues his collaboration with these two groups, as the results described in Section 7.14 illustrate. He participates regularly, over the net, to the reading group "Melange" of S. Rajodapdhye's group, with CSU students.

- Laure Gonnord and Maroua Maleej have a regular collaboration with Fernando Magno Quintao Pereira from the University of Mineas Gerais (Brazil). The results described in Section 7.2 are part of this collaboration. In Jan.-Feb. 2015, Compsys hosted Fernando Pereira, as a visiting professor.

9.4.2.2. Polyhedral Community

In 2011, as part of the organization of the workshops at CGO'11, Christophe Alias (with C. 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 for the past edition, in Amsterdam (2015), while Tomofumi Yuki is program co-chair and co-organizer of the next one, in Prague (2016).

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 of the first (and for the moment unique) school on polyhedral code analysis and optimizations (http://labexcompilation.ens-lyon.fr/polyhedral-school/). A second polyhedral school, more open, because involving themes and researchers from numerical analysis (users of HPC), will be organized in 2016.

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 7.15 .

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Invited Professors

- Fernando M. Pereira was invited in Jan. 2015 to work with Maroua Maleej and Laure Gonnord on static analyses for pointers.

9.5.1.2. Internships

- Tristan Dubois, M1 student from Lyon 1 University, worked for 6 weeks in January-February 2015, on pointer arithmetic in LLVM, supervised by Laure Gonnord.

- Marc Vincenti, M1 student from Lyon 1 University, worked for 6 weeks in January-February 2015, on comparison of termination benchmarks, in the context of the Artefact Evaluation of the PLDI'15 publication [7], whose results are described in Section 7.4 .

- Adilla Susungi, a M2 student from Strasbourg University, worked, from March 2015 to July 2015, on the compilation of streaming applications on multi-GPUs, supervised by Christophe Alias. Her internship was funded by Inria.

9.5.2. Visits to International Teams

Paul Feautrier has been invited by the University of Passau (Bavaria) in the team of Prof. Christian Lengauer, where he has given a seminar "Toward a Polynomial Model" (September 2015) and held scientific discussions with Armin Groesslinger and other members of the team.

CONVECS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. FSN (*Fonds national pour la Société Numérique*)

8.1.1.1. OpenCloudware
Participants: Rim Sakka Abid, Hugues Evrard, Frédéric Lang, Gwen Salaün [correspondent].

OpenCloudware [0] is a project funded by the FSN. The project is led by France Telecom / Orange Labs (Meylan, France) and involves 18 partners (among which Bull, OW2, Thalès, Inria, etc.). OpenCloudware aims at providing an open software platform enabling the development, deployment and administration of cloud applications. The objective is to provide a set of integrated software components for: (i) modeling distributed applications to be executed on cloud computing infrastructures; (ii) developing and constructing multi-tier virtualized applications; and (iii) deploying and administrating these applications (PaaS platform) possibly on multi-IaaS infrastructures.

OpenCloudware started in January 2012 for three years and nine months. The main contributions of CONVECS to OpenCloudware (see § 6.5.2) are the formal specification of the models, architectures, and protocols (self-deployment, dynamic reconfiguration, self-repair, etc.) underlying the OpenCloudware platform, the automated generation of code from these specifications for rapid prototyping purposes, and the formal verification of the aforementioned protocols.

8.1.1.2. Connexion
Participants: Hubert Garavel [correspondent], Frédéric Lang, Raquel Oliveira.

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. 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 (see § 6.5.6).

8.1.2. Competitivity Clusters

8.1.2.1. Bluesky for I-Automation
Participants: 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.opencloudware.org
[0]http://www.cluster-connexion.fr

Bluesky started in September 2012 for three years and was extended for nine month until June 2016. The main contributions of CONVECS to Bluesky (see § 6.1.5 and § 6.5.3) 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.

8.1.3. Other National Collaborations

Additionally, we collaborated in 2015 with the following Inria project-teams:

- PAREO (Inria Nancy — Grand Est): Pierre-Etienne Moreau

Beyond Inria, we had sustained scientific relations with the following researchers:

- Gaëlle Calvary and Sophie Dupuy-Chessa (LIG, Grenoble),
- Fabrice Kordon and Lom Messan Hillah (LIP6, Paris),
- Noël De Palma and Fabienne Boyer (LIG, Grenoble),
- Xavier Etchevers (Orange Labs, Meylan),
- Matthias Güdemann (Systerel, Aix-en-Provence),
- Christophe Deleuze, Ioannis Parissis, and Mouna Tka Mnad (LCIS, Valence),
- Pascal Poizat (LIP6, Paris).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. SENSATION

Participants: Hubert Garavel [correspondent], Radu Mateescu, José Ignacio Requeno, 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 contributes 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 (see § 6.5.4).

8.2.2. 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.

8.3. 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

8.3.1. Other International Collaborations

In 2015, we had scientific relations with several universities abroad, including:

- CWI, The Netherlands (Jurgen Vinju and Paul Klint),
- University of Málaga, Spain (F. Duran and C. Canal),
- University of Colorado, USA (Fabio Somenzi), and
- University of Utah, USA (Chris Myers and Zhen Zhang).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- The annual CONVECS seminar was held in Charavines (France) on May 27–29, 2015. The following invited scientists attended the seminar:
    - Eric Jenn (IRT Saint-Exupéry / Thales Avionics) gave on May 27, 2015 a talk entitled "*The INGEQUIP Project and the TwIRTee demonstrator*".
    - Alexandre Hamez (IRT Saint-Exupéry) gave on May 29, 2015 a talk entitled "*CAE-SAR.SDD*".
- Chris Myers (University of Utah, USA) visited us from June 8–12, 2015. He gave a talk entitled "*An Integrated Verification Architecture*" on June 9, 2015.
- Hernan Ponce de Leon (Aalto University, Finland) visited us from June 29 to July 1, 2015. He gave a talk entitled "*Unfolding Based Testing for Multithreaded Programs*" on June 29, 2015.

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

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.

8.2. National Initiatives

8.2.1. IPL Multicore

- Title: Large scale multicore virtualization for performance scaling and portability
- Multicore leader: Gilles Muller
- CORSE participants: Fabrice Rastello
- 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. Research directions are: (1) Memory management and scheduling; (2) Garbage collection; (3) Improving data locality; (4) Dynamic parallelization; (5) Fast execution of Sequential Sections; (6) Dynamic Code Generation; (7) Dynamic Binary Rewriting for Performance Portability; (8) Virtualization of floating-point computation; (9) Convergence between VMKit and StarPU

8.2.2. IPL C2S@Exa

- Title: Computer and Computational Sciences at Exascale
- C2S@Exa leader: Stéphane Lanteri
- Corse participants: François Broquedis, Frédéric Desprez, Jean-François Méhaut
- 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.

8.2.3. 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-Blanc

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

Program FP7

Duration: 01/10/2011 - 30/06/2015

Coordinator: Barcelona Supercomputing Center (BSC)

Mont-Blanc consortium: BSC, Arm, Bull, CNRS, CEA Leti, Juelich, LRZ, Genci, Cineca, Univ. Cantabria

Mont-Blanc website: http://www.montblanc-project.eu/

Corse contact: Jean-François Méhaut

Corse participants: Brice Videau, Kevin Pouget

There is a continued need for higher compute performance: scientific grand challenges, engineering, geophysics, bioinformatics, etc. However, energy is increasingly becoming one of the most expensive resources and the dominant cost item for running a large supercomputing facility. In fact the total energy cost of a few years of operation can almost equal the cost of the hardware infrastructure. Energy efficiency is already a primary concern for the design of any computer system and it is unanimously recognized that Exascale systems will be strongly constrained by power. The analysis of the performance of HPC systems since 1993 shows exponential improvements at the rate of one order of magnitude every 3 years: One petaflops was achieved in 2008, one exaflops is expected in 2020. Based on a 20 MW power budget, this requires an efficiency of 50 GFLOPS/Watt. However, the current leader in energy efficiency achieves only 1.7 GFLOPS / Watt. Thus, a 30x improvement is required. In this project, we believe that HPC systems developed from today's energy-efficient solutions used in embedded and mobile devices are the most likely to succeed. As of today, the CPUs of these devices are mostly designed by ARM. However, ARM processors have not been designed for HPC, and ARM chips have never been used in HPC systems before, leading to a number of significant challenges. The Mont-Blanc project has three objectives:

- To develop a fully functional energy-efficient HPC prototype using low-power commercially available embedded technology
- To design a next-generation HPC system together with a range of embedded technologies in order to overcome the limitations identified in the prototype system
- To develop a portfolio of exascale applications to be run on this new generation of HPC systems. This will produce a new type of computer architecture capable of setting future global HPC standards that will provide Exascale performance using 15 to 30 times less energy

8.3.1.2. Mont-Blanc2

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

Program FP7

Duration: 01/10/2013 - 30/09/2016

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.

8.3.1.3. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: 01/12/2015 - 30/11/2017

Coordinator: Barcelona Supercomputing Center (BSC)

European partners: Inria, Univ. Lancaster, Ciemat, Total, Repsol, Iberdrola

Brazilian partners: Coppe, LNCC, ITA, Petrobras, UFRGS, UFPE

Inria contact: Stephane Lanteri

Corse contact: Jean-François Méhaut

Corse participants: François Broquedis, Frédéric Desprez, Brice Videau

The main objective 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. HPC4E also aims at improving the usage of energy using HPC tools by acting at many levels of the energy chain for different energy sources. The project includes relevant energy industral 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.

8.3.1.4. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: 01/10/2015 - 30/11/2018

Coordinator: Commissariat à L'Energie Atomique et aux Energies Alternatives (CEA)

European partners: CEA, Juelich, MPG, Enea, Cerfacs, UNITN, Fraunhofer, Univ. Bath, CNR, Univ. Brussels, BSC

Inria contact: Michel Kern

Corse contact: Jean-François Méhaut

Corse participants: François Broquedis, Frédéric Desprez, Brice Videau

This projects establishes 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.

8.4. 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 (ENERGYLB) 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.

- LIRIMA (IDASCO team)
    - The general objective of IDASCO project team is to develop models and tools that can be used to collect the huge amount of data produced by complex computational, biological, epidemiological or environmental systems, and extract knowledge from these data in order to better understand their structure and dynamics for decision making. From 2010 to 2015, the IDASCO activities were focused on the following main thematics : programming environments for parallel execution, parallel algorithms for datamining, social network analysis and trace mining. Some work on wireless sensor networks and geographic information systems with application to sustainable management of natural resources have also been developed. Ten PhD Theses were defended during this period with eight on them co-supervised. There were some industrial collaborations with a brewery company (SABC) on e-Learning platforms and with ORANGE Labs on online registration platforms. These collaborations were done in partnership of the ALOCO project team. The EPICAM project was also developed in partnership with MEDES France, Centre Pasteur Cameroun and the National Program for Fight against Tuberculosis.
    - Jean-François Méhaut is co-director with Maurice Tchuenté of the IDASCO team.
    - Thomas Messi Nguelé is currently preparing a PhD with the coadvising of Maurice Tchuenté. His research work is also part of the IDASCO team.
    - Ylies Falcone and Jean-François Méhaut spent two weeks in Cameroon (Yaoundé) in the context of LIRIMA and CETIC (African Center of Excellence for IT, http://www.cetic. cm/).

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
- HOSCAR
- EnergySFE (STIC Amsud)

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Thierry Jéron, Hervé Marchand, and Antoine Rollet visited Yliès Falcone during 1 week in January 2015.
- Ezio Bartocci (TU Vienna) visited Y. Falcone during two weeks in August 2015.
- Sylvain Hallé (University of Québec at Chicoutimi) visited Yliès Falcone during 1 week in December 2015.

8.5.2. *Visits to International Teams*

8.5.2.1. Research stays abroad

- Fabrice Rastello visited P. Sadayappan at Ohio State University two times one month (mai 2015 + September 2015) in the context of the INRIA Associate Team IOComplexity.
- Ylies Falcone visited the University of Illinois at Urbana Champaign (USA) from February to July 2015.
- Jean-François Méhaut visited M. Tchuenté at Yaoundé. (February 2015) in the context of LIRIMA (Idasco team).
- Jean-François Méhaut visited P. Navaux at UFRGS (October 2015) in the context of LICIA and the Inria associated team Exase.
- Jean-François Méhaut visited M. Castro and L. Pilla at UFSC (October 2015) in the context of the Stic Amsud EnergySFE project.

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

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. Inter-LabEx project between CPU and TRAIL

The topic of the project is "Advanced statistical methods for analysis of multidimensional databases of human brain imaging". The project focuses on the analysis of variability factors driving hemispheric specialization (HS) of the brain, a human specific character, for which a dedicated database has recently been built by GIN (Neurofunctional Imaging Group from L). GIN provides the database and pe./irabotrforms genotyping of fifty loci potentially affecting HS. The "Probability and Statistics" group (EPS) from the LabEx CPU works on the methodological developments of statistical tools to analyze these high dimensional data. Interactions between GIN and EPS allow to identify and to characterize the best variables, to perform additional analyses, and to suggest appropriate additional variables, especially in the case of the voxel being implemented. GIN is also involved in the interpretation of the statistical results generated throughout the project.

Dr Solveig Badillo has been hired as Postdoctoral researcher in may 2014 on this project for 20 months.

9.1.3. GIS ALBATROS, HUMO (HUman MOnitoring) project

Approche interdisciplinaire de l'évaluation de l'état cognitif de l'utilisateur. Participants: Jean-Marc André, Liliana Audin Garcia, Veronique Lespinet, Frédérique Faïta, Jérôme Sarraco, Pierrick Legrand.

Le but de ce micro-projet et de valider un protocole de recueil, traitement, et interprétation des données physiologiques pour l'évaluation de l'état de l'utilisateur. Les objectifs en sont :

- Mise en place d'un protocole de recueil de données reposant sur un des modèles théoriques classiques en psychologie cognitive (ex. modèle de la mémoire de travail, modèle attentionnel, etc.) pour servir de base à la comparaison des états cognitifs (comparaison de 2 conditions expérimentales reconnues en terme de performances cognitives).
- Mise en oeuvre d'une diversité de capteurs physiologiques conduisant au recueil de signaux variés durant les conditions expérimentales issus des protocoles de psychologie cognitive.
- Conduire une analyse statistique multivariée avec les tests existants permettant de tirer des informations quant à la structure des paramètres de monitoring.
- Discriminer les variables pertinentes : choix des signaux à retenir ; efficacité/pertinence vs diversité
- Etablir et décrire le lien éventuel de significativité entre les données physiologiques recueillies et l'état cognitif de l'utilisateur.

9.1.4. EMG analysis

Participants: Luis Herrera, Eric Grivel, Gregory Barrière, Marie chavent, Pierrick Legrand

L'analyse spectrale et temporelle des activités électromyographiques (EMGs, activités musculaires) occupe une place importante dans l'aide au diagnostic de pathologies sensorimotrices chez l'homme. Néanmoins, les outils actuellement utilisés en EMGs (transformée de Fourier notamment) demeurent limités et dans certains cas obsolètes pour le diagnostic différentiel de certaines pathologies. Tel est le cas par exemple de la maladie de Parkinson, du tremblement essentiel et de troubles cérébelleux qui s'accompagnent de tremblements similaires en termes de fréquence et d'amplitude. Notre projet, qui s'inscrit à la convergence de plusieurs disciplines (mathématiques, traitement du signal, neurobiologie et neurologie), vise à enrichir la quantité d'information pouvant être extraite des signaux EMGs à l'aide d'outils d'analyse à la pointe en matière de traitement du signal, avec pour objectif d'identifier des signatures EMG spécifiques de chaque pathologie et utilisables pour le diagnostic différentiel.

9.2. National Initiatives

9.2.1. *ANR ADAPTEAU*

The ANR project ADAPTEAU has been obtained for the period 2012-2016.

ADAPTEAU aims to contribute to the analysis and management of global change impacts and adaptation patterns in River-Estuarine Environments (REEs) by interpreting the scientific challenges associated with climate change in terms of: i) scale mismatches; ii) uncertainty and cognitive biases between social actors; iii) interdisciplinary dialogue on the "adaptation" concept; iv) critical insights on adaptive governance and actions, v) understanding the diversity of professional, social and economic practices vis-à-vis global change. The project aims to build an integrative and interdisciplinary framework involving biophysical and social sciences, as well as stakeholders and civil society partners. The main objective is to identify adaptive strategies able to face the stakes of global change in REEs, on the basis of what we call 'innovative adaptation options'.

We consider the adaptation of Social-Ecological Systems (SES) through the expected variations of the hydrological regimes (floods / low-flow) of the Garonne-Gironde REE—a salient issue in SW France, yet with a high potential for genericity The ADAPTEAU project will be organised as follows:

- Achieve and confront socio-economic and environmental assessments of expected CC impacts on the Garonne-Gironde river-estuarine continuum (task 1);

- Identify the emerging 'innovative adaptation options' endorsed by various social, economic, political actors of the territory (depolderisation, 'room for rivers' strategies, changes in economic activities, agricultural systems or social practices), then test their environmental, economic and social robustness through a selected subset (task 2);

- Scientists, representatives from administrators and civil society collaborate to build adaptation scenarios, and discuss them in pluralistic arenas in order to evaluate their social and economic feasibility, as well as the most appropriate governance modes (task 3).

- Disseminate the adaptation strategies to academics and managers, as well as to the broader society (task 4).

  The expected results are the definition and diffusion of new regional-scale reference frameworks for the discussion of adaptation scenarios in REE and other SESs, as well as action guidelines to better address climate change stakes.

The CQFD team work on tasks 1 and 3.

9.2.2. *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.

9.2.3. 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 :

Université Victor Segalen Bordeaux II participation ended

Université 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: MTM2012-31393

Project acronym: NMMDP

Project title: Numerical methods for Markov decision processes

Duration: 01/2013 - 12/2015

Coordinator: Tomas Prieto-Rumeau

Other partners: 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: MTM2012-31393) for three years to support the scientific collaboration between Tomas Prieto-Rumeau, Jonatha Anselmi and François Dufour. This research project is concerned with numerical methods for Markov decision processes (MDPs). Namely, we are interested in approximating numerically the optimal value function and the optimal controls for different classes of constrained and unconstrained MDPs. Our methods are based on combining the linear programming formulation of an MDP with a discretization procedure referred to as quantization of a probability distribution, underlying the random transitions of the dynamic system. We are concerned with optimality criteria such as the total expected cost criterion (for finite horizon problems) and, on the other hand, the total expected discounted cost and the average cost optimality criteria (for infinite horizon problems).

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

Tomas Prieto-Rumeau (Department of Statistics and Operations Research, UNED, Madrid, Spain) visited the team during 2 weeks in 2015. The main subject of the collaboration is the approximation of Markov Decision Processes.

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 2015 supported by the Associate Team Inria: CDSS.

Alexey Piunovskiy (University of Liverpool) visited the team during 5 weeks in 2015. 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.

9.5.1.1. Internships

- Emigdio Z. Flores: 1 months, hosted by P. Legrand
- Luis Herrera: 3 months, hosted by P. Legrand

CRYPT Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. MOST's 973 Grant

Grant   2013CB834205

PIs   Phong Nguyen and Xiaoyun Wang

Duration   2013-17

MOST is China's Ministry of Science and Technology.

5.1.2. NSFC Grant

Grant   NSFC Key Project 61133013

PIs   Phong Nguyen and Xiaoyun Wang

Duration   2013-16

NSFC is the National Natural Science Foundation of China.

5.2. European Initiatives

5.2.1. Collaborations with Major European Organizations

CWI: Cryptography team of Ronald Cramer (Netherlands). This team is officially a partner of LIAMA's CRYPT international project.

5.3. International Initiatives

5.3.1. Inria International Labs

- CRYPT is an international project from LIAMA in China, hosted by Tsinghua University in Beijing. It is a joint project between Inria, Tsinghua University, CAS Academy of Mathematics and System Sciences, and CWI (Netherlands).
- Phong Nguyen was the European director of LIAMA until October 2015.

5.3.2. Inria International Partners

5.3.2.1. Informal International Partners

- Univ. Oklahoma, USA
- Univ. Wisconsin, USA

5.4. International Research Visitors

5.4.1. Visits of International Scientists

Cheng Qi   (Univ. Oklahoma, USA)

Guangwu Xu   (Univ. Wisconsin, USA)

5.4.2. Visits to International Teams

5.4.2.1. Research stays abroad

Yang Yu visited CWI for 3 months in Fall 2015.

<p style="text-align:center"><strong style="color:red">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. 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/sites/hpes

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: Inria Rennes, IRIT, Eolas.

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, G. Privat).

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. 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).

9.3.2. 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.

<p style="text-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. European Initiatives

8.2.1. MEALS

Title: Mobility between Europe and Argentina applying Logics to Systems

Programm: FP7

Duration: October 2011 - September 2015

Coordinator: Université de la sarre

Partners:

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

 Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

 Technische Universiteit Eindhoven (Netherlands)

 Technische Universitaet Dresden (Germany)

 University of Leicester (United Kingdom)

 Universitaet Desarlandes (Germany)

Inria contact: Castuscia Palamidessi

Computing systems are getting ever more ubiquitous, making us dependent on their proper functioning. Therefore we require that they are correct (i.e. they conform their intended behavior), safe (i.e. its operation does not have catastrophic consequences), reliable, available to provide the intended service, and secure (i.e., no user without appropriate clearance can access or modify protected data). Guarantees for such charcteristics rely on rigid specification and analysis techniques for both the required system functionality as well as its behavior. Formal methods provide a mathematical approach to model, understand, and analyze systems, especially at early development stages. In this project we focus on three aspects of formal methods: specification, verification, and synthesis. We consider the study of both qualitative behavior and quantitative behavior (extended with probabilistic information). We aim to study formal methods in all their aspects: foundations (their mathematical and logical basis), algorithmic advances (the conceptual basis for software tool support) and practical considerations (tool construction and case studies). The MEALS project includes five tightly interconnected thematic work packages. They focus on quantitative analysis of concurrent program behaviour (WP1), reasoning tasks for specification and verification (WP2), security and information

flow properties (WP3), synthesis in model-based systems engineering (WP4) and foundations for the elaboration and analysis of requirements specifications (WP5). The crosscutting concern of all these work packages is the development of formal techniques for the specification, verification and synthesis of dependable ubiquitous computing systems. Five carefully planned MEALS gatherings and workshops give the project an effectve structure for knowledge transfer, communitiy building, and result dissemination, aimed at a sustained transcontinental collaboration.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Victor Vianu, June 1st till December 31st, UC San diego

8.3.2. Visits to International Teams

8.3.2.1. Research stays abroad

Sylvain Schmitz visited the University of Warwick for six months thanks to a grant by the Leverhulme Trust, from February 1st to July 31st, 2015.

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

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.

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 5.8â¬Âš 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
    Participants: Paulo Gonçalves Andrade, 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 prioritization.

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.

The DANTE team will work on the monitoring of NFV proposing passive and light-weight metrology tools. They will then investigate the modeling 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 RESCUE
Participants: Thomas Begin, Isabelle Guérin Lassous [correspondant].

In the RESCUE project, we investigate both the underlying mechanisms and the deployment of a substitution network composed of a fleet of dirigible wireless mobile routers. Unlike many projects and other scientific works that consider mobility as a drawback, in RESCUE we use the controlled mobility of the substitution network to help the base network reduce contention or to create an alternative network in case of failure. The advantages of an on-the-fly substitution network are manifold: Reusability and cost reduction; Deployability; Adaptability.

The RESCUE project addresses both the theoretical and the practical aspects of the deployment of a substitution network. From a theoretical point of view, we will propose a two-tiered architecture including the base network and the substitution network. This architecture will describe the deployment procedures of the mobile routing devices, the communication stack, the protocols, and the services. The design of this architecture will take into account some constraints such as quality of service and energy consumption (since mobile devices are autonomous), as we want the substitution network to provide more than a best effort service. From a practical point of view, we will provide a proof of concept, the architecture linked to this concept, and the necessary tools (*e.g.*, traffic monitoring, protocols) to validate the concept and mechanisms of on-the-fly substitution networks. At last but not least, we will validate the proposed system both in laboratory testbeds and in a real-usage scenario.

9.1.1.7. ANR FETUSES
Participant: Paulo Gonçalves Andrade.

The goals of this ANR project consist in the development of statistical signal processing tools dedicated to per partum fetal heat rate characterization and acidosis detection, and are organized as follows: *(i)* construction of a large dataset of per partum fetal heart rate recordings, which is well documented and of significant clinical value; *(ii)* Developments of adaptive (*e.g.* data driven) algorithms to separate data into trend (deceleration induced by contractions) and fluctuation (cardiac variability) components; *(iii)* Developments of algorithms to characterize the non stationary and multifractal properties of per partum fetal heart rate ; *(iv)* Acidosis detection and assessment using the large datasets; *(v)* Algorithm implementation for performing tests in real clinical situations. ANR is a joint project between DANTE, the Physics Lab of ENS de Lyon (SiSyPhe team) and the *Hôpital Femme-Mère-Enfant* of Bron (Lyon). Fetuses started in january 2012 and ended in june 2015.

9.1.1.8. ANR SoSweet
Participants: Éric Fleury, Márton Karsai.

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 behaviors. 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.

9.2. 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: 2015, Dec to 2019

Coordinator: UPMC

Partners: UPMC, LIP6, France; UBIWHERE Lda, Portugal; Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung, Germany; Technische Universitaet Berlin, Germany; Inria, France

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.

9.2.1.2. ARMOUR

Title: Large-Scale Experiments of IoT Security & Trust (Project n°688237)

Programm: H2020

Duration: 2015 Dec to 2018

Coordinator: UPMC

Partners: UPMC, LIP6, France; Synelixis Lyseis Pliroforikis Automatismou & Tilepikoinonion Monoprosopi EPE, Greece; Smartesting Solutions & Services, France; Unparallel Innovation, Lda, Portugal; Easy Global Market, France; ODIN Solutions, Spain;

Inria contact: Eric Fleury

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 – a FIRE OpenLAB / FIT IoT LAB facility – 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

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

UPC (Spain): Department of Telematic Engineering. Collaboration with Monica Aguilar Igartua and Luis J. de la Cruz Llopis on vehicular and community networks.

University of Bergen: Institute of Computer Science (Norway). Collaboration with Pinar Heggernes on graph editing problems for analysis and modeling of complex networks.

Ecole Polytechnique Fédérale de Lausanne (Switzerland). Collaboration with Pierre Vandergheynst on Graph Signal Processing

LNCC, Petropolis (Brazil). Collaboration with Arthur Ziviani on Temporal Graph modeling ans algorithms.

Algorithms group: University of Bergen, Institute of Computer Science (Norway).

Collaboration with Pinar Heggernes on graph editing problems for analysis and modeling of complex networks.

Algorithmics group: University of Konstanz, Department of Computer and Information Science (Germany).

Collaboration with Ulrik Brandes on graph editing problems for analysis and modeling of complex networks.

9.3.1.1. Declared Inria International Partners

Taiwan, ACADEMIA SINICA & IIIS. Signature of a MoU in the framework of IoT-LAB.

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 predictin 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

Sahoo Prasan Kumar

Date: July 2015

Institution: Chang Gung University (Taiwan)

9.4.2. Visits to International Teams

9.4.2.1. Sabbatical programme

Begin Thomas

Date: Sep 2015 - Aug 2016

Institution: University of Ottawa (Canada)

Thomas Begin is on a research leave at DIVA lab - University of Ottawa - Canada for the 2015 - 2016 academic year. This leave is funded through a CNRS grant (délégation CNRS) & Inria grant (Sabatic grant).

Christophe Crespelle

Date: Sep 2015 - Aug 2016

Institution: Institute of Mathematics, Vietnam Academy of Science and Technology (Vietnam)

Christophe Crespelle is in CNRS delegation for academic year 2015-2016 at the Institute of Mathematics, Vietnam Academy of Science and Technology, Hanoï

DECENTRALISE Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

We obtained ARED funding (40% of a PhD) from the region (starting 11-2015). The focus of the proposed research is how to preserve a free and independent quality press in the age of online distribution. We propose to tackle this challenge from two sides: First, we will broaden the online revenue stream by enabling convenient anonymous payments that preserve the reader's privacy and are more efficient and secure than traditional payment systems. Thus, the resulting system will allow for a larger fraction of the payment to arrive at the newspaper, and for a higher conversion of visitors to purchases. Second, we will consider an alternative means for distributing news, which integrates the typical Web-processes of third parties linking to, commenting on, translating and regurgitating stories while also enabling fair compensation of those involved in the creative process. A key challenge here will be to semi-automate the editorial process, leaving it to readers and decentralized, privacy-preserving algorithms to filter worthwile news. The ideal outcome will be a news distribution system that provides censorship resistance, financial compensation for quality (online) journalism and privacy for readers.

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Locali

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

8.1.2. 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.

8.1.3. ANR Tarmac

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

8.2. International Research Visitors

8.2.1. Visits of International Scientists

Jim Lipton, professor at Wesleyan University (USA) has visited Deducteam from 9 to 14 March 2015.

8.2.1.1. Internships

Gaetan Gilbert did an internship with Arnaud Spiwack and Olivier Hermant.

Shuai Wang did an internship with Gilles Dowek.

Éric Uzena did an internship with Arnaud Spiwack and David Delahaye.

8.2.2. Visits to International Teams

8.2.2.1. Sabbatical programme

Olivier Hermant is a visiting professor at Wesleyan University (USA) since September 2015.

<div align="center">

DEFI Project-Team

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8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- H. Haddar is the DEFI coordinator of the ANR: Modelization and numerical simulation of wave propagation in metamaterials (METAMATH), program MN, 2011-2015. 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

- J.R. Li is the coordinator of the Inria partner of the project "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.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

- Partner 1: University of Bremen, Department of Math. (Germany)

  Joint PhD advising of T. Rienmuller, partly funded by French-German university. Correspondant: Armin Lechleiter.

- Partner 2: University of Goettingen, Department of Math. (Germany)

  Development of conformal mapping method to electrostatic inverse problems. Correspondant: Rainer Kress.

8.3. International Initiatives

8.3.1. Inria International Labs

- DEFI is the correpondnat of the LIRIMA Afrique team EPIC. The program ended in 2015. A followup is prepared in the framework of associate team program.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

QUASI

- Title: Qualitative Approaches to Scattering and Imaging
- International Partners (Institution - Laboratory - Researcher):
    - University of Delaware (United States) - Department of Mathematical Sciences (Department of Math) - Fioralba Cakoni
- 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 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

We had short visits (one week) of the following collaborators

- Fioralba Cakoni
- David Colton
- Ozgur Ozdemir
- Rainer Kress

8.4.1.1. Internships

- Guilherme Da Costa Sales
- Hoang Trong An TRAN

DEFROST Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

+ **IDeaS (ANR JCJC)**: 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. Defrost is involved with Magrit, MIMESIS and Nancy Hospital.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

Partner 1: King's College, Robotics Dept (UK)

Soft robot modeling and control using pneumatic and hydraulic technology

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

6. Partnerships and Cooperations

6.1. Regional Initiatives

AOI PARKDEMAR Participants: Christine Azevedo Coste, Benoît Sijobert. Appel d'offre Interne (AOI) CGS Merri (CHU Montpellier). Development and evaluation of Freezing detection system in parkinson disease. Program Région Languedoc-Roussillon "Manifestations scientifiques 2016" - 11000 euros for the organization of IFESS conference in 2016. http://ifess2016.inria.fr/

LABEX NUMEV Participants: Christine Azevedo Coste, Christian Geny, Benjamin Gilles. A M2 internship will be funded by the NUMEV Labex on the dynamic cartography of tremor using muscular echography.

6.2. National Initiatives

6.2.1. ADT SENSAS - SENSBIO

Participants: Christine Azevedo Coste, David Andreu, Benoît Sijobert.

SENSAS is an Inria ADT (Actions de Développement Technologique), implying several Inria project teams on the "SENSor network ApplicationS" theme. SENSAS aims to propose applications based on wireless sensor and actuator network nodes provided from the work done around senslab and senstools preliminary projects. SENSAS is organized around the following work packages :

- SensRob : Robotics applications
- SensBio : Bio-Logging applications
- SensMGT : Wireless sensor/actuator network management/configuration applications
- SensBox : Wireless sensor/actuator network simulation applications and tools

Our team is mainly implied in the SensBio work package, in particular for the following applications: Spinal Cord Injured Patients FES-Assisted Sit to Stand, Post-Stroke Hemiplegic Patient FES-correction of drop foot, Gait analysis of parkinson freezing and Motion analysis of longterm race data.

6.2.2. INTENSE project

Participants: David Guiraud, Olivier Rossel, Melissa Dali, Christine Azevedo Coste, David Andreu, Jérémie Salles, Guy Cathébras, Fabien Soulier, Baptiste Colombani, Guillaume Souquet, Milan Demarcq.

INTENSE (Initiative Nationale Technologique d'Envergure pour une NeuroStimulation Evoluée) is a PIA-PSPC Project (Programme Investissement d'Avenir, Projets RD Structurants des Pôles de Compétitivité) [2012-2018]. The aim of this project is to develop new implantable devices, based on neurostimulation, for heart failure.

Partners of this project are: DEMAR, SORIN CRM, MXM-Obélia, 3D plus, CEA-Leti, INRA Rennes, INSERM Rennes, HEGP, CHU Rennes.

6.2.3. 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.

6.3. European Initiatives

6.3.1. 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/

6.4. International Initiatives

6.4.1. Inria Associate Teams not involved in an Inria International Labs

6.4.1.1. 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) - ___Centre for Cognitive Science ___ - 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.

6.4.2. Inria International Partners

6.4.2.1. Declared Inria International Partners

Technology artificial and natural control assisted by electrical stimulation in functional transfers for subjects with disabilities after spinal cord injury Inria principal investigator: Christine Azevedo Coste International partner: Faculty of Ceilandia/ University of Brasilia - Emerson Fachin Martins, leader of the NTAAI-team. Nucleus of Assistive Technology, Accessibility and Innovation. CAPES, Scholarship: BEX 3160/13-0 (Montpellier/France - December 2013 - February 2015) CAPES, Appel: 88881.068134/2014-01 (2015 - 2017) Around 90 million people acquired disabilities from Spinal Cord Injury (SCI) worldwide. The options available to stand up individuals with SCI without orthotics devices do not provide a functional upright position. The wheelchairs and seats to verticalize do not ensure an active participation based in a technology-human interaction. Moreover, the Verticalization devices are rarely used outside. The present international collaboration initiates a series of collaborations between the DEMAR- team and the NTAAI-team based on academic mobility of students and researchers. The general aim of this project is investigated technologies based in the functional electrical stimulation to promote functional transfers of the individuals with disabilities after SCI.

6.4.3. Participation In other International Programs

France-Stanford GRANT :

DEMAR and the Department of Orthopaedic Surgery of Stanford University awarded with a collaborative research grant from the France-Stanford Center for Interdisciplinary Studies. on the topic of "Inertial Sensors Based Analysis of Gait on Children with Spastic Cerebral Palsy". https://project.inria.fr/siliconvalley/2015/11/23/interview-chrisitine-azevedo-coste/

6.5. International Research Visitors

6.5.1. Visits of International Scientists

6.5.1.1. Internships

Mitsuhiro Hayashibe supervised Saugat Bhattacharyya on "Study on Probabilistic nature of Motor Imagery Electroencephalography signals for control", PhD internship, Svaagata.eu: experience Europe as an Indian Erasmus Mundus, Jadavpur University, Kolkata, India, from Oct. 2014 to Jun. 2015.

Mitsuhiro Hayashibe supervised Roberto Baptista on "Framework for Automatic Assessment of Human Motion for Rehabilitation", PhD internship, bourse d'etudes du Gouvernement Bresilien, Fondation Capes, Universidade de Brasilia (UnB), Brasil, from May 2014 to Apr. 2015.

6.5.2. Visits to International Teams

Mitsuhiro Hayashibe visited Dr. Uttama Lahiri - Centre for Cognitive Science, IIT Gandhinagar, India and Dr. Abhijit Das, MD, Director of Neurorehabilitation, AMRI Institute of Neurosciences, Kolkata, India together with Dr. Anirban Dutta under Inria-DST project. (15-24 Jan. 2015).

Mitsuhiro Hayashibe was Visiting Researcher at RIKEN BSI-TOYOYA research institute and worked on "Tacit Synergetic Motor Learning for rehabilitation" (Jul.-Aug. 2015).

6.5.2.1. Research stays abroad

Christine Azevedo Coste is spending 2,5 months (November 2015-February 2016) at Brasilia University as an invited researcher. She is working 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.

DIANA Project-Team

8. Partnerships and Cooperations

8.1. 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.

8.2. National Initiatives

8.2.1. 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 "Équipements d'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 will study 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.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Program: FP7 FIRE programme

Project acronym:

Project title: Fed4Fire

Duration: October 2012 - October 2016

Coordinator: iMinds (Belgium)

Other partners: 17 european partners including iMinds (Belgium), IT Innovation (UK), UPMC (Fr), Fraunhofer (Germany), TUB (Germany), UEDIN (UK), NICTA (Australia), etc.

Web site: http://www.fed4fire.eu/

Abstract: Fed4FIRE will deliver open and easily accessible facilities to the FIRE experimentation communities, which focus on fixed and wireless infrastructures, services and applications, and combinations thereof. The project will develop a demand-driven common federation framework, based on an open architecture and specification. It will be widely adopted by facilities and promoted internationally. This framework will provide simple, efficient, and cost effective experimental processes built around experimenters' and facility owners' requirements. Insight into technical and socio-economic metrics, and how the introduction of new technologies into Future Internet facilities influences them, will be provided by harmonized and comprehensive measurement techniques. Tools and services supporting dynamic federated identities, access control, and SLA management will increase the trustworthiness of the federation and its facilities. A FIRE portal will offer brokering, user access management and measurements. Professional technical staff will offer first-line and second-line support to make the federation simple to use. The project will use open calls to support innovative experiments from academia and industry and to adapt additional experimentation facilities for compliance with Fed4FIRE specifications. A federation authority will be established to approve facilities and to promote desirable operational policies that simplify federation. A Federation Standardization Task Force will prepare for sustainable standardization beyond the end of the project. The adoption of the Fed4FIRE common federation framework by the FIRE facilities, the widespread usage by both academic and industrial experimenters, and the strong links with other national and international initiatives such as the FI-PPP, will pave the way to sustainability towards Horizon 2020.

8.3.2. EIT KIC funded activities

Program: FNS Future Networking Solutions Action Line

Project acronym: NFMD

Project title: Networks for Future Media Distribution (14082)

Duration: January 2015 to December 2015

Coordinator: Acreo, Sweden

Other partners: VTT (Finland), Ericsson, Lund University, SICS (Sweden).

Abstract: The EIT ICT Labs' Networks for Future Media Distribution (NFMD)' activity 14082 has as a specific innovation object set out in the application. The caching algorithm are evaluated and implemented as a proof-of-concept and integrated in the NetInf Information Centric Networking prototype. The field test at the Nordic Ski Championship in Falun was used to gain experience with the NetInf technology in a larger setting to be able to improve the implementations towards production quality. We furthermore in detail analyse and evaluate the test with the purpose to understand the benefits and limitations of the technology. The work on QoE metrics and tools aims to further develop and launch a service "streamingkollen.se" and "ACQUA" that enable consumers to measure the expected media quality that can be achieved with the user's current network connection and equipment. One result of the development is in open source code contributions. Related standardisation activities and business model analysis are also carried out in the activity. Of particular interest for this year is the business interest of INDRA in transferring the results in the area of QoE to a new line of monitoring systems.

8.4. International Initiatives

8.4.1. Inria International Labs

We collaborate with Javier Bustos from Inria Chile and his group on the measurements and analysis of users' quality of experience. This collaboration fits within our respective projects Adkinton Mobile and ACQUA, and aims at collecting measurements of both network and experience, and at using these measurements for the analysis and calibration of users' experience new models and for the design of network troubleshooting techniques in case of service degradation. In 2015, we hosted a student from Inria Chile who worked with us on setting up an experimental platform for Quality of Experience Measurement instantiated to the particular case of YouTube streaming. We also worked together on the Skype use case and published the results in [16].

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

We have collaborated with researchers at NICT, Japan to propose the Contrace tool for measuring and tracing Content-Centric Networks (CCNs). The tool allows to estimate the content popularity and can help in designing more effective cache control mechanisms.

We have an ongoing collaboration with Katia Obraczka's team at UCSC on the decentralization of the SDN control plane, following our previous COMMUNITY associated team.

We have collaborated with researchers at Universidad Diego Portales (UDP) and Universidad de Chile to design PcapWT, an efficient packet extraction tool for large experimentation traces.

We are collaborating with Augustin Chaintreau from Columbia University on the use of social networks to attrack traffic on news media sites.

We are collaborating with David Choffnes from Northeastern University on the detection, analysis, and prevention of privacy leaks from mobile devices.

We have designed and demonstrated a solution for virtual Service Providers in SOHO networks in collaboration with Ericsson and LISPERS.net (http://www.lispers.net/). The principle is to allow homenets and SOHO networks to use services normally available only for large networks. This, thanks to the virtualization of the Internet connections by the mean of overlay routing. We implemented a demonstrator using LISP implementation provided by LISPERS.net and deployed it in Google Cloud. The key element of the concept is a virtual CPE that has been implemented on a Raspberry Pi demonstrating the potential of the solution for IoT. A demonstration of the fully functional system can be watched at https://www.youtube.com/watch?v=Gzk-h5UK54E.

We collaborate with the CRISTAL Lab at ENSI in Tunisia on memory optimizations for content routing. See [17] for more details.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Nicolas Aguilera Miranda

Date: from October 2014 February 2015

Institution: University of Chile, CIRIC

Supervisor: Chadi Barakat

Subject: Measurements of users' quality of experience over Adkintun Mobile

Brahim Bellaoui

Date: from Mar 2015 until Aug 2015

Institution: University of Nice Sophia Antipolis

Supervisor: Thierry Turletti, Damien Saucez and Walid Dabbous

Subject: Optimization Framework and Fault Management for NFV and SDN

Yuri Bushnev

Date: from June 2015 until Aug 2015

Institution: Saint Petersburg State University

Supervisor: Thierry Turletti and Damien Saucez

Subject: Robust programmable communication networks

Anuvabh Dutt

Date: from Aug 2015 until Sep 2015

Institution: University of Nice Sophia Antipolis, International Master 1

Supervisor: Arnaud Legout

Subject: Analysis of Hashtag Relations to Identify Unusual User Activities on Twitter

Anastasia Kuznetsova

Date: from July 2015 until Aug 2015

Institution: University of Nice Sophia Antipolis, International Master 1

Supervisor: Arnaud Legout

Subject: Analysis of Hashtag Relations to Identify Unusual User Activities on Twitter

Mohamed Naoufal Mahfoudi

Date: from Mar 2015 until Aug 2015

Institution: University of Nice Sophia Antipolis, Ubinet Master

Supervisor: Walid Dabbous and Thierry Turletti

Subject: Reproducible and Realistic wireless Experiments in an Anechoic Chamber

Thierry Spetebroot

Date: from March 2015 until August 2015

Institution: Polytech Nice Sophia, Ubinet Master

Supervisor: Chadi Barakat

Subject: From network-level measurements to expected Quality of Experience for Video applications

8.5.2. Visits to International Teams

Walid Dabbous visited NICT in Tokyo Japan in the context of the Simulbed associated team. He also participated to the French-Japanese workshop dedicated to Cybersecurity in Tokyo, on April 1st to 3rd 2015.

Arnaud Legout visited Columbia University from August 31st to September in the context of the collaboration with Augustin Chaintreau.

8.5.2.1. Research stays abroad

Maksym Gabielkov visited Columbia University for 6 months (from June 15 to December 15). He collaborated with Augustin Chaintreau and his team on the topic "Social Clicks: What and Who Gets Read on Twitter?"

Xuan Nam Nguyen visited Aalto University for 3 months (from June to August). He collaborated with Jose Costa Requena team on "Versatile Caching Framework for LTE".

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. IXXI, Institute for Complex Systems

The Dice team is hosted in the Rhône-Alpes Institute for Complex Systems, IXXI, located in Ecole Normale Supérieure 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. ARC6 "Innovative Services for Social Networks"

DICE is involved in a regional project of the Rhône-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.

8.4.2. Inria International Partners

Dice is associated with the Institute of Massive Computing of ECNU, East China Normal University, in the framework of Joriss, associating ENS with ECNU. The project which focuses on "Promises of intermediation platforms for services frugal in resources" is headed by Aoying ZHOU on the ECNU side.

<h2 style="text-align:center;color:red;">DIONYSOS Project-Team</h2>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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.

8.2. European Initiatives

8.2.1. 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 (C. Viho (Dionysos); T. Watteyne (Eva))

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.

8.2.2. QuEEN project

Program: CELTIC

Project acronym: QuEEN

Project title: Quality of Experience Estimators in Networks

Duration: October 2011 - January 2015

Coordinator: Orange Labs

Other partners: 24 partners in many European partners

Abstract: QuEEN was a large 3-year Celtic project going from end 2011 to January 2015. The project's outputs include the development of automatic QoE measurement modules for Web services and applications, and the organization of these measurement modules as a network of cooperative agents in order to allow each agent to take advantage of the measurements done by the others. Dionysos was involved in most of the activities of the project, and QuEEN partners have benefit from our experience in developing the PSQA technology. QuEEN involved many companies and academic institutions (24 European partners); the project leader was Orange Labs, in Sophia Antipolis.

For more details, visit http://celtic-queen.inria.fr/dokuwiki/doku.php?id=start

8.2.3. Collaborations with Major European Organizations

Partner 1: FTW, Vienna (Austria)

We work with FTW on network economics.

8.3. International Initiatives

8.3.1. CIRIC

In the context of CIRIC, we cooperate with the team of Reinaldo Vallejos, professor at the UTFSM, Valparaíso, Chile, on different topics related to networking and modeling issues. Specifically, these activities have been organized around two collaborative projects, 8.3.2 and 8.3.4.1 below, where one can find the scientific details. We start to work also with Javiera Barrera's team at the University Adolfo Ibañez, Santiago de Chile, on stochastic optimization problems.

CIRIC stopped its activities in some whole areas such as telecommunications, but our cooperative work continues without interruption.

Inria Chile

Associate Team involved in the International Lab:

8.3.2. MANAP

Title: MANAP (Markovian ANalysis and APplications)

International Partner (Institution - Laboratory - Researcher):

Universidad Tecnica Federico Santa Maria (Chile) - Telematics - Vallejos Reinaldo

Start year: 2013

See also: http://people.rennes.inria.fr/Gerardo.Rubino/RESEARCH/MANAP/manap.html

This project had two goals. The main one was to develop techniques allowing to accelerate solving techniques for Markov models, both in equilibrium and in their transient phases. The applications behind these efforts are the evaluation of performance, dependability and performability properties of complex communication systems. The second goal was to apply these solving techniques to specific problems in networking, concerning optical and wireless infrastructures. On both cases there was some emphasis on dependability aspects: fault tolerance routing schemes in the first case, complex dependability characteristics and their analysis in the second one. A third explicit objective was to start the design of a software tool implementing the techniques coming from the main research direction of the project, designed to be used both by engineers and researchers.

We achieved some of these objectives, which made us decide to interrupt the associate team and to study the idea of proposing a new one at the end of 2016 or 2017 (see 8.3.4.1). A supplementary reason to do so is to rebuild some structure like MANAP but in a three-country scheme, including a group in Uruguay with which we worked during all MANAP's life.

8.3.3. Inria International Partners

8.3.3.1. MOCQUASIN

Title: Monte Carlo and Quasi- Monte Carlo for rare event simulation

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada)

Duration: 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 tools 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. A typical framework is that of rare event simulation for which getting even only one occurrence of the event could require a very long time. In this case, there are two main acceleration techniques: importance sampling and splitting, on which we work.

8.3.3.2. Informal International Partners

We restarted the cooperation of G. Rubino with the Cal Poly at Pomona, California, specifically with professor Alan Krinik, Head of the Mathematics Department. The topic is the transient analysis of stochastic processes. See [69] and [68], and the description made in 6.2 , page 6.2 .

8.3.4. Participation in other International Programs

8.3.4.1. Stic AmSud with UDELAR, Uruguay, and UTFSM, Chile

Program: Stic AmSud

Title: Dependability Analysis Tool (DAT)

Inria principal investigator: Gerardo Rubino

International Partners (Institution - Laboratory - Researcher):

University of the Republic (UDELAR), Montevideo, Uruguay – Computer Science at the Engineering Faculty – prof. Héctor Cancela

Technical University Federico Santa María (UTFSM), Valparaíso, Chile – Electronics Department – Prof. Reinaldo Vallejos

Duration: 2 years, Jan. 2015 – Dec. 2016

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. This constitute the main achievements of the associated team MANAP (see 8.3.2). 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Academic visitors

Reinaldo Vallejos, full professor

Date: 5/9/15 – 24/9/15

Institution: UTFSM, Valparaíso, Chile

Marta Barría, full professor

Date: 5/9/15 – 24/9/15

Institution: University of Valparaíso, Chile

Héctor Cancela, full professor

Date: 9/9/15 – 18/9/15

Institution: UDELAR, Uruguay

Jorge Graneri, assistant professor

Date: 15/11/15 – 15/1/16

Institution: Institution: UDELAR, Uruguay

Leslie Murray, assistant professor

Date: 21/11/15 – 11/12/15

Institution: University of Rosario, Argentina

DISCO Project-Team

9. Partnerships and Cooperations

9.1. 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).

9.2. National Initiatives

9.2.1. ANR

An ANR Blanc SIMI 3 *Multidimensional Systems: Digression On Stabilities* (MSDOS) has started at the beginning of 2014. Its main goal is to constructively study stabilities and stabilization problems of (nonlinear) multidimensional systems. For more details, see http://www.lias-lab.fr/perso/nimayeganefar/doku.php. Alban Quadrat is the local leader for Inria Saclay.

9.2.2. 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).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Sorin Olaru is coordinator of the European project FUTURUSM in the IEF scheme (Dr. Vasso Reppa as postdoctoral fellow).

Sorin Olaru is Principal investigator of the TEMPO ITN (Mohammed Laraba, Rajesh Koduri and Iris Ballesteros as PhD students financed by this training network within L2S).

9.3.2. Collaborations in European Programs, except FP7 & H2020

Program: GDRI (European research network founded by CNRS)

Project acronym: DelSys

Project title: Delay Systems

Duration: 2011-2015

Coordinator: Silviu Iulian Niculescu

Other partners: GIPSA-Lab and LAAS France, Ancona University Italy, Czech Technical University in Prague Czech Republic, Kent University Great-Britain, KTH Stockholm Sweden and KU Leuven Belgium.

Abstract: the aim of this GDRI is to bring together the main European teams which work in the fiels of Delay systems. This network meets once a year.

9.3.3. Collaborations with Major European Organizations

University of l'Aquila, Department of Electrical and Information Engineering (Italy)

Study of nonlinear systems with delay, (notably differential equations interconnected with difference equations) via Lyapunov-Krasovskii functionals.

Tel Aviv University, (Israel)

Stability analysis of nonlinear Partial Differential Equations, construction of observers (continuous/discrete obsevers for systems with delay, observers with convergence in finite time).

9.4. International Initiatives

Sorin Olaru is member of the LIA between several universities in Montreal Canada and Laboratoire des Signaux et Systèmes (L2S).

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- Kyushu Institute of Technology, Iizuka, Fukuoka and University of Kyoto, Kyoto, Japan.

- Louisiana State University, Baton Rouge, USA

- School of Electrical Engineering at the Tel-Aviv University

- Unicamp, Campinas, Brazil

- The University of Texas at Austn, Dept. of Aerospace Engineering & Engineering Mechanics

- University of Leeds, UK

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- S. Boatto, Feder. University Rio de Janeiro, Brazil, 20/06-07/10.
- G. Bitsoris, Univ of Patras, Greece.
- A. Fioravanti, UNICAMP Campinas, Brazil, 24/05-10/06.
- E. Fridman, University of Tel-Aviv, Isra\u00ab l, 07/07-13/07.
- M. Hovd, NTNU Trondheim, 01/09-31/12.
- Y. Yamamoto, University of Kyoto, Japan, 03/09-11/11.

9.5.1.1. Internships

- Licence: Q. Renvoise, *Lemme de perturbation homologique et ses applications en théorie du contrôle*, 03-06, Ecole Normale Supérieure de Rennes. Supervisor: A. Quadrat.
- Master 2: Liu Xuemin, *control of models of bioreactors with delay and piecewise constant feedbacks*, University Paris-Sud/CentraleSupelec. Financial support: iCODE. Supervisor : Frédéric Mazenc.

DIVERSE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. 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.

9.1.1.2. INFRA-JVM

- Coordinator: Université Paris 6
- Other partners: Université Bordeaux 1, Université Rennes 1 (DIVERSE), Ecole des Mines de Nantes
- Dates: 2012-2015
- Abstract: INFRA-JVM is an ANR project whose goal is to design and provide a new Java Virtual Machine dedicated to pervasive environments. This project focuses on designing a Java Virtual Machine for embedded computing platform offering dynamic reconfiguration capabilities. In this context, DIVERSEaddresses the problem of efficiently identifying faulty software components running simultaneously in a virtual machine without isolation. Current solutions that perform permanent and extensive monitoring to detect anomalies induce very high overhead on the system, and can, by themselves, make the system unstable. Our main objective is to investigate an optimistic adaptive monitoring system using models@runtime to determine the faulty components of an application.

9.1.1.3. 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.

9.1.2. BGLE / LEOC

9.1.2.1. 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.

9.1.2.2. 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).

9.1.2.3. 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.

9.1.3. DGA

9.1.3.1. 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.

9.1.3.2. FPML

- 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.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. 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.

9.2.1.2. 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.

9.2.2. Collaborations in European Programs, except FP7 & H2020

9.2.2.1. 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.

9.2.2.2. ITEA MERGE

- Coordinator: Thales Research and Technology
- Other partners: Thales Global Services, Thales Communications and Security, OBEO, ALL4TEC, Onera, Inria, Université Paris VI, Codenomicon, STUK - Radiation and Nuclear Safety Authority, POHTOnSense Oy, University of Oulu, University of Jyvaskyla, Space Applications Services NV, Melexis, E2S, Katholieke Universiteit Leuven
- Dates: 2012-2015
- Abstract: MERgE stands for "Multi-Concerns Interactions System Engineering". Within the "Engineering support" theme of ITEA2 roadmap, the purpose of this project is to develop and demonstrate innovative concepts and design tools addressing in combination the "Safety" and "Security" concerns, targeting the elaboration of effective architectural solutions. MERgE will provide tools and solutions for combining safety and security concerns in systems development in a holistic way. It will provide academically solid and practice proven solutions and models for system developers and system owners to tackle the challenges of designing seamless optimal cost effective safe and secure solutions conformant to the model driven engineering paradigm. This will be done by tightly integrating the following paradigms: requirement engineering, safety, security and risk management in an over-all design process which is supported by adequate tools and methods. MERgE aims to bring a system engineering solution for Combined Safe & Secure system design. The main technical innovation of the project is the application of state of the art design tools tailorisation capabilities and "multi concern engineering" core technologies to the issue of interactions of "Safety" and "Security" concerns as well as other concerns like "Performance" or "Timing" in the design process.

9.2.3. 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.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

9.3.1.1.1. Inria International Chair

Prof. Robert B. France [0] was granted by an Inria international chair for the period 2013-2017. Prof. France collaborate intensively with many members of DIVERSE on various joint work, e.g., the Familiar project and the GEMOC initiative. The Inria International Chair allows Prof. France to visit once a year the team along the period.

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[0]Colorado State University, USA. See. http://www.cs.colostate.edu/~france/

9.3.1.2. Informal International Partners

- Université de Montréal (Canada)
- McGill University (Canada)
- University of Alabama (USA)
- TU Wien (Austria)
- Michigan State University (MSU)
- Aachen University (Germany)

9.3.2. 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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Prof. Jörg Kienzle from McGill University (Canada) has been in the DIVERSE team during his Sabbatical from September 2015 to December 2015.
- Prof. Betty H.C. Cheng from Michigan State University (USA) visited the DIVERSE team in December 2015.
- Dr. Franck Fleurey from Sintef visited the DIVERSE team two weeks the team in July and November 2015.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

- CPER "data" (2015-2020) : co-leader of a workpackage "Research infrastructure". 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".
- PPF (Bioinformatics) : This national program within the University of Lille 1 deals with solving bioinformatics and computational biology problems using combinatorial optimization techniques.
- PPF HPC (High performance computing) : the objective is to support the coordination in terms of scientific animation, training, equipement and patnership development related to simulation and high performance computing. This action is granted 17K€ per year by University Lille 1.

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, CHRU Lille, CHRU Montpelier, CHICL, Alicante (7 partners) (2014-2017) - Coordinator -
- 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. Collaborations in European Programs, except FP7 & H2020

Program: COST

Project acronym: cHiPSet

Project title: High-Performance Modelling and Simulation for Big Data Applications

Duration: 01 2015 - 01 2018

Coordinator: Joanna Kolodziej

Other partners: organisme, labo (pays): Spain, Poland, Germany, France, Luxembourg, italy, ...

Abstract: The Big Data era poses a critically difficult challenge and striking development opportunities in High-Performance Computing (HPC): how to efficiently turn massively large data into valuable information and meaningful knowledge. Computationally effective HPC is required in a rapidly-increasing number of data-intensive domains, such as Life and Physical Sciences, and Socio-economical Systems.

Modelling and Simulation (MS) offers suitable abstractions to manage the complexity of analysing Big Data in various scientific and engineering domains. Unfortunately, Big Data problems are not always easily amenable to efficient MS over HPC. Also, MS communities may lack the detailed expertise required to exploit the full potential of HPC solutions, and HPC architects may not be fully aware of specific MS requirements.

Therefore, there is an urgent need for European co-ordination to facilitate interactions among data-intensive MS and HPC experts, ensuring that the field, which is strategic and of long-standing interest in Europe, develops efficiently - from academic research to industrial practice. This Action will provide the integration to foster a novel, coordinated Big Data endeavour supported by HPC. It will strongly support information exchange, synergy and coordination of activities among leading European research groups and top global partner institutions, and will promote European software industry competitiveness

9.3.2. Collaborations with Major European Organizations

University of Luxembourg: (Luxembourg)

Energy aware scheduling in Cloud computing systems

9.4. International Initiatives

9.4.1. Inria International Labs projects

- Collaboration with University of Mons (UMONS). The collaboration consists mainly in the joint supervision of three Ph.D theses: the thesis of Rudi Leroy defended on November 19th, 2015, the thesis of Jan Gmys started last year, and the thesis of Gautier Vaillant started in September 2015.

9.4.2. Inria Associate Teams not involved in an Inria International Labs

9.4.2.1. 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 (Nagano, Japan) and Inria, signed on March 2014.

9.4.3.2. Informal International Partners

- University of Coimbra, Portugal.
- IRIDIA, Université Libre de Bruxelles.
- Cologne University of Applied Sciences, Germany.
- Leiden University, Netherlands.
- UMONS University and Tractebel company, Belgium.
- EMI - Univ. Rabat, Morocco.
- Univ. Oviedo, Spain.
- Univ. Istanbul, Turkey.
- University of KULAK Team Codes (Belgium) - Data science for Optimization
- University of KENT (UK) - Knowledge and Optimization
- University of Aberdeen (UK) - Fitness landscape, representation and performance
- University of British Columbia, Canada
- University of Münster, Germany

9.4.4. Participation In other International Programs

- JSPS-MEXT project on Evolutionary multi-objective optimization, landscape analysis, and search performance, with Shinshu University, Nagano, Japan (2013—2016).
- Excellencia project(2015-2017) with University of Valencia (Spain) and University of Oviedo (Spain) on intelligent techniques for robust scheduling and energy-aware transportation systems.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Hernan Aguirre, Shinshu University, Nagano, Japan
- Prof. Kiyoshi Tanaka, Shinshu University, Nagano, Japan
- Fabio Daolio [PostDoc, Shinshu University, Nagano, Japan, from Sept 2014 to Sept 2015]
- Saúl Zapotecas-Martínez [PostDoc, Shinshu University, Nagano, Japan, from Nov 2014 to Dec 2015]
- Prof. Qingfu Zhang, CityU, Hong-Kong
- Dr. Oliver Schuetze, CINVESTAV-IPN, Mexico
- Prof. H-J. Siegel (Univ. Colorado, USA)
- Prof. R. Ellaia (EMI, Morocco)

- Prof. A. Tchernik (Mexico)
- Prof. B. Gendron (Canada)
- Dr. Myriam Delgado (Federal University of Technology of Paraná, Brazil), 1 week, December 2015
- Tiago-Carneiro Pessoa [Universidade Federal do CEARA, Brazil, from 09/2015 to 08/2016]

9.5.1.1. Internships (Master & PhD)

- Tiago-Carneiro Pessoa [Phd student from Universidade Federal do CEARA, Brazil. from Sept 2015 to Jan 2017].
- Juan Palacios Alonso (Univ. Oviedo Spain).
- Igor Machado Coelho (Univ. Fluminense Brazil).

9.5.1.2. Research stays abroad

- A. Liefooghe, May 2015, Shinshu University, Nagano, Japan.
- A. Liefooghe, Dec 2015, Shinshu University, Nagano, Japan.
- M-E Marmion, C. Dhaenens, invited at Shinshu University (1 week, february 2015)
- E-G. Talbi, Mar 2015, Univ. Murcia, Spain.
- E-G. Talbi, Juin 2015, EMI, Univ. Agdal Rabat, Morocco.
- E-G. Talbi, Jul 2015, Univ. Luxembourg.

<p align="center">**DRACULA Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Projects coordination by a member of Dracula

- ANR STOCHAGENE "Role of the chromatin dynamics on the stochasticity in gene expression in higher eukaryotic cells", 2011-2015.
  Participant: Olivier Gandrillon [Coordinator].

Collaboration in other projects

- ANR RPIB PrediVac "Innovative modeling tools for the prediction of CD8 T cell based vaccine efficacy", 2013-2016. Partners: U1111 Inserm (J. Marvel, coordinator), Dracula, Altrabio (small company), CoSMo (small company). For Dracula, the budget from 2013 to 2016 is 198 keuros, including three one-year post-doc positions (one post-doc has been recruited in April 2014 (Xuefeng Gao)), and the members are Fabien Crauste and Olivier Gandrillon.
- Thomas Lepoutre participates in the ANR (jeunes chercheurs) MODPOL (head Vincent Calvez (ENS Lyon)) "Cell polarization modeling", 2011-2015.
- Thomas Lepoutre is a member of the ANR KIBORD (head L. Desvillettes) dedicated to "kinetic and related models in biology". 2012-2016.
- Thomas Lepoutre is a member of the ERC MESOPROBIO (head V. Calvez) dedicated to "Meso-scopic models for propagation in biology". 2015-2020.
- 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".

8.1.2. Other projects

- Inria ADT : SiMuScale "Simulations Multi-Échelles de Populations Cellulaires", 2014-2016.
  Participants: Samuel Bernard [Coordinator], Fabien Crauste, 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.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7 & H2020

- Research program PHC POLONIUM (2014-2015) "Applications of reaction-diffusion equations in biology and medicine". Partners: Warsaw, Poland (Slawomir Bialecki, Jolanta Ciesielska, Bogdan Kazmierczak (coordinator), Marek Kochanczyk, Tomasz Lipniacki).
  Participants: Mostafa Adimy, Abdennasser Chekroun, Laurent Pujo-Menjouet [Coordinator], Alen Tosenberger, Vitaly Volpert.

8.2.2. Collaborations with Major European Organizations

- University of Valladolid (Spain). Collaboration with Oscar Angulo, Juan Carlos Lopez-Marcos and Miguel Ange Lopez-Marcos, on the analysis of an age-structured model describing erythropoiesis, and its numerical resolution.
- Karolinska University Hospital of Stockholm (Sweden). Collaboration with Peter Arner, Mats Eriksson, Erik Arner, Mikael Rydén and Kirsty L. Spalding, on the study of dynamics of human adipose lipid turnover in health and metabolic disease.

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):

Center for Scientific Computation And Mathematical Modelling, University of Maryland (United States).

Duration: 2013 - 2015.

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.

8.3.2. Participation In other International Programs

8.3.2.1. M3CD

Program: Euromediterranean 3+3

Title: Mathematical Models and Methods in Cell Dynamics

Inria principal investigator: Mostafa Adimy

International Partners (Institution - Laboratory - Researcher):

Institut Pasteur de Tunis (Tunisia) - Slimane Ben Miled

Consiglio Nazionale delle Ricerche- Istituto per le Applicazioni del Calcolo Mauro Picone (Italy) - Istituto per le Applicazioni del Calcolo Mauro Picone - Roberto Natalini

Cadi Ayyad University (Morocco) - Populations Dynamics Laboratory - Moulay Lhassan Hbid

Duration: Jan 2012 - Dec 2015

The aim of this project is to establish a network working on mathematical and computational models in cell dynamics. This network consists of five groups which have already established close bilateral relations. Those are the Inria teams Bang and Dracula in Paris and Lyon, France, the team IAC-CNR in Rome, Italy, the laboratory of Mathematical Population Dynamics (LMDP) from the university of Marrakech in Morocco, and the team of Mathematical Modelling and Computing in Biology (MoMinBi) from the Pasteur Institute in Tunis. Modelling cell dynamics and related processes is one of the main subjects of interest for the partners for many years. The issues addressed in the present project can be divided into five parts:

1) Analysis of structured models in cell population dynamics ;

2) Dynamics of normal and pathological haematopoiesis ;

3) Dynamics of Darwinian adaptation, in particular by drug resistance in competing cell or parasite populations, healthy and pathological / pathogenic (cancer, bacteria, parasites) ;

4) Dynamics of chemical and physical determinants of filament formation and intracellular spatial organisation of the cytoskeleton conformation ;

5) Coupling of the molecular mechanisms of control of the cell division cycle and cell proliferation.

The first part has been developed for many years by all the partners in this project. It tackles issues related to cell dynamics and biological mechanisms, physiological and chemical properties of cells and cell populations. The other four aspects of the project have been studied in the past by the Inria teams "Bang" and "Dracula" (**2**, **4**, **5**) and the IAC-CNR team (Rome), or are a rapidly emergent theme in Bang (**3**, cell Darwinism) with possible and natural connections with the other teams, in particular IAC-CNR and MoMinBi in Tunisia. Themes (**2**, **4**, **5**) have also been initiated (for their fundamental part) in a recent collaboration between Dracula and the teams from Morocco and Tunisia. The objectives of the present project are to pursue and deepen the study of cell proliferation dynamics and cellular mechanisms using structured models that take into account some new structure variables. The development of computer models will also be investigated in this project. Training and research activities related to these topics are currently underway between the Inria teams and the teams from Marrakech and Tunis, and between the Italian team and Bang. Two co-supervised theses are currently in progress, a Spring school on this subject will be organised by the partners in 2012. This program comes at the right time to give a new impetus to this collaboration. It will lead to the establishment of a multi-site laboratory expertise in population dynamics modelling, especially in cellular dynamics. This project will also allow the teams from Morocco and Tunisia to use their knowledge on mathematics applied to cell dynamics.

8.3.2.2. FCRF

Program: Fonds France Canada pour la recherche (FFCR)- France Canada research fund (FCRF) "New research collaboration" 2014-2015.

Title: Mathematical modelling of megakaryopoiesis and applications to platelet related diseases

Participants: Mostafa Adimy, Fabien Crauste, Laurent Pujo-Menjouet [Coordinator].

International Partners : Canada (Jiguo Cao, Nemanja Kosovalic, Jianhong Wu).

DREAM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PEPS: Pharmaco-epidemiology for Health Products
Participants: Thomas Guyet, René Quiniou, Véronique Masson, 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 (3.6M€).

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. The pharmaco-epidemiology is the study of the uses, the effectiveness and the effects of health products (especially drugs) for the patients in a real live context, on a large population. Using medico-administrative databases – that contains information about the reimbursement of the medication, the medical visits and the cares – is a recent approach to enable studies on large cohortes and to reduce the response time to a pharmaco-epidemiology question.

Our contribution to this project will be the proposal of pattern mining algorithms and reasoning techniques to analyze typical care pathways of specific groups of insured patients.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

9.2.1.1.1. 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.

9.2.1.1.2. 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. T. Guyet and J. Romero worked together on using preferences to select best sequential patterns with ASP (see section 7.2.4) using the ASPRIN system. T. Guyet visited the Potascco group in may 2015.

DREAMPAL Project-Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Inria International Partners

8.1.1.1. Informal International Partners

We have a long-lasting collaboration with the universities of Illinois at Urbana Champaign (USA) and Iasi (Romania), which has been particularly fruitful in 2015 with 5 co-signed articles published or accepted for publication in high-quality journals.

<p align="center">**DYLISS Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Regional partnership with computer science laboratories in Nantes

Participants: Anne Siegel, Jérémie Bourdon, Damien Eveillard, François Coste, Jacques Nicolas, Vincent Picard.

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 process. The Ph-D students V. Picard and J. Laniau are also co-supervised with members of the LINA laboratory.

8.1.2. Regional partnership in Marine Biology

Participants: Catherine Belleannée, Jérémie Bourdon, Guillaume Collet, Jean Coquet, François Coste, Damien Eveillard, Olivier Dameron, Clémence Frioux, Clovis Galiez, Jeanne Got, Yann Guitton, Julie Laniau, Jacques Nicolas, Vincent Picard, 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 with the Biocore and Ange teams, together with Ifremer-Nantes, focused on the understanding on micro-algae (thesis of Julie Laniau).

8.1.3. Regional partnership in agriculture and bio-medical domains

Participants: Aymeric Antoine-Lorquin, Catherine Belleannée, Charles Bettembourg, François Coste, Jean Coquet, Olivier Dameron, Victorien Delannée, Jacques Nicolas, Anne Siegel, Nathalie Théret, Aurélie Evrard.

We have a strong and long term collaboration with biologists of INRA in Rennes : PEGASE and IGEEP units. This partnership is acted 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 post-doc of Charles Bettembourg strengthens these collaborations. This collaboration is also reinforced by collaboration within ANR contracts (MirNadapt, FatInteger). Lately, Aurélie 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, 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 will be pushed forward in the recent TGFSYSBio project funded by Plan Cancer on the modelling of the microenvironment of TGFbeta signaling network.

8.2. National Initiatives

8.2.1. Long-term contracts

8.2.1.1. "Omics"-Line of the Chilean CIRIC-Inria Center

Participants: Anne Siegel, Jérémie Bourdon, François Coste, Marie Chevallier, Meziane Aite, Clémence Frioux, Damien Eveillard, Jacques Nicolas.

Cooperation with Univ. of Chile (MATHomics, A. Maass) on methods for the identification of biomarkers and software for biochip design. 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, Guillaume Collet, François Coste, Damien Eveillard, Clémence Frioux, Clovis Galiez, Jeanne Got, Yann Guitton, 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 to workpackages 1 (establishment of a virtual platform for integrating omics studies on seaweed) and 4 (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) within workpackage 5 [More details].

8.2.2. Proof-of-concept on dedicated applications

8.2.2.1. ANR Fatinteger

Participants: Aymeric Antoine-Lorquin, Catherine Belleannée, Jacques Nicolas, Anne Siegel.

This project (ANR Blanc SVE7 "biodiversité, évolution, écologie et agronomie" from 2012 to 2015) is leaded by INRA UMR1348 PEGASE (F. Gondret). Its goal is the identification of key regulators of fatty acid plasticity in two lines of pigs and chickens. To reach these objectives, this project has for ambition to test some combination of statistics, bioinformatics and phylogenetics approaches to better analyze transcriptional data of high dimension. Data and methods integration is a key issue in this context. We work on the recognition of specific common cis-regulatory elements in a set of differentially expressed genes and on the regulation network associated to fatty acid metabolism with the aim of extracting some key regulators.

8.2.2.2. ANR Mirnadapt

Participants: Jacques Nicolas, Anne Siegel, Olivier Dameron, Charles Bettembourg.

This ANR project is coordinated by UMR IGEPP, INRA Le Rheu (D. Tagu) and funded by ANR SVSE 6 "Génomique, génétique, bioinformatique, biologie systémique" from 2012 to 2014. This cooperation was strengthened by a co-tutored PhD thesis (V. Wucher) defended in Nov. 2014 [92]. It proposes an integrative study between bioinformatics, genomics and mathematical modeling focused on the transcriptional basis of the plasticity of the aphid reproduction mode in response to the modification of environment. An important set of differentially expressed mRNAs and microRNAs are available for the two modes, asexual parthenogenesis and sexual reproduction. Our work is to combine prediction methods for the detection of putative microRNA/mRNA interactions as well as transcription factor binding sites from the knowledge of genomic sequences and annotations available on this and other insects. The results will be integrated within a coherent putative interaction network and serve as a filter for the design of new targeted experiments with the hope to improve functional annotations of implied genes.

8.2.2.3. ANR Samosa
Participants: Anne Siegel, Jeanne Got, Damien Eveillard.

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.

8.2.3. Programs funded by research institutions

8.2.3.1. INSERM TGFSYSBIO
Participants: Nathalie Théret, Jacques Nicolas, Olivier Dameron, Anne Siegel, Jean Coquet.

TGFSYSBIO project aims to develop the first model of extracellular and intracellular TGF-β system that might permit to analyze the behaviors of TGF-β 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-β-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-β. 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.

8.2.3.2. ADT Complex-biomarkers and ADT Proof of concept
Participants: Jeanne Got, Guillaume Collet, 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).

8.2.3.3. 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.

8.2.3.4. PEPS VAG

Participants: François Coste, Clovis Galiez, Jacques Nicolas.

PEPS VAG started a collaboration between IMPMC UMR 7590, Institut de biologie de l'Ecole Normale Supérieure (IBENS) UMR8197, Atelier de Bioinformatique UPMC and Dyliss. It aims at defining the needs and means for a larger project about viruses in marine ecosystems. More specifically,we develop new methods based on both sequential and structural information of proteins to improve the detection of viral sequences in marine metagenomes. This will make possible to identify new viruses and to compare the viral populations specifically associated with different environment parameters (temperature, acidity, nutriments...) and ultimately to connect them with the potential hosts identified by population sequencing.

8.2.3.5. PEPS CONFOCAL

Participants: Olivier Dameron, Jean Coquet, Nathalie Théret, Jacques Nicolas, Anne Siegel.

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 Rémy (Mathematics Institute Luminy, "Mathematical Methods for Genomics" team).

8.3. European Initiatives

8.3.1. *Collaborations with Major European Organizations*

Partner: EBI (Great-Britain)

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 joined the team as an engineer to improve softwares resulting from collaborations.

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) - Alejandro Maass

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 considered as a different scale of a biological process, either in time or space. But ultimately they 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-scale 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).

8.4.2. Inria Associate Teams

8.4.2.1. INTEGRATIVEBIOCHILE

Title: Bioinformatics and mathematical methods for heterogeneous omics data

Inria principal investigator: Anne Siegel

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - Center for Mathematical Modeling - Alejandro Maass

Duration: 2011 - 2016

See also: http://www.irisa.fr/dyliss/public/EA/index.html

IntegrativeBioChile is an Associate Team between Inria project-team "Dyliss" and the "Laboratory of Bioinformatics and Mathematics of the Genome" hosted at CMM at University of Chile. The Associated team is funded from 2011 to 2016. The project aims at developing bioinformatics and mathematical methods for heterogeneous omics data. Within this program, we funded long and short stay visitings in France.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- **Chile**. Centro de Modelimiento Matematico, Santiago [A. Maass, N. Loirà, M. Latorre]
- **Germany**. Frei Universitat Berlin [A. Bockmayr, H. Siebert]
- **Niger**. University of Maradi [O. Abdou-Arbi]
- **Turkey**. University of Istambul [A. Aravena]

8.5.2. Visits to International Teams

8.5.2.1. Explorer program

Galiez Clovis

Date: Mar 2015 - May 2015

Institution: University of California, Irvine (United States)

8.5.2.2. Short visits

- **Chile**. Centro de Modelimiento Matematico, Santiago de Chile [J. Bourdon, M. Chevallier, C. Frioux, A. Siegel]
- **Chile**. Centro de Modelimiento Matematico, Santiago de Chile [M. Chevallier]
- **Germany**. Frei Berlin University [A. Siegel]

<div align="center">

DYOGENE Project-Team

</div>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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.

9.1.2. ANR

9.1.2.1. ANR GAP

Graphs, Algorithms and Probability - PI: Marc Lelarge; started in Jan 2012 - 48 months. http://www.di.ens.fr/~lelarge/ANR-GAP.html

Over the last few years, several research areas have witnessed important progress through the fruitful collaboration of mathematicians, theoretical physicists and computer scientists. One of them is the cavity method. Originating from the theory of mean field spin glasses, it is key to understanding the structure of Gibbs measures on diluted random graphs, which play a key role in many applications, ranging from statistical inference to optimization, coding and social sciences.

The objective of this project is to develop mathematical tools in order to contribute to a rigorous formalization of the cavity method:

- From local to global, the cavity method on diluted graphs. We will study the extent to which the global properties of a random process defined on some graph are determined by the local properties of interactions on this graph. To this end, we will relate the cavity method to the analysis of the complex zeros of the partition function, an approach that also comes from statistical mechanics. This will allow us to apply new techniques to the study of random processes on large diluted graphs and associated random matrices.

- Combinatorial optimization, network algorithms, statistical inference and social sciences. Motivated by combinatorial optimization problems, we will attack long-standing open questions in theoretical computer science with the new tools developed in the first project. We expect to design new distributed algorithms for communication networks and new algorithms for inference in graphical models. We will also analyze networks from an economic perspective by studying games on complex networks.

9.1.2.2. 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.

9.2. International Initiatives

9.2.1. Inria Associate Teams not involved in an Inria International Labs

9.2.1.1. PARIS

Title: Probabilistic Algorithms for Renewable Integration in Smart Grid

International Partner (Institution - Laboratory - Researcher):

> University of Florida (United States) - Department of Electrical and Computer Engineering - Sean Meyn

Start year: 2015

See also: http://www.di.ens.fr/~busic/PARIS/

The importance of statistical modeling and probabilistic controlechniques in the power systems area is now evident to practitioners in both the U.S. and Europe. Increased introduction of renewable generation has brought unforeseen volatility to the grid that require new techniques in distributed and probabilistic control. This Associate Team brings together the complementary skills in optimization, Markov modeling, simulation, and stochastic networks with aim to help solving some pressing open problems in this area. This collaboration also opens many exciting new scientific questions in the broad area of stochastic modeling and control.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Venkatachalam Anantharam [Professor, University of California, Jul 2015]
- Bruce Hajek [Professor, CSL, from Feb 2015 until Mar 2015]
- Holger Keeler [Post-Doctoral Fellow, Weierstrass Institute, Mar 2015]
- Armand Makowski [Professor, University of Maryland, Jul 2015]
- Peter Marbach [Professor, University of Toronto, from Jan until Jul 2015]
- Piotr Markowski [PhD Student, University of Wroclaw, Jun 2015]
- Sean Meyn [Professor, University of Florida, Feb 2015 and Jul 2015]

9.3.2. Visits to International Teams

9.3.2.1. Research stays abroad

Bartek Blaszczyszyn was visiting Mathematical Department of Wroclaw Universty for two weeks in April and October 2015 giving a series of lectures on stochastic geometry and modeling of communication networks.

ECUADOR Project-Team

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 Bonn, Germany, december 2-5.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Krishna Narayanan from Argonne National Laboratory, september 21-25.

8.4.2. Internships

- Marcin Wyrozebski from Warsaw University of Technology, september 1-30.

8.4.3. Visits to International Teams

- Laurent Hascoët visited Argonne National Laboratory, april 13-23.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. 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/

8.1.1.2. 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-Lafferière, H. Lopez-Maestre, C. Marchet, G. Sacomoto, M.-F. Sagot, B. Sinaimeri
- Type: ANR (2013-2016)
- Web page: http://colibread.inria.fr/

8.1.1.3. ExHyb

- Title: Exploring genomic stability in hybrids
- Coordinator: C. Vieira
- ERABLE participant(s): C. Vieira
- Type: ANR (2014-2018)
- Web page: Not available

8.1.1.4. 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

8.1.2. Others

Notice that were included here regional projects of our members from Italy when these have no other partners than researchers from the same country.

8.1.2.1. Exomic

- Title: Functional annotation of the transcriptome at the exon level
- Coordinator: D. Auboeuf (Inserm, Lyon)
- ERABLE participant(s): V. Lacroix, M.-F. Sagot
- Type: INSERM Systems Biology Call (2012-2015)
- Web page: Not available

8.1.2.2. Amanda

- Title: Algorithmics for MAssive and Networked DAta
- Coordinator: G. Di Battista (University of Roma 3)
- ERABLE participant(s): R. Grossi, N. Pisanti
- Type: MIUR PRIN, Italian Ministery of Research National Projects (2014-2017)
- Web page: http://www.dia.uniroma3.it/~amanda/research-units.php

8.1.2.3. Effets de l'environnement sur la stabilité des éléments transposables

- Title: Effets de l'environnement sur la stabilité des éléments transposables
- Coordinator: C. Vieira
- ERABLE participant(s): C. Vieira
- Type: Fondation pour la Recherche Médicale (FRM) (2014-2016)
- Web page: Not available

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. BacHBerry

- Title: BACterial Hosts for production of Bioactive phenolics from bERRY fruits
- Duration: November 2013 - October 2016
- Coordinator: Jochen Förster, DTU Danemark
- ERABLE participant(s): R. Andrade, L. Bulteau, A. Julien-Laferriére, V. Lacroix, A. Marchetti-Spaccamela, A. Mary, D. Parrot, M.-F. Sagot, L. Stougie, A. Viari, M. Wannagat
- Type: FP7 - KBBE
- Web page: http://www.bachberry.eu/

8.2.1.2. MicroWine

- Title: Microbial metagenomics and the modern wine industry
- Duration: January 2015 - January 2019
- Coordinator: Lars Hestbjerg Hansen, University of Copenhagen
- ERABLE participant(s): A. Marchetti-Spaccamela, A. Mary, H. T. Pusa, M.-F. Sagot, L. Stougie
- Type: H2020-MSCA-ETN-2014
- Web page: http://www.microwine.eu/

8.2.1.3. SWIPE

- Title: Predicting whitefly population outbreaks in changing environments
- Duration: 2012 - 2015
- Coordinator: E. Zchori-Fein
- ERABLE participant(s): F. Vavre
- Web page: Not available

8.2.1.4. SISYPHE
- Title: Species Identity and SYmbiosis Formally and Experimentally explored
- Duration: 2010-2015 (ended March 31st)
- Coordinator: M.-F. Sagot
- BAMBOO participant(s): Whole BAMBOO team
- Type: ERC Advanced Grant
- Web page: http://team.inria.fr/erable/en/older-projects/erc-sisyphe/

8.2.2. Collaborations with Major European Organisations

By itself, ERABLE is built from what initially were collaborations with some major European Organisations (CWI, Sapienza University of Rome, Universities of Florence and Pisa, Free University of Amsterdam) and now has become a European Inria Team.

8.3. International Initiatives

8.3.1. 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 the presence of 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.

8.3.2. 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/

8.3.3. 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 BAMBOO. 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/bamboo/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". 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. The project started in 2013 for 2 years, and then 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 had a Stic AmSud project accepted in 2015 that will start 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 tumor/normal samples and RNAseq of tumor samples). One of the scientific goals is to decipher whether the HER2/ERBB2 amplification is a driver or passenger event in the course of tumor development.

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

In 2015, ERABLE greeted the following International scientists:

- In France: Katharina Huber (University of Warwick, UK), Giuseppe Italiano (Tor Vergata University of Rome, Italy, various visits), Ana Rute Neves and Zeidan (ChR Hansen, Oslo, Danemark), three members of the LIA LIRIO (Arnaldo Zaha from the Federal University of Rio Grande do Sul, Maria Cristina Motta from the Federal University of Rio Grande do Sul, and Ana Tereza Vasconcelos from the LNCC, all in Brazil), Susana Vinga and various members of her team (IDMEC-IST Portugal), Tiziana Calamoneri (Sapienza University of Rome).

- In Italy: David Coudert (Inria Sophia Antipolis, France, to Florence), Alberto Policriti (University of Udine, Italy, to Pisa), Fabio Vandin (University of Southern Danemark to Pisa), Solon Pissis (King's College London UK to Pisa), Costas Iliopoulos (King's College London UK to Pisa), Grzegorz Rozenberg (Leiden University, The Netherlands, and Boulder University of Colorado, USA, to Pisa).

- In The Netherlands: Kirk Pruhs (University of Pittsburgh, USA), Kevin Schewior (Technical University of Berlin, Germany), Paola Bonizzoni, Yuri Pirola and Simone Zaccharia (all from the University of Milano-Bicocca, Italy).

8.4.2. *Internships*

In 2015, ERABLE greeted on average the following internship students:

- In France: Bastien Sylvere, Master 1 (2 months); Audric Cologne, Master 1 (3 months); Henri Dupoy, Master 1 (2 months); Virginie Jouffret, Master 1 (2 months); Caroline Michaud, Master 2 (6 months); Hong-Phong Pham, Master 2 (5 months); Nabel Sersoub, Master 1 (2 months); Manon Villa, Master 1 (2 months).

- In Italy: Anna Tarsia, Master 2 (Pisa).

- In The Netherlands: Gunnar Klau supervised a couple of MSc and BSc theses.

8.4.3. *Visits to International Teams*

8.4.3.1. Visits

In 2015, 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 Departement 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 the members of her team (IDMEC-IST Portugal).

- In Italy: visit to Pierre Fraigniaud and Michel Habib at LIAFA, Paris, visit to Solon Pissis and Costas Iliopoulos at King's College London UK.

- In The Netherlands: visit to the Technical University of Berlin, visit to Paola Bonizzoni and her group at the University of Milano-Bicocca.

8.4.3.2. Research stays abroad

Gunnar Klau will be spending 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.

<h1 style="text-align:center; color:red">ESTASYS Team</h1>

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Privacy

Participants: Axel Legay, Fabrizio Biondi, Jean Quilbeuf.

Privacy is a regional project whose objective is to quantify privacy of data. This includes, e.g., quantifying the anonymity of a voting protocol.

7.1.2. Variability

Participants: Axel Legay, Jin Hyun Kim, Louis-Marie Traonouez.

Variability is a regional project whose objective is to lift scheduling techniques to connected-objects. The main application of the project is Systems of Systems.

7.2. National Initiatives

7.2.1. ANR Malthy

Participants: Axel Legay, Rudolf Fahrenberg, Louis-Marie Traonouez.

The objective of this project is to study new models and techniques to reason on quantitative systems. We mainly focus on the composition of timed components in a dynamic setting.

7.2.2. BGLE SyS2Soft

Participants: Axel Legay, Thomas Given-Wilson, Cyrille Jegourel.

This national project studies various languages and techniques for quantitative systems.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. ACANTO

Title: ACANTO: A Cyber physicAl social NeTwOrk using robot friends

Programm: H2020

Duration: February 2015 - August 2018

Coordinator: Universita di Trento

Partners:

Atos Spain (Spain)

Envitel Tecnologia Y Control S.A. (Spain)

Foundation for Research and Technology Hellas (Greece)

Servicio Madrileno Delud (Spain)

Siemens Aktiengesellschaft Oesterreich (Austria)

Telecom Italia Spa (Italy)

Universita' Degli Studi di Siena (Italy)

Universita Degli Studi di Trento (Italy)

University of Northumbria At Newcastle. (United Kingdom)

Inria contact: Axel Legay

'Despite its recognised benefits, most older adults do not engage in a regular physical activity. The ACANTO project proposes a friendly robot walker (the FriWalk) that will abate a some of the most important barriers to this healthy behaviour. The FriWalk revisits the notion of robotic walking assistants and evolves it towards an activity vehicle. The execution of a programme of physical training is embedded within familiar and compelling every-day activities. The FriWalk operates as a personal trainer triggering the user actions and monitoring their impact on the physical and mental well-being. It offers cognitive and emotional support for navigation pinpointing risk situations in the environment and understanding the social context. It supports coordinated motion with other FriWalks for group activities. The FriWalk combines low cost and advanced features, thanks to its reliance on a cloud of services that increase its computing power and interconnect it to other assisted living devices. Very innovative is its ability to collect observations on the user preferred behaviours, which are consolidated in a user profile and used for recommendation of future activities. In this way, the FriWalk operates as a gateway toward a CyberPhysical Social Network (CPSN), which is an important contribution of the project. The CPSN is at the basis of a recommendation system in which users' profiles are created, combined into 'circles' and matched with the opportunity offered by the environment to generate recommendations for activities to be executed with the FriWalk support. The permanent connection between users and CPSN is secured by the FriPad, a tablet with a specifically designed user interface. The CPSN creates a community of users, relatives and therapists, who can enter prescriptions on the user and receive information on her/his state. Users are involved in a large number in all the phases of the system development and an extensive validation is carried out at the end.'

7.3.2. Danse

Program: FP7

Project acronym: DANSE

Project title: Designing for Adaptability and evolutioN in System of systems Engineering

Duration: Octobre 2011 – March 2015

Coordinator: Offis

Abstract: Design and verification of Systems of Systems. We contributed by proposing the first verification engine for Heterogeneous SoS. For doing so, we have combined Plasma with Desyre that is a simulator for SoS described via the standardised FMI/FMU approach.

7.3.3. Meals

Program: Marie Curie

Project acronym: Meals

Project title: Mobility between Europe and Argentina applying Logics to Systems

Duration: Octobre 2012 – Octobre 2015

Coordinator: Germany (Saarbrucken) and Argentina (Corona)

Abstract: Collaborative action on the topic of quantitative systems

7.3.4. Sensation

Program: Fet ProActif

Project acronym: Sensation

Project title: Self Energy-Supporting Autonomous Computation

Duration: Octobre 2012 – Octobre 2015

Coordinator: Aalborg University

Abstract: Development of new results for energy-centric systems. We contributed by proposing new algorithms for rare-event simulation.

7.3.5. EMC2

Program: ARTEMIS

Project acronym: EMC2

Project title: Embedded Multi-Core systems for Mixed Criticality applications in dynamic and changeable real-time environments

Duration: mars 2014 – mars 2017

Coordinator: Infineon

Abstract: Large initiative on embadded systems and SoS. We will contribute with our expertise from DANSE and Sensation projects.

7.3.6. Collaborations with Major European Organizations

- Partner 1: Aalborg University, Computer Science, Denmark
- Statistical Model Checking, and Systems of Systems
- Partner 2: Rice University, Computer Science, USA
- Synthesis of components of Systems of Systems
- Partner 3: Namur University, Computer Science, Belgium
- Variability in software engineering
- Partner 4: Louvain University, Computer Science, Belgium
- Verification of Systems of Systems via Statistical Model Checking, especially train stations in collaboration with Alstom.
- Partner 5: Waterloo University, Computer Science, Canada
- Variability in Systems of Systems

7.4. International Initiatives

7.4.1. Visits of International Scientists

7.4.1.1. Internships

- Karin Quaas, PostDoc at Leipzig University
- Kim Larsen, Professor at Aalborg University
- Rafael Olochea, PhD student at Waterloo University
- Yusuke Yamamoto, Assistant Professor, Japan.

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Competitivity Clusters

9.1.1.1. SAHARA

Participants: Pascale Minet, Erwan Livolant.

Period: 2011 - 2015.

Partners: EADS (coordinator), Astrium, BeanAir, CNES, ECE, EPMI, Eurocopter, GlobalSys, Inria, LIMOS, Oktal SE, Reflex CES, Safran Engineering Systems.

SAHARA is a FUI project, labelled 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.

During year 2015, we provided support to the SMEs in the SAHARA project for the implementation of network algorithms and protocols.

9.1.1.2. 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 May and June 2015, we contributed with our Connexion partners to a demonstration showing that OCARI:

- supports wireless sensors of various types (e.g. temperature sensor PT100, smoke detector produced by CEA, fire alarm produced by ADWAVE, various types of flowmeters by Krohne);
- supports mobile nodes and collects their data using router nodes depending on the location of the node embedded in a mobile robot.

All the chain ranging from the physical sensors, the OCARI wireless network, the OPC/UA bus to the KASEM software was integrated to build a Service-Oriented Architecture where new services are created when new sensor nodes are deployed. Services corresponding to sensor nodes that are no longer available, are suppressed. After a service discovery, clients can select the types of measurements made by the sensor nodes they want to visualize.

In June 2015, the CONNEXION project organized an open workshop where EXERA (group of users of instrumentation and systems) was invited. **Pascale Minet** and Erwan Livolant contributed to a demonstration illustrating the integration of the OCARI wireless sensor network, the OPC-UA/ROSA middleware and the KASEM predictive maintenance system in an industrial application. A video presenting this integration was made with the participation of EDF, Inria, Telecom ParisTech, KASEM and CEA.

We also focused on deployment algorithms for mobile wireless sensor networks in temporary worksites or after a disaster. These deployments must meet coverage and connectivity requirements. In 2015 we studied solutions to ensure full coverage of the area to monitor as well as network connectivity. We proposed the OA-DVFA distributed algorithm to deploy autonomous and mobile wireless sensor nodes in a 2D area in the presence of unknown obstacles that are progressively discovered. This distributed algorithm combines the advantages of virtual forces for a fast spreading of sensor nodes and those of a virtual grid avoiding node oscillations and allowing a simple detection of redundant nodes. We also tackled the problem of deploying static sensor nodes, assisted by mobile robots that place the sensor nodes at the positions computed. The solution proposed, called MRDS, solves a multi-objective optimization problem by using a genetic algorithm.

We also studied network connectivity, more particularly how to ensure a reliable connectivity of the sink with each sensor node located at some point of interest (PoI). Our goal was to find the best trade-off between the number of relay nodes deployed and the length of the paths connecting each PoI to the sink.

9.1.2. 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. FP7 & 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 TROPIC (Distributed computing, storage and radio resource allocation over cooperative femtocells) project.

9.2.2. Collaborations with Major European Organizations

European Telecommunications Standards Institute (ETSI)

Co-organization First ETSI 6TiSCH plugtest (interop event) in Prague, Czech Republic, 17-18 July 2015.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. REALMS

Type: Associate Team

Inria International Lab: Inria@SiliconValley

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: https://realms-team.github.io/

Inria contact: **Thomas Watteyne**

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

Inria-EVA has a strong relationship with ENSI (Tunisia) and ENSIAS (Morocco). A significant part of our PhD students come from these engineering schools.

University of California, Berkeley, CA, USA

- 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 .

University of Michigan, Ann Arbor, MI, USA

- Collaboration with Prof. Branko Kerkez through the REALMS associate team, see Section 9.3.1.1 .

KU Leuven, Belgium

- Collaboration with Prof. Danny Hughes, Prof. Wouter Joosen, Dr. Nelson Matthys, Fan Yang, Wilfried Daniels on MicroPnP and on security for the IoT.
- Dr. Malisa Vucinic, postdoctoral researcher at KU Leuven, works part time in the Inria-EVA team.
- We won Third Place in the IPSO CHALLENGE 2015 for common project MicroPnP, see Section 5.1 .
- Joint publication(s) in 2015: [35].

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.

- We won the IPSO CHALLENGE 2015 People's Choice Award for common project HeadsUp!, see Section 5.1 .
- Joint publication(s) in 2015: [44].

9.3.2.2. Informal International Partners

University of California, Berkeley, CA, USA

- Collaboration with Prof. Kris Pister, Dr. Nicola Accettura, Dr. Kazuki Muraoka and David Burnett on OpenWSN and 6TiSCH standardization.
- Joint publication(s) in 2015: [5], [16], [10].

Universitat Oberta de Catalunya, Barcelona, Spain

- Collaboration with Prof. Xavi Vilajosana and Dr. Pere Tuset on OpenWSN, 6TiSCH standardization and OpenMote technologies.
- We organized two OpenWSN/OpenMote tutorials together, see Section 5.1 .
- Joint publication(s) in 2015: [16], [17], [41], [15].

University of Luxembourg, Luxembourg

- Collaboration with Prof. Thomas Engel and Dr. Maria-Rita Palattella on 6TiSCH standardization.
- Joint publication(s) in 2015: [10], [13], [15]. Joint publications in 2015: TODO.

Universidad Diego Portales, Chile

- Collaboration with Prof. Diego Dujovne on OpenWSN and 6TiSCH standardization.
- Joint publication(s) in 2015: [10].

University of Science and Technology, Beijing, China

- Collaboration with Prof. Qin Wang and Tengfei Chang on 6TiSCH standardization and OpenWSN.
- Joint publication(s) in 2015: [5], [10].

University of Southern California, CA, USA

- Collaboration with Prof. Bhaskar Krishnamachari, Pedro Henrique Gomes and Pradipta Gosh on OpenWSN and 6TiSCH-based research.
- Joint publication(s) in 2015: [40].

University of Bari, Italy

- Collaboration with Prof. Alfredo Grieco, Prof. Gennaro Boggia, Dr. Giuseppe Piro and Savio Sciancalepore on security for the IoT.
- Joint publication(s) in 2015: [10].

Swedish Institute of Computer Science (SICS), Sweden

- Collaboration with Prof. Olaf Landsiedel, Dr. Simon Duquennoy and Beshr Al Nahas on distributed scheduling for TSCH networks.
- Joint publication(s) in 2015: [28].

University of Trento, Italy

- Collaboration with Dr. Oana Iova on routing in the IoT.
- Joint publication(s) in 2015: [9].

IMEC, Netherlands

- Collaboration with Dr. Pouria Zand on 6TiSCH standardization.
- Joint publication(s) in 2015: .

9.3.3. Participation In other International Programs

9.3.3.1. 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: TPropose 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.

9.3.3.2. AWSN

Program: Euromediterranean 3+3

Title: Adaptive Wireless Sensor Networks

Inria principal investigator: **Pascale Minet**

International Partners (Institution - Laboratory - Researcher):

University of Catania (Italy) - DIEEI - Lucia Lo Bello

Ecole Nationale Supérieure d'Informatique et d'Analyse des Systèmes (Morocco) - ND-SRG - Mohamed Erradi

Ecole Nationale des Sciences de l'Informatique (Tunisia) - CRISTAL - Leila Azouz Saidane

Duration: Jan 2012 - Dec 2015

Wireless sensor networks (WSNs) allow the development of numerous applications in various domains, such as security and surveillance, environment protection, precision agriculture, intelligent transportation, homecare of elderly and disabled people... Communication in such WSNs has to cope with limited capacity resources, energy depletion of sensor nodes, important fluctuations of traffic in the network, changes in the network topology (radio link breakage, interferences ...) or new application requirements. In the AWSN project, we focus on the different techniques to be introduced in the WSNs to make them auto-adaptive with regard to these various changes, while meeting the application requirements. Thus, we address:

- network deployment and redeployment in order to fulfill the application requirements,
- QoS (Quality of Service) optimization taking into account real-time traffic and dynamic bandwidth allocation,
- energy efficiency and replacement of failed sensor node,
- component generation and dynamic adaptation of the application.

After the mid-term evaluation, the last topic has been replaced by the use of game theory in WSNs, where the Moroccan team is leader.

Three applications have been identified to apply the results obtained within the AWSN project: e-health, precision agriculture and Industrial WSNs with cooperative mobile robot applications. The first three topics previously defined have to be addressed in all these applications. A hierarchical architecture with different types of networks is present: WBAN and/or WSN, wireless or wired LAN, interconnected to the Internet. In addition, mobile nodes exist in these applications (e.g. mobile sinks with nurses and doctors as well tractors and farm machines, mobile robots).

In 2015, the AWSN project organized two workshops open to students and researchers:

- Workshop in Rabat in November 2015.
- Workshop in Rocquencourt in December 2015.

The AWSN project organized also open international workshops and conferences:

- RAWSN 2015: Agadir, May 2015, organized by the Moroccan team, http://www.fsdmfes.ac.ma/rawsn/
- WINCOM 2015: Marrakech, October 2015, organized by the Moroccan team, http://www.wincom-conf.org/
- the PEMWN 2015 conference in Hammamet in November 2015, 4th edition organized by the Tunisian and French teams, see the program on https://sites.google.com/site/pemwn2015/final-program

The outcomes of the AWSN project are multiple:

- Degrees obtained: 2 HDR, 5 PhD and 11 Masters.
- Hiring: 6 Assistant Professors in Tunisia.
- Internships: 5 internships of Tunisian students at Inria.
- Invited Professor: Leila saidane was invited at Inria for a month in 2015.
- Publications: 13 international journals and 49 international conferences

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- **Carlos Oroza**, PhD student, UC Berkeley, USA, 19-30 October 2015
- **Prof. Diego Dujovne**, Professor, Universidad Diego Portales, Chile, 28-31 July 2015
- **Sami Malek**, PhD student, UC Berkeley, USA, 26 May - 12 June 2015
- **Leila Saidane**, ENSI, Tunis, Tunisia, October, November and December 2015
- **Mohammed Erradi**, ENSIAS, Rabat, Morocco, September 2015
- **Abdellatif Kobbane**, ENSIAS, Rabat, Morocco, September 2015

9.4.1.1. Internships

- **Kevin Tewouda**, internship on simulation of wireless networks with NS3, March-August 2015.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

- **Thomas Watteyne**, visits to Prof. Glaser's team at UC Berkeley, as part of the REALMS associate team (Section 9.3.1.1), 10-16 May, 1-17 August, 30 November-4 December 2015.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. DigiPods – Remote Collaborative Interaction among Heterogeneous Visualization Platforms

Type: CESAME equipment grant

Funding: Région Île-de-France

Duration: 2012-2015

Coordinator: Stéphane Huot

Partners: Digiteo/FCS Campus Paris-Saclay, Univ. Paris-Sud, Inria, CNRS, CEA, Telecom Paris-Tech

Abstract: The goal is to design new interactive equipment and devices for collaborative interaction in immersive and high-resolution visualization platforms, connected through a high-end telepresence infrastructure. Beyond the usual interactive devices of such platforms (motion capture, interactive surfaces, haptic devices, audio and video systems), we are creating new devices to facilitate co-located or remote interaction and collaboration: telepresence robots and Digicarts, mobile hubs that gather interaction and communication devices. This equipment will be used by Human-Computer Interaction researchers to explore the visualization and manipulation of large datasets, interaction in virtual reality, and remote collaboration among heterogeneous platforms. Researchers and professionals in other fields will also be able to use DigiPods to explore and manipulate complex datasets.

9.1.2. DigiCarts – Remote Collaborative Interaction Devices for Heterogeneos Visualization Platforms

Type: Post-doctoral fellowship

Funding: Digiteo research network

Duration: 2013-2015

Coordinator: Stéphane Huot

Partners: Univ. Paris-Sud, Inria, CNRS, CEA, Telecom ParisTech

Abstract: This grant complements the DigiPods project with funding for a 18-month post-doctoral position focused on the design, implementation and evaluation of the DigiCart devices. This project funded Joe Malloch, a post-doctoral fellow who received his Ph.D. from McGill University.

9.1.3. DigiZoom – Multiscale navigation: from mobile devices to collaborative wall-sized displays

Type: Ph.D. grant

Funding: Digiteo network

Duration: 2012-2015

Coordinator: Olivier Chapuis

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Abstract: The goal of the project was to study multiscale navigation on a variety of devices, with an emphasis on large wall-sized displays in the context of the Digiscope project. This requires to properly operationalize the relevant factors in the various tasks that we seek to study. This work led to an award-winning publication at ACM CHI'14 [6], which introduces an abstract classification task to compare the performance of interaction techniques for navigating and manipulating content. This project funded Can Liu, a joint PhD student between the VIA group at Institut Mines-Telecom and InSitu who defended her thesis [10] in december, 2015.

9.1.4. 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.

9.1.5. 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.

9.1.6. 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.

9.1.7. *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 will be active during the month of December, 2016 in the Evry shopping mall, next to the Agora Theater. A prototype will also be shown during the Fête de la Science on the Plateau de Saclay in October, 2016.

9.2. National Initiatives

9.2.1. *ANR*

9.2.1.1. DRAO – Dessin Réaliste Assisté par Ordinateur

Type: Jeunes Chercheuses - Jeunes Chercheurs

Duration: 2012-2015

Coordinator: Adrien Bousseau (Inria Sophia Antipolis)

Partners: Inria Saclay, Inria Sophia Antipolis

ExSitu contacts: Theophanis Tsandilas, Wendy Mackay

Abstract: The goal of the project was to facilitate and accelerate drawing for amateurs as well as for expert designers and illustrators (https://www-sop.inria.fr/members/Adrien.Bousseau/drao). The project explored the following research directions: (1) understanding how professionals draw, (2) automating parts of the drawing process, and (3) teaching people to draw.

9.2.2. *Investissements d'Avenir*

9.2.2.1. 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 2015, nine of the ten rooms are operational, and the telepresence network is being developed.

9.2.3. *Institut Universitaire de France*

9.2.3.1. 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 [18] illustrate this approach.

9.3. European Initiatives

9.3.1. *CREATIV*

Type: IDEAS

Instrument: ERC Advanced Grant

Duration: June 2013 - May 2018

Coordinator: Wendy Mackay

Partner: Inria (France)

Inria contact: 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. 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.

9.3.2. *Collaborations with Major European Organizations*

EIT Digital Master School, European Institute of Technology. Coordinator: M. Beaudouin-Lafon. Partners: KTH (Sweden), U. Paris-Sud (France), U. Aalto (Finland), Technical University Berlin (Germany), Technical University Twente (Netherlands), U. College London (UK), U. Trento (Italy). InSitu participates in the Human-Computer Interaction and Design (HCID) major of the EIT Digital European Master School. Paris-Sud is one the sites for the first year of this Master Program, and host one of the specialties for second-year students. Students in this program receive a double degree after studying in two countries. https://www.dep-informatique.u-psud.fr/en/formation/lmd/M1_HCID.

9.4. International Initiatives

9.4.1. *Inria Associate Teams not involved in an Inria International Labs*

The MidWay Equipe Associée, *Musical Interaction Design Workbench And technologY*, was created in collaboration with the Input Devices and Music Interaction Technology (IDML) at the Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT) at McGill University. The Principle investigator from Inria, Stéphane Huot, was promoted to a Research Director position at Inria Lille, so the projet is now based there, but members of ExSitu have continued to collaborate on the project. The NIME paper on evaluation is a first result from this collaboration [14].

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

We are collaborating with Clemens Klokmose from University of Aarhus, Denmark, on our exploration of information substrates. This resulted in Webstrates [18], which received a best paper award at ACM UIST'15.

We are working with Shumin Zhai from Google in Mountain View, California, on our project on "expressive keyboards", which allows users to produce expressive output from "shapewriting" on soft keyboards.

We are working with Professor Bjoern Hartmann from U.C. Berkeley and will be starting an Inria Equipe Associée, called DECIBel, in 2016.

We are working with Professor Jürgen Steimele from the Max Planck Institute for Informatics and Saarland University on paper electronics and have recently recruited one of his students as a Ph.D. candidate, Michael Wesseley.

We are working with Marco Gilles, Rebbecca Fiebrink and Atau Tanaka of Goldsmith's college in London, U.K. on Human-Centred Machine Learning, and will run a workshop together in 2016.

We are working with Kim Halkov and Peter Dalsgaard from Aarhus University, on blended interaction spaces.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Joanna McGrenere, Professor at the University of British Columbia, Canada, from August 2015.
- Ana Bernardos, Universidad Politécnica de Madrid, Spain, from September to December 2015.

EXMO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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 §7.2).

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. Ready4SmartCities

Title: ICT Roadmap and Data Interoperability for Energy Systems in Smart Cities

Programm: FP7

Duration: October 2013 - September 2015

Coordinator: D'Appolonia SPA

Partners:

    Aec3 Ltd (United Kingdom)

    Ait Austrian Institute of Technology (Austria)

    Ethniko Kentro Erevnas Kai Technologikis Anaptyxis (Greece)

    Centre Scientifique et Technique Du Batiment (France)

    D'appolonia Spa (Italy)

    Empirica Gesellschaft für Kommunikations- und Technologie Forschung Mbh (Germany)

    Politecnico di Torino (Italy)

    Universidad Politecnica de Madrid (Spain)

    Teknologian Tutkimuskeskus Vtt (Finland)

Inria contact: Jérôme Euzenat

See also: http://ready4smartcities.eu

READY4SmartCities operates in a European context where other initiatives are currently running in order to create a common approach on Smart Cities, Such initiatives, even if of fundamental importance for the EU, have some relevant gaps not allowing them to fully cover fundamental aspects for Smart Cities, i.e. to define a common data framework allowing full interoperability among different city system, as well as a consistent vision on how ICT can support energy systems in smart cities. Within this context READY4SmartCities cover a unique role thanks to its specific mission of bringing together relevant stakeholders including engineering specialists, ICT software and equipment providers, RES providers, energy companies (including ESCOs – Energy Service Companies), construction sector companies, as well as local and regional authorities. In co-operation with these stakeholders, the aim is to deliver:

A new energy data ecosystem that will accommodate cross-domain data (climatic, occupation, pollution, traffic, activity, etc.) and will allow the exploitation of such data at global scale; by identifying the set of ontologies relevant to energy-efficiency in Smart Cities and the different requirements and guidelines on how to use (publish and interchange) data described according to those ontologies.

An holistic and shared vision, allowing feasible step-by-step action plans for city authorities and other relevant stakeholder groups to develop and use ICT-based solutions for energy system in urban and rural communities towards future Smart Cities, and thus, leading to reduced energy consumption and CO2 emissions.

9.3. International Initiatives

9.3.1. 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).

9.3.2. 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 will be working with the team of Fernanda Baião and Kate Revoredo at the Universidade Federal do Estado do Rio de Janeiro (UNIRIO). Together, we investigate methods for evolving ontologies and alignments which involve users and agents. The goal of the project is to design methods and algorithms for both revising ontologies to represent the evolution of knowledge in a reliable manner and obtaining better quality alignments.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Kate Revoredo and Fernanda Baião (Federal University of the State of Rio de Janeiro) visited EXMO in May 2015, working on learning alignments to evolve alignments.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

Tatiana Lesnikova and Jérôme Euzenat visited Tsinghua University from March 30 to April 15, 2015 within the LINDICLE project (§9.1.1) on multilingual data interlinking and key extraction.

FLOWERS Project-Team

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: http://comacina.org. 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

F. Stulp: Collaboration: with Olivier Sigaud of the Institut des Systèmes Intelligents (ISIR) et de Robotique of Université Pierre et Marie Curie (UPMC) [37].

F. Stulp: Collaboration: with Xavier Lamy of Laboratoire d'Intégration de Systèmes et des Technologies of the Commissariat à l'énergie atomique et aux énergies alternatives (CEA-LIST) and Pedro Rodriguez-Ayerbe and Sami Tliba of Supélec [57], [58]. Funded by Digiteo, project "PrActIx".

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.

A collaboration with the national InMediats project was organized around the Poppy project. InMediats is a national project gathering 6 science museums (Bordeaux, Rennes, Grenoble, Caen, Toulouse, Paris) that aims at setting large popular science actions allowing the general public to access the latest research and development http://inmediats.fr/le-programme/. In this context, the collaboration with the Flowers team consisted in setting up a network of educational activities around robotics and the use of the Poppy platform in the six towns, with the target to foster the discovery of robotics technologies and their societal dimensions: http://inmediats.fr/poppy-lhistoire-dune-collaboration-inter-centre/. In this context several successful workshops with the general public were organized.

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 Universitaet Darmstadt (Germany)
>
> Universitaet Innsbruck (Austria)
>
> Universitaet 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. http://www.3rdhandrobot.eu

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):

University of Columbia (United States) - Neuroscience - Jacqueline Gottlieb

Start year: 2013

See also: https://flowers.inria.fr/curiosity-information-seeking-and-attention-in-human-adults-models-and-experiments/

One of the most striking aspects of human behavior is our enormous curiosity, drive for exploration. From a child feverishly examining a new toy with its hands and its eyes, to a tourist exploring a new city, to a scientist studying the brain, humans incessantly want to know. This exuberant curiosity shapes our private and social lives, and is arguably a key cognitive feature that allows our species to understand, control and alter our world. We aim to develop a novel unified biological and computational theory, which explains curiosity in the domain of visual exploration and attention as a deliberate decision motivated by learning progress. This theory will build and improve upon pioneer computational models of intrinsic motivation elaborated in developmental robotics, and be empirically evaluated in the context of visual exploration in monkeys through behavioral and brain imaging techniques. This will be the first attempt at a biological-computational framework of intrinsic motivation and perceptual exploration and their underlying cognitive mechanisms.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

AL Vollmer and PY Oudeyer continued a major collaboration with Katharina Rohlfing (**Univ. Paderborn, Germany**) and Britta Wrede (**CITEC/Univ. Bielefeld, Germany**) on the study of how interactional structures help learners to acquire sensorimotor and linguistic skills in interaction with teachers, and based on the development of a new framework for conceptualizing pragmatic frames.

In the context of the Neurocuriosity project, a collaboration was initiated with Celeste Kidd, **Rochester Baby Lab, Univ. Rochester, US**.

In the context of the SMART-E Marie Curie Project (http://smart-e-mariecurie.eu), Yasmin Ansari from **SSSA, Pisa, Italy**, is visiting the Flowers team for 3 months for a collaboration involving the study of how algorithms for active learning of inverse models can be applied to learn soft robot control.

In the context of our projects on educational robotics research and applications, Didier Roy and PY Oudeyer have collaborated with Francesco Mondada, Morgane Chevallier and Gordana Gerber (**EPFL, Lausanne**), and Stéphane Magnenat and Fanny Riedo (**Mobsya association, Switzerland**).

Collaboration with Vittorio Loreto, Physics Department, Sapienza University of Rome, on statistical aspects of the Language Games. (W. Schueller and P.-Y. Oudeyer)

9.4.3. Participation In other International Programs

F. Stulp: Collaboration with Andrej Gams and Rok Vuga of the Josef Stefan Institute, Ljubljana, Slovenia. Funded by the "Programme Proteus 2015" for cooperations between France and Slovenia. Project "LoCoRoS".

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Marc Toussaint, University of Stuttgart, Sept 2015
- Michele Sebag, CNRS, Sept 2015
- Oliver Brock, Technical University of Berlin, Sept 2015
- Stephano Cerri, University of Montpellier, Sept 2015
- Pierre Bessière, Univ. Paris VI and CNRS, april 2015
- Verena Hafner, Univ. Berlin, Germany, april 2015
- Jean-Baptiste Mouret, Inria, april 2015
- Yasmin Ansari, SSSA, Italy, december 2015

9.5.2. Visits to International Teams

- Pierre-Yves Oudeyer visited the SPECS Lab, Univ. Pompeu Fabra, Barcelona
- Pierre-Yves Oudeyer visited ISIR, Univ. Paris VI
- Pierre-Yves Oudeyer visited LPNC/GIPSA Lab, Grenoble

9.5.2.1. Research stays abroad

- Manuel Lopes spent 2 weeks at the University of Columbia
- Anna-Lisa Vollmer is visiting Bielefeld University, Germany for a long-term research stay

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Comins'lab: SEACS*

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, mathmathics 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.

8.2. National Initiatives

8.2.1. *ANR JCJC GERONIMO : Advanced GEophysical Reduced-Order Model construction from IMage Observations*

Participant: Cédric Herzet.

duration 48 months. The GERONIMO project which starts 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.

8.2.2. *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.

8.2.3. *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.

8.3. International Initiatives

8.3.1. *Informal International Partners*

Universidad de Buenos Aires (ARGENTINA) We have maintained academic exchanges with the group of Guillermo Artana.

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.

8.3.2. *Participation In other International Programs*

SticAMSUD project Voiceproduction leaded by Denisse Sciamarella (CNRS, LIMSI)

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FOCUS Project-Team

</div>

8. Partnerships and Cooperations

8.1. National Initiatives

- REVER (Programming Reversible Recoverable Systems) is an ANR project that started on 1st December 2011 and 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, Lienhardt, Lanese, Laneve, Zavattaro.

- PACE (Processus non-standard: Analyse, Coinduction, et Expressivité) is an ANR project that started in 2013. The project targets three fundamental ingredients in theories of concurrent processes, namely coinduction, expressiveness, and analysis techniques. The project aims at 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 more 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 which started on October 2014 and that we will finish on September 2018. ELICA is a project about methodologies for the static analysis of programs as for 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.

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), Bernadet

- 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 behavior.

  Main persons involved: Lanese

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. One joint PhD supervision (J.-M. Madiot).

- 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, 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.

- 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 2015.

- Facultad de Informatica, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project "ESTuDIo: ESpecificacion y Testing de sistemas altamente DIstribuidos" (Specification and Testing of Highly Distributed Systems) January 1, 2013 - December 31, 2015 (3 years), 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):

Todai (Japan) - 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 a 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.

8.3.2. Participation In other International Programs

Complexity Analysis of Higher-Order Rewrite Systems is an FWF (Austrian Science Fund, see http://www.fwf.ac.at/) project which is conducted in Bologna from April 2014 to April 2016. The project aim is the development of logical methodologies for the static resource analysis of higher-order rewrite systems, a formal model of computation that closely captures the evaluation semantics of functional programs. Particular attention is paid to automation, so that the developed complexity-techniques can be integrated into the Tyrolean Complexity Tool, a highly modular complexity analyser for rewrite systems.

Main persons involved: Avanzini, Dal Lago.

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.

- Giovanni Pardini: "Lazy Security Controllers."
- Antonio Ravara: "Towards static deadlock resolution in the pi-calculus."
- Silvia Crafa: "Concurrency theory and concurrent languages: an evolutionary view of programming abstractions."
- Henning Kerstan: "Probabilistic Transition Systems."
- Jean-Bernard Stefani: "Location graphs: yet another global computing model (but with reason)."
- Isabel Oitavem: "P, NP and Pspace from a recursion-theoretic perspective."
- Reinhard Kahle: "Theories for Classes of Computational Complexity."
- Violet Ka I Pun: "Meeting Deadlines, Elastically."
- Volker Stolz: "Search-based composed refactorings."

- Giuseppe De Ruvo: "An Unusual Context for Formal Verification: Wiki Evolution."
- Manuel Mazzara: "Applications of reversibility".
- Claudio Antares Mezzina and Doriana Medic: "Calculi for reversibility".
- Thomas Leventis: " Theories in Probabilistic lambda-calculus."
- Mirko Viroli: "Perspectives on Aggregate Computing".
- Benoit Valiron and Claudia Faggian: "Resource control and linear logics".
- Beniamino Accattoli: "Abstract machines and resource control".
- Georg Moser, Thomas Powell and Stephane Gimenez: "Tools for compuational complexity".
- Ichiro Hasuo, Akira Yoshimizu, and Ryo Tanaka: "Game semantics".
- Ales Bizjak: "Step-Indexed Logical Relations for Probability".
- Roberto Di Cosmo: "Preserving Software: challenges and opportunities for reproducibility of Science and Technology".

8.4.2. Visits to International Teams

January 14-28: Ugo Dal Lago visited Shanghai Jiaotong University, and collaborated with Yuxin Deng, as for the PACE project.

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 style="text-align:center">**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 - Avril 2015

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. PIPA

Participant: Nathalie Mitton [correspondant].

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, 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: Raymond Borenstein, 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 2015: [2], [8], [17], [19], [27].

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 - August 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 2015 in the framework of this project are: [7], [16], [18].

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. PREDNET
Participants: Nathalie Mitton [correspondant], Viktor Toldov, Julien Vandaele.

Title: Predator network

Type: LIRIMA

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 2015.

9.4.2. Inria International Partners

9.4.2.1. 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 gave birth to the PALMARES project (see section International programs), students and researchers exchanges (see section international visits) and joint publications, among them for 2015: [4], [3].

9.4.2.2. 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. It gave birth to joint project submission, joint conference organization (UIC 2016) and several publications, among them for 2015: [9].

9.4.2.3. PhD co-supervision
Participants: Nathalie Mitton [correspondant], Mouna Rekik.

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 2015: [22], [23], [24], [25].

9.4.3. Participation In other International Programs

9.4.3.1. CROMO
Participants: Valeria Loscri, Nathalie Mitton [correspondant], Riccardo Petrolo, Tahiry Razafindralambo.

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 Brasilian 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.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Several researchers have visited our group in 2015, mainly from our partner universities but not only:

- Zied Chtourou, Univ. Sfax, Tunisia, March 2015
- Sajid Mubashir Sheikh, Univ. Stellenbosch, South Africa, July-August 2015
- Arun Sen, Arizona State University, USA, June-Nov 2015
- OP Vyas, Indian Institute of Information Technology, India July 2015
- Riaan Wolhuter, Univ. Stellenbosch, South Africa, July 2015

9.5.1.1. Internships

We have hosted and supervised several master students. Some came to run their master internship in our lab, like

Ana Garcia Alcala from University of Lille (4 months), Mohamed El Amine Seddik from Telecom Lille (6 months), Ayoub El Yagoubi (4 months).

Other students have visited us from our partner universities in the framework of the joint project we run together. This is the case for Solomon Peterus Le Roux (2 months) who came from Stellenbosch university, South Africa, in the framework of the PredNET program and Anup Bhattacharjee from IIIT Allahabad, India (2 months).

9.5.2. Visits to International Teams

9.5.2.1. Research stays abroad

- Nathalie Mitton visited IIIT Allahabad, India for 2 weeks in March 2015.
- Riccardo Petrolo visited UFRJ, Brasil for 2 months (Oct-dec 2015).

<h1 style="color:red; text-align:center">GALAAD2 Team</h1>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. GEOLMI

GEOLMI - Geometry and Algebra of Linear Matrix Inequalities with Systems Control Applications - is an ANR project working on topics related to the Geometry of determinantal varieties, positive polynomials, computational algebraic geometry, semidefinite programming and systems control applications.

The partners are LAAS-CNRS, Univ. de Toulouse (coordinator), LJK-CNRS, Univ. Joseph Fourier de Grenoble; Inria Sophia Antipolis Méditerranée; LIP6-CNRS Univ. Pierre et Marie Curie; Univ. de Pau et des Pays de l'Adour; IRMAR-CNRS, Univ. de Rennes.

More information available at http://homepages.laas.fr/henrion/geolmi.

7.1.2. ANEMOS

ANEMOS - Advanced Numeric for ELMs (Edge Localized Mode): Modeling and Optimized Schemes - is an ANR project devoted to 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 study of spline spaces for isogemetric finite element methods is proposed in this context.

The partners are IRFM, CEA, Cadarache; JAD, University of Nice - Sophia Antipolis; Inria, Bacchus; Maison de la Simulation CEA-CNRS-Inria-University of Orsay- University of Versailles St Quentin.

7.2. International Initiatives

7.2.1. Participation In other International Programs

We have a bilateral collaboration between Galaad and the University of Athens-DIT team ERGA, headed by Ioannis Emiris for the period August 2014-August 2015. It is supported by both Inria and the University of Athens.

> Title: Algebraic algorithms in optimization
> Abstract: In the past decade, algebraic approaches to optimization problems defined in terms of multivariate polynomials have been intensively explored and studied in several directions. One example is the work on semidefinite optimization and, more recently, convex algebraic geometry. This project aims to focus on algebraic approaches for optimization applications in the wide sense. We concentrate on specific tools, namely root counting techniques, the resultant, the discriminant and non-negative polynomials, on which the two teams have extensive collaboration and expertise. We examine applications in convex algebraic geometry as well as to a newer topic for the two teams, namely game theory. A common thread to these approaches is to exploit any (sparse) structure.

We participate to a bilateral collaboration between France and Spain which is supported as a PICS from CNRS. The Spanish partner is the University of Barcelona (J. Burgos, C. D'Andrea, Martin Sombra) and the French partners are The university of Caen (F. Amoroso, M. Weimann), the University of Paris 6 (M. Chardin, P. Philippon) and GALAAD.

> Title: Diophantine Geometry and Computer Algebra
> Abstract: This project aims at exploring interactions between diophantine geometry and computer algebra by stimulating collaborations between experts in both domains. The research program focus 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.

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 Galaad.

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

Abstract: 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 focus on rational maps in low dimension, typically parameterizations of curves and surfaces embedded in the projective space of dimension 3, 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.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Internships

Ibrahim Adamou (Université Dan Dicko DanKoulodo de Maradi, Niger), *Voronoï diagram of half-lines*, December 2015 - January 2016.

Nathan Clement (University of Texas at Austin, USA), *Offset of parametric curves*, Jun 2015-Aug 2015

Alexis Papagiannopoulos (NTUA, Athens, Greece), *Isogeometric analysis and parameterization of computational domains*, May 2015- September 2015.

Meng Wu (Hefei Univ. of Technology, China), *Splines over domain with arbitrary topology and isogeometric applications*, October 2015 - November 2015.

7.3.2. Visits to International Teams

7.3.2.1. Sabbatical programme

Hubert Evelyne

Date: Sep 2015 - Feb 2016

Institution: Fields Institute, Toronto, Canada.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Excellence Clusters

- Program: DIGITEO (Chair)

  Project acronym: SubSample

  Project title: Identification and prediction of Salient brain States through probabilistic structure learning towards fusion of imaging and genomic date

  Duration: 01/2012-12/2015

  Coordinator: ECP - FR

- Program: DIGITEO

  – Project acronym: SOPRANO

  – Project title: Structured Output Prediction on Large Scale Neuroscience Data

  – Duration: 3/2013-3/2016

  – Coordinator: Ecole Centrale Paris - FR

- Program: MEDICEN

  Project acronym: ADOC

  Project title: ADOC – Diagnostic peropératoire numérique en chirurgie du cancer

  Duration: 11/2011-09/2015

  Coordinator: LLTECH - FR

8.2. National Initiatives

8.2.1. 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

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. DIOCLES

Title: Discrete bIOimaging perCeption for Longitudinal Organ modElling and computEr-aided diagnosiS

Type: FP7

Instrument: European Research Council

Duration: September 2011 - August 2016

Coordinator: Nikos Paragios

Partner: Ecole Centrale de Paris (FR)

Inria contact: Nikos Paragios

Recent hardware developments from the medical device manufacturers have made possible non-invasive/in-vivo acquisition of anatomical and physiological measurements. Despite enormous progress made on the field of biomedical image analysis still a huge gap exists between clinical research and clinical use. The aim of this proposal is three-fold. First we would like to introduce a novel biomedical image perception framework for clinical use towards disease screening and drug evaluation. Such a framework is expected to be modular (can be used in various clinical settings), computationally efficient (would not require specialized hardware), and can provide a quantitative and qualitative anatomo-pathological indices. Second, leverage progress made on the field of machine learning along with novel, efficient, compact representation of clinical bio-markers toward computer aided diagnosis. Last, using these emerging multi-dimensional signals, we would like to perform longitudinal modelling and understanding the effects of aging to a number of organs and diseases that do not present pre-disease indicators such as brain neurological diseases, muscular diseases, certain forms of cancer, etc.

8.3.1.2. 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.

8.3.1.3. 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.

8.3.1.4. 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.

8.3.1.5. 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.'

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- 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.
- Ecole Polytechnique de Montreal - Collaborative research with Samuel Kadoury. Collaboration Topic: Multi-atlas co-segmentation, co-registration.
- University of Pennsylvania - Collaborative research with Aristeidis Sotiras. Collaboration Topic: Higher Order Graphs in biomedical image analysis.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Angst, Roland. Max Planck Center for Visual Computing and Communication, GE (April 2015)
- Professor Maragos, Petros: Technical University of Athens, GR (13-20 November 2015)

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

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.

9.1.2.2. CEEC

Participants: Maxime Dénès, Xavier Leroy.

The "CEEC" project (2011–2015) is coordinated by the Prove & Run company and also involves Esterel Technologies and Trusted Labs. It is funded by the *Briques Génériques du Logiciel Embarqué* programme of *Fonds national pour la Société Numérique*. The CEEC project develops an environment for the development and certification of high-security software, centered on a new domain-specific language designed by Prove & Run. Our involvement in this project focuses on the formal verification of a C code generator for this domain-specific language, and its interface with the CompCert C verified compiler.

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, Mike 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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Research stays abroad

From November 2014 to June 2015, Damien Doligez was on a sabbatical at Jane Street (New York, USA), a financial company (a member of the Caml Consortium) that invests considerable R&D in the OCaml language and system.

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GAMMA3 Project-Team

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7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. 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.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

P. Laug participates in the GEOPRISM (GEOlogical resources PRotection and exploitation using Innovative Simulation Methods - Towards new generations of simulation technologies) project, submitted to H2020-FETOPEN-2014-2015-RIA. This project involves several Inria teams (Sage, Gamma3, Pomdapi, Coffee) and several European research centers and universities.

7.3. International Initiatives

7.3.1. Inria Associate Teams not involved in an Inria International Labs

7.3.1.1. 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.

7.4. International Research Visitors

7.4.1. Visits to International Teams

7.4.1.1. Sabbatical programme

Laug Patrick

Date: Sep 2014 - Aug 2015

Institution: Polytechnique Montréal (Canada)

GANG Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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 Ph. D.

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.

9.1.2. *Laboratory of Information, Networking and Communication Sciences (LINCS)*
Participants: François Durand, The-Dang Huynh, Leonardo Linguaglossa, Laurent Viennot.

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.

9.2. European Initiatives

9.2.1. *FP7 & H2020 Projects*

Amos Korman has received 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.

9.3. International Initiatives

9.3.1. *Inria International Partners*

9.3.1.1. *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.

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).

9.3.2. Participation In other International Programs

Involvement in the bilateral Franco-Israeli project MAIMONIDE (2014-2015) on "Resource Allocation in the Cloud". Pierre Fraigniaud was the project's co-coordinator for the French side. Financed by Partenariats Hubert Curien.

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: LIAFA and LaBRI (France), UNAM (Mexico).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Zvi Lotker (Ben Gurion University, Israel) is a long-term visitor of the team. He has also been awarded the Junior Chair of Fondation Sciences Mathématiques de Paris (FSMP) for 2015/2016.

Andrea Pietracaprina (Univ. Padova, Italy), 1 month's visit, Fall 2015.

Geppino Pucci (Univ. Padova, Italy), 1 month's visit, Fall 2015.

Eli Gafni (UCLA, USA), 2 months' visit, June-July 2015.

Sam Toueg (Univ. Toronto, Canada), 1 month's visit, January 2015.

Flavia Bonomo (Universidad de Buenos Aires, Argentina), 1 month's visit, June 2015.

9.4.1.1. Internships

Rai Nishant

Date: May 2015 - Jul 2015

Institution: IITK (India)

Shah Parth

Date: May 2015 - Jul 2015

Institution: Indian Institute of Technology Bombay (India)

Ricardo De La Paz Guala

Date: Feb 2015 - May 2015

Institution: Universidad de Concepción (Chile)

Marc Heinrich

Date: Mar 2015 - Jun 2015

Institution: ENS Paris

Simon Collet

Date: Mar 2015 - Jun 2015

Institution: Paris VII

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

Amos Korman made several monthly visits to Israel, collaborating with Weizmann Institute of Science and Tel-Aviv University.

GECO Project-Team

7. Partnerships and Cooperations

7.1. 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 are involved in three actions funded by iCODE:
    - one action on control of quantum systems, in collaboration with Nicoals Boulant of Neurospin. The action is coordinated by Ugo Boscain;
    - one action on control of wave propagation on networks. The action is coordinated by Mario Sigalotti;
    - one action on switched system. The action is coordinated by Marianne Akian (and handled by MAXPLUS).
- 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 and is renewable for up to three years. The grant is coordinated by Luca Rizzi and Mario Sigalotti.

7.2. National Initiatives

7.2.1. 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.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

Program: ERC Starting Grant

Project acronym: GeCoMethods

Project title: Geometric Control Methods for the Heat and Schroedinger Equations

Duration: 1/5/2010 - 1/5/2015

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.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. 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.

7.4.2. Participation In other International Programs

- Laboratoire Euro Maghrébin de Mathématiques et de leurs Interactions (LEM2I)
  http://www.lem2i.cnrs.fr/
- GDRE Control of Partial Differential Equations (CONEDP)
  http://www.ceremade.dauphine.fr/~glass/GDRE/

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GENSCALE Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Bioinformatics computing center of Roscoff

Participants: Sébastien Brillet, Erwan Drezen, Patrick Durand, Dominique Lavenier, Ivaylo Petrov.

Through the collaborative project KORIBLAST2 funded by Région Bretagne (June 2014-December 2015) and within the KoriScale lab, we worked: (1) to improve the KLAST software with new alignment methods developed by GenScale; (2) to extend the capabilities of KLAST toward metagenomic processing; (3) to develop a cloud version targeting huge sequence comparison processing.

9.1.2. Etablissement Français du sang (EFS)

Participant: Dominique Lavenier.

An active collaboration with EFS started in 2015 to speed up individual HLA genotyping. A first prototype has been designed (see section New Results) and should be intensively tested in 2016 on many patient data.

9.1.3. 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.

9.1.4. Partnership with INRA in Rennes

Participants: Cervin Guyomar, Dominique Lavenier, Fabrice Legeai, Claire Lemaitre, Sébastien Letort, Pierre Peterlongo, François Moreews.

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 two INRA engineers (F. Legeai, F. Moreews) and one PhD student (C. Guyomar).

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. Project FATINTEGER

Participants: Dominique Lavenier, François Moreews.

Coordinateur: F. Gondret
Duration: 36 months (Mar. 2012 - feb. 2015)
Partners: PEGASE Inra Rennes, CNRS IRISA Rennes, AgroCampus Ouest LMA-IRMAR Rennes

The FatInteger project aims to identify some of the transcriptional key players of animal lipid metabolism plasticity, combining high throughput data with statistical approaches, bioinformatics and phylogenetic. GenScale is involved in the design of the workflow for processing the genomic data.

9.2.1.2. 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.

9.2.1.3. 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 does not require the availability of a reference genome. https://colibread.inria.fr/

9.2.1.4. Project GATB: Genome Analysis Tool Box

Participants: Dominique Lavenier, Erwan Drezen, Pierre Peterlongo, Claire Lemaitre, Guillaume Rizk, Charles Deltel.

Coordinator: D. Lavenier (Inria/Irisa, GenScale, Rennes)
Duration: 24 months (Feb. 2013 – Jan. 2015)
Partners: GenScale Inria/IRISA, Rennes – DTI Inria, Rennes.

This project aims to develop algorithms and tools for genome analysis based on a compact data structure having a very low memory footprint allowing end-users to process huge volume of genomic data on a simple desktop computer. The GATB is structured around a C++ library from which many efficient NGS tools can be developed. GATB has been published and is used outside Genscale (LIRMM, Inria Erable team). http://gatb.inria.fr

9.2.1.5. Project HydroGen: Metagenomic applied to ocean life study

Participants: Dominique Lavenier, Pierre Peterlongo, Claire Lemaitre, Guillaume Rizk, Gaëtan Benoit.

Coordinator: D. Lavenier (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.

9.2.1.6. 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 butterflies 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, Pierre Peterlongo.

Coordinator: N. Nessi (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.

9.3. International Initiatives

9.3.1. Brazil

- IMECC, UNICAMP, Campinas [A. Mucherino]
- Federal University of Florianópolis, Santa Catarina: Distance geometry, optimal vertex orders [A. Mucherino]

9.3.2. Chile

- university of Utalca, genomes of aphid parasitoids [F. Legeai]

9.3.3. USA

- Los Alamos National Laboratory (LANL), Los Alamos: Graph algorithms, Parallelism, GPU [R. Andonov, D. Lavenier]
- University of Miami, member of the international Aphid genome consortium [F. Legeai]
- University of Arizona, genomes of aphid parasitoids [F. Legeai]
- University of Ohio, genomics of the soybean aphid [F. Legeai]

9.3.4. China

- SouthWest university, member of the international Spodoptera litura genome project [F. Legeai]

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. *ANR Présage*

Participants: Marc Glisse, Rémy Thomasse.

- Acronym: Presage.

- Type: ANR blanc.

- Title: *méthodes PRobabilistes pour l'Éfficacité des Structures et Algorithmes GÉométriques*.

- Coordinator: Xavier Goaoc.

- Duration: 31 december 2011 - 31 december 2015.

- Other partners: Inria VEGAS team, University of Rouen.

- Abstract: This project brings together computational and probabilistic geometers 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 or underlying random continuous geometric objects. This raises questions such as:

- What does a random geometric structure (convex hulls, tessellations, visibility regions...) look like?
- How to analyze and optimize the behavior of classical geometric algorithms on *usual* inputs?
- How can we generate randomly *interesting* discrete geometric structures?

9.1.2. *ANR TOPDATA*

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

- Acronym : TopData.

- Type : ANR blanc.

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

- Coordinator : Frédéric Chazal (GEOMETRICA).

- 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. 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 (University of Groningen), May

Arijit Ghosh (MPII, Saarbrucken), June-July

Clément Maria (Queen's College, Brisbane), June

Omer Brobowski (Duke University), May

Jessica Cisewski (Carnegie Mellon), October

Jisu Kim (Carnegie Mellon), May-July

Yanir Kleiman (Tel Aviv University), October

Bertrand Michel (Paris 6), 2015

Jan Felix Senge (Bremen), October

Primoz Skraba (Jozef Stefan Institute), May

Kelly Spendlove (Rutgers), May-July

Jian Sun (Tsinghua), February

Justin Solomon (Stanford), February

9.4.1.1. Internships

Sivaprasad Sudhir (IIT Bombay), June-July

Stéphane Lundy (Supélec), July-August

Siargey Kachanovich (ENS Rennes), March-August

Anatole Moreau (EPITA), May-August

Tullia Padellini (Roma University), May-September

Yuping Ren (Erasmus), January-July

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

+ Steve Oudot spent 1 month in July-August in the group of Benjamin Burton at the Pure Maths Department of University of Queensland, Australia.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

Conseil Regional Aquitaine Project CAVERNOM (ref. 9129): *Cardiac Arrythmia Complexity and Variability by Means of Robust Nonlinear Methods*. One year.

9.2. National Initiatives

- 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 provided by CNES and Conseil Regional Aquitaine, in collaboration with Laboratoire d'Astrophysique de Bordeaux. Starting: end 2016. Subject: understanding the dynamics of galatic dust clouds and their relation with star formation process.

- PhD grant for C. Artnana from UPMC University, under co-supervision with H. Yahia and C. Provost (LOCEAN, Paris).

9.3. International Initiatives

- The Toubkal project "Caractérisation multi-capteurs et suivi spatio-temporel de l'Upwelling sur la côte atlantique marocaine par imagerie satellitaire", led by K. Daoudi, has been accepted. The partners in this project are: Faculté des sciences de Rabat, Centre Royal de Télédetection Spatiale, Mercator-Ocean and Geostat.

9.3.1. Inria Associate Teams not involved in an Inria International Labs

9.3.1.1. OPTIC

Title: Optimal inference in Complex and Turbulent data.

International Partner (Institution - Laboratory - Researcher):

IITR (India), Department of Electronics and Communication Engineering: Dharmendra Singh

Start year: 2014

See also: https://optic.bordeaux.inria.fr/.

The OptIC associated team is co-managed by Prof. D. Singh (IIT Roorkee) and N. Brodu, H. Yahia (Inria Geostat).

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.

*9.3.1.2. Summary of work done in 2015*
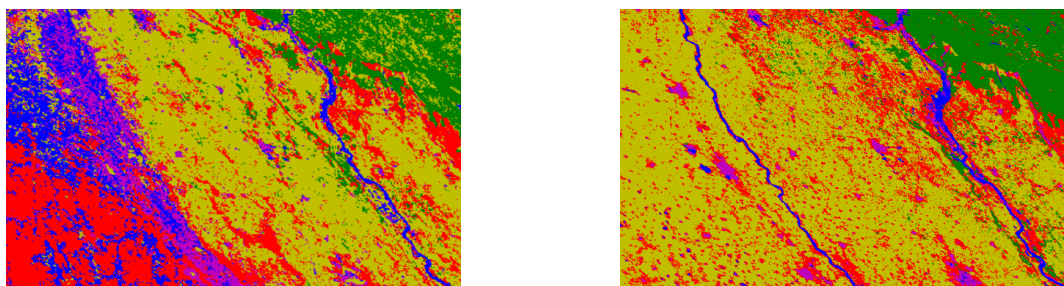
Figure 7. Left: nearest neighbors classification with the original 500m data, showing a cross-validated accuracy of 0.81±0.03. Right: results on the superresolved 250m data, accuracy of 0.83±0.02. Although the performance did not improve significantly on the reference points, the generalization capabilities are greatly enhanced: water regions (river, right, and canal, left) are well recognized, together with villages (magenta dots) and bare soil (red) adequatly spotting the lanscape instead of the incorrect zones on the lower-left at 500m. The other two classes are crops/small vegetation (yellow) and dense/tropical vegetation (green). The region is a MODIS sinusoidal projection around Roorkee.

- The public availability of low-resolution MODIS data is cost-effective, but limited in precision. Some applications, such as land monitoring and anomaly detection, must not only operate on objects smaller than provided in the freely available data, but also offer a high level of confidence in the classified land occupation. We are working on both aspects:

- Augmenting numerically the resolution of the images. This can be done with different methods, out of which two are currently explored in our team. The first relies on wavelet decompositions, with an attempt at preserving the spatial structure around each pixel (e.g. edges). This is typically done by propagating the high-frequency components to higher wavelet decomposition level through some interpolation mechanism, plus artifact-reduction steps. The second method considers a sub-pixel mixing model which is fit from all multispectral bands. The assumption is that, irrespectively of the reflectance of natural elements at each wavelength, the proportion of these elements is a physical property shared through all spectral bands. Then, unmixing is performed in order to estimate the best sub-pixels. See figure 7 .

- Resolution-augmented images are then exploited for classification. We use by field measurements, in
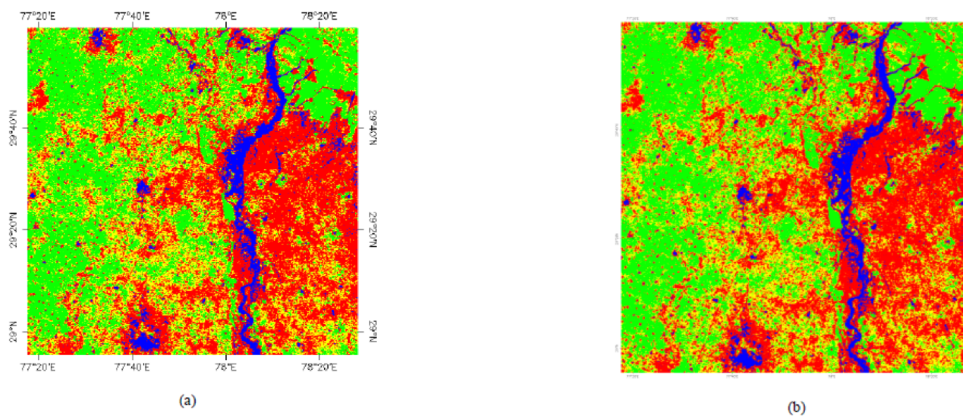
Figure 8. Classified MODIS image (a) Low resolution (b) after resolution enhancement.

order to provide the ground truth for a corpus of well-registered locations, which together encompass a wide variety of objects (e.g. urban, crops, etc). We then train our super-resolution algorithms, and quantitatively assess our super-resolved maps on how well they improve the performance of land classification. As the final accuracy results from the interplay between the considered feature space and the classification method itself, we quantify both aspects with cross-validated data sets. We have tested state of art classification methods (SVM, decision trees, probabilistic models, nearest neighbors, etc...). Classification accuracy is improved by the used of superresolved images but, more importantly, so are the generalization ability of the classifiers. This is shown in the following two images, demonstrating the improvement in land recognition between the use of the original 500m MODIS data and the superresolved 250m data.

- A wavelet based resolution enhancement technique has been crtically analyzed to see the effect of it on resolution enhancemnt modified discrete wavelet transform and interpolation based technique is proposed for enhancing the resolution of satellite images having low resolution in such a way that a highly resolved satellite image can be obtained without losing any image information. The advent of DWT has given a major impetus to many techniques based on achieving super resolution starting with a single low resolution image. In the proposed method, DWT is employed on the input satellite image to decompose it into sub-bands then the high frequency subbands and the input low resolution satellite image have been interpolated to obtain four interpolated images which are later combined after minor alterations to the interpolated input image using IDWT. The quantitative peak signal-to-noise ratio (PSNR) and classification results show that the resolution has been enhanced to a good scale without losing any information content present in the satellite image. The quality assessment parameters also illustrate the supremacy of the proposed technique over the conventional techniques. Results are shown in fig 8 .

- A technique based on feature extarction has been attempted to apply in the low resolution satellite data by which a land cover monitoring system can be developed. Moderate resolution imaging spectroradiometer (MODIS) data is a good resource for land cover monitoring as it is freely available data, having high temporal frequency and spatial resolutions 250 m, 500m and 1000m. MODIS being optical satellite data suffers from various atmospheric and cloud disturbances due to which, feature extraction and land cover interpretation using MODIS data is a significant and challenging task. In the past various features like spectral indices (EVI, SAVI, GEMI, PAVI etc), fourier based features, wavelet based features were extracted for land cover classification from MODIS data but the role of
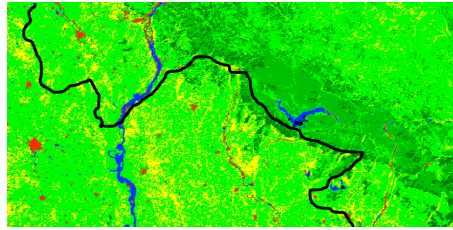
Figure 9. Classification MODIS image by developed approach.

texture descriptors and color features in land cover analysis has not been focussed, which has the potential to provide a new stage of land cover discrimination. Therefore, the objective of this work was to explore the applicability of MODIS composite data for land cover monitoring by texture and color features extraction. Various texture features and descriptors like GLCM (Gray Level Co-occurrence Matrix) measures, LBP (Local Binary Pattern), EHD (Edge Histogram Descriptor), gabor wavelets and color features like Red-Green-Blue (RGB) color space, Hue-Saturation-Value (HSV) color space, Hue-Min-Max-Difference (HMMD) color space, MPEG-7 Dominant Color Descriptor (DCD), MPEG-7 Color Structure Descriptor (CSD) and MPEG-7 Scalable Color Descriptor (SCD) were extracted. These color features were extracted over the artificial-color image obtained by mapping band2 (infrared band), NDVI (Normalized Vegetation Index) and band1 (red band) to the red, green and blue (RGB) color channels, respectively. It is observed that the extracted features are giving quite good results for land cover identification and classification. This infers that in near future these features could play a major role in the development of the land monitoring system using MODIS data. A clssified result of Roorkee region of India is shown in fig 9 which has the overall classification accuracy approx. 82%.

- An another approach based on KLT (Kanade-Lucas-Tomasi) tracker has also been explored to apply on the Phased Array L-Band Synthetic Aperture Radar (PALSAR) satellite image for adapative monitoring the land cover changes. It is observed that KLT tracking algorithm has good potential to be used as monitoring of vegetation in less time without applying time consuming image registration technique.
  Related publications: link to list of publications on OPTIC web site.

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

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 économique de Bitcoin) was accepted as interdisciplinary research for a PEPS (Projet exploratoire Premier Soutien) cofunded by the CNRS and Université 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.

Two M2 interns, Loïs Saublet and Kofi Manful, have been hired, located in Aviz team, and D. Augot co-supervised them with Petra and Tobias Isenberg.

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 [33], 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.

9.2. National Initiatives

9.2.1. ANR

- CATREL (accepted June 2012, ending December 2015): "Cribles: Améliorations Théoriques et Résolution Effective du Logarithme" (Sieve Algorithms: Theoretical Advances and Effective Resolution of the Discrete Logarithm Problem). This project aims to make effective "attacks" on reduced-size instances of the discrete logarithm problem (DLP). This is a key ingredient for the assessment of the security of cryptosystems relying on the hardness of the DLP in finite fields, and for deciding on relevant key sizes.
- MANTA (accepted July 2015, starting January 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. See http://anr-manta.inria.fr/

9.2.2. DGA

- DIFMAT-3: this 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 [34].

- 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.

9.3.2. Major European Organizations with which the Team have followed Collaborations

Program: COST

Project acronym: COST 4175/11

Project title: Random Network Coding and Designs over GF(q) http://www.network-coding.eu/index.html

Duration: 04/2012 - 04/2016

Coordinator: Marcus Greferath

Other partners: Camilla Hollanti, Aalto University, Finland Simon R. Blackburn, Royal Holloway, University of London, UK Tuvi Etzion, Technion, Israel Ángeles Vázquez-Castro, Autonomous University of Barcelona, Spain Joachim Rosenthal, University of Zurich, Switzerland (Chairs of the five working groups).

Abstract: Random network coding emerged through an award-winning paper by R. Koetter and F. Kschischang in 2008 and has since then opened many new directions in networking, internet, wireless communication systems, and cloud computing. This COST Action will set up a European research network and establish network coding as a European core area in communication technology. Its aim is to bring together experts from pure and applied mathematics, computer science, and electrical engineering, who are working in the areas of discrete mathematics, coding theory, information theory, and related fields.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- P. Beelen, J. Nielsen, DTU Lyngby
- M. Bossert, Ulm Universität
- S. Galbraith, Department of Mathematics, University of Auckland.

9.5. International Research Visitors

9.5.1. Internships

- C. Berghoff is a visiting Phd student, from Bonn Universität.

GRAPHDECO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Regional Ph.D. Scholarship

The thesis of T. Thonat is financed in part by a Région Provence Alpes-Côte d'Azur Ph.D. scholarship, with the industrial support of Kaleidoscope (Toulon).

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR ALTA

Participants: Emmanuelle Chapoulie, Stefan Popov, George Drettakis.

The ANR ALTA project started in October 2011, and focuses on the development of novel algorithms for realistic and efficient global illumination. The project is coordinated by the Grenoble Inria group ARTIS (N.Holzschuch), and the Bordeaux Inria group MANAO (X. Granier) is also a partner. Our participation is the study of error bounds for these algorithms and the development of interactive global illumination. This year we developed a new global illumination algorithm described in Sec. 7.2.12 which was published at EGSR [10].

9.2.1.2. ANR DRAO

Participants: Emmanuel Iarussi, 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.

The first part of the project involved the observation of how people draw with existing tools. To do so we conducted observational studies where we will interview designers and illustrators and collect data by videotaping drawing sessions and by recording drawings with digital pens. In the second part of the project we deduced from our observations new user interfaces and rendering algorithms that automate part of the drawing process and enrich 2D drawings with realistic rendering capabilities. We combined computer vision and computer graphics techniques to estimate geometric information from sketches and then used this information to guide rendering algorithms that generate plausible depictions of material and lighting over the drawing. We also developed computer-assisted drawing lessons to help amateurs draw from photographs and 3D models, using image analysis algorithms to estimate the structure of a photograph and use that structure as guidance for drawing. To summarize, the goal of the ANR DRAO project was to make amateurs more confident in their drawing skills and to allow expert designers to produce complex illustrations more effectively.

The ANR DRAO has resulted in three publications this year on normal field estimation from rough sketches [7], 3D interpretation of line drawings [14] and jewelry design [8].

9.2.1.3. ANR SEMAPOLIS

Participant: George Drettakis.

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 part.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. 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.

We have started specific scientific collaborations with TUD on capture guidance and IBR and with UCL on video-based rendering.

9.4. International Initiatives

Inria@SiliconValley
Associate Team involved in the International Lab:

9.4.1. 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 2015 we published two papers in the Computer Graphics Forum journal, which were presented at the Eurographics Symposium on Rendering (EGSR). In the first paper we used a model of texture similarity to transfer seasons between photographs . Our algorithm predicts how to change colors and textures in an image to give it the seasonal appearance of another image. In particular, our method captures season-related effects such as leaves on trees, snow and flooding. This work was done in collaboration with Alexei Efros who is an expert in data-driven image manipulation.

The second paper contributes to more traditional, physically-based rendering using bidirectional path tracing . The key idea behind our approach is to exploit combinatorial explosion to cheaply construct a set of light paths as the Cartesian product of the eye and light sub-paths. The novelty of our work is to approximate the contribution of these paths in a probabilistic manner, without constructing each path in the set explicitly. This work results from collaboration with Ravi Ramamoorthi.

We are currently focusing our efforts on two core topics of the CRISP collaboration: perceptual rendering and plausible image-based rendering. In particular, we plan to explore several projects related to the perception and rendering of stereo images. This research will greatly benefit from an Inria postdoc, George Koulieris, who will share his time between Inria and UC Berkeley. In addition, Martin S. Banks from UC Berkeley plans to spend part of his sabbatical at Inria.

CRISP has resulted in two publications this year with Aloyha Efros [9] and R. Ramammoorthi [10].

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

Canada. A. Bousseau collaborates regularly with the University of Toronto (K. Singh) and the University of British Columbia (A. Sheffer).

United Kingdom. In the context of the postdoctoral fellowship of K. Vanhoey, we collaborate with I. Jermyn from Durham University.

India. A. Bousseau collaborates with Vinay Namboodiri from IIT Kanpur. They co-advised two master students, one came for an internship at Inria (Rahul Arora).

United States. We have several collaborations with Adobe Research. We worked on jewelry design [8] with Wilmot Li, who hosted Emmanuel Iarussi for an 3-months internship. We also work with Eli Shechtman and Sylvain Paris in the context of the multi-view inpainting project of T. Thonat. We collaborate with F. Durand from MIT in the context of the global illumination project [10]. We collaborate with Daniel Aliaga from Purdue University on sketch-based procedural modeling.

Greece. We collaborate with the Technical University of Crete in the context of the project on attention and Virtual Reality (G. Koulieris).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Prof. D. Aliaga from Purdue (US) visited in June for two weeks, Prof. K. Bala (Cornell, US), A. Shamir (IDC, IS), D. Salesin (Adobe, US) visited early September and participated in a workshop after the HDR defense of A. Bousseau. Prof. N. Mitra (UCL, UK), M. Alexa (TU Berlin, D) visited end September and participated in a scientific workshop after the defense of E. Iarussi.

9.5.1.1. Internships

Rahul Arora, was a Masters Intern, until Apr 2015 from IIT Kampur. Vivien Cabannes was a 3rd year intern from ENS Ulm from June 2015 until July 2015. Lorenzo Caroggio and Huayi Huang were last year engineering student interns from Univ. Genova in teh context of an ERASMUS exchange. Ayush Tewari was a Masters II intern from MOSIG Grenoble Feb. -Jul. 2015. Georgios Kopanas, was an ERASMUS intern from the Tech. Un. Thessaly, Sep.-Dec. 2015.

9.5.2. Visits to International Teams

G. Drettakis visited Berkeley in the context of the CRISP Associate team in August.

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ASPIQ

Participants: Jean-François Baget, Fabien Garreau, Marie-Laure Mugnier, Jérôme Fortin, Michel Leclère.

ASPIQ (ASP technologIes for Querying large scale multisource heterogeneous web information), is an ANR white project (duration: 4 years) that started in Oct. 2012. 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 7.1 for this year's results (Extensions of the Framework).*

9.1.1.2. 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 7.1 for this year's results.*

9.1.1.3. Qualinca

Participants: Michel Leclère, Michel Chein, Madalina Croitoru, Rallou Thomopoulos, Alain Gutierrez, Swan Rocher, 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 7.3 for this year's results.*

9.1.1.4. Dur-Dur
Participants: Abdallah Arioua, Patrice Buche, Madalina Croitoru, Jérôme Fortin, 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.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EcoBioCap
Participants: Patrice Buche, Madalina Croitoru, Jérôme Fortin, Nouredine Toumani.

EcoBiocap is a FP7-KBEE project that lasted 4 years and ended in March 2015. It was led by INRA (and scientifically managed by Montpellier IATE laboratory). It involved sixteen partners among which Cork University (Ireland), CSIC (Spain), Roma University La Sapienza (Italy), SIK (Sweden). The objective of EcoBioCAP was to "provide the EU food industry with customizable, ecoefficient, biodegradable packaging solutions with direct benefits both for the environment and EU consumers in terms of food quality and safety". The budget was managed by IATE team.

- *See Section 7.2 for this year's results.*

9.2.2. Collaborations with Major European Organizations

- On existential rules, we collaborate with TU Dresden and have scientific contacts with the University of Oxford.
- On description logics, we collaborate with the universities of Bremen, Liverpool, London, Rome and Vienna (new collaborations brought by Meghyn Bienvenu).
- On argumentation, we work with the universities of Aberdeen and Southampton.

9.3. International Research Visitors

Odile Papini, PR Univ. Aix-Marseille, is a visitor from Sept. 2015 (one year CNRS delegation) (see ASPIQ project in Section 9.1).

Pierre Bisquert is currently an international visitor for one year at the University of Amsterdam (from May 2015).

Rallou Thomopoulos is currently a visitor at the University of Quebec for one year (from July 2015).

HEPHAISTOS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- B. Senach participated in the regional event : Workshop Santé - Maison des Sciences de l'Homme (NICE)
- project *Le refuge-Lecture: accéssibilité à la compréhension d'un texte pour des personnes en situation de handicap (auditif, visuel, cognitif)*, Conseil général projet Santé
- CPER project MADORSON for the assistance to elderly people (with the STARS project)

9.2. National Initiatives

9.2.1. Other activities

9.2.1.1. FHU

- the team has been involved for the FHU *INOVPAIN : Innovative Solutions in Refractory Chronic Pain* that has been labeled in December

9.2.1.2. Challenges and grants

- Submission to the I-Lab 2015 challenge (prize winner)
- Submission to Charles Foix Grant
- Submission to the call AUTON (CNRS) with Marc Relieu (Telecom ParisTech) (accepted)

9.2.1.3. Euthenia Start-up

Participants: Ting Wang, Bernard Senach, Jean-Pierre Merlet.

We pursued our actions to valuate technologies developed within HEPHAISTOS project team. The goal is to bring to the market an instrumented walker which provides to its users and to other stakeholder various information about walking performance. This year we proposed the creation of the Inria start-up Euthenia and we submitted to two national challenges. We won a prize for the I-Lab 2015 challenge (30 keuros) and were nominated for the Charles Foix Grant. Our Safe Walker was used as a pilot during the first Summer school of the European Institute of Technology and it was presented in Nice at the opening ceremony the Living Lab "27 Delvalle". For personal reasons the start-up is in stand-by for now but we hope to be able to reactivate it.

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), IN-GEMA (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. Inria International Partners

9.4.1.1. 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. Visit of International Scientists

We have received our joint PhD student J. Pickard from University of New Brunswick, K. Hanahara from Kobe University while several other scientists from other domains have visited our robotics flat.

HIEPACS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Innovative simulation methods for large scale numeric prototypes on emerging architectures computers

Participants: Emmanuel Agullo, Olivier Coulaud, Aurélien Esnard, Mathieu Faverge, Luc Giraud, Abdou Guermouche, Pierre Ramet, Jean Roman.

Grant: Regional council
Dates: 2013 – 2015
Partners: EPIs REALOPT, STORM from Inria Bordeaux Sud-Ouest, CEA-CESTA and l'Institut pluridisciplinaire de recherche sur l'environnement et les matériaux (IPREM) .
Overview: Numerical simulation is now integrated into all the design levels and the scientific studies for both academic and industrial contexts. Given the increasing size and sophistication of the simulations carried out, the use of parallel computing is inescapable. The complexity of such achievements requires collaboration of multidisciplinary teams capable of mastering all the necessary scientific skills for each component constituting the chain of expertise. In this project we consider each of these elements as well as efficient methods for parallel codes coupling. All these works are intended to contribute to the design of large scale parallel multiphysics simulations. In addition to this research human activities the regional council also support some innovative computing equipment that will be embedded in the PlaFRIM experimental plateform, project led by O. Coulaud.

9.2. National Initiatives

9.2.1. Inria Project Lab

9.2.1.1. 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.

9.2.2. ANR

9.2.2.1. SOLHAR: SOLvers for Heterogeneous Architectures over Runtime systems

Participants: Emmanuel Agullo, Mathieu Faverge, Abdou Guermouche, Xavier Lacoste, 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.

9.2.2.2. SONGS: Simulation Of Next Generation Systems
Participant: Abdou Guermouche.

Grant: ANR 11 INFRA 13
Dates: 2011 – 2015

Partners: Inria (Bordeaux Sud-Ouest, Nancy - Grand Est, Rhone-Alpes, Sophia Antipolis - Méditerranée), I3S, LSIIT

Overview:

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 exploit such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, 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.

9.2.2.3. ANEMOS: Advanced Numeric for ELMs : Modeling and Optimized Schemes

Participants: Xavier Lacoste, 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.

9.2.2.4. RESCUE: RÉsilience des applications SCientifiqUEs

Participants: Emmanuel Agullo, Luc Giraud, Abdou Guermouche, Jean Roman, Mawussi Zounon.

Grant: ANR-Blanc (computer science theme)
Dates: 2010 – 2015
Partners: Inria EPI ROMA (leader) and GRAND LARGE.
Overview: The advent of exascale machines will help solve new scientific challenges only if the resilience of large scientific applications deployed on these machines can be guaranteed. With 10,000,000 core processors, or more, the time interval between two consecutive failures is anticipated to be smaller than the typical duration of a checkpoint, i.e., the time needed to save all necessary application and system data. No actual progress can then be expected for a large-scale parallel application. Current fault-tolerant techniques and tools can no longer be used. The main objective of the RESCUE project is to develop new algorithmic techniques and software tools to solve the exascale resilience problem. Solving this problem implies a departure from current approaches, and calls for yet-to-be-discovered algorithms, protocols and software tools.

This proposed research follows three main research thrusts. The first thrust deals with novel checkpoint protocols. This thrust will include the classification of relevant fault categories and the development of a software package for fault injection into application execution at runtime. The main research activity will be the design and development of scalable and light-weight checkpoint and migration protocols, with on-the-fly storing of key data, distributed but coordinated decisions, etc. These protocols will be validated via a prototype implementation integrated with the public-domain MPICH project. The second thrust entails the development of novel execution models, i.e., accurate stochastic models to predict (and, in turn, optimize) the expected performance (execution time or throughput) of large-scale parallel scientific applications. In the third thrust, we will develop novel parallel algorithms for scientific numerical kernels. We will profile a representative set of key large-scale applications to assess their resilience characteristics (e.g., identify specific patterns to reduce checkpoint overhead). We will also analyze execution trade-offs based on the replication of crucial kernels and on decentralized ABFT (Algorithm-Based Fault Tolerant) techniques. Finally, we will develop new numerical methods and robust algorithms that still converge in the presence of multiple failures. These algorithms will be implemented as part of a software prototype, which will be evaluated when confronted with realistic faults generated via our fault injection techniques.

We firmly believe that only the combination of these three thrusts (new checkpoint protocols, new execution models, and new parallel algorithms) can solve the exascale resilience problem. We hope to contribute to the solution of this critical problem by providing the community with new protocols, models and algorithms, as well as with a set of freely available public-domain software prototypes.

9.2.2.5. DEDALES: Algebraic and Geometric Domain Decomposition for Subsurface/Groundwater Flows

Participants: Emmanuel Agullo, Luc Giraud, Mathieu Faverge, 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.

9.2.2.6. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: 2015 - 2018

Coordinator: Barcelona Supercomputing Center

Inria contact: Stephane Lanteri

Objectives: This project has three general objectives and a large list of specific technical objectives related with research in each technology:

1. The main objective 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 envir onmental issues using the state of the art HPC systems.

2. Improve the cooperation between energy industries from EU and Brazil. The project includes relevant energy industral 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

3. Improve the cooperation between the leading research centres in EU and Brazil in HPC applied to energy industry. 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.

9.3.1.2. EXA2CT

Type: FP7

Defi: Special action

Instrument: Specific Targeted Research Project

Objectif: Exascale computing platforms, software and applications

Duration: September 2013 - August 2016

Coordinator: IMEC, Belgium

Partner: Particular specializations and experience of the partners are:

- Applications:
  - NAG - long experience in consultancy for HPC applications
  - Intel France - collaboration with industry on the migration of software for future HPC systems
  - TS-SFR - long experience in consultancy for HPC applications in Aerospace and Oil & Gas
- Algorithms – primarily numerical:
  - UA - broad experience in numerical solvers, with some taken up by the PETSc numerical library and other work published in high-ranking journals such as Science.
  - USI - expertise in parallel many-core algorithms for real-world applications on emerging architectures
  - Inria - expertise on large scale parallel numerical algorithms
  - IT4I - experience in the development of scalable solvers for large HPC systems (e.g. PRACE)
- Programming Models & Runtime Environments:
  - Imec - leads the programming model research within the Flanders ExaScience Lab
  - UVSQ - specialized in code optimization and performance evaluation in the area of HPC
  - TS-SFR - leading the BMBF funded GASPI project
  - Fraunhofer - developed a GASPI runtime environment used in industrial applications
- Hardware Optimization:
  - Intel France - investigates workloads for new hardware architectures within the context of the Exascale Computing Research centre

Inria contact: Luc Giraud

Abstract: 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. 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.

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.

9.4. International Initiatives

We are involved in the Inria@SiliconValley initiative through the associate team FASTLA described below.

9.4.1. Inria Associate Teams not involved in an Inria International Labs

9.4.1.1. MORSE

Title: Matrices Over Runtime Systems @ Exascale

International Partner (Institution - Laboratory - Researcher):

KAUST Supercomputing Laboratory (USA)

Duration: 2014 - 2016

See also: http://icl.cs.utk.edu/projectsdev/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.

9.4.1.2. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra

International Partner (Institution - Laboratory - Researcher):

Stanford University (USA)

Lawrence Berkeley National Laboratory (USA)

Duration: 2014 - 2016

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 hybrid linear solvers, that appear in many intensive numerical simulations in computational sciences. Regarding the FMM we plan to study novel generic formulations based on $\mathcal{H}$-matrices techniques, that will be eventually validated in the field of material physics: the dislocation dynamics. For the hybrid solvers, new parallel preconditioning approaches will be designed and the use of $\mathcal{H}$-matrices techniques will be first investigated in the framework of fast and monitored approximations on central components. Finally, the innovative algorithmic design will be essentially focused on heterogeneous manycore platforms. The partners, Inria HiePACS, Lawrence Berkeley Nat. Lab and Stanford University, have strong, complementary and recognized experiences and backgrounds in these fields.

9.4.2. Participation In other International Programs

9.4.2.1. HOSCAR

We are involved in the Inria-CNPq HOSCAR project led by Stéphane Lanteri.

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models (Group 1), (ii) scientific data management (Group 2), and (iii) high-performance software systems (Group 3).

The final annual meeting has been organized in Inria Sophia, on September 21-24, 2015, while a follow-up of the project will exist as a H2020 project entitles HPC4E (HPC for Energy) to be started in 2016 with an enlarged partnership.

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Research stays abroad

Mathieu Faverge has been invited to KAUST University from October to December 2015 in the context of the associate team MORSE.

Pierre Blanchard participated to the Gene Golub SIAM Summer school on Randomized Numerical Linear Algebra held in Delph, Greece in June 2015.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. 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 - IRISA/Inria, Hycomes - IRISA/Inria. 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.

9.1.2. Labex HEMISFER

Participants: Anatole Lécuyer [contact], Marsel Mano, Lorraine Perronnet.

HEMISFER is a 3-year project (2013-2016) 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).

9.1.3. Labex SABRE

Participants: Anatole Lécuyer [contact], Jussi Lindgren, Nataliya Kosmina.

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.

9.1.4. 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 collaborate with b<>com within two 3-year projects: ImData (on "Immersive Interaction") and GestChir (on "Augmented Healthcare").

9.1.5. CNPAO Project

Participants: Valérie Gouranton [contact], Jean-Baptiste Barreau, Quentin Petit.

CNPAO ("Conservatoire Numérique du Patrimoine Archéologique de l'Ouest") is an on-going research project partially funded by the Université Européenne de Bretagne (UEB). 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.

9.1.6. Imag'In CNRS IRMA

Participants: Bruno Arnaldi, Jean-Baptiste Barreau, Valérie Gouranton [contact].

The IRMA project is an Imag'In project directly funded by CNRS which aims at developping innovative methodologies for research in the field of cultural heritage based on a combination of medical imaging technologies and methods of interactive 3D modalities (virtual reality, augmented reality, haptic, additive manufacturing). These tools are based on recent research results from a close collaboration between Hybrid team with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET, and are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. The innovative methodologies proposed in the project gave rise to a real interest in the archaeological community. We worked on a large number of archeological artefacts (15), of different nature, composition and/or fabrication on various time period (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We mention in particular: the oldest human bones found in Brittany (clavicle Beg Er Vil), a bone-made flute outcome of an archeo-musicology study conducted at the University of Burgundy, a cremation of the late First Iron Age Guipry (35), metal and organic furniture from the chariot burial of Warcq (08) (horses harnessed skull, char tiller, buckets), a Bronze Cauldron from a burial of the Merovingian necropolis Crassés Saint-Dizier (51). This work involves a strong collaboration with Ronan Gaugne (IMMERSIA), Théophane Nicolas (INRAP), and Grégor Marchand (CReAAH).

9.2. National Initiatives

9.2.1. ANR MANDARIN

Participants: Merwan Achibet, Adrien Girard, Anatole Lécuyer, Maud Marchal [contact].

MANDARIN ("MANipulation Dextre hAptique pour opéRations INdustrielles en RV") is a 4-year ANR project (2012-2015). MANDARIN partners are CEA-List (coordinator), Inria/Hybrid, UTC, Haption and Renault. It aims 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 is 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 will be evaluated with a representative industrial application which is not feasible with currently existing technologies: the bi-manual manipulation of complex rigid objects and cables bundles.

9.2.2. ANR HOMO-TEXTILUS

Participants: Anatole Lécuyer [contact], Maud Marchal, Jonathan Mercier-Ganady.

HOMO-TEXTILUS is a 4-year ANR project (2012-2015). Partners of the project are : Inria/Hybrid, CHART, LIP6, TOMORROW LAND, RCP and potential end-user is Hussein Chalayan fashion designer. The objective of HOMO TEXTILUS is 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 is strongly oriented towards human science, with both user studies and sociological studies. The involvement of Hybrid team in the project consists in studying the design of next-gen prototypes of clothes embedding novel kinds of sensors and actuators. Envisionned sensors relate to physiological measurements such as with EEG (electroencephalograpohy and Brain-Computer Interfaces), EMG (muscular activity), GSR (galvanic skin response) or Heart Rate (HR). Envisionned actuators relate to new sensory stimulations such as vibrotactile displays or novel visual (eg LED) displays. These prototypes will thus be used in the various experiments planned in the project.

9.2.3. FUI Previz

Participants: Bruno Arnaldi [contact], Valérie Gouranton [contact], Emmanuel Badier, Thomas Boggini, Rozenn Bouville Berthelot, Cédric Le Cam.

Previz is a 3-year project (2013-2016) funded by the competitive cluster "Images et Réseaux". Previz involves 4 Academic partners (Hybrid/INSA Rennes, ENS Louis-Lumière, LIRIS, Gipsa-Lab) and 9 Industrial partners (Technicolor, Ubisoft, SolidAnim, loumasystem, Polymorph). Previz aims at proposing new previsualization tools for movie directors. The goal of Hybrid in Previz is 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 will end 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. ADT MAN-IP

Participant: Valérie Gouranton [contact].

The ADT MAN-IP is a 2-year project (2013-2015) funded by Inria for software support and development. MAN-IP involves two Inria teams: Hybrid and MimeTIC. MAN-IP aims at proposing a common software pipeline for both teams to facilitate the production of populated virtual environments. The resulting software should include functionalities for motion capture, automatic aquisition and modification, and high-level authoring tools.

9.2.5. ADT OpenViBE-NT

Participants: Anatole Lécuyer [contact], Jussi Lindgren [contact].

The ADT OpenViBE-NT is a 3-year project (2012-2015) funded by Inria for support and development of the OpenViBE software (section 6.1). OpenViBE-NT involves four Inria teams: Hybrid, Potioc, Athena, Neurosys - all being extensive users of OpenViBE. OpenViBE-NT aims at improving the current functionalities of OpenViBE platform, and helping in supporting its active and ever growing community of users.

9.2.6. Ilab CertiViBE

Participants: Anatole Lécuyer [contact], Jussi Lindgren, Charles Garraud, Jérôme Chabrol.

CertiViBE is a 1-year "Inria Innovation Lab" (2015-2016) 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 developing a novel version of the software wich should comply with medical certification rules.

9.2.7. IPL BCI-LIFT

Participants: Anatole Lécuyer [contact], Jussi Lindgren [contact], Andéol Evain, Lorraine Perronnet, Nataliya Kosmina.

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 - January 2018

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 contacts: Nicolas Roussel, 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.

9.4. International Research Visitors

9.4.1. Visits of Scientists

We have welcomed Dr. Antonio Capobianco from team IGG (Université de Strasbourg) between November 3rd and December 4th, 2015.

HYCOMES Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Ayman Aljarbouh's PhD is partially funded by an ARED grant of the Brittany Regional Council. His doctoral work takes place in the context of the Modrio and Sys2Soft projects on hybrid systems modeling — see sections 7.2 and 7.2 . 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 is participating to the S3PM project 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 [32]. 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.

7.2. National Initiatives

Program:« Briques génériques du logiciel embarqué » (Embedded Software Generic Building-Blocks)

Project acronym: Sys2soft

Project title: Physics Aware Software

Duration: June 2012 – November 2015

Coordinator: Dassault Systèmes (France)

Other partners: Thales TGS / TRT / TAS, Alstom Transport, Airbus, DPS, Obeo, Soyatec

Abstract: The Sys2soft project aims at developing methods and tools supporting the design of embedded software interacting with a complex physical environment. The project advocates a methodology where both physics and software are co-modeled and co-simulated early in the design process and embedded code is generated automatically from the joint physics and software models. Extensions of the Modelica language with synchronous programming features are being investigated, as a unified framework where interacting physical and software artifacts can be modeled.

7.3. European Initiatives

7.3.1. 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)

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

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.

7.4. International Research Visitors

7.4.1. Research stays abroad

Ayman Aljarbouh has visited for two months Walid Taha's team (http://www.hh.se/english/research/professors/walidmohamedtaha.10235.html) at Halmstad university in Sweden. He has been working on the implementation in the Accumen language of the regularization techniques he is developing in his PhD work.

<center>**I4S Project-Team**</center>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MAG2C-Pont Tabarly

Participant: Ivan Guéguen.

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.

The instrumentation auscultates globally the structure, a structural defect in a given location changes its modal parameters and thus the vibration behavior. Then it can be detected on any part of the structure with an accelerometer. These measures coupled with a wireless data transmission system type or wifi 3g will allow remote monitoring of the evolution of the structure. And where appropriate, to deploy when necessary, for maintenance. The different objectives are

- Experimentation on a bridge
- Equipment qualification in real conditions over the long term
- Apply different vibration processing algorithms
- Surveillance and Detection
- Measurement database

The instrument proposed is based on an accelerometer-based distributed network on the structure. This assembly is connected to a data acquisition system and a modem 3g for continuous measurements and remotely. The vibration will be collectable on the internet.

9.1.2. Project wind turbine in St Hilaire de Chaleon

Participant: Ivan Guéguen.

Type: GIS

Objectif: bridge instrumentation

Duration: Since 2014

Coordinator : LIRGEC

Partners: IFSTTAR

Inria contact: Ivan Guéguen

Abstract: The project deals with the instrumentation of the wind turbine.

The aim is firstly, to instrument the foundation before casting with continuous optical fibers, optical strain gauges, temperature sensors and accelerometers for a detailed analysis of the behavior of the founding quasi static and dynamic. In a second time to instrument the mast with accelerometers to the study by SSI under ambient vibration method. All of which should help better understand the global behavior of the structure.

9.1.3. 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

Objectif: bridge SHM

Duration: 11/2014 to 11/2018

Coordinator: RAILENIUM

Partners : IFSTTAR, EIFFAGE, RFF, LGCgE

Inria contact: Ivan Guéguen

Abstract: This project aims to orchestrate 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 measures environmental conditions (temperature, precipitation on the site). Accelerometers, to monitor the dynamic behavior of the track, with measures at several levels: the hammer beams on top of the grave-bitumen layer, on top of the soil. These measures will include acceleration compare the dynamic response of a section with and without GB. Instrumentation of severe bitumen strain gauges for measuring the longitudinal and transverse tensile strains at the base of the UK, 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. These optical fibers used to monitor deformation obtained following the transverse profile in the game with underlay in the UK (in ballast) and the part with underlay GNT (Differential settlement, appearance of a crack ...).

9.2.2. REPTILES

Participant: Jean Dumoulin.

Type: FUI

Objectif: Innovation for rehabilitation of potable water tubes

Duration: Since 11/2012

Coordinator: FREYSSINET

Inria contact: J. Dumoulin

Since 2012, within FUI Reptiles, J. Dumoulin was coordinator of the conception, study and development of a thermoplastic composite assembly system for water tubes reenforcement. Moreover, infrared thermography was used for active control. [37]

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. [43], [27] (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.

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. Collaboration with BAM, Berlin
Participants: Laurent Mevel, Michael Doehler, Eva Viefhues.

Eva Viefhues is currently student in BAM, Berlin. a PhD will start in 2016. Michael Doehler has visited a few times BAM in 2015 to prepare and plan the PhD.

9.3.2.2. Collaboration with CNR-IREA, Italy
Participants: Jean Dumoulin, Nicolas Le Touz.

This internship aims to identify defects in the interior walls, using thermal and electromagnetic reconstruction method, developed by IFSTTAR (in Bouguenais) for thermal and CNR-IREA (in Naples) for electromagnetism.

First, we make a numerical study for the two direct problems, with the resolution of the heat equation with finite elements, allowing a detailed study of how is made the assembly of matrices for a problem in two or three dimensions. A study of Maxwell's equations solving by using a centered finite difference method is also conducted for the direct problem of electromagnetism.

We also study the resolution of these inverse problems, in particular with the calculation of a functional gradient using the adjoint method for the thermal reconstruction, what allows the resolution of the problem with the Levenberg-Marquardt algorithm, and a study of the Born model for the electromagnetism problem.

Applications to the reconstructions of various types of defects are then lead. These different situations allow to highlight the stimuli, thermal of electrical, to bring to the system so that the reconstruction is made correctly. We could thus reconstruct defects in domains of various dimensions with thermal or electromagnetism highlighting the electrical (conductivity, permittivity and permeability), thermal (effusivity) and mathematical parameters (regularization terms) playing on the fidelity of the reconstruction.

A coupling of these two reconstruction methods is then carried out to improve the fidelity of the reconstructions realized with only one of these two methods. In the case of this coupling, the reconstruction get with GPR data provides a priori information to the thermal inverse problem allowing to get a better location of the defects.

9.3.2.3. 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.

9.3.2.4. MODRIO
Participants: Qinghua Zhang, Liangquan Zhang.

Type: ITEA2

Defi: Model Driven Physical Systems Operation

Objectif: To meet the evermore stringent safety and environmental regulations for power plants and transportation vehicles, system operators need new techniques to improve system diagnosis and operation.

Duration: June 2012 to November 2015

Coordinator: Daniel Bouskela (EDF)

Inria teams PARKAS, HYCOMS, I4S

Inria contact: B. Caillaud

Abstract: Open standards are necessary for different teams to cooperate by sharing compatible information and data. To meet the evermore stringent safety and environmental regulations for power plants and transportation vehicles, system operators need new techniques to improve system diagnosis and operation. Open standards are necessary for different teams to cooperate by sharing compatible information and data. The objective of the MODRIO project is to extend modeling and simulation tools based on open standards from system design to system diagnosis and operation. This project joined by partners from Austria, Belgium, Finland, France, Germany, Italy and Sweden has been selected by the board of Information Technology for European Advancement (ITEA 2). The involved Inria project-teams are PARKAS, HYCOMES and I4S. This project is funded from June 2012 to November 2015.

9.3.2.5. 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 technologies and structural performance".

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.

9.4. International Initiatives

9.4.1. *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 2016 for 3 years.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

S. Allahdadian from British Columbia University has visited us for a week in 2015.

IBIS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Project name	Séminaire grenoblois des systèmes complexes
Coordinators	S. Achard, O. François, A. Maignan, E. Prados, S. Rafai, D. Ropers
IBIS participants	D. Ropers
Type	Funding by Institut des Systèmes Complexes de Lyon (IXXI)
Web page	http://www.ixxi.fr/?page_id=114&lang=fr

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-)
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	E. Cinquemani, J. Geiselmann, C. Gomez Balderas, H. de Jong, S. Lacour, Y. Markowicz, C. Pinel, D. Ropers
Type	Bioinformatics call, Investissements d'Avenir program (2012-2017)
Web page	https://project.inria.fr/reset/

Project name	Fonction du système de régulation post-transcriptionnel CSR dans la dynamique de l'adaptation métabolique chez la bactérie modèle Escherichia coli
Coordinators	M. Cocaign-Bousquet (Inra, LISBP), B. Enjalbert (INSA, LISBP), D. Ropers
IBIS participants	M. Morin, D. Ropers
Type	Contrat Jeune Scientifique Inra-Inria (2012-2015)
Web page	http://www.inra.fr/les_hommes_et_les_femmes/rejoignez_nous/completer_sa_formation/le_recrutement_de_doctorants/cjs__1/inra_inria

Project name	A web application for the analysis of time-series fluorescent reporter gene data
Coordinator IBIS participants Type	H. de Jong E. Cinquemani, J. Geiselmann, M. Page, D. Ropers, V. Zulkower (University of Edinburgh) IFB call for development of innovative bioinformatics services for life sciences (2016-2017)

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Computer Engineering & Systems Science Department of University of Pavia (Italy), 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 professor Subject	Alberto Soria-Lopéz (Centro de Investigación y de Estudios Avanzados (Cinestav) of Instituto Politécnico Nacional (IPN), Mexico) Development of an automatically-controlled system of multiplexed mini-bioreactors
Visiting scientist Subject	Aline Métris (Institute of Food Research (IFR), Norwich, UK) Comparative analysis of metabolic networks of Escherichia coli and Salmonella

ILDA Team

8. Partnerships and Cooperations

8.1. 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.

8.2. National Initiatives

8.2.1. 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.

8.2.2. 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: Emmanuel Pietriga (PI), André Spritzer.

8.3. European Initiatives

8.3.1. 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 consulting on the design and implementation of user interfaces for array operations monitoring and control for the Cherenkov Telescope Array (CTA) project, to be built in the Canary Islands (Spain) and in the Atacama desert (Chile).

8.4. International Initiatives

8.4.1. Inria International Labs

Inria Chile / CIRIC. Since 2012, Emmanuel Pietriga is 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.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Japan Advanced Institute of Science and Technology (JAIST): René Vestergaard on the interactive visualization of complex networks in molecular biology.

Microsoft Research: Nathalie Henry Riche and Bongshin Lee on defining the value of interaction on complex visualization systems. Participants: Anastasia Bezerianos.

Northwestern University: Steven Franconeri and Steve Haroz on understanding the impact of animations on interactive visual exploration. Participants: Anastasia Bezerianos.

University of Konstanz: Daniel Keim and Johannes Fuchs on mapping out the design space for visualization glyphs. Participants: Anastasia Bezerianos.

Universidad Carlos III de Madrid: Teresa Onorati and Paloma Diaz on the visualization of tweet feeds related to crisis events using a wall display, so as to help crisis monitoring and management. Participants: Anastasia Bezerianos, Emmanuel Pietriga.

8.4.3. Participation In other International Programs

Program MIT-France, Hae-Jin Song, summer 2015 (3-month senior student internship).

8.5. International Research Visitors

Steve Feiner, Professor of Computer Science, head of the Computer Graphics and User Interfaces Lab at Columbia University (March 2015).

Deb Agarwal and David Brown, LBNL Computational Research Division, University of California at Berkeley (June 2015).

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

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Labex Persyval*

Participants: Rémi Ronfard, Olivier Palombi, Armelle Bauer.

We received a doctoral grant from LABEX PERSYVAL, as part of the research program on authoring augmented reality (AAR) for PhD student Adela Barbelescu. Her thesis is entitled *directing virtual actors by imitation and mutual interaction - technological and cognitive challenges*. Her advisors are Rémi Ronfard and Gérard Bailly (GIPSA-LAB).

Additionally, this project funds the PhD thesis of Armelle Bauer which has started in October, co-advised by François Faure, Olivier Palombi, and Jocelyne Troccaz from TIMC-GMCAO. The goal is to tackle the scientific challenges of visualizing one's self anatomy in motion using Augmented Reality techniques.

7.1.2. *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), is a follow-up and a generalization of Dynam'it. The goal is to propose an integrated software for the animation and final rendering of high-quality movies, as an alternative to the ever-ageing Maya. It will include dynamics similarly to Dynam'it, as well as innovative sketch-based kinematic animation techniques invented a Imagine by Martin Guay and Rémi Ronfard. This contract, started in October, funds 2 engineers for 3 years.

7.2.2. *ANR CHROME (01/2012 - 08/2015)*

Participant: Rémi Ronfard.

Chrome is a national project funded by the French Research Agency (ANR). The project is coordinated by Julien Pettré, member of MimeTIC. Partners are: Inria-Grenoble IMAGINE team (Remi Ronfard), Golaem SAS (Stephane Donikian), and Archivideo (Francois Gruson). The project has been launched in september 2012. The Chrome project develops new and original techniques to massively populate huge environments. The key idea is to base our approach on the crowd patch paradigm that enables populating environments from sets of pre-computed portions of crowd animation. These portions undergo specific conditions to be assembled into large scenes. The question of visual exploration of these complex scenes is also raised in the project. We develop original camera control techniques to explore the most relevant part of the animations without suffering occlusions due to the constantly moving content. A long-term goal of the project is to enable populating a large digital mockup of the whole France (Territoire 3D, provided by Archivideo). Dedicated efficient human animation techniques are required (Golaem). A strong originality of the project is to address the problem of crowded scene visualisation through the scope of virtual camera control, as task which is coordinated by Imagine team-member Rémi Ronfard.

Three phd students are funded by the project. Kevin Jordao is working on interactive design and animation of digital populations and crowds for very large environments. His advisors are Julien Pettré and Marie-Paule Cani. Quentin Galvanne is working on automatic creation of virtual animation in crowded environments. His advisors are Rémi Ronfard and March Christie (Mimetic team, Inria Bretagne). Julien Pettre. Chen-Kin Lim is working on crowd simulation and rendering of the behaviours of various populations using crowd patches. Her advisors are Rémi Ronfard and March Christie (Mimetic team, Inria Bretagne). Julien Pettre.

7.2.3. AEN MorphoGenetics (10/2012 - 09/2015)

Participant: François Faure.

3-year collaboration with Inria teams Virtual Plants and Demar, as well as INRA (Agricultural research) and the Physics department of ENS Lyon. The goal is to better understand the coupling of genes and mechanical constraints in the morphogenesis (creation of shape) of plants. Our contribution is to create mechanical models of vegetal cells based on microscopy images. This project funds the Ph.D. thesis of Richard Malgat, who started in October, co-advised by François Faure (IMAGINE) and Arezki Boudaoud (ENS Lyon).

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 injurypredictionsthan 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 interestwhen 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 ergonomicsmodeling. The consortium will be balanced between industrial users (with seven European car manufacturers represented), academic users involved ininjury biomechanics, 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

- Laurent Grisoni (Univ. Lille / Inria): An HCI view of sketch-based interaction. (12/11/2015).

- Philippe Guillotel (Technicolor), Arnav Jhala (Univ. of California Santa Cruz), Mateu Sbert (University of Girona), Karan Singh (University of Toronto), participated to the Expressive Cinematography seminar (26/10/2015).

- Adrien Bousseau (Inria Sofia Antipolis): Computer Drawing Tools for Assisting Learners, Hobbyists, and Professionals (01/10/2015).

- Ludovic Hoyet (Inria Rennes), Perception of Biological Human Motion: Towards New Perception-Driven Virtual Character Simulations (10/09/2015).

- Michiel van de Panne (University of British Columbia), Animation Potpourri: New Models for Animated Vector Graphics, Motion Optimization, and Data-driven Animation (03/07/2015).

- Henri Gouraud, Histoire de l'ombrage de Gouraud (05/06/2015).

- Jean-Michel Dischler (Univ. Strasbourg), Procedural texturing from Example (28/05/2015).

- Paul Kry (MacGill University), Balancing Speed and Fidelity in Physics Based Animation and Control (23/04/2015).

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR AJACS

The AJACS project (Analyses of JavaScript Applications: Certification & Security) has been funded 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.

7.1.2. 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.

7.2. European Initiatives

7.2.1. FP7

7.2.1.1. MEALS

Title: Mobility between Europe and Argentina applying Logics to Systems

Program: FP7

Instrument: International Research Staff Exchange Scheme

Duration: October 2011 - September 2015

Coordinator: Pedro D'Argenio

Partners:

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

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Dresden (Germany)

University of Leicester (United Kingdom)

Universitaet Desarlandes (Germany)

Universidad de Córdoba (Argentina)

Universidad de Buenos Aires (Argentina)

Inria contact: Castuscia Palamidessi

Abstract:The MEALS project (Mobility between Europe and Argentina applying Logics to Systems) goals cover three aspects of formal methods: specification (of both requirement properties and system behavior), verification, and synthesis. The Indes members are involved in the task of Security and Information Flow Properties (WP3). The partners in this task include University of Buenos Aires, University of Córdoba, Inria (together with Catuscia Palamidessi, Kostas Chatzikokolakis, Miguel Andrés) and University of Twente. The web page of the project can be found at http://www.meals-project.eu.

7.2.1.2. RAPP

Program: http://rapp-project.eu

Title: Robot App Store

Collaborator: Inria Coprin

Abstract: RAPP is a 36 months pan-european FP7 project, started in December 2013. Hop is used in the development of prototypes of the Coprin Ang rollator transfer device, for mobility assistance and activity monitoring.

7.2.2. Collaborations in European Programs, except FP7 & H2020

Program: ICT Cost Action IC1201

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.

Program: ICT Cost Action IC1405

Project title: Reversible computation - extending horizons of computing

Duration: November 2014 - November 2018

Coordinator: Irek Ulidowski, University of Leicester

Abstract: Reversible computation is an emerging paradigm that extends the standard forwards 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 Action is the first European network of excellence aimed at coordinating research on reversible computation.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Internships

Vineet Rajani

Date: December 2014 - March 2015

MPI (Germany)

Katyal Rohan

Date: June 2015 - Aug 2015

Institution: IIIT-D (India)

Francis Dolière Some

Date: July 2015 - Sept 2015

University of Ouagadougou (Burkina)

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INFINE Team

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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, Ichrak Amdouni, Alaeddine Weslati, Vincent Ladeveze.

Partners: Inria (Lille, Sophia-Antipolis, Grenoble), INSA, UPMC, Institut Telecom Paris, Institut TÃ©lÃ©com 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 Researchâs "Ãquipements dâExcellence" (Equipex) research grant program, in 2011.

One component of the FIT platform is the sets of IoT-LAB testbeds (see site IoT-LAB). These were motivated by the observation that the world is moving towards an âInternet of Thingsâ, 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, 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.

8.3.2. 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 threedimensional space of time, location and interest (i.e. âwhatâ, âwhenâ and âwhereâ users are pulling data from the network), it is possible to derive efficient data offloading protocols. Such protocols would pre-fetch 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. The first annual report will be delivered before January 25, 2015.

8.3.2.2. ANR/BMBF SAFEST
Participants: Emmanuel Baccelli, Cedric Adjih, Oliver Hahm.

Program: ANR/BMBF French-German partnership within CSOSG Framework

Project acronym: SAFEST

Project title: Social Area Framework for Early Security Triggers

Duration: 2012-2015

Coordinators: Emmanuel Baccelli (France), Jochen Schiller (Germany)

Other partners: Freie Universitat Berlin, Fraunhofer, Hamburg University, Sagem, Daviko, FOS

Abstract: Public spaces, such as airports, railway stations, or stadiums bring together large numbers of people on limited space to use security-sensitive infrastructure. These spaces pose two distinct challenges to public security: (a) detecting unauthorized intrusions and (b) monitoring large crowds in order to provide guidance in case of unexpected events (e.g., mass panic). To ensure the safety of the general public as well as individuals, we thus require a flexible and intelligent method for area surveillance. One example in which current monitoring systems proved to be dangerously inefficient is the Love Parade music festival in Duisburg, Germany, July 2010. Crowd control failed to provide guidance to a large crowd, resulting in a mass panic with 21 deaths and several hundred injured. In this particular case, overloaded communication infrastructure led to a lack of information about the density and the movement of the crowd, which in turn resulted in misjudgments on appropriate strategies to resolve the situation. This incident highlights the need for more sophisticated and

reliable methods for area surveillance. The SAFEST project aims to analyse the social context of area surveillance and to develop a system that can fulfill this task, both in terms of technology as well as acceptance by the general public. The system will operate in distributed way, collect anonymised data, securely transfer this data to a central location for evaluation, and if necessary notify the operator and/or issue alerts directly to the general public. SAFEST addresses the following topics: (i) it proposes a solution for crisis management, addressing social, technical, and economic issues, (ii) it enhances the protection of the population against risks and dangers, including the evaluation of acceptance of said solution, and (iii) it addresses the protection of critical infrastructures by the means of a comprehensive technical solution. Project completed in 2015. One of its main result was the emergence of RIOT.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

1. On-going formal collaboration with Freie Universitaet Berlin around the long-term stay of Emmanuel Baccelli in Berlin, around the topics of the Internet of Things and Information-Centric Networking.

2. 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, ldots.

8.4.1.2. Informal International Partners

1. On-going collaboration with Hamburg University of Applied Science around RIOT.

2. Informal collaborations with UIUC and UMass.

8.4.2. Participation In other International Programs

8.4.2.1. STIC AmSud UCOOL

Participants: Aline Carneiro Viana, Eduardo Mucelli.

Program: STIC AmSud

Project acronym: UCOOL

Project title: Understanding and predicting human demanded COntent and mObiLity

Duration: 2013-2015

Coordinator: Aline Carneiro Viana

Other partners: National Laboratory for Scientific Computing (Brazil), Facultad de IngenierÃa, Universidad de Buenos Aires (Argentina), Universidad Tecnica Federico Santa Maria (Chile), Telecom Sud Paris, and Inria (with INFINE at Saclay and DANTE at Rhone-Alpes)

Abstract: The UCOOL (Understanding and predicting human demanded COntent and mObiLity, https://macaco.inria.fr/) project is granted by STIC-AmSUD, it is a 2-year project, and has officially started in January 2014. The main goal of this project is to define solutions for the identification and modelling of correlations between the user mobility â describing changes in the user positioning and the current environment he/she is in â and the traffic demand he/she generates.

8.4.2.2. 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 of International Scientists

1. Artur Ziviani, National Laboratory for Scientific Computing (LNCC), Brazil, October 2015.
2. José Ignacio Alvarez-Hamelin, Facultad de Ingeniería, Universidad de Buenos Aires, Argentina, November 2015.
3. Joao P. Vilela, University of Coimbra, July 2015

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

Emmanuel Baccelli has been visiting Freie Universitaet (FU) Berlin in 2015, within the context of the SAFEST project. The closer collaboration enabled by this stay allowed the initial development of the RIOT community (http://www.riot-os.org), and the development of new activities around Information-centric networking in the Internet of Things.

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

ANR project Transports Terrestres Durable "RESPET - Gestion de réseaux de service porte-à-porte efficace pour le transport de marchandises", in collaboration with LAAS (Toulouse), DHL, JASSP, LIA (Univ. Avignon) (2011-2015).

6.1.2. National Initiatives (Belgium)

Combinatorial Optimization: Meta-heuristics and Exact Methods (2012-2017, coordinator: Bernard Fortz (GOM-ULB/INOCS-Inria). Study and modeling of combinatorial optimization problems; Advancements in algorithmic techniques; Implementation of solution methods for large-scale, practically relevant problems.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

Program: BEWARE FELLOWSHIPS Academia

Project acronym: PARROT

Project title: Planning Adapter performing ReRouting and Optimization of Timing

Duration: 10/2014 - 09/2017

Coordinator: Martine Labbé (ULB)

Other partners: INFRABEL (Belgique).

Abstract: The Belgian railway company needs a new tool for the trains which have to be rescheduled when the company must do some maintenance operations on the network. The difficulties are the number of constraints, the size of the network, the quantity of trains and many other features related to the Belgian railway system. These difficulties imply that some choices have to be made to balance the quantity of work feasible in the 3 years project. After developing an interface between the INFRABEL database and the framework used in this project, a first model (MIP) will be implemented and then tested.

6.2.2. Collaborations in European Programs, except FP7 & H2020

Program: JPI Urban Europe

Project acronym: e4-share

Project title: Models for Ecological, Economical, Efficient, Electric Car-Sharing

Duration: 11/2014 - 10/2017

Coordinator: Markus Leitner (U. Vienna, Austria)

Other partners:

- AIT, Vienna, Austria
- GOM, Université Libre de Bruxelles (Inria/INOCS)
- Department of Electrical, Electronics and information Engineering, Alma Mater University of Bologna, Italy
- iC consulenten Ziviltechniker GesmbH, Vienna, Austria

Abstract: Car-sharing systems and the usage of electric cars become increasingly popular among urban citizens. Thus, providing vast opportunities to meet todays 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.

The project e4-share (Models for Ecological, Economical, Efficient, Electric Car-Sharing) runs from October 2014 to October 2017 and is funded by FFG, INNOVIRIS and MIUR via Joint Programme Initiative Urban Europe. The project comprises an interdisciplinary team of five partners from Austria, Belgium and Italy.

6.3. International Initiatives

6.3.1. Informal International Partners

- CIRRELT, GERAD, Montreal (P. Marcotte, G. Savard, M. Gendreau, G. Laporte, B. Gendron, ..)
- University of Maastricht (Stan Van Hoesel)
- Politecnico di Milano (Edouardo Amaldi)
- University of Lisbon (Luis Gouveia)
- University of Aveiro (Cristina Requejo)
- University of Sevilla (Justo Puerto)
- University of Chile (Fernando Ordonez)

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

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR Programme blanc international (BLAN) LODIQUAS 2012-2015

Participants: Philippe Chartier, Florian Méhats, François Castella, Mohammed Lemou.

The project, entitled "LODIQUAS" (for: Low DImensional QUANtum Systems), received fundings for 4 postdocs (48 months) and one pre-doc (36 months). The whole project involves the following researchers : Norbert Mauser (Vienna), Erich Gornik (Vienna), Mechthild Thalhammer (Innsbruck), Christoph Naegerl (Innsbruck), Jörg Schmiedmayer (Vienna), Hans-Peter Stimming (Vienna),Francis Nier (Rennes), Raymond El Hajj (Rennes), Claudia Negulescu (Toulouse), Fanny Delebecque (Toulouse), Stéphane Descombes (Nice), Christophe Besse (Lille).

The expected scientific and technological progress brought by the present project are as follows.

Quantum technology as the application of quantum effects in macroscopic devices has an increasing importance, not only for far future goals like the quantum computer, but already now or in the near future. The present project is mainly concerned with the mathematical and numerical analysis of these objects, in conjunction with experimental physicists. On the side of fermions quantum electronic structures like resonant tunnelling diodes show well studied non classical effects like a negative differential resistance that are exploited for novel devices. On the side of bosons the creation and manipulation of Bose Einstein Condensates (the first creation of BECs by Ketterle et al merited a Nobel prize) has become a standard technique that allows to study fundamental quantum concepts like matter-wave duality with increasingly large objects and advanced quantum effects like decoherence, thermalization, quantum chaos. In state-of-the-art experiments e.g. with ultracold atoms in optical lattices the bosonic or fermionic nature of quantum objects can change and it makes a lot of sense to treat the models in parallel in the development of mathematical methods. The experimental progress in these fields is spectacular, but the mathematical modelling and analysis as well as the numerical simulation are lagging behind. Low dimensional models are mostly introduced in a heuristic way and there is also a need for systematic derivations and comparison with the 3-d models. To close the gap is a main goal of this project that aims to deliver reliable tools and programme packages for the numerical simulation of different classes of quantum systems modelled by partial differential equation of NLS type. Virtually all participants have a strong track record of international collaboration, they grew up with the concept of the European Research Area where science knows no boundaries and scientists used to work in different countries, as it was the case in a pronounced way in mathematics and in quantum physics in the thirties of the last century. The Pre- and Post-Docs to be funded by this project will be trained in this spirit of mobility between scientific fields and between places.

This project gave rise to the following scientific achievements

PhD students

Boris Pawilowski, has been hired as a PhD student, under the supervision of F. Nier and N. Mauser. His contract started october 2012, and the PhD thesis was defended on December 2015. His PhD subject is "Mean field limit for discrete models and nonlinear discrete Schrödinger equations".

Postdocs

Loïc Le Treust has been hired as a Postdoc, under the supervision of F. Méhats (main) and N. Mauser. His contract started October 2013, and it did last two years, in Rennes and Vienna.

Yong Zhang, under contract in Vienna, has been invited for several one month periods in Rennes. There are works in progress with F. Méhats and P. Chartier.

Kristelle Roidot, had a six months contract in Vienna, and this gave rise to works with N. Mauser, C. Klein, J.-C. Saut, S. Descombes.

Workshops

July 2012, kick-off meeting of the LODIQUAS project, WPI, Vienna (one week, approx. 40 people, amongst which most of the participants of the project).

February 2013, WPI, Vienna, with a similar organization as the kick-off meeting.

July 2013, WPI, Vienna. At the WPI for one week. "Quantized Vortices in Superfluidity and Superconductivity and Related Problems", organisers W. Bao, C. Bardos, Q. Du, N. Mauser.

September 2013, WPI Vienna, "Modified dispersion for dispersive equations and systems ", organisers R. Carles, Mauser, J.C. Saut.

September 2013, WPI Vienna, "Modified dispersion for dispersive equations and systems ", organisers R. Carles, Mauser, J.C. Saut.

October 2014, WPI Vienna, "Blow-up and Dispersion in nonlinear Schrödinger and Wave equations", organizers G. Lebeau, A. Jüngel, O. Ivanovici, J.-C. Saut, H.-P. Stimming.

December 2014, Saint-Malo, "Lodiquas Meeting", organisers F. Castella and P. Chartier.

December 2015, Dinard, "Joint Lodiquas and Ipso Meeting",

6.1.2. *ANR MOONRISE: 2015-2019*

Participants: Nicolas Crouseilles, Philippe Chartier, Florian Méhats, François Castella, Mohammed Lemou.

The project *Moonrise* submitted by F. 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, F. Castella, P. Chartier, N. Crouseilles and M. Lemou are members of the project Moonrise.

6.1.3. *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.

6.2. European Initiatives

6.2.1. *FP7 & H2020 Projects*

6.2.1.1. Geopardi

Title: Numerical integration of Geometric Partial Differential Equations

Programm: FP7

Duration: September 2011 - August 2016

Coordinator: E. Faou

Inria contact: E. Faou

'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.'

6.2.1.2. EUROfusion 2015-2017

N. Crouseilles and M. Lemou are members of the EUROFusion project entitled "Enabling research project for the implementation of the fusion roadmap". The leader is E. Sonnendrücker (IPP Garching, Germany).

6.3. International Initiatives

6.3.1. Inria International Partners

6.3.1.1. Informal International Partners

Several IPSO members have international collaborations

- L. Einkemmer, University of Innsbruck. Collaboration on numerical schemes for Vlasov-Maxwell equations with N. Crouseilles and E. Faou.
- M. Thalhammer, University of Innsbruck. Collaboration on multi-revolution methods for the Schrödinger equation and Dirac equation with F. Méhats and P. Chartier.
- S. Jin, University of Madison. Collaboration on numerical schemes for highly-oscillatory problems with N. Crouseilles and M. Lemou.
- G. Vilmart, University of Geneva. Collaboration on uniformly accurate methods for highly-oscillatory problems with F. Méhats and P. Chartier
- F. Casas, University Jaume. Collaboration on splitting methods for Vlasov equations with N. Crouseilles and E. Faou.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

6.4.1.1. Internships

S. Jin (University of Madison) spent 2 months at IRMAR (University of Rennes) within the framework of the Labex H. Lebesgue semester "PDEs and long time behavior", to collaborate with N. Crouseilles and M. Lemou.

6.4.2. Visits to International Teams

6.4.2.1. Research stays abroad

- P. Chartier: invitation at the University of Geneva (Switzerland), by G. Vilmart (one month in July).

- F. Méhats: invitation at the University of Geneva (Switzerland), by G. Vilmart (one week).

- F. Méhats: invitation at the Beijing Computational Science Research Center (China), by W. Bao (10 days).

- M. Lemou: invitation at the University of Wisconsin-Madison (US), by S. Jin (two weeks, october 2015).

- M. Lemou: invitation at the University of Geneva (Switzerland), by G. Vilmart (two weeks, july 2015).

- A. Debussche participated to the semester "New challenges in PDE: Deterministic dynamics and randomness in high and infinite dimensional systems" at MSRI (Berckeley, US).

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

OverFlow (2015–2019). 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. Within this project, A. Costan is jointly working with Kate Keahey (University of Chicago and Argonne National Laboratory), Bogdan Nicolae (IBM Research) and Christophe Blanchet (Institut Français de Bioinformatique).

9.1.2. Other National Projects

DISCOVERY (2015–2019). An Inria Project Lab, led by Adrien Lebre (ASCOLA), that 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 unending demand. Project-teams: ASAP, ASCOLA, Avalon, Myriads, and KerData. Within DISCOVERY, S. Ibrahim (KerData Inria Team) is working with Gilles Fedak (Avalon Inria Project-Team) to address the VM images management challenge.

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

Program: H2020

Duration: January 2015–January 2019

Coordinator: Universidad politecnica de Madrid

Participants:

- Barcelona Supercomputing Center — Centro Nacional de Supercomputacion (Spain)
- CA Technologies Development Spain (Spain)
- CEA — Commissariat a 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)

URL: http://www.bigstorage-project.eu/

Inria contact: Gabriel Antoniu and Adrien Lèbre

BigStorage is a European Training Network (ETN) whose main goal is to 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. 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. It has ben created in 2014 as a follow-up of the Inria-UIUC JLPC — *Joint Laboratory for Petascale Computing* to collaborate on concurrency-optimized I/O for Extreme-scale platforms (see details in Section 7.4). The KerData team is collaborating with teams from ANL and UIUC within this lab since 2009. This collaboration has now been formalized as the *Data@Exascale* Associate Team with ANL and UIUC (2013–2015).

9.3.1.1.1. Associate Team involved in the International Lab: Data@Exascale

Title: Ulta-scalable I/O and storage for Exascale systems

International Partner: Argonne National Laboratory (United States) — Mathematics and Computer Science Division (MCS) — Robert Ross

Start year: 2013

URL: http://www.irisa.fr/kerdata/data-at-exascale/

As the computational power used by large-scale scientific applications increases, the amount of data manipulated for subsequent analysis increases as well. Rapidly storing this data, protecting it from loss and analyzing it to understand the results are significant challenges, made more difficult by decades of improvements in computation capabilities that have been unmatched in storage. For many applications, the overall performance and scalability clearly become driven by the performance of the I/O subsystem. As we anticipate Exascale systems in 2020, there is a growing consensus in the scientific community that revolutionary new approaches are needed in computational science storage. These challenges are at the center of the activities of the Joint Inria-Illinois-ANL-BSC-JSC-RIKEN/AICS Laboratory for Extreme-Scale Computing (JLESC, formerly called JLPC). This project gathers researchers from Inria, Argonne National Lab and the University of Illinois at Urbana Champaign to address 3 goals: 1) investigate new storage architectures for Exascale systems; 2) investigate new approaches to the design of I/O middleware for Exascale systems to optimize data processing and visualization, leveraging dedicated I/O cores and I/O forwarding techniques; 3) explore techniques enabling adaptive cloud data services for HPC.

9.3.2. Inria International Partners

9.3.2.1. DataCloud@work

Title: DataCloud@Work — Distributed data management for cloud services

International Partner: Politehnica University of Bucharest (Romania) — Computer Science and Engineering Department — Valentin Cristea and Nicolae Tapus

Start year: January 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

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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Research stays abroad

Luis Eduardo Pineda Morales: Research visit at ANL, hosted by Kate Keahey and Balaji Subramaniam for 3 months (June–August), funded by the PUF NextGen peoject and by the Microsoft Research Inria Joint Centre project. This work is done in the context of the Joint Laboratory for Extreme-Scale Computing (JLESC).

Orçun Yildiz   Research visit at ANL, hosted by Rob Rossa and Matthieu Dorier for 3 months, funded by the PUF NextGen project and by the Data@Exascale Associate Team. This work is done in the context of the Joint Laboratory for Extreme-Scale Computing (JLESC).

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *HandiViz project - SATT Ouest Valorisation*
Participants: François Pasteau, Marie Babel.

duration: 12 months.

This project started in June 2014. Thanks to a strong collaboration with Ergovie Company and the rehabilitation center Pôle Saint Hélier (Rennes), the semi-autonomous navigation solution designed for wheelchair systems (see Section 7.3.3) has been medically validated and tested by patients. The resulting technology is currently under transfer towards Ergovie (SATT/INSA funding). This technology, compliant with any off-the-shelf electrical wheelchair, is expected to be commercialized at mid 2016. We expect that this technology should be helpful for many handicapped people. In particular, intensive clinical trials have shown that such a system can lift the medical interdiction to drive wheelchairs for people who suffer from severe handicap such as hemispatial neglect or cerebral palsy.

9.1.2. *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 started in October 2013. It supports in part Suman Raj Bista's Ph.D. about visual navigation (see Section 7.3.1).

9.1.3. *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 shearlet transform. (see Section 7.6.5).

9.1.4. *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).

9.1.5. *"Equipement mi-lourd Rennes Metropoles"*
Participant: Paolo Robuffo Giordano.

no Irisa 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 6.12 has been purchased in part thanks to this grant.

9.2. National Initiatives

9.2.1. *ANR P2N Nanorobust*
Participants: Le Cui, Eric Marchand.

no. UR1 11FA310-06D, duration: 48 months.

This project started in November 2011 and will end in March 2016. It is composed of a consortium managed by Femto-ST in Besançon with LPN and Isir in Paris, Thalès and Lagadic group through the "Université de Rennes 1". Nanorobust deals with the development of micro- and nano-manipulation within SEM (Scanning Electron Microscope). We provided visual servoing techniques for positioning and manipulation tasks with a micrometer precision.

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 7.1.4).

9.2.3. ANR Platinum

Participants: Patrick Rives, Vincent Drevelle.

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 through Inria Sophia Antipolis. It aims at proposing novel solutions to robust long-term mapping of urban environments.

9.2.4. ANR SenseFly

Participants: Paolo Robuffo Giordano, Riccardo Spica, Thomas Bellavoir, Muhammad Usman.

no Irisa CNRS 50476, duration: 36 months.

The ANR "Jeune Chercheur" project SenseFly 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 6.12 has been purchased thanks to this grant.

9.2.5. PEA Decsa

Participants: Aurélien Yol, François Chaumette, Eric Marchand.

no Inria Rennes 6630, duration: 36 months.

This project started in November 2011 and ended in November 2015. It was composed of a consortium managed by Astrium/Airbus with the Novadem, Sirehna, Spot Image and Magellium companies, and with the Inria Lagadic and Steep groups (Peter Sturm). It was devoted to the development of navigation and perception algorithms for small drones in urban environment.

9.2.6. Oseo Romeo 2

Participants: Nicolas Cazy, Suman Raj Bista, Fabien Spindler, François Chaumette.

no Inria Rennes 7114, duration: 48 months.

This project started in November 2012. It is composed of a large consortium managed by Aldebaran Robotics. It aims at developing advanced control and perception functionalities to a humanoid robot. It supports in part Suman Raj Bista's Ph.D. about visual navigation (see Section 7.3.1), as well as Nicolas Cazy's Ph.D. about model-based predictive control for visual servoing (see Section 7.2.3).

9.2.7. Equipex Robotex

Participants: Fabien Spindler, François Chaumette.

no Inria Rennes 6388, duration: 10 years.

Lagadic is one of the 15 French partners involved in the Equipex Robotex network. It is devoted to get significative equipments in the main robotics labs in France. In the scope of this project, we have got the humanoid robot Romeo (see Section 6.11).

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 2016

Coordinator: University of Surrey (United Kingdom)

Partners: Surrey Satellite Technology (United Kingdom), Astrium (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. [38]

9.3.1.2. Comanoid

Participants: Paolo Robuffo Giordano, François Chaumette.

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - January 2019

Coordinator: CNRS (Lirmm)

Partners: Airbus Groups (France), DLR (Germany), Universita Degli Studi di Roma La Sapienza (Italy)

Inria contact: François 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. Romans

Participants: Paolo Robuffo Giordano, Nicolo Pedemonte, Firas Abi Farraj, François Chaumette.

Title: Robotic Manipulation for Nuclear Sort and Segregation

Programm: H2020

Duration: May 2015 - May 2018

Coordinator: Univ. Birmingham (UK)

Partners: NLL (UK), CEA (France), Univ. Darmstat (Germany)

CNRS contact: Paolo Robuffo Giordano

The RoMaNS project aims at advancing the state of the art in autonomous, tele-operative and shared control for remote manipulation. This has far reaching cross-sector applications in nuclear, aerospace, oil and gas, space, food and agriculture. Within the nuclear industries of multiple EU states, it applies across the entire sector, such as waste processing, decommissioning, asset care, maintenance, repair, characterization and sampling. The novel technology that will be produced within this project will be applied to a very challenging and safety-critical nuclear "sort and segregate" industrial problem, which is driven by urgent market and societal needs. The purpose of nuclear sort and segregate is to place low-level waste in low-level storage containers, rather than occupying extremely expensive and resource intensive higher level storage containers and facilities. Also, Waste Requiring Additional Treatment (WRAT) will be either decontaminated, recycled, compacted, incinerated or grouted. Finally, any unstable waste items are sorted into a more suitable storage state. Indeed, it can be noted that cleaning up the past half century of nuclear waste, in the UK alone (mostly at the Sellafield site), represents one of the largest environmental remediation projects in Europe. Most EU countries have similar challenges. Many older EU nuclear sites (> 60 years in UK) contain large numbers of legacy storage containers, many of which have contents of mixed contamination levels, and sometimes unknown contents. Some of this waste have been temporarily stored in containers, which may need to be disrupted or cut open, to investigate their contents, before sorted and segregated. Any country that possesses a nuclear plant, even without a current backlog of legacy waste, will face similar challenges when they begin decommissioning. Vast quantities of highly contaminated plant machinery and infrastructure will have to be demolished, cut and resized, and the parts sorted and segregated. Much of this work can only be done by remote manipulation methods, because the high levels of radioactive material are hazardous to humans. In this respect, the RoMaNS project will address the following points: (i) development of novel hardware, and improvement the TRL level of existing experimental hardware, to enable robot arms and grippers with advanced capabilities, but which are suitable for deployment in high radiation environments; (ii) development of advanced autonomy methods for highly adaptive and generalizable automatic grasping and manipulation actions; (iii) development of hardware and software solutions for advanced bi-lateral tele-operation of arms and grippers; (iv) combination of autonomy and tele-operation methods using state-of-the-art understanding of mixed initiative planning, variable autonomy and shared control approaches; (v) delivery of a TRL 6 demonstration in an industrial plant-representative environment at the UK National Nuclear Lab Workington test facility, in close proximity to the Sellafield nuclear site.

9.4. International Initiatives

9.4.1. Inria Associate Teams not involved in an Inria International Labs

Participants: Marie Babel, Vishnu Karakkat Narayanan.

Sampen (Self Adaptive Mobile Perception and Navigation) is an Inria associated team with the Iceira Lab supervised by Prof Ren C. Luo at the National University of Taiwan. It has been accepted in 2014 for 2 years. The coordinator of the team for Inria is Anne Spalanzani from UPMF University at Grenoble. The other French participants are Marie Babel, Daney David (Phoenix group in Bordeaux) and Christian Laugier (e-Motion group in Grenoble).

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.

In the scope of this project, Marie Babel and Vishnu Karakkat Narayanan spent a one-week visit in Iceira Lab in April 2015. Vishnu Karakkat Narayanan was then invited to spend a three-month visit from August till November 2015 in that lab.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- As a follow up to the long term collaboration with the "Centro de Tecnologia da Informação Renato Archer" (CTI) in Campinas (Brazil), Renato José Martins benefits a Ph.D. grant from the CNPq (2013-2017). He is co-directed by Patrick Rives and Samuel Siqueira Bueno from "Divisio de Robotica e Viseo Computacional" at CTI.

- Alexandre Krupa has a collaboration with Nassir Navab from the Technische Universität München concerning the joint supervision of Pierre Chatelain's Ph.D.

- Patrick Rives has a collaboration with Javier Gonzales-Jimenez from the University of Malaga (Spain). Eduardo Fernandez-Moral who received his Ph.D. in Malaga by September 2014, is currently on a Postdoctoral position in Sophia Antipolis.

9.4.3. Participation In other International Programs

The Lagadic group is one of the few external partners of the Australian Center for Robotic Vision roboticvision.org. It groups QUT in Brisbane, ANU in Canberra, Monash University and Adelaide University. In the scope of this project, Riccardo Spica spent a six-month visit at ANU collaborating with Prof Rob Mahony, and François Chaumette spend a short visit at QUT and ANU in November 2015.

9.5. International Research Visitors

9.5.1. Research stays abroad

- Pierre Chatelain spent a nine-month visit in Nassir Navab's lab at TUM, Germany, in the scope of his Ph.D. (see Section 9.4.2).

- Ricardo Spica spent a six-month visit in Rob Mahony's lab at ANU, Canbera, in the scope of the Australian Center of Robotic Vision (see Section 9.4.3).

- Vishnu Karakkat Narayanan spent a three-month visit in Ren Luo's lab at Iceira Lab, National Taiwan University, Taiwan, in the scope of his Ph.D as well as the SAMPEN associated team (see Section 9.4.1).

LARSEN Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. AME Satelor

Participants: François Charpillet, Maxime Rio, Nicolas Beaufort, Xuan Son Nguyen, Thomas Moinel, Mélanie Lelaure, Théo Biasutto-Lervat.

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.

9.1.2. PEPS PsyPhINe: Cogito Ergo Es

Participant: Amine Boumaza.

PEPS site Mirabelle (CNRS & University of Lorraine) gathering researchers from the following institutes: MSH Lorraine (USR3261), InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Inria Bordeaux Sud-Ouest, Loria (UMR7503). Refer to sec. 7.2.2.1 for further information.

9.2. National Initiatives

9.2.1. PIA LAR Living Assistant Robot

Participants: François Charpillet, Abdallah Dib.

Partners : Crédit Agricole, Diatelic, Robosoft
LAR project has the objective to designing an assistant robot to improve the autonomy and quality of life for elderly and fragile persons. The project started at the beginning of the year. 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 dynamic environment. Another issue is for the robot to be able to behave with acceptable social skills.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. RESIBOTS
Participants: Jean-Baptiste Mouret, Dorian Goepp, Konstantinos Chatzilygeroudis, Vassilis Vassiliades, Federico Allocati.

> Title: Robots with animal-like resilience
>
> Program: H2020
>
> Type: ERC
>
> Duration: May 2015 - May 2020
>
> Coordinator: Inria
>
> Inria contact: Jean-Baptiste Mouret
>
> Abstract: 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 damages 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, nor 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 open new research avenues for adaptive machines.

9.3.1.2. 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 about robust, goal-directed whole-body motion interaction with multiple contacts. CoDyCo will go beyond traditional approaches: (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) was 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.

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. PHC MUROTEX
Participant: François Charpillet.

Program: Hubert Curien Partnerships

Project acronym: MUROTEX

Project title: Multi-agent coordination in robotics exploration and reconnaissance missions

Duration: Jan. 2014 – Dec. 2015

Coordinator: O. Simonin (INSA LYON)

Other partners: Jan Faigl at the Czech Technical University in Prague

Abstract: The main objective of the project is to develop a distributed planning framework for efficient task-allocation planning in exploration and reconnaissance missions by a group of mobile robots operating in an unknown environment with considering communication constraints and uncertainty in localization of the individual team members. One main challenge is to decentralize the decision, in order to scaling up with large fleet of robots (existing solutions are centralized or depend on full communication).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

- Valerio Modugno, PhD student at the Robotics Lab, DIAG, Sapienza (Rome, Italy), visited LARSEN for 9 months (Apr. 2015 – Dec. 2015) to work on learning of task priorities for a robotic arm.

LEAR Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. *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 LEAR.

9.1.2. *ANR Project Macaron*
Participants: Julien Mairal, Zaid Harchaoui, 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.

9.1.3. *MASTODONS Program CNRS - Project Titan*
Participants: Zaid Harchaoui, Julien Mairal.

The project is concerned with machine learning and mathematical optimization for big data. The partners are from LJK (Grenoble), LIG (Grenoble), LIENS (ENS, Paris), Lab. P. Painleve (Lille). Principal investigator/leader: Zaid Harchaoui. Dates: Jan 2015-Dec. 2015

9.1.4. *Equipe-action ADM du Labex Persyval (Grenoble) "Khronos"*
Participants: Zaid Harchaoui, Massih-Reza Amini [LIG].

The partners of this project are from the laboratories LJK, LIG, GIPSA, TIMC, CEA. The principal investigators/leaders are Zaid Harchaoui (Inria and LJK), Massih-Reza Amini (LIG). The project started in Jan. 2014 and ends in Dec. 2016.

9.2. European Initiatives

9.2.1. *FP7 & H2020 Projects*

9.2.1.1. AXES
Participants: Ramazan Cinbis, Matthijs Douze, Zaid Harchaoui, Dan Oneata, Danila Potapov, Cordelia Schmid, Jakob Verbeek, Clement Leray, Anoop Cherian.

This 4-year project started in January 2011 and ended in May 2015. Its goal is to develop and evaluate tools to analyze and navigate large video archives, eg. from broadcasting services. The partners of the project are ERCIM, Univ. of Leuven, Univ. of Oxford, LEAR, Dublin City Univ., Fraunhofer Institute, Univ. of Twente, BBC, Netherlands Institute of Sound and Vision, Deutsche Welle, Technicolor, EADS, Univ. of Rotterdam. See http://www.axes-project.eu/ for more information.

9.2.1.2. ERC Advanced grant Allegro

Participants: Cordelia Schmid, Karteek Alahari, Jerome Revaud, 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. International Initiatives

9.3.1. Inria International Partners

- **UC Berkeley:** This collaboration between Bin Yu, Jack Gallant, Yuval Benjamini, Adam Bloniarz (UC Berkeley), Ben Willmore (Oxford University) and Julien Mairal (Inria LEAR) 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. Yuansi Chen, from UC Berkeley visited LEAR in the summer 2015 to work on this project.

- **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. J. Mairal also started a collaboration with Peter Richtarik, professor at university of Edinburgh and Dominik Csiba (PhD student), on the topic of local low-rank matrix estimation.

- **MPI Tübingen:** C. Schmid collaborates with M. Black, a research director at MPI since 2013. She spent one month at MPI in January 2015. End of 2015 she was award a Humbolt research award funding a long-term research project with colleagues at MPI.

- **Technion:** J. Mairal started a collaboration with Yonina Eldar (Technion) and Andreas Tillmann (Darmstadt university) to develop dictionary learning techniques for phase retrieval. Andreas Tillmann visited the LEAR team for a week in May 2015. Their collaboration resulted in a paper accepted to the ICASSP'16 conference.

9.3.2. Participation In other International Programs

- **France-Berkeley fund:** The LEAR team was awarded in 2014 a grant from the France-Berkeley fund for a project between Julien Mairal and 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 for a period of one year, from November 2014 to April 2016. The funds are meant to support scientific and scholarly exchanges and collaboration between the two teams.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Andreas Tillmann (Darmstadt university) and Dominik Csiba (Edinburgh university) visited Julien Mairal for a week, respectively in May and October 2015.

9.4.2. Visits to International Teams

- **Sabbatical program** Zaid Harchaoui was on sabbatical at New-York university, from October 2014 to September 2015.

LEMON Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **Cart'Eaux** project (funded by Languedoc Roussillon region): in partnership with colleagues of LIRMM and HSM (Montpellier) Carole DELENNE will develop a new method to gather various types of data in order to produce a regular and complete mapping of urban assainissement, in order to allow sharp and complete hydrodynamical modeling of urban pipes.
- 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 precisiption 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

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. Nuwat / LIRIMA

With Moshen Chebbi (Phd student, ENIT, Tunis) we continue to explore the stochastic modeling for biotechnological problems. We proposed a framework that allows for both analysis and simulation of the models. This framework slightly generalized standard jump Markov processes on grids popularized by Tom Kurtz and co-workers. With Oussama Hadj-Abdelkader (Univ. Tlemcen) we continue to explore the nonlinear filtering techniques for the chemostat including unscented Kalman filtering and particle filtering.

9.3.1.2. Inria Chile

Antoine ROUSSEAU visited Inria Chile in January, 2015 (2 weeks) in order to prepare a long stay in Chile in 2016.

9.3.2. Inria International Partners

9.3.2.1. 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 *resource assessment & site characterization*.

9.3.2.2. Informal International Partners

Vincent GUINOT collaborates with B.F. Sanders (Irvine University, Californie, USA)
Vincent GUINOT collaborates with S. Soares-Frazao (Unité de Génie Civil, Université catholique de Louvain, Belgium)
Antoine ROUSSEAU and Fabien MARCHE collaborate with Rodrigo Cienfuegos and Cristián Escauriaza (CIGIDEN and PUC Chile, Santiago)

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Carine Lucas (Université of Orléans, France) spent several months in LEMON to collaborate with Antoine ROUSSEAU on nontraditional models in oceanography.

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

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *ANR Peace – Parameter spaces for Efficient Arithmetic and Curve security Evaluation*

Participants: Bill Allombert, Karim Belabas, Jean-Marc Couveignes, Andreas Enge, Hamish Ivey-Law, Enea Milio, Damien Robert.

http://chic2.gforge.inria.fr/

The PEACE project is joint between the research teams of Institut de Recherche en Mathématiques de Rennes (IRMAR), LFANT and Institut Mathématiques de Luminy (IML).

The project aims at constituting a comprehensive and coherent approach towards a better understanding of theoretical and algorithmic aspects of the discrete logarithm problem on algebraic curves of small genus. On the theoretical side, this includes an effective description of moduli spaces of curves and of abelian varieties, the maps that link these spaces and the objects they classify. The effective manipulation of moduli objects will allow us to develop a better understanding of the algorithmic difficulty of the discrete logarithm problem on curves, which may have dramatic consequences on the security and efficiency of already deployed cryptographic devices.

One of the anticipated outcomes of this proposal is a new set of general criteria for selecting and validating cryptographically secure curves (or families of curves) suitable for use in cryptography. Instead of publishing fixed curves, as is done in most standards, we aim at proposing generating rationales along with explicit theoretical and algorithmic criteria for their validation.

The ANR organised the conference "Effective moduli spaces and applications to cryptography" in June 2014 as a part of the Centre Henri Lebesgue's Thematic Semester 2014 "Around moduli spaces".

7.1.2. *ANR Simpatic – SIM and PAiring Theory for Information and Communications security*

Participants: Guilhem Castagnos, Damien Robert, Sorina Ionica, Cyril Bouvier.

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.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. ANTICS

Title: Algorithmic Number Theory in Computer Science

Programm: 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.'

7.2.1.2. Open Dream Kit

Title: Algorithmic Number Theory in Computer Science

Programm: FP7

Duration: September 2015 - August 2019

Inria contact: Karim Belabas

OpenDreamKit is a Horizon 2020 European Research Infrastructure project (#676541, call e-infrastructures for virtual research environments) that will run for four years, starting from September 2015. It will provide substantial funding to the open source computational mathematics ecosystem, and in particular popular tools such as LinBox, MPIR, SageMath, GAP, Pari/GP, LMFDB, Singular, MathHub, and the IPython/Jupyter interactive computing environment.

From this ecosystem, OpenDreamKit will deliver a flexible toolkit enabling research groups to set up Virtual Research Environments, customised to meet the varied needs of research projects in pure mathematics and applications, and supporting the full research life-cycle from exploration, through proof and publication, to archival and sharing of data and code.

The project involves about 50 people spread over 15 sites in Europe, with a total budget of about 7.6 million euros. The largest portion of that will be devoted to employing an average of 11 researchers and developers working full time on the project. Additionally, the participants will contribute the equivalent of six other people working full time.

Countries involved include France (Universités Paris-Sud, Versailles, Bordeaux, Grenoble and the industrial partner Logilab), Germany (Kaiserslautern, Bremen), United Kingdom (Oxford, Southampton, Sheffield, St Andrews, Warwick), Norway (Simula), Poland (University Silesia), Switzerland (University Zürich).

7.3. International Initiatives

7.3.1. Inria International Labs

The *MACISA* project-team (Mathematics Applied to Cryptology and Information Security in Africa) is one of the new teams of LIRIMA. Researchers from Inria and the universities of Bamenda, Bordeaux, Dakar, Franceville, Maroua, Ngaoundéré, Rennes, Yaoundé cooperate in this team.

The project is concerned with public key cryptology and more specifically the role played by algebraic maps in this context. The team focus on two themes:

- Theme 1: Rings, primality, factoring and discrete logarithms;
- Theme 2: Elliptic and hyperelliptic curve cryptography.

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 Libreville with the International Center for Pure and Applied Mathematics (ICPAM/CIMPA), March 2015, attended by most of the members of Macisa;
- The visit of Abdoul Aziz Ciss (Dakar) and Emmanuel Fouotsa (Bamenda) to Bordeaux, September 2015, for the Elliptic Curve Cryptography and Summer School conference;
- The visit of Tony Ezome to Bordeaux, October 2015;
- The visit of Damien Robert to Yaoundé, Cameroun, to give courses on cryptography for a special seminar on security event.

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 David Kohel (Université d'Aix-Marseille), Tony Ezome (Université des Sciences et Techniques de Masuku, Franceville), Abdoul Aziz Ciss (Ecole Polytechnique de Thiès, Sénégal), Emmanuel Fouotsa (École Normale Supérieure de l'Université de Bamenda), Renate Scheidler (University Calgary), Eduardo Friedman (Universidad de Chile), Benjamin Smith (Inria & LIX, École Polytechnique), Bernadette Perrin-Riou (Paris-Sud).

The visit of Ciss, Ezome and Fouotsa were also part of the collaboration through the Macisa team.

LIFEWARE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

- ANR Blanc HYCLOCK (2014-2018) on "Hybrid modeling of time for Circadian Clock Biology and Chronopharmacology", coordinated by F. Delaunay (CNRS, Nice), F. Lévi (INSERM Paris-Sud), G. Bernot (CNRS I3S, Nice), O. Roux (Ecle Centrale Nantes).
- 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).
- ANR Blanc NET-WMS-2 (2011-2015) on "constraint optimization in Wharehouse Management Systems", coordinated by F. Fages, with N. Beldiceanu (Ecole des Mines de Nantes, EPI TASC), and Abder Aggoun (KLS optim).

8.1.2. GENCI Contract

- GENCI (2009-) 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. Collaboration with National Taiwan University

Since 2012, we develop a collaboration with Prof. Jie-Hong Jiang, National Taiwan University which culminated this year with the defence of the PhD Thesis of Katherine Chiang [1], co-supervised by Jie-Hong Jiang and François Fages with two internships in 2012 and 2013, and with several publications [5], [11], [6]. Our aim is to pursue our collaboration on the concept of biochemical programming and the development of biochemical programming tools, in particular for the design of artificial biosensors in partnership with Franck Molina (CNRS, Sys2diag, Montpellier).

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 short visits of a few days
- Prof. Hugo Fort, Univ. Montevideo, Uruguay
- Prof. Andreas Weber, Univ. Bonn, Germany
- Damien Woods, Caltech, USA

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *CominLabs Project Linking Media in Acceptable Hypergraphs (LIMAH)*

Participants: Rémi Bois, Vincent Claveau, Guillaume Gravier, Grégoire Jadi, Pascale Sébillot.

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., 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.

8.2. National Initiatives

8.2.1. *ANR Project FIRE-ID*

Participant: Hervé Jégou.

Duration: 3 years, started in May 2012
Partner: Xerox Research Center Europe

The FIRE-ID project considers the semantic annotation of visual content, such as photos or videos shared on social networks, or images captured by video surveillance devices or scanned documents. More specifically, the project considers the fine-grained recognition problem, where the number of classes is large and where classes are visually similar, for instance animals, products, vehicles or document forms. We also assumed that the amount of annotated data available per class for the learning stage is limited.

8.2.2. *ANR Project Secular*

Participants: Laurent Amsaleg, Teddy Furon, Hervé Jégou, Ewa Kijak.

Duration: 3 years, started in September 2012
Partners: Morpho, Univ. Caen GREYC, Telecom ParisTech

Content-based retrieval systems (CBRS) are becoming the main multimedia security technology to enforce copyright laws or to spot illegal contents over the Internet. However, CBRS were not designed with privacy, confidentiality and security in mind. This comes in serious conflict with their use in these new security-oriented applications. Privacy is endangered due to information leaks when correlating users, queries and the contents stored-in- the-clear in the database. This is especially the case of images containing faces which are so popular in social networks. Biometrics systems have long relied on protection techniques and anonymization processes that have never been used in the context of CBRS. The project seeks to a better understanding of how biometrics related techniques can help increasing the security levels of CBRS while not degrading their performance.

8.2.3. *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.

8.2.4. *FUI 19 NexGenTV*

Participants: Vincent Claveau, Guillaume Gravier, Ewa Kijak, Pascale Sébillot.

Duration: 2.5 years, started in May 2015
Partners: Eurecom, Avisto Telecom, Wildmoka, Envivio

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.

8.3. International Initiatives

8.3.1. *Inria Associate Teams not involved in an Inria International Labs*

8.3.1.1. *MOTIF*

Title: Unsupervised motif discovery in multimedia content

International Partner (Institution - Laboratory - Researcher):

Pontifícia Universidade Católica de Minas Gerais, Brasil - VIPLAB - Silvio Jamil Guimãraes

Universidade Federal Minas Gerais, Brasil - NPDI - Arnaldo Albuquerque de Araújo

Duration: 2014 - 2017

See also: http://www-linkmedia.irisa.fr/motif

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.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

- National Institute for Informatics, Japan
- University of Amsterdam, The Netherlands
- Katholieke Universiteit Leuven, Belgium
- National Technical University of Athens, Greece

8.3.3. 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
- STIC AmSud MAXIMUM Unsupervised Multimedia Content Mining
    - International coordinator: Guillaume Gravier, CNRS – IRISA, France
    - Scientific coordinators : Arnaldo de Albuquerque Araújo (Universidade Federal de Minas Gerais, Computer Science Department, NPDI); Benjamin Bustos (Universidad de Chile, Department of Computer Science, PRISMA); Silvio Jamil F. Guimarães (Pontifícia Universidade Católica de Minas Gerais, VIPLAB)
    - Jan. 2014 - Dec. 2015
- France Berkeley Fund Graph-NN: Computing and Manipulating Very Large Graphs of Nearest Neighbors
    - International coordinator: Laurent Amsaleg, CNRS – IRISA, France
    - Scientific coordinators : Michael Franklin (AMPLab, UC Berkeley)
    - Jun. 2015 - Dec. 2015

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Bùi Văn Thạch (Ph.D. Student)

Date: Oct 2015 - Nov 2015

Institution: National University of Sokendai, Japan

8.4.2. Visits to International Teams

Ahmet Iscen

Date: Apr 2015 - Jun 2015

Institution: McGill University, Montreal, Canada

8.4.2.1. Explorer programme

Balu Raghavendran

Date: Jul 2015 - Sep 2015

Institution: University of California Berkeley (United States of America)

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

Links participates in the CPER DATA (2015-19)

9.2. National Initiatives

ANR Aggreg (2014-19): Aggregation Queries.

- Participants: 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], A. Bonifati, S. Tison.
- Parteners: 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.

9.2.1. Competitivity Cluster Picom

FUI Hermes (2012-15): The future of shopping

- We participate in the Hermes project of the Pôle de compétitivité PICOM, a regional research cluster on the industy of commerce.
- Participants: I. Boneva [correspondent], A. Bonifati, J. Niehren
- Objective: Here we work on filtering publicity offers by newspaper arriving on complex event streams in real time.
- Parteners: Norsys, Auchan, etc

9.3. International Initiatives

9.3.1. Inria Associate Teams not involved in an Inria International Labs

Associated Team "Integrating Linked Data" with the Datbase group of the University of Oxford (2013-15).

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

AMSud project "Foundations of Graph Databases" (2016-17)

Partners: Santiago de Chili (C. Riveros), Buenos Airos (S. Figuera), Bordeaux (G. Puppis).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

George Fletcher, Eindhoven University of Technology, Belgium, Apr 2015

Martin Musicante, Federal University of Rio Grande do Norte, Bresil, Sep 2014- Oct 2015.

9.4.1.1. Internships

M. Linardi, University of Trento. On Web Data Integration, from Feb 2015 until Sep 2015.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

Slawek Staworko, University of Edinburgh, 2014-16.

<h1 style="text-align:center; color:red">M3DISIM Team</h1>

9. Partnerships and Cooperations

9.1. European Initiatives

9.1.1. FP7 & H2020 Projects

9.1.1.1. VPH-Share

Title: Virtual Physiological Human: Sharing for Healthcare – A Research Environment

Programm: FP7

Duration: March 2011 - May 2015

Coordinator: Univ. Sheffield (UK)

Other partners: Cyfronet (Cracow), University College London, Istituto Ortopedico Rizzoli (Bologna), NHS, IBM Israel, Univ. Auckland, Agència d'Informació, Avaluació i Qualitat en Salut (Barcelona), Biocomputing Competence Centre (Milano), Universitat Pompeu Fabra (Barcelona), Philips Research, TUE (Eindhoven), Sheffield Teaching Hospitals, Atos Origin (Madrid), the Open University (UK), Univ. Vienna, King's College London, Empirica (Bonn), Fundació Clínic (Barcelona), Univ. Amsterdam

See also: http://vph-share.org/

Inria contact: Dominique Chapelle

Abstract: VPH-Share (concluded in May 2015) aimed at developing the organisational fabric (the infostructure) and integrating the optimised services to expose and share data and knowledge, to jointly develop multiscale models for the composition of new VPH workflows, and to facilitate collaborations within the VPH community. Within this project, the M3DISIM team was in charge of developing some high-performance data assimilation software tools.

9.1.1.2. VP2HF

Title: Computer model derived indices for optimal patient-specific treatment selection and planning in Heart Failure

Programm: FP7

Duration: October 2013 - September 2016

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.

9.2. International Initiatives

9.2.1. Participation In other International Programs

M3DISIM is the leading representative of Inria within the "Living Heart Project", a research network coordinated by Dassault-Systèmes to foster collaborations on cardiac modeling between various academic and industrial partners.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

9.3.1.1. Internships

Alexandre Laurin [Simon Fraser Univ., Canada] Sébastien Imperiale [correspondant] Philippe Moireau Dominique Chapelle Gabriel Valdes Alonzo [Pontificia Univ. Católica de Chile] Radomir Chabiniok [correspondant] Dominique Chapelle

A. Laurin's doctoral internship (2 months) has taken place in the context of an ongoing collaboration between the Aerospace Physiology lab (Simon Fraser University, Vancouver, Canada) and Inria (M3DISIM and Reo teams), with the objective of initiating the modelling of seismocardiography (SCG) measurements. SCG consists in measuring displacements of the sternum and ribs generated by a heart beat using accelerometers placed on the thorax. In this context, linear elastodynamics equations are applicable to account for the transient propagation of motion from the heart to the sternum via the highly heterogeneous underlying materials (cartilage and bone). Specific care has been taken to solve the aforementioned equation in a realistic 3D geometry including the complete thoracic cage. Fully coupled simulations (beating heart with thorax deformation) are planned at the final stage of this modelling work. Following the completion of his PhD, A. Laurin has joined the team for a post-doc, which provides the setting for continuing and extending this work.

G. Valdes (Master's student at Pontificia Univ. Católica de Chile) has been awarded a Conicyt funding for a 3 months internship within our team. He has worked on a simplified dynamical model of venous return, allowing to account for the evolution of the preload – the pressure that induces the filling of the heart – under the effect of variations of cardiac output. This is crucial for simulating sequences of heartbeats in transient regimes, and one major motivation for this was to initiate the modeling of the dynamics of heart failure.

MADYNES Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. 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 control of a fleet of UAV (with or without leader, using particle swarm optimisation [25] and [24]) and the organisation of a Federation Charles Hermite research day in may 2015.

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

9.1.2. Hydradrone FEDER Région Lorraine project

Participants: Adrien Guenard, Laurent Ciarletta [contact].

Funded by the Region Lorraine under the R&D program.

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 form 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 first year has been dedicated to the development of :

- a couple of small scale hydradrones / proofs of concept (the UxV) for both hardware and software (embedded / remote)
- a larger 1:1 scale hydradrone for heavy sensor payload
- evaluation of the needed sensor payload, and the requirements to turn them into "cyber physical" components.

9.1.3. *Satelor AME Lorraine regional project*

Participants: Mandar Harshe, 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 2016). 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 keeping 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) [28]. 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 [38]. 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.

9.2. National Initiatives

9.2.1. *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.: NDN) 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 emerging networks functions or protocols in a virtualized networking environment; (2) the monitoring and security of virtually deployed networking architectures.

This year, we mainly worked on the WP1 which goal is to define the global architecture of DOCTOR and select the most relevant technologies solutions [66], [27]. We focused on performance of different virtualization solutions. We also contributed to WP4, dedicated to the testbed infrastructure [71]. We also provided a routing scheme for NDN based on a softwarization approach (Software-Defined Networking, SDN) [22], [21].

9.2.2. *PIA LAR*

Participants: Kévin Roussel, Ye-Qiong Song [contact].

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 year we have intensively tested the S-CoSenS MAC protocol under RIOT OS by using ARM Cortex-M3 motes of IoT-LAB (Grenoble) and especially contributed to the improvement of the robustness (see section 7.7.1). Another achievement is the connection of our MPIGate-based sensor data collect system to the application server, by the mean of properly defined JSON message formats.

9.2.3. *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 Interministerial) 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 started in September 2015 and 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. Academic partners will be mainly focused on defining those techniques while industrial partners will build an experimental platform to design a testing platform and data collectors.

9.2.4. *Inria-Orange Joint Lab*

Participants: Jérôme François [contact], Rémi Badonnel, Olivier Festor, Maxime Compastié.

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.

9.2.5. *Technological Development Action (ADT)*

9.2.5.1. *ADT Métroscope*

This ADT is linked to the consortium Metroscope http://metroscope.eu/, whose goal is to understand the behavior of the Internet and its uses within a mobile environment. Through this ADT, funded by Inria, an engineer (Mohammad-Irfan Khan) was hired for 2 years (2013-2015). He is participating in the design and deployment of a distributed platform. This platform is composed of a services providing measurement tools that collect a set of data and interact with probes located at various points of the network.

9.2.5.2. ADT SEA

The goal of this ADT is to provide an novel security solution for Android platforms where the users will be able to evaluate the security level of their devices. The solution relies on the analysis and collection of logs and network activities of running Android applications to detect malicious activities and also the detection of vulnerable configurations of the device using an OVAL-based approach. Through this ADT, funded by Inria an engineer (Eric Finickel) was hired for 2 years (2013-2015). The work was focused on the development of Android devices embedded probes to export logs and network activities, and also the design and setup of collector and analysis applications using a Hadoop based framework. The resulting platform from this ADT is currently deployed in the High Security Lab and it will be extended during the year 2016.

9.2.5.3. ADT R2D2

The goal of this ADT is to provide assistance in developing the Aetournos platform. Through this ADT, funded by Inria, Ceilidh Hoffmann stayed until february 2015 and then Raphaël Cherfan was hired for the rest of the year (2015). They both have been helping maintaining the Aetournos platform, coordinating students work on the platform and tutoring the Aetournos team for the 2014 and 2016 Outback Joe Search and Rescue / Medical Express Challenge.

9.2.5.4. ADT LAPLACE

This ADT started on 2014 and will end on 2016. The Madynes project is a major partner funded at the level of 120k€. ADT LAPLACE builds upon the foundations of the Grid'5000 testbed 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.

9.2.5.5. ADT COSETTE

This ADT started on 2013 and will end 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.

9.2.5.6. ADT RIOT

RIOT ADT is a multi-site project with Infine and Madynes teams, which started in December 2015 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 www.riot-os.org and 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.

Specific objectives of Madynes team include (a) implementation, on RIOT, of new MAC protocols issuing from the latest research, as well as the design of the MAC layer interfaces both with the upper network layer and directly with applications (API), (b) RIOT drivers development to allow efficiently interfacing with both radio transceivers and sensors (via UART, SPI, I2C, GPIO, . . .), according to the chosen hardware platforms (e.g., Zolertia Z1, AVR, ARM Cortex), (c) implementation of the previous solutions in a smart home environment, (d) development of an MCU emulator, (e) integration of the developed MCU emulator into a network simulation tool (e.g. Cooja).

9.2.6. Other Initiative

Participants: Ciarletta Laurent, Gurriet Thomas, Xu Yang, Amza Catalin, Guenard Adrien, Nataf Emmanuel [contact].

Alerion is an "e-falconry" startup created by a member of Madynes in June 2015. Its goal is to provide novel solutions and services in the field of UxV (Unmanned Air, Ground, Surface ... Vehicles) and in moving and interacting objects of the "Internet of Things". The concept is to enhance such existing systems or design new ones by combining well-designed (i.e with regards to efficiency, safety, ease of use) components and containers seen as Cyber Physical bricks. This has also given some publications [53], [52] and [30]. The Alerion project is also actively supporting the international UAV Challenge team that is participating to the "Medical Express", the new "Outback Joe Challenge".

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Flamingo

> Title: Management of the Future Internet
>
> Programm: FP7
>
> Duration: November 2012 - October 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 2015, our activities of Flamingo have been focused on automated configuration using service function chaining for mobile device (section 7.2.3), sensor network monitoring to counter-fight attacks in cooperation with the Jacobs University Bremen (§7.1.4), leading the standardization activities of the project (WP leader), enhancing our flow-based monitoring specification to be standardized at the IETF in a close future (§6.3) and Online training material on network management (§10.2.1).

9.4. International Initiatives

9.4.1. Inria International Labs

- LIRIMA (*Laboratoire international de recherche en informatique et mathématiques appliquées*): Madynes is associated with the MASECNESS research team of the Yaoundé University, Cameroun. The collaboration is about wireless sensors networks and was the support for funding student mobility (4 months this year). The LIRIMA has also supported the purchase of thirty sensors used in our common work. Some results have been presented this year at the scientific workshop of the LIRIMA held in St-Louis of Senegal.

- Since September 2015, Thomas Silverston is on leave at JFLI (*délégation CNRS*), an international joint-laboratory between CNRS, Inria, UPMC, Univ. Paris Sud, Keio University, NII and the University of Tokyo located in Tokyo, Japan. He is currently hosted at the University of Tokyo. His main research objectives are on virtualization on new network architecture (e.g.: ICN/NDN) through the use of software-defined networking or Network Function Virtualization.

  Dash Kondo, a PhD student from Madynes, is currently doing an internship at JFLI at the University of Tokyo with Prof. Asami Tohru and Thomas Silverston, on virtualization and security in NDN.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- University of Luxembourg: Jérôme François is a Fellow at SnT (Interdisciplinary Center for Security, Reliability and Trust) to empower our collaboration with the University of Luxembourg. This collaboration is now focused on network virtualization, which also includes the co-advising of S. Signorello.
- University of Waterloo: we pursue our collaboration with the team of Prof. Raouf Boutaba especially on using SDN for scheduling flows generated by *Big Data* applications. This work lead to a a survey [55].

9.4.3. Participation In other International Programs

9.4.3.1. STIC-AmSud AKD Project
Participants: Remi 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 started in January 2015 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.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

Nesrine Khelifi, 18/06/2015-18/09/2015, Université de Manouba - Tunisie. See §7.4.1

Seetaraman Savita, 10/07/2015-31/10/2015, University of Trento (Italy), Benchmarking of virtualized network functions [62]

9.5.1.2. Scientific visits

Dr. Jian Li, associate professor at Shanghai Jiaotong University (China) visited the team for two weeks in December and given a talk on the recent research results of his group on network virtualization and cloud applications.

9.5.2. Visits to International Teams

9.5.2.1. Research stays abroad

Thomas Silverston is currently on leave (Delegation CNRS) at the University of Tokyo within JFLI, an international joint-lab between CNRS, Inria, UPMC, Univ. Paris Sud, Keio University, NII and the University of Tokyo. Daishi Kondo, co-advised with Prof. Olivier Perrin (UL) and Thomas Silverston, is also doing an internship at the JFLI from September 2015 to February 2016.

<h1 style="text-align: center; color: red;">MAESTRO Project-Team</h1>

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. FP7 & H2020 Projects

9.2.1.1. CONGAS

Participants: Eitan Altman, Konstantin Avrachenkov, Yonathan Portilla, Alexandre Reiffers-Masson.

Title: Dynamics and COevolution in Multi-Level Strategic INteraction GAmeS

Programm: FP7

Duration: October 2012 - September 2015

Coordinator: Create-Net

Partners:

iNSPIRE, Create-Net (center for Research and Telecommunication Experimentation for Networked Communities) (Italy)

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

Electrical Engineering, Technion Israel Institute of Technology

Telecommunications Department, Technische Univ. Delft (Netherlands)

Computer Science Laboratory, Univ. d'Avignon et des Pays de Vaucluse (France)

Department of Information Engineering, Univ. di Pisa (Italy)

Inria contact: Konstantin Avrachenkov

Many real world systems possess a rich multi-level structure and exhibit complex dynamics that are the result of a web of interwoven interactions among elements with autonomous decision-making capabilities. CONGAS will develop new mathematical models and tools, rooted in game theory, for the analysis, prediction and control of dynamical processes in such complex systems. It will provide a coherent theoretical framework for understanding the emergence of structure and patterns in such systems, accounting for interactions spanning various scales in time and space, and acting at different structural and aggregation levels. This framework will be built around game theoretical concepts, in particular evolutionary and multi-resolution games, and will include also techniques drawn from graph theory, statistical mechanics, control and optimization theory. Specific attention will be devoted to systems that are prone to intermittency and catastrophic events due to the effect of collective dynamics. The theory developed in the project will be validated by considering three use cases, one on the growth of the Internet, one on business ecosystems and one on viral marketing dynamics in Internet marketplaces. The CONGAS Consortium comprises seven universities and research institution and includes leading scientists in game theory, evolutionary games, complex systems science, network science and data-driven analysis of socio-technical systems.

MAESTRO's task is to develop game theoretic models to model (a) the formation of technological and social network; (b) the routing for competing agents; and (c) the competition of information in social networks.

http://www.congas-project.eu/

9.2.2. Collaborations in European Programs, except FP7 & H2020

Participants: Konstantin Avrachenkov, Abdulhalim Dandoush.

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.

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, Alexandre Reiffers-Masson.

Title: THeory and Application of NEtwork Science

International Partners (Institution - Laboratory - Researcher):

Purdue Univ. (USA) - 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 .

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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Professors / Researchers

Giuseppe Bianchi

Date: 9-10 December 2015

Institution: Univ. of Roma (Italy)

Vivek Borkar

Date: 10-18 October 2015

Institution: IIT Mumbai (India)

Jerzy Filar

Date: 6-10 July 2015

Institution: Flinders Univ. (Australia)

Vaishnav Janardhan

Date: 4 March 2015

Institution: Akamai Technologies (USA)

Moshe Haviv

Date: 28 September - 8 October 2015

Institution: Univ. of Jerusalem (Israel)

Jie Li

Date: 13 January - 15 April 2015

Institution: Univ. of Tsukuba (Japan)

Vladimir Mazalov

Date: 14-28 February and 18-24 November 2015

Institution: Russian Academy Of Sciences (Russia)

Leon Petrosjan

Date: 29 July 2015

Institution: St Petersburg Univ. (Russia)

Bruno Ribeiro

Date: 8-26 June 2015

Institution: Carnegie Mellon Univ. (USA)

Matteo Sereno

Date: October 2015 - March 2016

Institution: Univ. of Torino (Italy)

9.4.1.2. Post-doc / Ph.D. students

Tejas Bodas

Date: 15-30 March and 12 October - 11 December 2015

Institution: IIT Mumbai (India)

Rajib Ranjan Maiti

Date: 9-12 March 2015

Institution: CNR Pisa (Italy)

9.4.1.3. Internships

Andrea Cantore

Date: 1 March - 31 August 2015

Institution: Univ. Nice Sophia-Antipolis (France)

Supervisor: Giovanni Neglia

Amal Chaker

Date: 1 March - 31 August 2015

Institution: Univ. Nice Sophia-Antipolis (France)

Supervisor: Giovanni Neglia

Ashish Chandra

Date: 21 May - 20 July 2015

Institution: IIT Mumbai (India)

Supervisor: Konstantin Avrachenkov

Baptiste Goujaud

Date: 1 June - 31 August

Institution: ENS Cachan (France)

Supervisor: Eitan Altman

Mikhail Grigorev

Date: 15 September - 31 October 2015

Institution: MIPT (Russia)

Supervisor: Alain Jean-Marie

Lenar Iskhakov

    Date: 15 September - 31 October 2015

    Institution: MIPT (Russia)

    Supervisor: Konstantin Avrachenkov

Wafa Khlif

    Date: 1 March - 31 August 2015

    Institution: Univ. Nice Sophia-Antipolis (France)

    Supervisor: Sara Alouf

Maksim Mironov

    Date: 15 September - 31 October 2015

    Institution: MIPT (Russia)

    Supervisor: Konstantin Avrachenkov

Dimitra Politaki

    Date: 1 March - 31 August 2015

    Institution: Univ. Nice Sophia-Antipolis (France)

    Supervisor: Sara Alouf

Dimitra Tsigkari

    Date: 15 October 2015 - 31 July 2016

    Institution: Univ. of Thessaloniki (Greece)

    Supervisor: Giovanni Neglia

Alina Tuholukova

    Date: 1 March - 31 August 2015

    Institution: Univ. Nice Sophia-Antipolis (France)

    Supervisor: Konstantin Avrachenkov, Giovanni Neglia

9.4.2. Visits to International Teams

9.4.2.1. Sabbatical programme

Philippe Nain

    Date: 1 March 2015 - 29 February 2016

    Institution: MIT, Laboratory for Information & Decision Systems - LIDS (USA)

    Activities: Besides conducting research with colleagues at MIT, Univ. of Massachusetts in Amherst, MA, and Raytheon BBN Technologies in Cambridge, MA, P. Nain has been asked by Inria to launch new scientific collaborations between Inria and universities of the East Coast and to strengthen existing ones. He attended the Inria-Industry Meeting (San Francisco, May 11, 2015) and the fifth BIS (Berkeley-Inria-Stanford) workshop (Berkeley May 12-14, 2015).

9.4.2.2. Research stays abroad

Eitan Altman

    Date: 16-20 February, 21-31 October, 21-28 December 2015

    Institution: Technion (Israel)

    Date: 27 April - 8 May 2015

    Institution: New York Univ. - Tandon School of Engineering (USA)

    Date: 20-30 May 2015

    Institution: IISc Bangalore and IIT Mumbai (India)

Konstantin Avrachenkov

    Date: 2-10 March 2015

    Institution: IIT Mumbai (India)

    Date: 11-19 May 2015

    Institution: Yandex Research (Russia)

Ilaria Brunetti

    Date: 5 January - 15 April 2015

    Institution: Macquaire Univ. (Australia)

Alain Jean-Marie

    Date: 3-25 October 2015

    Institution: Univ. of Montreal (Canada)

    Date: 7-18 December 2015

    Institution: Univ. of Rosario (Argentina)

Jithin Kazhuthuveettil Sreedharan

    Date: 1-14 August 2015

    Institution: Univ. Federal do Rio de Janeiro (Brazil)

Arun Kadavankandy

    Date: 25-29 May 2015

    Institution: IIT Mumbai (India)

Philippe Nain

    Date: 10-15 May 2015

    Institution: Univ. of California, Berkeley (USA)

    Date: June 4-6, 14-20, July 13-17, September 20-26, November 15-21, December 6-11 2015

    Institution: Univ. of Massachusetts at Amherst (USA)

Giovanni Neglia

    Date: 19 and 26 January; 2, 9 and 23 February; 2 and 9 March; 4-7 and 29 May; 13-17 July; 11-14 and 21 September; 22-23 October; 12-17 November 2015

    Institution: Univ. of Florence (Italy)

    Date: August 1-19 2015

    Institution: Univ. Federal do Rio de Janeiro (Brazil)

Alexandre Reiffers-Masson

    Date: 1-15 August 2015

    Institution: New York Univ. - Tandon School of Engineering (USA)

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MAGIQUE-3D Project-Team

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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 involves 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 wit Inria .

Since its beginning (2009), eight PhD students have been funded and Magique 3D has hired six of them, one being shared with the project team Nachos (http://www-sop.inria.fr/nachos/). Moreover, several internships have been realized. In 2014 the second phase of DIP has begun. Lionel Boillot has been hired as engineer to work on the DIP platform.

8.2.2. Micro-local analysis of wave equations

The numerical solution of wave equations most often requires to truncate the propagation domain to define a computational domain limited by an artificial boundary. Magique-3D is very involved in the construction and mathematical validation of boundary conditions which are set on the artificial boundary. Different techniques can be used for the design of such conditions and Magique-3D maintains a collaboration with Prof. Olivier Lafitte from the University of Paris 13 on the mathematical analysis of the Dirichlet-to-Neumann (DtN) operator for acoustic waves. This issue is addressed by applying micro-local analysis which enables us to consider the full DtN operator in the whole space of frequencies.

8.2.3. Partnership with the department DMAE of ONERA

title: Modeling of multiperforated plates

Coordinator: Sébastien Tordeux

Other partners: Department DMAE of ONERA

Abstract: In the aeronautic industry, there is a need of numerical models for the design of turbore-actors of new generation. Magique-3D is cooperating with the department DMAE of ONERA to develop acoustic models of multiperforated plates which is an important component of the turbore-actors.

This project is interdisciplinary, since it involves the experimental expertise of Estelle Piot (acoustician engineer of ONERA working on acoustic bench), the competences in mathematical modeling of Magique 3D. In parallel to the obtention of new theoretical results we are jointly developing a new numerical library based on the discontinuous Galerkin approximation which aims in interpreting experimental data.

This cooperation is formalized thanks to the common supervision of the PhD of Vincent Popie funded by ONERA and DGA and is a follow-up of the ANR APAM (2008-2011).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. GEAGAM

Title: Geophysical Exploration using Advanced GAlerkin Methods

Programm: H2020

Duration: January 2015 - January 2018

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/ Euskal Herriko Unibertsitatea (Spain)

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 CO_2 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

Programm: H2020

Duration: December 2015 - December 2017

Coordinator: Barcelona Supercomputing Center

Inria contact: Stephane Lanteri

During the last years, High Performance Computing (HPC) resources have undergone a dramatic transformation, with an explosion on the available parallelism and the use of special purpose processors. There are international initiatives focusing on redesigning hardware and software in order to achieve the Exaflop (10^{18} flops) capability. This project aims at applying the new exascale HPC techniques to energy industry simulations, customizing them if necessary, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources that are the present and the future of energy: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs.

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.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Andrew Wang, graduate student from the Massachusetts Institute of Technology, visited MAGIQUE-3Dfor a two months internship in June and July 2015.

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MAGNET Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

Mikaela Keller participated in the joint Inria Campus-Institut Pasteur workshop whose goal was to reinforce the collaboration between both institutes.

Marc Tommasi belongs to the drafting committee of the Lille IDEX project, and is a representative for the COMUE in the DAS commission "Ubiquitaire et Internet des Objets".

Marc Tommasi and Pascal Denis supervise the PhD thesis of David Chatel on semi-supervised spectral clustering. The PhD is funded by Inria and the "Région Nord - Pas de Calais".

9.2. National Initiatives

9.2.1. *Competitivity Clusters*

We are part of FUI Hermes (2012-2015), a joint project in collaboration with many companies (Auchan, KeyneSoft, Cylande, ...). The main objective is to develop a platform for contextual customer relation management. The project started in November 2012.

9.2.2. *EFL*

Pascal Denis is an associate member of the Laboratoire d'Excellence *Empirical Foundations of Linguistics* (EFL), http://www.labex-efl.org/.

9.2.3. *SCAGLIA*

The project SCAGLIA (Scalable Graph Algorithms for Learning in Networked Data) of Fabio Vitale was accepted at the JCJC INS2I 2015 call.

9.3. European Initiatives

9.3.1. *Collaborations in European Programs, except FP7 & H2020*

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

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.

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

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.

9.4. International Initiatives

9.4.1. Inria Associate Teams not involved in an Inria International Labs

Program: Inria North-European Labs

Project acronym: RSS

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 derive 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.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

We have started a collaboration with Fei Sha (University of California, Los Angeles) on the topic of representation learning for Natural Language Processing, materialized by the submission of a proposal to the 2016 call of the Inria Associate Teams program.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

We invited Prof. Claudio Gentile (Università dell'Insubria, Italy) in July, collaborating with MARC TOMMASI and FABIO VITALE on contextual node classification and bipartite graph matching problems on social network with user binary feedback.

Prof. Mark Herbster (University College London, UK) was invited for the PhD dissertation defense of THOMAS RICATTE in January and for Amir Sani's thesis in May 2015. He also collaborated with FABIO VITALE.

Several international researchers have also been invited to give a talk at the MAGNET seminar:

- Jan Ramon (KU Leuven, Belgium): "Learning theory for network-structured data" (January)
- Borja Balle (University of McGill, Canada): "A General Framework for Learning Weighted Automata" (February)
- Tiago P. Peixoto (Universität Bremen, Germany): "Inferring the large-scale structure of networks" (April)
- Dan Roth (University of Illinois at Urbana/Champaign, USA): "Learning, Inference and Supervision for Structured Prediction Tasks" (May)
- Michael Mathioudakis (Helsinki Institute for Information Technology, Finland): "Absorbing random-walk centrality – theory and algorithms" (June)
- Andre Martins (Priberam Labs and Instituto Superior Técnico Lisbon, Portugal): "Advances in Structured Regularization" (December)

9.5.2. *Visits to International Teams*

In July and in August, FABIO VITALE visited Aalto University (Helsinki, Finland), collaborating with Prof. Aristides Gionis on learning influence processes in social networks and graph reconstruction with queries.

<p style="text-align:center; color:red;">**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 Guevara 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. ANR

- ANR IDeaS (2012-2015)
  Participants: R. Anxionnat, M.-O. Berger, E. Kerrien.
  The IDeaS Young Researcher ANR grant explores the potential of Image Driven Simulation (IDS) applied to interventional neuroradiology. IDS recognizes the current, and maybe essential, incapacity of interactive simulations to exactly superimpose onto actual data. Reasons are various: physical models are often inherently approximations of reality, simplifications must be made to reach interactive rates of computation, (bio-)mechanical parameters of the organs and surgical devices cannot but be known with uncertainty, data are noisy. This project investigates filtering techniques to fuse simulated and real data. MAGRIT team is in particular responsible for image processing and filtering techniques development, as well as validation.

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 and AEN SOFA

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 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 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 Research Visitors

8.3.1. Visits to International Teams

8.3.1.1. Research stays abroad

Pierre-Frédéric Villard is spending one year and a half as a visiting professor in the Harvard Biorobotics Lab (http://biorobotics.harvard.edu) led by Professor Robert D. Howe in Harvard University, Cambridge (USA). The first year (Sept 2014-Aug 2015) was funded by the CNRS and the last semester (Sept 2015-Jan 2016) is funded by Inria. The research is on individual-specific heart mitral valve simulation with biomechanical models.

MAMBA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR 2011-2014 Bimod

It has been prolonged until March 2015, time at which an international workshop on "Multi-scale and hybrid modelling in cell and cell population biology" has been held at UPMC, Paris (J. Clairambault and V. Volpert organisers), with 25-30 speakers on invitations. Its proceedings under the form of extended abstracts are available on a dedicated website: http://www.itm-conferences.org/articles/itmconf/abs/2015/02/contents/contents.html

8.1.1.2. ANR Blanc 2014-2018 "Kibord"

This recently accepted 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.

8.1.1.3. 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.

8.1.1.4. INSERM 2014 - 2016, INVADE.

Emmanuel Barillot, Institut Curie (coordinateur). Partners: Groups from Institut Curie, Dirk Drasdo. Objective is a model for a better understanding of breast cancer invasion.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. ERC Starting Grant SKIPPER^{AD}, 2012-2017, Principal Investigator: M. Doumic.

This grant allowed to fund Sarah Eugène's Ph.D and M. Tournus's post-doc, as well as to develop the new collaborations with W-F. Xue in Canterbury and T. Teixeira in IBCP.

8.2.2. Collaborations in European Programs, except FP7 & H2020

8.2.2.1. NOTOX

Type: COOPERATION

Instrument: Integrated Project

Objectif: NC

Duration: January 2011 - December 2015

Inria contact: Dirk Drasdo

NOTOX developed and established a spectrum of systems biological tools including experimental and computational methods for (i) organotypic human cell cultures suitable for long term toxicity testing and (ii) the identification and analysis of pathways of toxicological relevance. NOTOX initially used available human HepaRG and primary liver cells as well as mouse small intestine cultures in 3D systems to generate own experimental data to develop and validate predictive mathematical and bioinformatic models characterizing long term toxicity responses. Cellular activities were monitored continuously by comprehensive analysis of released metabolites, peptides and proteins and by estimation of metabolic fluxes using 13C labelling techniques (fluxomics). At selected time points a part of the cells was removed for in-depth structural (3D-optical and electron microscopy tomography), transcriptomic, epigenomic, metabolomic, proteomic and fluxomic characterisations. Together with curated literature and genomic data the toxicological data was organised in a toxicological database (cooperation with DETECTIVE, COSMOS and TOXBANK). Physiological data including metabolism of test compounds have been incorporated into large-scale computer models that are based on material balancing and kinetics. Various "-omics" data and 3D structural information from organotypic cultures will be integrated using correlative bioinformatic tools. These data also served as a basis for large scale mathematical models. The overall objectives are to identify cellular and molecular signatures allowing prediction of long term toxicity, to design experimental systems for the identification of predictive endpoints and to integrate these into causal computer models.

Inria contributions were multilevel and multiscale models of drug toxicity and its consequences on ammonia detoxification and are detailed in the result section on liver modeling. Webpage: http://notox-sb.eu/fp7-cosmetics-europe/

8.2.3. Collaborations with Major European Organisations

U. Klingmüller: DKFZ (German Cancer Research Centre), Department for Systems Biology (Germany)

Role of HGF in liver regeneration. Lung cancer.

K. Breuhahn: University Hospital of Heidelberg, Pathology (Germany)

Lung cancer invasion. Role of HGF in liver regeneration.

JG Hengstler: Leibniz Center, IfADo (Germany)

Liver research, toxicology, regeneration.

University of Leipzig, Interdisciplinary center for bioinformatics (Germany)

Projects on tissue regeneration, software

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

1. German Research Ministry (BMBF) funded project on the systems biology of lung cancer. The major aim is to better understand the early metastasis formation and invasion of lung cancer, including therapeutical options. Data on all levels ranging from intracellular up to organ level will be used to establish successively an integrated multiscale model of cellular and migration decisions in lung cancer. A particular focus will be on dissecting how cellular organisation and communication in spheroid cultures and co-cultures of lung cancer cell lines with selected endothelial cells affects information processing and the proliferation and migration decisions downstream. To reveal the inhomogeneous spatio-temporal organisation in these tumour growth models, specific probes for medical imaging, quantify extracellular cytokine concentrations will be used, and the effects of pharmacological inhibitors be monitored. By data and model integration, parameters should be identified that critically determine early spread and facilitate to predict possibilities for improved therapeutic options. The project coordinator is Ursula Klingmueller, German Cancer Research Centre (DKFZ), Heidelberg (http://www.lungsys.de/)

2. German Research Ministry (BMBF) funded project on the systems biology of liver (Virtual Liver Network). The aim of the VLN project is to set up multiscale models of liver. The Virtual Liver will be a dynamic model that represents, rather than fully replicates, human liver physiology morphology and function, integrating quantitive data from all levels of organisation. Our part ranges from the intracellular up to the level of groups of liver lobules. A liver lobule is the basic repetitive functional unit of liver. Applications are explained in the text. The networks has 69 Principle Investigators organised in about 10 work packages, each of which have a number of sub-projects (http://www.virtual-liver.de).

8.3.2. Participation In other International Programs

8.3.2.1. EuroMed3+3 programme

The M3CD network (https://www.rocq.inria.fr/bang/M3CD_website/), coordinated by J. Clairambault, has led in 2015 as usual to bilateral visits (M. Adimy, J. Clairambault, to Marrakesh and to Tlemcen, T. Touaoula to Lyon, visits of students to Paris and Lyon). It has terminated its activities in 2015 by a meeting in September in Rabat (Morocco) together with other EuroMed3+3 networks. The future of EuroMed3+3 (http://www.inria.fr/en/europe-international/international-relations/international-calls-for-projects/euromediterranean-3-3) will be discussed in June 2016 in a meeting at the Sophia-Antipolis Inria research centre.

8.3.2.2. CAPES-COFECUB project

"Modeling innovative control methods for dengue fever", in collaboration with Fondation Oswaldo Cruz (FioCruz), Rio de Janeiro, Brazil.

8.3.2.3. Convergence SU/FAPERJ programme

"Control and identification for mathematical models of dengue epidemics" in collaboration with IMPA, Rio de Janeiro, Brazil.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Juan Calvo came for a one month visit in January and February, 2015, to work on a new model for long-term protein polymerisation (work in progress).

8.4.2. Internships

Andreas Buttenschön (Team of Thomas Hillen, University of Alberta, Canada) visits the team from December 2015 to May 2016 for be trained on agent-based modeling and the software tool TiSim.

Geert Peeters (Team Patrick Segers, University of Gent, Belgium) visited the German subgroup of the team in January 2015 for one week to be trained on the software tool TiQuant.

8.4.2.1. Research stays abroad

Nicolas Vauchelet stayed two months at IMPA, Rio de Janeiro, Brazil, in the framework of a teaching agreement between UPMC and IMPA.

<p style="color:red; text-align:center">**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.

9.2.2. 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.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7 & H2020

Program: COST

Project acronym: CA15123EUTYPES

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

Duration: 30 October 2015– 29 October 2019

Coordinator: Herman Geuvers (Radboud University, Nijmegen)

Other partners: List too long to repeat here.

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 Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

We have important collaborations with the team of Thierry Coquand at Chalmers and University of Göteborg.

We are setting up a collaboration with the team of Adam Chlipala at the Massachusetts Institute of Technology.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Isabela Dramnesc, from the University of Timişoara in Romania, visited our team in June and July to study proving techniques in the Coq context.

Tsvetan Dunchev, from the University of Bologna, visited our team in July to work on ELPI, the λ-prolog interpreter.

8.4.2. Visits to International Teams

Yves Bertot organised a meeting with representatives of University of Pennsylvania, Princeton University, Yale University, Harvard University, and the Massachusetts Institute of Technology in Boston in April. Janet Bertot, Philippe Nain, and Matthieu Sozeau from Inria also attended this meeting. The agenda of the meeting was preliminary discussions for the creation of a consortium around the Coq software system.

Enrico Tassi visited the team of Jesper Bengtson at the IT University in Copenhagen for a week at the end of September.

Cyril Cohen visited Chalmers university in Febrary and October to work on cubical type theory.

Cyril Cohen was invited by AIST in Japan for a one-week stay in Tsukuba in November to work on formalization problems for robotics.

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

8. Partnerships and Cooperations

8.1. National Initiatives

The project-team is involved in several ANR projects:

- 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).
- S. Boyaval's ANR proposal SEDIFLO, about the improvement of current numerical models of solid transport in rivers operating at large-scale for industrial purposes, by means of new non-Newtonian rheology equations, has been selected for funding as a JCJC (Jeunes Chercheuses Jeunes Chercheurs) grant.
- 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 Quantum dynamics. This interdisciplinary research network is focused on physical and mathematical problems related to the time evolution of quantum systems (transport problems, nonequilibrium systems, etc),
- the GdR Shocks,
- the GdR Maths et entreprise,
- the GdR correl (correlated methods in electronic structure computations),
- the GdR Rest (rencontres de spectroscopie théorique).
- the GdR CoDFT (electronic structure computations using density functional theory).
- the GdR EGRIN
- the GdR MASCOT-NUM (stochastic methods for the analysis of numerical codes),

The MATHERIALS 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) has started in June 2014.

8.3. International Initiatives

S. Boyaval has obtained a *Germaine de Staël* grant to pursue his research with A. Caboussat (Lausanne) about 3D numerical simulation 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 on the French side research teams from Université de Nancy, Université de Lyon and Inria Rennes.

<div align="center">

MATHRISK Project-Team

</div>

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
- Xiao Wei, Beijing university, 2 months

9.3.1.1. Internships

- Houzhi Li (April to July 2015): Study and implementation in Premia of the 4/2 stochastic volatility model proposed by M. Grasselli; adviser A. Alfonsi

9.3.2. Visits to International Teams

9.3.2.1. Research stays abroad

- A. Alfonsi IPAM, UC Los Angeles , invited by René Carmona (April 13- 23)
- A. Sulem: Participation to the "Stochastics in Environmental and Financial Economics" program, Centre of Advanced Studies of the Norwegian Academy of Sciences and Letters, Oslo,Spring 2015.

MAVERICK Project-Team

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. 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.

We are funded by the ANR for a joint research project on acquisition and restitution of micro-facet based materials.

two other Inria research teams, REVES in Sophia-Antipolis and iPARLA 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.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

We have an ongoing cooperation with the Université De Montréal (Derek Nowrouzhezarai, Pierre Poulin), dealing with light transport and isotropic filter decomposition in the spherical domain, based on zonal harmonic basis.

We also have an ongoing cooperation with Polytechnique de Montréal (Thomas Hurtut) dealing with procedural texture design and color transfer.

8.3. International Research Visitors

8.3.1. Visits to International Teams

8.3.1.1. Sabbatical programme

Soler Cyril

Date: Aug 2015 - Jul 2016

Institution: Université de Montréal (Canada)

8.3.1.2. Research stays abroad

Neyret Fabrice

Date: Jan 2015 - Mar 2015 and Nov 2015 - Mar 2016

Institution: WETA Digital (New-Zeland)

Maxplus Team

9. Partnerships and Cooperations

9.1. Actions nationales/National Initiatives

9.1.1. ANR

- Participation de Cormac Walsh au projet ANR FINSLER (Géométrie de Finsler et applications).
- 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.
- Participation de Marianne Akian et Stéphane Gaubert au projet "STORY: Stochastic and Robust Optimization Network and Teaching", responsables: Laurent El Ghaoui (UC Berkeley) et Michel De Lara(CERMICS).

9.1.3. iCODE (Institut pour le Contrôle et la Décision de l'Idex Paris-Saclay)

Projet "blanc" intitulé "Stabilité et stabilisation des systèmes commutés" (Oct. 2014-fin 2015), faisant intervenir M. Akian, X. Allamigeon, S. Gaubert, et des membres de EPI Geco, L2S, LIX, LSV (ENS Cachan), UVSQ.

9.2. Actions internationales/International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

Collaborations régulières dans le cadre des programmes internationaux ci-dessous, ainsi qu'avec:

- Michael Joswig (TU-Berlin), invité 3 mois en 2015 sur un poste rouge du CNRS.
- Ricardo Katz (Conicet et Cifasis, Argentine);
- Alexander Guterman (Moscow State University);
- Françoise Tisseur (Université de Manchester) qui participe à l'encadrement de la thèse d'Andrea Marchesini.

9.3. Accueils de chercheurs étrangers/International Research Visitors

9.3.1. Chercheurs étrangers/Visits of International Scientists

- Bas Lemmens (Univ. of Kent), 2 jours en mars.
- Brian Lins (Hampden-Sydney College), 2 jours en mars.
- Vassili Kolokoltsov (Warwick Univ.), 4 jours en juillet autour de SIAM CT.
- Visites d'un jour de Peter Butkovic (Univ. of Birmingham), Paul Van Dooren (Univ. Catholique de Louvain) et Francçoise Tisseur (Univ. of Manchester) en décembre (autour de la soutenance de thèse d'Andrea Marchesini).

9.3.2. Séjours à l'étranger/Visits to International Teams

9.3.2.1. Research stays abroad

- M. Akian, 1 semaine à Univ. of Bar Ilan en juin.
- A. Niv, 1 week in Birmingham (visit of P. Butkovic and S. Sergeev) in March 2015, few days in Aberdeen (visit of Z. Izhakian) in April 2015, and 2 weeks in Bar-Ilan Univ. (visit of L. Rowen and R. Adin) in June 2015.

MCTAO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- The "région" *Provence Alpes Côte d'Azur* (PACA) partially supports Helen Heninger's PhD . The other part comes from Thales Alenia space, see section 7.1 .
- The "région" *Provence Alpes Côte d'Azur* (PACA) partially supports Jérémy Rouot's PhD.

8.2. National Initiatives

8.2.1. ANR

Weak KAM beyond Hamilton-Jacobi (WKBHJ). Started march, 2013, duration: 4 years. Ludovic Rifford is in the scientific comitee.

Géométrie et transport optimal de mesure (GMT). Ludovic Rifford is a member.

8.2.2. Others

Bernard Bonnard and Ludovic Rifford participate in the GDR MOA, a CNRS network on Mathematics of Optimization and Applications. http://gdrmoa.univ-perp.fr/.

Jean-Baptiste Caillau is in the board of governors of the group SMAI-MODE (http://smai.emath.fr/spip.php?article338).

Jean-Baptiste Caillau is a member of the Centre de Compétences Techniques (CCT) Mécanique orbitale du CNES

Jean-Baptiste Caillau is the corresponding member in Dijon for the Labex AMIES (http://www.agence-maths-entreprises.fr/).

8.3. European Initiatives

8.3.1. ANR/DFG franco-german project

Exploring the physical limits of spin systems: A challenge in medical imaging (Explosys). Started October, 2014, duration: 4 years.

Bernard Bonnard is a member of this project. The coordinators are Dominique Sugny (Dijon) and Stefen Glaser (Munich). The budget is approximately 500 K€.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Velimir Jurdjevic (University of Toronto), 1 month, September-October, 2015.

8.4.2. Visits to International Teams

Ludovic Rifford stayed at Center for Mathematical Modeling, Universidad de Chile, Santiago (Chili), 6 months in March-August, 2015.

<p style="text-align:center; color:red">**MEMPHIS 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.

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 - May 2018
>
> Coordinator: University of Bristol
>
> Partners:
>
> > Airbus Defence and Space (Germany)
> >
> > Dassault Aviation (France)
> >
> > Deutsches Zentrum fur 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 Cape Town (South Africa)
> >
> > University of Bristol (United Kingdom)
> >
> > Valeols (France)
>
> Inria contact: Angelo IOLLO

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 defence 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 the MRGM lab. They are interesting 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 the power. This simulation is challenging 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 Partners

9.4.1.1. Informal International Partners

With Rajat Mittal, of Johns Hopkins University, we collaborate on the simulation of complex biological flows that involve fluid- structure interactions with large deformations like fonation, heart beating, freely moving elastic capsules in blood vessels, fish-like swimming or flapping wings. A common journal paper in Bionspiration & Biomimetics has been issued so far. This collaboration will continue in the future.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Frédéric Gibou, from UC Santa Barbara, visited us in 2015. With the team of Frédéric Gibou we collaborate to develop general enough numerical models that allow a simplified geometrical and computational set up by the systematic use of hierarchical Cartesian meshes and monolithic models: multi-resolution schemes based on octree grid structures, refined grid patches, numerical zooms, overset.

Giovanni Russo, of the University of Catania, shares many of our scientific objectives: one of his past PhD students, Armando Cocco, has spent one year in Bordeaux dedicated to the parallelization of a multigrid cartesian solver. G. Russo has spent several weeks in Bordeaux as a visiting scientist at the Memphis team in 2015. This visit was dedicated to the study of new all-Mach schemes for conservative equations, guaranteeing accuracy and efficiency of the schemes used to solve problems where the time scales are those of the material velocities as opposed to acoustic wave time scales.

Gabriella Puppo, initially at the Politecnico di Torino and now at the university of Insubria, also visited us in 2015. We have an established collaboration with her to extend our approaches to rarefied gas dynamics, i.e., problems governed by the BGK equation. We have co-directed the PhD of Florian Bernard and we have now another co-direction, that of Emanuela Abbate, who will be studying relaxation equations for stiff problems of compressible non-linear elasticity.

Conglin Liu (univ. Harbin China), visited Charles-Henri Bruneau during the whole academic year 2014-2015. She had a grant from the Chinese Government.

9.5.1.1. Internships

Nadia Loy is an international internship from the university of Florence.

9.5.2. Visits to International Teams

With the team of Frédéric Gibou we collaborate to develop general enough numerical models that allow a simplified geometrical and computational set up by the systematic use of hierarchical Cartesian meshes and monolithic models: multi-resolution schemes based on octree grid structures, refined grid patches, numerical zooms, overset.

In this framework we have recently organized a commun workshop in Santa Barbara funded by the Idex initiative in Bordeaux.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR BECASIM

G. Dujardin and I. Lacroix are members 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 2016.

Partners: Université Lille 1, UPMC, Ecole des Ponts ParisTech, Inria-Nancy Grand-Est, Université Montpellier 2, Université Toulouse 3.

8.1.2. 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 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.

8.1.3. MIS

Incentive Grant for Scientific Research (MIS) of the Fonds National de la Recherche Scientifique (Belgium)

Title: Patterns, Phase Transitions, 4NLS & BIon.

Coordinator: Denis Bonheure.

Duration: January 2014 - December 2016.

Partner: Université libre de Bruxelles.

8.1.4. 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: Unibersité Libre de Bruxelles (Belgium)
>
> Partner: Inria
>
> Inria contact: Antoine 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.'

8.3. International Initiatives

8.3.1. Informal International Partners

Felix Otto's group at Max Planck Institute for Mathematics in the Sciences.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Louis Huguet, MA1 internship from ENS Cachan, 3 months.

8.4.2. Visits to International Teams

8.4.2.1. Sabbatical programme

Denis Bonheure was awarded a "Mission scientifique du FNRS" (sabbatical).

8.4.2.2. Research stays abroad

Denis Bonheure was visiting professor (in the frame of his sabbatical year) at

- USP Sao Carlos, ICMC, Departamento de matematica
- Karlsruher Institut fuer Technologie (KIT), Institut fuer Analysis
- Pontificia Universidad Católica de Chile, Facultad de Matemáticas
- Instituto Superior Tecnico de Lisboa, Departamento de Matemática
- Université Aix-Marseille, Laboratoire d'Analyse, Topologie et Probabilités
- Universidad de Buenos Aires, Departamento de Matemática
- Università degli studi di Torino, Dipartimento di Matematica

Antoine Gloria spent two months at IHES (February–March 2015), as a guest of the Schlumberger chair of Felix Otto.

Christopher Shirley was invited by Pr. Nariyuki Minami and Pr. Fumihiko Nakano to Japan, from Nov. 26 to Dec. 13.

MESCAL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CIMENT

The CIMENT project (Intensive Computing, Numerical Modeling and Technical Experiments, http://ciment.ujf-grenoble.fr/) gathers a wide scientific community involved in numerical modeling and computing (from numerical physics and chemistry to astrophysics, mechanics, bio-modeling and imaging) and the distributed computer science teams from Grenoble. Several heterogeneous distributed computing platforms were set up (from PC clusters to IBM SP or alpha workstations) each being originally dedicated to a scientific domain. More than 600 processors are available for scientific computation. The MESCAL project-team provides expert skills in high performance computing infrastructures. The members of MESCAL involved in this project are Pierre Neyron and Olivier Richard.

8.1.2. Cluster Région

Partners: the Inria GRAAL project-team, the LSR-IMAG and IN2P3-LAPP laboratories.

The MESCAL project-team is a member of the regional "cluster" project on computer science and applied mathematics, the focus of its participation is on handling large amount of data large scale architecture.

8.2. National Initiatives

8.2.1. Inria Large Scale Initiative

- *HEMERA, 2010-2014* Leading action "Completing challenging experiments on Grid'5000 (Methodology)" (see https://www.grid5000.fr/Hemera).

  Experimental platforms like Grid'5000 or PlanetLab provide an invaluable help to the scientific community, by making it possible to run very large-scale experiments in controlled environment. However, while performing relatively simple experiments is generally easy, it has been shown that the complexity of completing more challenging experiments (involving a large number of nodes, changes to the environment to introduce heterogeneity or faults, or instrumentation of the platform to extract data during the experiment) is often underestimated.

  This working group explores different complementary approaches, that are the basic building blocks for building the next level of experimentation on large scale experimental platforms.

8.2.2. ANR

- *ANR GAGA (2014-2017)*

  GAGA is a "Young Researchers" project funded by the French National Research Agency (ANR) to explore the Geometric Aspects of GAmes. The GAGA teamis spread over three different locations in France (Paris, Toulouse and Grenoble), and is coordinated by Vianney Perchet, assistant professor (Maître de Conférences) in the Probabilities and Random Models laboratory in Université Paris VII.

  As the name suggests, our project's focus is game theory, a rapidly developing subject with growing applications in economics, social sciences, computer science, engineering, evolutionary biology, etc. As it turns out, many game theoretical topics and tools have a strong geometrical or topological flavor: the structure of a game's equilibrium set, the design of equilibrium-computing algorithms, Blackwell approachability, the geometric character of the replicator dynamics, the use of semi-algebraicity concepts in stochastic games, and many others. Accordingly, our objective is to perform a systematic study of these geometric aspects of game theory and, by so doing, to establish new links between areas that so far appeared unrelated (such as Hessian-Riemannian geometry and discrete choice theory).

- *ANR MARMOTE, 2013-2016*. Partners: Inria Sophia (MAESTRO), Inria Rocquencourt (DIOGEN), PRiSM laboratory from University of Versailles-Saint-Quentin, Telecom SudParis (SAMOVAR), University Paris-Est Créteil (*Spécification et vérification de systèmes*), Université Pierre-et-Marie-Curie/LIP6.

  The project aims at realizing a software prototype dedicated to Markov chain modeling. It gathers seven teams that will develop advanced resolution algorithms and apply them to various domains (reliability, distributed systems, biology, physics, economy).

- *ANR NETLEARN, 2013-2015*. Partners: PRiSM laboratory from University of Versailles-Saint-Quentin, Telecom ParisTech, Orange Labs, LAMSADE/University Paris Dauphine, Alcatel-Lucent, Inria (MESCAL).

  The main objective of the project is to propose a novel approach of distributed, scalable, dynamic and energy efficient algorithms for managing resources in a mobile network. This new approach relies on the design of an orchestration mechanism of a portfolio of algorithms. The ultimate goal of the proposed mechanism is to enhance the user experience, while at the same time to better utilize the operator resources. User mobility and new services are key elements to take into account if the operator wants to improve the user quality of experience. Future autonomous network management and control algorithms will thus have to deal with a real-time dynamicity due to user mobility and to traffic variations resulting from various usages. To achieve this goal, we focus on two central aspects of mobile networks (the management of radio resources at the Radio Access Network level and the management of the popular contents users want to get access to) and intend to design distributed learning mechanisms in non-stationary environments, as well as an orchestration mechanism that applies the best algorithms depending on the situation.

- *ANR SONGS, 2012-2015*. Partners: Inria Nancy (Algorille), Inria Sophia (MASCOTTE), Inria Bordeaux (CEPAGE, HiePACS, RunTime), Inria Lyon (AVALON), University of Strasbourg, University of Nantes.

  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 exploit such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, 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 (Simulation of Next Generation Systems) 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 led 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.

8.2.3. National Organizations

Jean-Marc Vincent is member of the scientific committees of the CIST (Centre International des Sciences du Territoire).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. 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

8.3.1.2. 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.

8.3.1.3. NEWCOM#

Program: FP7-ICT-318306

Project acronym: NEWCOM#

Project title: Network of Excellence in Wireless Communications

Duration: 11 2012 – 10 2015

Coordinator: Consorzio Nazionale Interuniversitario per le Telecomunicazioni (Italy)

Other partners: Aalborg Universitet (AAU). Denmark; Bilkent Üniversitesi (Bilkent). Turkey; Centre National de la Recherche Scientifique (CNRS). France; Centre Tecnològic de Telecomunicacions de Catalunya (CTTC). Spain; Institute of Accelerating Systems and Applications (IASA). Greece; Inesc Inovacao; Instituto de Novas Tecnologias (INOV). Portugal; Poznan University of Technology (PUT). Poland; Technion - Israel Institute of Technology (TECHNION). Israel; Technische Universitaet Dresden (TUD). Germany; University of Cambridge (UCAM). United Kingdom; Universite Catholique de Louvain (UCL). Belgium; Oulun Yliopisto (UOULU). Finland

Abstract: NEWCOM# is a project funded under the umbrella of the 7th Framework Program of the European Commission (FP7-ICT-318306). NEWCOM# pursues long-term, interdisciplinary research on the most advanced aspects of wireless communications like Finding the Ultimate Limits of Communication Networks, Opportunistic and Cooperative Communications, or Energy- and Bandwidth-Efficient Communications and Networking.

8.3.1.4. 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.

8.3.2. Collaborations in European Programs, except FP7 & H2020

8.3.2.1. CROWN

Program: European Community and Greek General Secretariat for Research and Technology

Project acronym: CROWN

Project title: Optimal Control of Self Organized Wireless Networks

Duration: 2012-2015

Coordinator: Tassiulas Leandros

Other partners: Thales, University of Thessaly, National and Kapodistrian University of Athens, Athens University of Economics and Business

Abstract: Wireless networks are rapidly becoming highly complex systems with large numbers of heterogeneous devices interacting with each other, often in a harsh environment. In the absence of central control, network entities need to self-organize to reach an efficient operating state, while operating in a distributed fashion. Depending on whether the operating criteria are individual or global, nodes interact in an autonomic or coordinated way. Despite recent progress in autonomic networks, the fundamental understanding of the operational behaviour of large-scale networks is still lacking. This project will address these emergent network properties, by introducing new tools and concepts from other disciplines.

We will first analyze how imperfect network state information can be harvested and distributed efficiently through the network using machine learning techniques. We will design flexible methodologies to shape the competition between autonomous nodes for resources, with aim to maintain robust social optimality. Both cooperating and non-cooperating game-theoretic models will be used. We also consider networks with nodes coordinating to achieve a joint task, e.g., global optimization. Using algorithms inspired from statistical physics, we will address two representative paradigms in the context of wireless ad hoc networks, namely connectivity optimization and the localization of a network of primary sources from a sensor network.

Finally, we will explore delay tolerant networks as a case study of an emerging class of networks that, while sharing most of the characteristics of traditional autonomic or coordinated networks, they present unique challenges, due to the intermittency and constant fluctuations of the connectivity. We will study tradeoffs involving delay, the impact of mobility on information transfer, and the optimal usage of resources by using tools from information theory and stochastic evolution theory.

8.3.3. Collaborations with Major European Organizations

University of Athens: Panayotis Mertikopoulos was an invited professor for 3 months.

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.

University of Edinburgh and Istituto di Scienza e Tecnologie della Informazione: we strongly collaborate through the Quanticol European project.

University of Antwerp: we collaborate with Benny Van Houdt on caching problems.

TU Wien: Research Group Parallel Computing, Technische Universität Wien (Austria). We collaborate with Sascha Hunold on experimental methodology and reproducibility of experiments in HPC.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. 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 MESCAL are partners of this laboratory, and have done several visits to Urbana-Champaign or NCSA.

8.4.2. Inria Associate Teams not involved in an Inria International Labs

8.4.2.1. 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 synthetized visualizations for large traces analysis and then analyze schedulers and energy traces for correlation analysis

8.4.3. Inria International Partners

8.4.3.1. Declared Inria International Partners

- MESCAL 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.

- MESCAL has strong bounds with the University of Illinois Urbana Champaign, within the (Joint Laboratory on Petascale Computing, see previous section).

8.4.4. Participation In other International Programs

8.4.4.1. 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*). Jean-Marc Vincent is the director of the laboratory, on the French side.

  The main themes are high performance computing, language processing, information representation, interfaces and visualization as well as distributed systems.

  More information can be found at http://www.inf.ufrgs.br/licia/.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Stan Zachary and James Cruise, from Heriot-Watt University at Edinburgh, came for a week in the context of the European Quanticol project. Lucas Schnorr and Philippe Navaux from UFRGS (Porto Alegre, Brazil) both came for a week in the context of the EXASE associated team.

MEXICO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives: IRT

9.1.1. SystemX

Participants: Simon Theissing, Yann Duplouy, Serge Haddad.

We participate in the projects

- MIC on multi-modal transport systems with in the IRT *System X*, with academic partners UPMC, IFSTTAR and CEA, and several industrial partners including Alstom (project leader), COSMO and Renault. MIC is scheduled to be completed late in 2016, and

- the project SVA (*Simulation pour la Sécurité du Véhicule Autonome*), where the PhD Thesis of Yann Duplouy targets the application of formal methods to the development of embedded systems for autonomous vehicles.

9.2. National Initiatives

We have not yet been notified about acceptance of our ANR submissions.

9.3. European Initiatives

In preparation.

9.3.1. FP7 & H2020 Projects

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

9.4. International Initiatives

9.4.1. Inria International Labs projects

LIA INFORMEL with CMI, Chennai, India ; see below.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

1. The CMI (Chennai Mathematical Institute) is a long-standing partner of our team. The project *Île de France/Inde* in the *ARCUS* program from 2008 to 2011 has allowed several exchange visits between Cachan and Chennai, organizations of ACTS workshops with french and indian researchers in Chennai, internships in Cachan, and two theses in *co-tutelle* (Akshay Sundararaman, defended in 2010) and Aiswarya Cyriac (defended in 2014).

   Currently, Paul Gastin is co-head (with Madhavan Mukund) of the CNRS International Associated Laboratory (LIA) INFORMEL (INdo-French FORmal Methods Lab, http://projects.lsv.ens-cachan.fr/informel/), see below.

2. We have been exchanging visits for several years between *MExICo* the computer science and electrical engineering departments at Newcastle University, UK , with visits in both directions; they involve in particular Maciej Koutny, Alex Yakovlev, Victor Khomenko and Andrey Mokhov, as well as Anil Wipat, co-director of the center for Synthetic Biology and the Bioeconomy at Newcastle University.

3. Exchanges are frequent with Rolf Hennicker from LMU and Javier Esparza at TUM, both in Munich, Germany.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- 5 – 31 March 2015: Prakash Saivasan (CMI) visits LSV to work with Paul Gastin on nested words for higher-order pushdown systems

- 19 May – 6 June 2015: S. Krishna and S. Akshay visit LSV to work with Paul Gastin on split-width techniques for the analysis of timed systems.

- 10 June – 4 July 2015: K. Narayan Kumar (CMI) visit France to pursue several collaborations: with Paul Gastin (LSV) on bounded time-stamping for message passing systems, with Ahmed Bouajjani (LIAFA) on analysis of multi-pushdown systems, and with Pascal Weil (LaBRI) on bounded reachability analysis for shared memory systems.

9.5.1.1. Internships

Georgios Christodoulis

Date: May 2015 - Jul 2015

Institution: National University Athens (Greece)

Supervisor: Stefan Haar

Sougata Bose

Date: May 2015 - Jul 2015

Institution: CMI (India)

Supervisor: Benedikt Bollig and Paul Gastin

9.5.2. Visits to International Teams

9.5.2.1. Short stays abroad

- In July 2015, Serge Haddad visited U of Turin, Italy, for a research cooperation with Prof. Giuliana Franceschinis.

- Stefan Haar visited Newcastle University (UK), TU of Eindhoven (NL) and University of Luxemburg for short visits.

- 29 November – 20 December 2015: Paul Gastin (LSV) visits S. Krishna and S. Akshay (IIT Bombay) to work on tree automata techniques for timed-systems.

MIMESIS Team

8. Partnerships and Cooperations

8.1. National projects

8.1.1. ADT (Aide au Développement Technologique, Inria) - DynMesh

The objectives of this ADT are the coupling of SOFA, the physical simulation platform supported by Inria, and CGoGN, the mesh management library developed within the ICube lab at Strasbourg. It aims at extending 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.

8.1.2. ADT - Sofa

SOFA Large Scale Development Initiative (ADT) : the SOFA project is an international, multi-institution, collaborative initiative, aimed at developing a flexible and open source framework for interactive simulations. This will eventually establish new grounds for a widely usable standard system for long-term research and product prototyping, ultimately shared by academic and industrial sites. The SOFA project involves 4 Inria teams: ASCLEPIOS, DEFROST, IMAGINE and MIMESIS. The development program of the ADT started in 2007. This ADT ended in September 2015 and the associated contract of our SOFA engineer Marc Legendre ended at the same time.

8.1.3. ADT - SofaOR

In December 2014, a new ADT national initiative started. The objective of this ADT is twofold: first, we aim 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 is 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.

8.1.4. ANR - IDEFI

In the IDEFI ANR, the MIMESIS team is involved in the EVEREST project which aims to develop a new generation on-line training platforms, dedicated to the theory and practice of image-guided minimally invasive surgery. A central objective is to develop a framework for the integration and the rapid spread of numerical interactive simulation systems, associated with online assessment methodologies. The IHU Strasbourg is the ANR project leader and we collaborate on the topic of virtual simulations.

8.1.5. ANR - RESET

At the end of 2014, the team has been awarded a new ANR project: RESET. This project started in March 2015. 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).

8.1.6. IDEX - CNRS

The aim of the project CONECT (Couplage de la rObotique et de la simulatioN mEdicale pour des proCédures auTomatisées) is to develop a robotic system for needle insertion in deformable tissues which is entirely controlled and driven by a numerical simulation. The results of this work could be extremely beneficial for medical applications, such as brachytherapy or biopsy, given the accuracy and the precision required in this kind of procedures. A first demonstration is currently under development where the needle will be inserted in a silicone gel samples. Given a non-straight predefined trajectory, our goal is to control a Mitsubishi MRV1 robot that will automatically insert a needle along the predefined path, taking into account the deformation of both the environment and the needle. The deformation of the gel is tracked with camera using the Optitrack system. The simulation is based on real time finite element models. Based on inverse simulations, we are developing a control model that provides the kinematics of the robot such that the needle remains on the trajectory during the insertion. The activities carried out already allowed a first publication at IROS (2015) "Haptic Rendering of Hyperelastic Models with Friction" and the presentation of a poster at the conference DD23 in South Korea in july 2015 "Domain Decomposition for FE Simulation for Needle Insertion".

8.1.7. REBOAsim, Department of Defense USA

REBOA stands for Resuscitative Endovascular Balloon Occlusion of the Aorta. The objective of the REBOAsim project is to develop a low-cost miniaturized tracking and haptic interface for catheters and guidewires, meeting requirements for training and intraoperative guidance of Resuscitative Endovascular Balloon Occlusion of the Aorta (and other catheterization procedures). The second aspect of the project is the development of a computer-based simulation of REBOA procedures, allowing the training of medical personnel. This project was accepted in late 2015. In this context, we collaborate with the American Department of Defense.

8.1.8. IHU, Strasbourg

Our team has been selected to be part of the IHU of Strasbourg. This institute, for which funding (67M€) has just been announced, is a very strong innovative project of research dedicated to future surgery of the abdomen. It will be dedicated to minimally invasive therapies, 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). Our group and SOFA have a important place in the project. Since September 2011 a part of our team is located within the IHU, to develop a number of activities in close collaboration with clinicians.

8.2. National collaborations

At the national level, the MIMESIS team collaborates with:

ICube 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 IGG team: we have two active collaborations, one with Dr. Caroline Essert on trajectory planning (in the context of Deep Brain Stimulation) and the group involved in research on dynamic topologies. These collaborations are supported by two IHU projects: BILIKIMO and HAYSTACK.

IHU Strasbourg: as mentionned in 8.1.8 , our team is one of the principal partners of the IHU Strasbourg. We developed a number of projects in close collaboration with clinicians and members of IHU.

LML Lille: is a French research laboratory (UMR CNRS 8107) part of the Carnot institute ARTS. With more than two hundreds researchers, LML focuses on the following research area : mechanical reliability and Tribology, fluid mechanics, civil engineering and soil mechanics. In 2105, Mathias Brieu from LML visited our team.

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 with started in March 2015. We also collaborate with Prof. Patrick Pessaux, a surgeon who helps us in the context of the SOFA-OR project.

R&D team at IRCAD: the computer science group at IRCAD has been involved in segmentation, 3D reconstruction and augmented reality for abdominal surgery since the 2000. An important activity on simulation also took place and led to the creation of a start-up company, Digital Trainers. Currently, the main activities are centered around augmented reality, registration, and medical imaging.

TIMC, 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 this 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,

8.3. Inria collaborations

Within Inria, the MIMESIS team collaborates with:

ASCLEPIOS: although the core activities of team are in the field of medical image analysis, it also has a strong expertise in physics-based simulation of the heart. We collaborated on the development of an electro-mechanical model of the heart, and on some core components of SOFA. We collaborate with the ASCLEPIOS team on the development of the SOFA framework and on the development of a simulation system for radio-frequency ablation in the case of cardiac arrhythmia,

DEFROST: the team imagines future robots which don't need to be "rigid" but made of complex deformable structures, composed of stiff and soft regions, close to organic materials that can be found in nature. Soft robotics opens very attractive perspectives in terms of new applications, reduction of manufacturing costs, robustness, efficiency and security. It could constitute a great jump in robotics in the following years. We continue to interact with the team in Lille given our common research background. A joint article of constraint-based haptic modeling has already been submitted.

IMAGINe: the team has a general focus on animation and simulation of natural objects. We essentially collaborate with Prof. François Faure on real-time finite element techniques, collision detection and contact response (which led to a SIGGRAPH paper) and the development of SOFA,

MAGRIT: their research field is computer vision, with a focus on augmented reality applications. The team is also fairly involved in computer-based solutions for the planning or the simulation of interventional radiology procedures, with a strong collaboration with the CHU in Nancy. We collaborate with the MAGRIT team in the area of interventional radiology and augmented reality. A common PhD thesis, whose subject was to develop implicit representations of anatomical structures such as blood vessels or aneurysms, was defended in 2013. Another joint PhD thesis was defended in January 2015 on the topic of non-rigid augmented reality and combined the computer vision expertise of MAGRIT with our expertise on real-time simulation and biomechanical modeling.

8.4. European Initiatives

8.4.1. RASimAs

2015 was the second year of the RASimAs project (STREP project funded under FP7) during which we developed new models of the biomechanics of the leg and arm, as well as the simulation of the insertion of the anaesthesiology needle. Regional anaesthesia has been used increasingly during the past four decades. This is due to the perceived advantages of reduced postoperative pain, earlier mobility, shorter hospital stay, and significantly lower costs. Current training methods for teaching regional anaesthesia include cadavers, video teaching, ultrasound guidance, and simple virtual patient modeling. These techniques have limited capabilities

and do not consider individual anatomy. The goal of this project is to increase the application, the effectiveness and the success rates of RA and furthermore the diffusion of the method through the development VPH models for anaesthesia. The goal of the MIMESIS team is to provide the computational infrastructure for the physics-based simulation and to propose new methods for patient-specific modeling and simulation of soft tissues and their interaction with the needle, including its effect on nerve physiology.

See http://rasimas.imib.rwth-aachen.de for more details.

In the context of the RASimAS project, we collaborate with the company:

- **SenseGraphics**: develops next generation medical simulator software for a wide range of surgical procedures. It is used in simulators for training surgeons in various fields such as robotic surgery, eye surgery, dentistry, ultrasound interpretation and anesthesia. The simulators combine the latest technologies in real-time graphics rendering as well as advanced force feedback to allow the surgeons to have an experience that is as close to reality as possible.

With the RASimAS project, we also collaborate with: the University Hospital Aachen, RWTH Aachen University, 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.

8.5. International Initiatives

8.5.1. Inria International Partners

At the international scale, the MIMESIS team collaborates with:

CIMIT, Boston: we are restarting our interactions on interventional radiology simulation, in particular the design and development of a hardware interface for tracking catheters and guidewires. A joint proposal to the DoD has been submitted to this end.

Harvard Biorobotics lab, Cambridge: this group focuses on the role of sensing and mechanical design in motor control, in both robots and humans. This work draws upon diverse disciplines, including biomechanics, systems analysis, and physiology. We started a collaboration on inverse problems for identifying optimal areas of cardiac ablation using our work on electro-mechanical modeling of the heart. Other areas of collaboration are planned, such as cardiac valve interactions with blood flow.

Humanoid and Intelligence Systems Lab, Karlsruhe Institute of Technology: we started a collaboration with Dr Stefanie Speidel and Dr. Stefan Suwelack on the topics of real-time soft tissue modeling and laparoscopic augmented reality.

Institute of Computer Science, Masaryk University, Czech Republic: we have an extensive collaboration with Igor Peterlik at the ICS, leading to 7 publications over that past 18 months. This collaboration covers the fields of non-rigid registration, augmented reality and haptics.

Interactive Graphics and Simulation, Innsbruck: the IGS group in Innsbruck is a continuation of a group led at ETH by Matthias Harders. Its scientific focus is on physically-based simulation, computer haptics, and to a limited extent, augmented reality. The main application area is the medical domain.

Surgical Planning Lab, Boston: this research laboratory at Brigham and Women's Hospital has a large expertise in the analysis of diagnostic data using computational image analysis. We know this group very well, in particular in the field of Deep Brain Stimulation and through their work on Open Source solutions for computer aided surgery. We are regularly interacting with them on the development of a version of SOFA dedicated to the operating room.

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).

Team Legato, University of Luxembourg: since last year we have active discussions with Prof. Stéphane Bordas on real-time soft tissue cutting simulation. This has already led to a journal article in Media [33] and a co-supervision of a post-doctoral fellow.

8.6. International Research Visitors

8.6.1. Visitors

In 2015, MIMESIS invited several visitors:

- Jim Ueltschi (founder of the HelpMeSee non-profit organization)
- Karol Miller (Winthrop Professor, School of Mechanical and Chemical Engineering, The University of Western Australia)
- Stéphane Bordas (LEGATO team, Luxembourg)
- Karel van Gelder (Product manager, MOOG, Amsterdam)
- Alexandre Krupa (Inria, Rennes)
- Mathias Brieu (Laboratoire de Mécanique, Ecole Centrale Lille)

8.6.2. Internships

In 2015, the MIMESIS welcomed two international interns (for 6 months):

Santiago Camacho, Universidad de Buenos Aires, worked on "Improvement of Visualization Tools for Augmented Reality Applications"

Sabrina Izcovich, Universidad de Buenos Aires, worked on "Quadratic Tetrahedron Element for FEM simulations".

8.6.3. Visits to International Teams

8.6.3.1. Explorer programme

This year, Hugo Talbot obtained an Inria Explorer grant in the context of a partnership with the Harvard BioRobotics Laboratory from Harvard, Cambridge. The Explorer programme covered the one-month visit (June 2015). This visit allowed to discuss about our respective work around simulation, especially concerning simulation in the field of cardiology. This was also the opportunity to establish several academic and industrial contacts in the United States. Hugo Talbot namely visited:

- **Thermedical**: is a company developing a new generation of radio-frequency catheters.
- **Center of Medical Simulation**: is a simulation center focusing on training based on mannequins.
- **SimQuest**: is a company developing simulation technologies for medicine, very close to the research topic of our team.
- **Surgical Planning Laboratory** (Brigham and Womens' Hospital) is a research center very close to the clinics and working mainly on medical imaging, but also interested in the medical simulation.
- **CIMIT**: is a research center developing mannequins for training.

MIMETIC Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. Cinecitta
Participants: Marc Christie [contact], Cunka Sanokho, Quentin Galvane, Christophe Lino, Hui-Yin Wu.

Cinecitta is a 3-year young researcher project funded by the French Research Agency (ANR) lead by Marc Christie. The project started in October 2012 and will end in March 2016. The main objective of Cinecitta is 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 propose a novel cinematographic workflow that features a dynamic collaboration of a creative human filmmaker with an automated virtual camera planner. We expect the process to enhance the filmmaker's creative potential by enabling very rapid exploration of a wide range of viewpoint suggestions. The process has the potential to enhance the quality and utility of the automated planner's suggestions by adapting and reacting to the creative choices made by the filmmaker. This requires 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 will gather feedback on our prototype by involving professionals (during dedicated workshops) and will perform user evaluations with students from cinema schools.

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 a metrics to measure the performance of users. It will be used to develop a technological system embedded on users to evaluate his performance and provide him with real-time feedback to correct potential errors.

9.1.3. ADT

9.1.3.1. ManIP
Participants: Franck Multon, Ludovic Hoyet.

The ADT-MAN-IP aims at proposing a common production pipeline for both MimeTIC and Hybrid teams. This pipeline intends to facilitate the production of populated virtual reality environments.

The pipeline starts with the motion capture of an actor, using motion capture devices such as a Vicon (product of Oxford Metrics) system. To do so, we need to design new methods to automatically adapt all motion captures data to an internal skeleton that can be reused to retarget the motion to various types of skeletons and characters. The purpose is then to play this motion capture data on any type of virtual characters used in the demos, regardless their individual skeletons and morphology. The key point here is to make this process be as automatic as possible.

The second step in the pipeline is to design a high level scenario framework to describe a virtual scene and the possible user's interactions with this scene so that he/she can interact with the story directly.

In this ADT we also connect these two opposite parts into a unique framework that can be used by non-experts in computer animation to design new immersive experiments involving autonomous virtual humans. The resulting framework can consequently be used in the Immersia immersive room for various types of application.

9.1.3.2. Immerstar
Participants: Franck Multon, Georges Dumont.

The ADT-Immerstar is drivenby 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 will have to homogeneize the software modules and development facilities in each platform, help installing new upgrades and to develop collaborative applications between the two sites.

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) - Computer Science Department - Pr. Tsai-yen Li

Start year: 2013

The application context targeted by this proposal is Interactive Virtual Storytelling. The growing importance of this form of media reveals the necessity to re-think and re-assess the way narratives are traditionally structured and authored. In turn, this requires from the research community to address complex scientific and technical challenges at the intersection of literature, robotics, artificial intelligence, and computer graphics. This joint collaboration addresses three key issues in virtual storytelling: (i) delivering better authoring tools for designing interactive narratives based on literary-founded narrative structures, (ii) establishing a bridge between the semantic level of the narrative and the geometric level of the final environment to enable the simulation of complex and realistic interactive scenarios in 3D, and (iii) providing a full integration of the cinematographic dimension through the control of high-level elements of filmic style (pacing, preferred viewpoints, camera motion). The project is founded on a past solid collaboration and will rely on the team's complementarity to achieve the tasks through the development of a joint research prototype.

9.2.1.2. 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. Inria International Partners

9.2.2.1. Informal International Partners

Hubert Shum, Northumbria University, Newcastle, UK, collaboration with Franck Multon with joint papers,

Edouard Auvinet, Imperial College London, UK, collaboration with Franck Multon with joint papers,

Alexandra Covaci, Middlesex University of London, collaboration with Franck Multon with joint papers,

Jean Meunier, Carl-Eric Aubin, and Maxime Raison, University of Montreal, collaboration with Franck Multon with joint papers,

<h1 style="text-align:center; color:red;">MIMOVE Team</h1>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Inria Support

8.1.1.1. Inria ADT iCONNECT

Participant: Nikolaos Georgantas [correspondent].

- **Name:** iConnect – *Emergent Middleware Enablers*
- **Related activities:** § 6.2
- **Period:** [October 2013 – December 2015]
- **Partners:** Inria MiMove.

The pervasive computing vision is hampered by the extreme level of heterogeneity in the underlying infrastructure, which impacts on the ability to seamlessly interoperate. Further, the fast pace at which technology evolves at all abstraction layers increasingly challenges the lifetime of networked systems in the digital environment.

Overcoming the interoperability challenge in pervasive computing systems has been at the heart of the FP7 FET IP CONNECT project (http://www.connect-forever.eu/), which ran from 2009 to 2012, and was coordinated by Inria ARLES (MiMove's predecessor team). Specifically, CONNECT has been investigating the paradigm of *Emergent middleware*, where protocol mediators are dynamically synthesized so as to allow networked systems that provide complementary functionalities to successfully coordinate. The CONNECT project has in particular delivered prototype implementation of key enablers for emergent middleware, spanning discovery, protocol learning, and mediator synthesis and deployment. Further, while CONNECT focused on learning and reconciling interaction protocols at the application layer, the FP7 project CHOReOS (http://www.choreos.eu) to which ARLES contributed as well, investigated a complementary enabler that supports interoperability across systems implementing heterogeneous interaction paradigms (i.e., client-service, event-based and shared memory). The proposed enabler introduces the concept of XSB - eXtensible Service Bus, which revisits the notion of Enterprise Service Bus and features an end-to-end interaction protocol that preserves the interaction paradigms of the individual components, while still allowing interoperability.

The objective of the Inria iConnect ADT is to leverage and integrate the above complementary results, packaging and further enhancing enabler prototypes, for take-up of the results by the relevant open source community. The work will involve development effort focused on the following core enablers:

- Universal discovery of resources composing legacy discovery protocols,
- Dynamic synthesis and deployment of mediators specified as enhanced labelled transition systems,
- XSB as underlying run-time support for mediators so as to support interoperability across systems based on heterogeneous interaction paradigms,
- Experiment in the area of federated social networking.

We are releasing the software prototypes through the OW2 open source initiative FISSi (Future Internet Software and Services initiative – http://www.ow2.org/view/Future_Internet/), as our solutions are of direct relevance to sustaining interoperability in the Future Internet.

8.1.1.2. Inria ADT CityLab Platform

Participant: Valérie Issarny [correspondent].

- **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 focused on the study of ICT-based smart city systems from supporting "sensing" systems up to advanced data analytics and new services for the citizens. While the topic is broad, the lab leverages relevant effort within Inria project-teams that is further revisited as well as integrated to meet the challenges of smart cities

There is the promise of enabling radically new ways of living in, regulating, operating and managing cities through the increasing active involvement of citizens. The latest technology trends of crowd- sourcing/sensing (crowd-Xing) and location-based social networking have reignited citizen engagement, opening new perspectives for cost-effective ways of making local communities and cities more sustainable. However, this requires investigating supporting systems of systems from advanced sensing systems up to integrated data management and associated data analytics. This is specifically the objective of the CityLab Inria ProjectLab, where the related ADT is focused on the development and maintenance of the CityLab Platform. The platform integrates the software prototypes developed as part of the undertaken research and will be made available under open source license. It is further the objective of the ADT to deploy and experiment with the platform within cities.

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

Participants: Valérie Issarny [correspondent], Nikolaos Georgantas [correspondent].

Name: FIESTA – *Federated Interoperable Semantic IoT/cloud Testbeds and Applications*

URL: *Under construction*

Type: Research & Innovation Action (ICT)

Topic: FIRE+ (Future Internet Research & Experimentation)

Related activities: § 7.3 and § 6.3

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 ICT Labs 3cixty

Participants: Animesh Pathak [correspondent], Rachit Agarwal [correspondent].

Name: 3cixty – *A Platform for Apps and Services that Offer Comprehensive Views of a City*

URL: http://www.3cixty.com/

Period: [January 2014 - December 2015]

Partners: Ambientic (F), CEFRIEL (IT), DFKI (DE) [**coordinator**], Eurecom (F) [**associate leader**], Fondazione Politechnico di Milano (IT), Innovalor (NL), Inria MiMove [**associate leader**], LocaliData (ES), Mobidot (NL), Politechnico di Milano (IT), Telecom Italia (IT) [**associate leader**], Thales (F), TU Delft (NL), UC London (UK).

3cixty is a platform, well motivated in business terms, for developing apps for city visitors that makes it easy for application developers to access and process comprehensive heterogeneous information about a city; and a Showcase App using the platform that demonstrates its added value. The project will result new opportunities to enable city visitors to exploit the transportation, business, cultural, and touristic opportunities offered by a city more fully and in a more personally and environmentally appropriate way, thereby benefiting cities, their visitors, and application and service developers.

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 CITRIS, EECS, University of California, Berkeley.

Sara Hachem and Cristhian Parra have been carrying out their postdoc research at UC Berkeley in the context of the Inria@Silicon Valley program and CityLab@Inria.

8.3.2. Inria Associate Teams not involved in an Inria International Lab

8.3.2.1. Inria DRI/DST-CEFIPRA Associate Team: SARATHI
Participants: Animesh Pathak [correspondent], Nikolaos Georgantas [correspondent].

> **Name:** SARATHI – *Personalized Mobility Services for Urban Travelers*
> **Instrument:** Inria DRI/DST-CEFIPRA Associate Team
> **Period:** [January 2014 - December 2016]
> **Partners:** Indraprastha Institute of Information Technology (IIIT), Delhi (India), Inria MiMove.
> **Website:** https://saarthiproject.wordpress.com/

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.

8.3.3. Inria International Partners

8.3.3.1. Informal International Partners

We have a lasting collaboration with Prof. Fabio Costa at the Federal University of Goias (UFG), Brazil, on self-adaptive ubiquitous and cloud-based systems. This collaboration was funded by the Inria-Brazil International Scientific Cooperation Program during the period 2012-2014. In 2015, Raphael de Aquino Gomes, UFG PhD student, conducted an 1-year PhD internship with MiMove, funded by a scholarship of the CAPES/CNPq Brazilian Science without Borders program. A collaborative project proposal by Inria MiMove and UFG was submitted at the "Associate Teams with Brazil Program" 2016 Call, co-funded by Inria and the Brazilian Research Foundations (FAPs). The project was successfully evaluated and will be funded for three years, enabling further fruitful exchanges between UFG and Inria MiMove.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Raphael de Aquino Gomes (from Sep. 2014 until Aug. 2015)

PhD internship funded by a visitor PhD student scholarship of the Brazilian Science without Borders program provided by CAPES and CNPq.

Subject: *Self-Adaptive Use of Cloud Resources for Heterogeneous Dynamic Service Choreographies*

Institution: Federal University of Goias - UFG (Brazil)

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Valérie Issarny is visiting scholar at CITRIS at UC Berkeley, 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.

MINT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. MATRICE

24 month project. lead: Lille school of architecture. Partners: Telecom Lille, Ecole des mines de douai, Centrale Lille, Lille school of design. Subject: 3D printing for construction industry. Funding for MINT: 12 months engineer, 12 months post-doc.

8.1.2. Iconographie Numérique (Sept. 2015-Dec. 2018)

From sept. 2015 to dec. 2018.
Funding from MEL, 24 months for post-doctoral position.
Subject: Design of a digital tool for historians and archaeologists.

8.1.3. Art/science projects

Pauline de Chalendar (FreeHands project). Shown at Panorama exposition sept-dec. 2015, Fresnoy (Tourcoing). Also shown at VISAP, IEEE Infoviz ArtTrack, august 2015, Chicago.
Pauline Delwaulle
Out of space: Mirror Lake Station Pictanovo project 2013-2015 in collaboration with Mathilde Lavesnne. Shown at "Portes ouvertes, La Malterie, October 17th to 19th 2014; "Expériences interactives" de Pictanovo, l'Hospice d'Havré, May 28th to July 10th 2015; La cartographie, Espace Culture de l'Université de Lille 1, October 6th to December 11th 2015; "Hyper-archéologie", Centre Arc-en-ciel de Liévin, January 29th to February 29th 2016

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. Smart-Store (12th FUI, 2011-2014, extended to 2015)

Participants: Samuel Degrande [correspondant], Laurent Grisoni, Fabrice Aubert.

The aim of this project is to set up, in the context of retail, some middleware and hardware setup for retail interactive terminal, that allows customer to connect with their own smart-phone on a system that includes a large screen, and allows to browse some store offer, as well as pre-order and/or link to further reconsulting. SME Ides-3com leads this FUI, which also includes Immochan, Oxylane, and VisioNord. Grant for MINT is 301 Keuros. This project started on September 2012 (start of this project has been delayed due to administrative problems), for a duration of 36 months.

Associated competitivity cluster: PICOM (retail)

8.2.3. 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.

8.2.4. 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.

8.2.5. 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.

8.2.6. 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).

8.3. International Initiatives

8.3.1. Participation In other International Programs

8.3.1.1. Mac Gill University, Canada, (CIRRMT, Marcelo Wanderley)

Technological tool for an Opera, Two years project, Planned for January 2017. Composed by Arnaud Petit, written by Alain Fleischer.

8.3.1.2. Université de Liège

Application for project C-SHADE

8.3.1.3. Institut Superior Technico, Lisbon (Joaquim jorge)

Application for project C-SHADE

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **PERSYVACT projects.**

  MISTIS is involved in the 3-year project-team Oculo Nimbus, funded (250 keuros for the whole project) by the PERSYVAL labex (https://persyval-lab.org/en), with other teams from local laboratories, LJK, GIPSA-Lab and LPNC. The goal of this research project is to develop tools for analyzing eye-movement data.

  MISTIS is also invollwed in another action (2015-2018) recently granted Persyvact2 action supported by the Persyval Labex for 3.5 years. This project is a follow-up of the Persyvact Exploratory labex project. Persyvact2 consists of about 20 researchers from different laboratories, GIPSA-lab, LJK and TIMC-IMAG and different fields related to data science (statistics, machine learning, image and signal processing). Our contribution and involvement will lie essentially in a Graph signal processing work package with application in neuroscience for which we are planning to hire a PhD student with S. Achard (GIPSA-Lab). Persyvact2 also intends to organize scientific events and an international workshop during its lifetime. Persyvact2 will contribute, with other teams of Persyval, to enhance the international visibility of data science in Grenoble. The financial support for the consortium is of 250 keuros.

- **Grenoble Pole Cognition (2013-15).** We received in 2015 2.5 keuros from the Grenoble Pole Cogntion, http://www.grenoblecognition.fr/, for collaborative projects involving the GIN and the Pixyl startup. This funding was used this year for the internship of Priscillia Previtero on brain MRI analysis.

- 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.

9.2. National Initiatives

9.2.1. 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 made in the HUMAVIPS project. The CNRS support for the network is of 20 keuros.

9.2.2. 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).

9.2.3. 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. European Initiatives

9.3.1. FP7 & H2020 Projects

European H2020 RESSTORE (2015-2018). F. Forbes is involved in this multi-center Stroke European H2020 project including 20 partners. F. Forbes will contribute through the Pixyl startup which will receive 70 keuros as a subcontractor. RESSTORE stands for REgenerative Stem cell therapy for STroke in Europe. It is part of the Clinical research on regenerative medicine program. It will involve a phase 2 trial with 300 patients imaged at 4 time points over a 3 year timeframe. Pixyl will provide automatic stroke lesion segmentations.

9.4. International Initiatives

9.4.1. Inria International Labs

LIRIMA

Associate Team involved in the International Lab:

9.4.1.1. SIMERGE

Title: Statistical Inference for the Management of Extreme Risks and Global Epidemiology

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LERSTAD - Abdou Kâ Diongue

Start 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.

9.4.2. Inria International Partners

9.4.2.1. 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, the Russian Academy of Science in Moscow, and more recent partners like IDIAP involved in the past HUMAVIPS project, Université Gaston Berger in Senegal and Universities of Melbourne and Brisbane in Australia. We also work at turning other current European contacts, *e.g.* at EPFL (A. Roche at University Hospital Lausanne and Siemens Healthcare), into more formal partnerships.

The main international collaborations that we are currently trying to develop are with:

- Fabrizio Durante, Free University of Bozen-Bolzano, Italy.
- K. Qin and D. Wraith 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.
- Alexandre Nazin and Russian Academy of Science in Moscow, Russia.
- Alexis Roche and University Hospital Lausanne/Siemens Healthcare, Advanced Clinical Imaging Technology group, Lausanne, Switzerland.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Researchers

- Seydou Nourou Sylla (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for four months.
- El Hadji Deme has been hosted by the MISTIS team for 3 weeks.
- Abdelhakim Necir (University Biskra, Algeria) has been hosted for 2 weeks.

9.5.1.2. Internships

Sebastian Torres Leiva (Master, from Feb 2015 until June 2015)

Subject: Extreme value modelling of some glacial processes in Chilean Andes.

Institution: UTFSM - Universidad Tecnica Federico Santa Maria, Valparaiso, Chile

<div align="center">

Mjolnir Team

</div>

8. Partnerships and Cooperations

8.1. National initiatives

8.1.1. 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 2015 publications: [23], [18], [27].

8.1.2. ParkEvolution (Carnot Inria - Carnot STAR, 2015-2016)

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/

8.1.3. 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/

8.2. European initiatives

8.2.1. Happiness (H2020-ICT-2014-1/ICT-03-2014/RIA, 2015-2018)

Participants: Thomas Pietrzak, Nicolas Roussel [correspondent].

The main objective of this project is to develop and evaluate new types of haptic actuators based on Advanced Thin, Organic and Large Area Electronics (TOLAE) technologies for use in car dashboards.

Partners: CEA (coordinator), Inria Rennes' HYBRID team, Arkema, Bosch, Glasgow University, ISD, Walter Pack, Fundacion Gaiker.

Web site: http://happiness-project.eu/

8.2.2. 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.

Partner: University College London Interaction Centre (United Kingdom).

8.3. International initiatives

8.3.1. 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 2015 publications: [16].

8.4. International research visitors

8.4.1. Visits of international scientists

Visiting scholars:

- Marcelo Wanderley, 4 one week visits, Professor at McGill University, Canada
- Edward Lank, November 24-25th, Associate Professor at the University of Waterloo, Canada
- Mathieu Nancel, March-April, Postdoctoral researcher at the University of Waterloo, Canada

Internships:

- Jeronimo Barbosa, November-December, PhD student at McGill University, Canada
- Aakar Gupta, February-May, PhD student at University of Toronto, Canada

8.4.2. Visits to international teams

Two internships sponsored by Mitacs — Inria research awards:

- Alix Goguey: 4 months (June-September) at the University of Waterloo with Daniel Vogel
- Justin Mathew: 3 months (June-August) at McGill University with Catherine Guastavino and Marcelo Wanderley

MNEMOSYNE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. PsyPhINe: Cogito Ergo Es
Participant: Nicolas Rougier.

PEPS site Mirabelle (CNRS & University of Lorraine) gathering researchers from the following institutes: MSH Lorraine (USR3261), InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Loria (UMR7503).

PsyPhiNe is an interdisciplinary and exploratory project between philosophers, psychologists and computer scientists. The goal of the project is related to cognition and behavior. Cognition is a set of processes that are difficult to unite in a general definition. 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, our aim is to design a "non-verbal" Turing Test, which satisfies the definitions of our various fields (psychology, philosophy, neuroscience and computer science), using a robotic prototype. Some of the questions that we aim to answer are: is it possible to give the illusion of cognition and of intelligence through such a technical device? How elaborate must be the control algorithms or "behaviors" of such a device to fool test subjects? How many degrees of freedom must it have?

9.1.2. Project PEPS of the Idex: Dopamine control of a novel basal ganglia cell-type
Participants: André Garenne, Nicolas Rougier.

The neurotransmitter dopamine (DA) plays a key role in basal ganglia (BG) circuits. However, despite the fundamental importance of DA in those circuits, the electrophysiological effects of dopamine on target neurons are largely unknown. Furthermore, contrary to classical models that only view the globus pallidus (GP) as a relay station of the indirect pathway, our neuroscientist colleagues at IMN have discovered a novel GP cell-type called the Arkypallidal (Arky-GP) neurons that only project to striatum in a very dense way. We thus have been modeling the structure of the striatum ($\approx$ 3 millions neurons) and the globus pallidus ($\approx$ 50,000 neurons) in the mouse using down-scaled models. Two models have been made, the first one utilized the neural field theory while the other one utilized integrate-and-fire neurons. The goal was to study the activity around the electrode contact point in order to give account on recorded activity in vivo. Unfortunately, electrophysiological recording were not precise enough to conclude on these models.

9.1.3. Project of the Aquitaine Regional Council: Decision making, from motor primitives to action
Participants: Nicolas Rougier, Meropi Topalidou.

The aim of this project (partly funding the PhD of Meropi Topalidou) is to investigate decision making at intermediate level in order to establish the link between motor primitives and higher level actions. The question is to understand how continuous complex motor sequences can be dynamically represented as actions such that they can be manipulated to resolve conflict when several actions are possible. In tight collaboration with Thomas Boraud from the Institute of Neurodegenerative Diseases, we have been modeling the basal ganglia such as to explain the formation of habits in the monkey. This fruitful collaboration lead to the joint publication of several articles [4], [43], [42], [5] and the model enabled us to make very precise prediction on the behavior of the monkeys (dissociation of goal-directed and habitual behavior). Early experiments on two female macaques tend to confirm the prediction.

9.1.4. 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. A draft paper is then currently modified before submission to take into account these last results.

9.1.5. Thematic Transverse Action of the University of Bordeaux: Project MISTERE

Participant: André Garenne.

The MISTERE (Etude du Mécanisme d'Interaction des Signaux de Téléphonie mobile sur des Réseaux de neurones in vitro) project has been recently accepted and we have obtained financial support and 1 year of post-doctoral contract by the Science and Technology department of the University of Bordeaux. The main topic of this project lies in the elucidation of the cellular mechanisms of the effects of the GSM radio frequencies (GSM-RF) on the neuronal activity. The approach will consist both in computational modeling studies and in pharmacological tests of neuronal cultures activity when submitted to GSM-RF.

9.2. National Initiatives

9.2.1. GDR3672 - BioComp - Material Implementation of natural computation

Participant: Nicolas Rougier [member of the steering commitee].

The GDR BIOCOMP has been officially created on January 2015 and gathers the INP, INSIS, INS2I, INSB, INC institutes of the CNRS. The goal of this GDR is to facilitate interdisciplinary exchanges in France around a common goal: the realization of bio-inspired hardware systems. More precisely, this GDR seeks to understand the mechanisms at work in biological systems to create chips based on natural computation, but also vice versa, building hardware architectures as test systems to better understand biology. In France there is a wealth of expertise in all disciplines concerned with hardware implementations of natural computation: biology, computational neuroscience, mathematics, computer architecture and computer systems, microelectronics, nanotechnology and physics. Making bio-inspired chips is extremely complex and requires advanced skills in all these disciplines. By organizing interdisciplinary meetings and conferences, the goal is hence to bring together different communities so that they can understand each other and work together.

9.2.2. 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) has been recently accepted and will be financed by the ANSES (the french national agency for health security). This 3 years project includes substantial financial support as well as 2 years of post-doctoral contracts with our partner IMS regarding the effects of GSM-RF on living matter and especially neuronal activity and development. It is designed to be synergistic with the MISTERE project previously obtained (cf section 9.1.5). Our main involvement will concern electrophysiological data and spike trains analysis as well as the development of pharmacological protocols to test GSM-RF effects hypotheses.

9.2.3. 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. 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 (*cf.* § 7.4) as well as for their relation with other brain structures (*cf.* § 7.2).

9.3.3. 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).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

Nallapu Bhargav Teja

Date: June 2015 - Dec 2015

Institution: University of Hyderabad (India)

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

7. Partnerships and Cooperations

7.1. Regional Initiatives

- MOAIS 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).
  Leader: CESICE, UPMF (Théodore Cristakis). Partners: Inria/Privatics and LIG/Moais, Gipsa-lab, LJK, Institut Fourier, TIMA, Ve´rimag, LISTIC (Pole MSTIC)

7.2. National Initiatives

7.2.1. ANR

- **ANR grant MOEBIUS (2013-2015).** Multi-objective scheduling for large computing platforms. Coordinator: Grenoble-INP (Moais team). Partners: Grenoble-INP, Inria, BULL.

- **ANR grant EXAVIZ (2011-2015).** Large Scale Interactive Visual Analysis for Life Science. Partners: Inria Rhône-Alpes, Université d'Orléans, the LBT lab from IBPC, the LIMSI from Université d'Orsay, and the CEMHTI labs from CNRS.

- **ANR HPAC (2012-2015)**. High Performance Algebraic Computing. Coordinator: UJF (LJK/CASYS team). Partners: project-team MOAIS (Grenoble), project-team ARENAIRE (LIP, Lyon), project-team SALSA (LIP6, Paris), the ARITH group (LIRMM lab, Montpellier).

- **Equipex Kinovis (2012-2017)**. 2.6 Meuros. Large scale multi-camera platform (extension of the Grimage platform to 60 cameras, depth and X-ray cameras). Coordinator E Boyer, LJK Inria MORPHEO team. Partners: Inria Rhône-Alpes and the LJK, LIG, LADAF and GIPSA labs.

- **ANR-11-LABX-0025 PERSYVAL-Lab** funds the following PhD in collaboration with other labs:
  - in collaboration with Verimag: Multi-objective optimization for resource management on multicore systems, (PhD Abhinav Srivastav, since 9/2012)
  - In collaboration with Gipsa-lab and Inria BiBop: Simulations of Fibrous Materials. (PhD Gilles Daviet, since 9/2013)
  - in collaboration with Inria Privatics and Verimag: Secure Outsourcing (PhD Amrit Kumar, since 11/2013)

7.2.2. Competitivity Clusters

- **SoC-Trace**, Minalogic 2011-2015 contract. This project aims the development of tools for the monitoring and debug of mumticore systems on chip. Leader: ST-Microelectonic. Partners: Inria (Mescal, Moais); UJF (TIMA, LIG/Hadas); Magilem, ProBayes. Moais contributes with technics and tools for visual aggregation of application traces. The contract funds 1 phd thesis (Damien Dosimont) and 1 year engineer.

- **ARAMIS, PIA contract n°P3342-146798 (2014-2017)**: Architecture Robuste pour les Automates et Mate´riels des Infrastructures Sensibles. Coordinator: ATOS-WorldGrid; Partners: CEA, SecLab, UJF. The UJF gathers the following teams: LIG (Moais, Drakkar, Vasco); LJK (Casys); IF; Verimag (DCS). BPI funds UJF with 775 ke (funds 4 PhDs and 5 years egineers), among which 410ke for LIG. Moais co-advises two PhD Thesis: Nicolas Kox with LIG-VASCO team (Protocol firewall with security guarantees for control-command systems); Maxime Puys with VERIMAG-DCS (Generation of certified filters for control-command systems).

- **PIA ELCI (2014-2017)**. Environnement Logiciel pour le Calcul Intensif. Coordinator BULL. Partners: BULL, CEA, Inria, SAFRAB, UVSQ.

7.2.3. National ADT

- ADT K'STAR with cooperation between EPIs MOAIS and RUNTIME (Bordeaux). Coordinator: T. Gautier. https://gforge.inria.fr/projects/kstar. The main objective is to provide OpenMP-3.1 with some extension from OpenMP-4.0 standard to perform OpenMP programs on multi-CPUs multi-GPUs by using XKaapi and StarPU runtimes.

7.2.4. Inria Project Lab

7.2.4.1. C2S@Exa - Computer and Computational Scienecs at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

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. 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.

T. Gautier is coordinator of the Pole 4: Programming Models.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: 2015-2020

Coordinator: Barcelona Supercomputing Center

Inria contact: Stephane Lanteri

The main objective 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 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: Exploitation: In wind energy (respond to demand peaks, output prediction) Efficiency: In biomass-derived fuels (develop more efficient and renewable fuels, reduce green-house gas emissions, reduce hydrocarbon dependency and fuel cost) Exploration: In wind energy (resource assessment) and in hydrocarbons (improve available reserves, explore with less financial and environmental risk). 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 will benefit from the project's results. They guarantee that TRL of the project technologies will be very high. A last objective is to improve the cooperation between the leading research centres in EU and Brazil in HPC applied to energy industry. 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.

7.3.1.2. VISIONAIR

Title: VISION ADVANCED INFRASTRUCTURE FOR RESEARCH

Programm: FP7

Duration: February 2011 - January 2015

Coordinator: Grenoble-INP

Partners:

Ecole Nationale Superieured'arts et Metiers (France)

Universited'aix Marseille (France)

Consiglio Nazionale Delle Ricerche (Italy)

Cranfield University (United Kingdom)

Ecole Centrale de Nantes (France)

"european Manufacturing and Innovation Research Association, A Cluster Leading Excellence" (Belgium)

Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

Institut Polytechnique de Grenoble (France)

Inpg Entreprise (France)

Kungliga Tekniska Hoegskolan (Sweden)

Politecnico di Milano (Italy)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Poznan University of Technology (Poland)

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Magyar Tudomanyos Akademia Szamitastechnikai Es Automatizalasi Kutato Intezet (Hungary)

Technion - Israel Institute of Technology. (Israel)

University College London (United Kingdom)

University of Essex (United Kingdom)

Technische Universitaet Kaiserslautern (Germany)

University of Patras (Greece)

Universitaet Stuttgart (Germany)

University of Bristol (United Kingdom)

The University Offord (United Kingdom)

Universite de la Mediterraneed'aix-Marseille Ii (France)

Universiteit Twente (Netherlands)

"fundacio Privada I2cat, Internet I Innovacio Digital A Catalunya" (Spain)

Inria contact: G. Dumont

VISIONAIR is a project of creation of a European infrastructure that should be a unique, visible and attractive entry towards high level visualisation facilities. These facilities must be open to the access of a wide set of research communities. By integrating existing facilities, it will create a world-class research infrastructure enabling to conduct frontier research. This integration will provide a significant attractiveness and visibility of the European Research Area. Current scientific challenges concern climate evolution, environmental risks, health, energy, etc. and require the management of more and more complex information. The development of information technologies, the increasing complexity of the information to be handled and analysed, along with the increasing capacities in scientific and engineering simulations, call for the development of increasingly powerful visualisation tools and methods. The Europe Research Area must be able to compete with other big Research Areas when addressing the previously defined challenges. By integrating visualisation facilities with the VISIONAIR project, ERA will be able to answer integrated challenges out of the scope of usually disseminated research teams. Both, physical access and virtual services, will be provided by the infrastructure. A full access to visualisation dedicated software will be organised, while physical access on high level platforms, will be partially (about 20% of global usage) open for other scientists for free on behalf of excellence of submitted projects. The partners of this project propose to build a common infrastructure that would grant access to high level visualisation facilities and resources to researchers. Indeed, researchers from Europe and from around the world will be welcome to carry out research projects using the visualisation facilities provided by the infrastructure. Visibility and attractiveness of ERA will be increased by the invitation of external projects.

7.3.1.3. 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.

7.3.1.4. GRAIN 2

Type: Cooperation

Defi: Transport (incl. Aeronautics)

Instrument: Coordination and Support Action (CSA)

Duration: October 2013 - June 2016

Coordinator: Centre Internacional de Metodes Numerics en Enginyeria, Barcelone (Spain)

Partner: Airbus (Sp), Alenia (I), EADS-IW (F), Rolls-Royce (UK), Ingenia (Sp.), Numeca (B), U. Sheffield (UK), U. Birmingham (UK), CIRA (I), VKI (B), Airbone (NL), Leitat (Sp), Cerfacs (F), U. Cranfield (UK), CAE (CN), GTE (CN), ARI (CN), FAI (CN), ASRI (CN), SAERI (CN), BIAM (CN), ACTRI (CN), BUAA (CN), NPU (CN), PKU (CN), NUAA (CN), ZIU (CN)

Inria contact: Toan Nguyen

Abstract: The main objective of GRAIN2 is to focus its greening activities following the Flight Path 2050 Vision for Aircraft. GRAIN2 will in particular identify innovative R&D methods, tools and HPC environments (supercomputers and GPGPUs) according to the needs of major aeronautical industries to deeper understand the mechanism of engine exhaust emissions, to improve fuel efficiency and environmental performance.

7.4. International Initiatives

7.4.1. Inria International Labs

JLESC
Associate Team involved in the International Lab:

7.4.1.1. ANOMALIES@EXASCALE

Title: Anomalies Detection and Handling towards Exascale Platforms

International Partner (Institution - Laboratory - Researcher):

University of Chicago (United States) - Argonne National Laboratory (ANL) - Franck Cappello

Start year: 2014

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.

7.4.2. Inria Associate Teams not involved in an Inria International Labs

7.4.2.1. ExaSE

Title: Exascale Computing Scheduling and Energy

International Partner (Institution - Laboratory - Researcher):

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.

7.4.3. Participation In other International Programs

7.4.3.1. 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 parternship 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). Moais is deeply invovled in the creation and animation of LICIA. Bruno Raffin is LICIA associate director.

7.4.3.2. CAPES/COFECUB StarShip

Title: Scalable Tools and Algorithms para Resilient, Scalable, Hybrid Interactive Processing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2013 - 2016

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Daouda Traore, Director of Informatics Dept at Seguou Univ., Mali (oct-nov. 2015)

7.5.1.1. Internships

KHATIRI Mohammed

Date: Sep 2015 - Dec 2015

Institution: UMP (Morocco)

Supervisor: Denis Trystram

7.5.2. Visits to International Teams

7.5.2.1. Research stays abroad

- B. Raffin visited the Universidad A Coruña, Spain, from Sept 2015 to Dec 2015.

MODAL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Christophe Biernacki has some contracts and/or PhD theses with regional companies: Arcelor-Mittal (thesis), Auchan (contract), PIXEO (contract and thesis), Cylande (contract).

9.1.1. *Collaborations within PSo-Innov*

Participant: Sophie Dabo.

Sophie Dabo is a member of the regional emergent project *Précarité, Solidarité, vers un accompagnement innovant des personnes en difficultés d'une association spécialisée* with the LGI2A, CRIL, Discontinuité, LEM, APSA-Pas-de-Calais and coordinator: Issam Nouaouri (issam.nouaouri@univ-artois.fr).

9.1.2. *MPAGenomics2*

Participants: Samuel Blanck, 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. This last one financed the project MPAGenomics2, coordinated by Guillemette Marot, to biologically validate on cohorts of patients suffering from leukaemia the tools developed by the Development Technological Action MPAGenomics. The project lasted five months and other partners were Functional Genomics platform from Univ. Lille 2, INSERM UMR-S 1172 and biology pathology center of Lille hospital.

9.2. National Initiatives

9.2.1. *ANR ClinMine*

Participants: Julien Jacques, Cristian Preda, Vincent Vandewalle.

Modal team is member of ClinMine ANR project (http://www.lifl.fr/ClinMine/pmwiki/index.php) in charge with statistical methdology. Collaborators : LIFL, CHRU Lille, CHU Montpellier, ALICANTE, GHICL.

9.2.2. *ANR Imagiweb*

Participant: Julien Jacques.

Julien Jacques is member of Imagiweb ANR project (http://mediamining.univ-lyon2.fr/people/velcin/imagiweb/) as member of the ERIC laboratory (Univ. de Lyon).

9.2.3. *ANR Calibration*

Participant: Alain Celisse.

Alain Celisse is a member of the Calibration ANR project (https://sites.google.com/site/anrcalibration/anr-calibration) in charge with statistical methdology. Collaborators : Select, ENS Cachan, Université Paris-Sud, Université Nice, Université Paul Sabatier de Toulouse.

9.2.4. Working groups

Christophe Biernacki is the president (since 1012) of the data mining and learning group of the French statistical association (SFdS, http://www.sfds.asso.fr/)

Sophie Dabo belongs to the working groups

- STAFAV (STatistiques pour l'Afrique Francophone et Applications au Vivant),
- ERCIM Working Group on computational and Methodological Statistics, Nonparametric Statistics Team,
- Ameriska, Paris.

Guillemette Marot belongs to the StatOmique working group

Julien Jacques belongs to the Working Group on Model Based Clustering (University of Washington)

Benjamin Guedj belongs to the following GdR of CNRS: ISIS (local referee for Inria Lille - Nord Europe), MaDICS, MASCOT-NUM (local referee for Inria Lille - Nord Europe).

Alain Celisse belongs to the Statistics for Systems Biology group (SSB) in Paris.

Alain Celisse belongs to a working group on change-point detection with people from Lancaster university (UK).

9.3. International Initiatives

9.3.1. SIMERGE

Participant: Sophie Dabo.

SIMERGE is 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

LEM lab, Lille Economie et Management, Université Lille 1, 2, 3

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Benjamin Guedj regularly collaborates with Olivier Wintenberger from Københavns Universitet (KU, Denmark).

9.4. International Research Visitors

Benjamin Guedj regularly collaborates with Olivier Wintenberger from Københavns Universitet (KU, Denmark).

9.4.1. Visits of International Scientists

Sylvain Robbiano (March 2015 - University College London, UK) and Pierre Alquier (April 2015 - ENSAE ParisTech, France) have visited Benjamin Guedj. Those two visits have been followed by the submission of two research papers (Nov. 2015 and Jan. 2016, respectively).

9.4.1.1. Internships

Siddharth Sharma Siddharth

Date: Nov 2015 - May 2016

Institution: LNM Institute of Information Technology (India)

Supervisor: Guillemette Marot

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MODEMIC Project-Team

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8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Labex Numev

Within the Labex Numev (Solutions Numériques, Matérielles et Modélisation pour L'Environnement et le Vivant [0]), the team has obtained several funding for internships and invitation of international visitors, for the coming year:

- six months of MsC internships on optimal control for bioprocesses (jointly with the LBE unit, Inra Narbonne),
- the venue of Prof. Chris Klausmeir from Michigan State Univ. about micro-algae modeling (jointly withe the UMR EcoSols, Montpellier).

8.1.2. Inter-teams seminar

J. Harmand is the coordinator of the inter-teams seminar about the modeling of bioprocesses [0], involving the labs INRA-LBE (Narbonne), UMR LISPB (Toulouse) and the two Inria project teams BIOCORE and MODEMIC.

C. Lobry has been invited to participate to the "Séminaire au vert" of BIOCORE team in November 2015.

8.2. National Initiatives

8.2.1. ANR Soilμ3D

The team is partner of the ANR project SoilMicro-3D: *Emergent properties of soil microbial functions: Upscaling from 3D modeling and spatial descriptors of pore scale heterogeneity*, conducted by the UMR EGC for 4 years (2015-19). The other partners are UMR iEES, UMI UMMISCO, SIMBIOS (Scotland), UMR Géosciences Rennes, UMR JJL and UR Inra Science du Sol Orléans). The main goal of the project are

- develop new descriptors of the pore scale 3D soil heterogeneity that explain the fluxes measured at the core scale,
- improve the performance of 3D pore scale models to simulate processes from pores to cores with a reduction of the computational time,
- develop new simple models describing the soil micro-heterogeneity and integrating these micro-features into field-scale models.

The kick-off meeting is held in Jan 2016.

8.2.2. PGMO "OPTIBIO"

OPTIBIO (New challenges in the optimal control of bioprocesses [0]) is a new project funded by the french Fundation FMJH (Fondation Mathématique Jacques Hadamard) in 2014 for three years, within the program PGMO (Gaspard Monge Program for Optimization and operations research).

The project is coordinated by T. Bayen (ACSIOM, Univ. Montpellier II) and the other partners are: MODEMIC, Univ. Limoges, EPI COMMANDS (Saclay) and EPI BIOCORE (Sophia Antipolis).

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[0] http://www.lirmm.fr/numev
[0] https://sites.google.com/site/journeesthematiquesdulbe/
[0] http://www.math.univ-montp2.fr/~bayen/articles/posterPGMO.pdf

The overall objective of this project is to address the optimization of bioprocesses over an *infinite horizon*. Infinite horizon optimal control is well suited for every problem where the time horizon is uncertain and can be expected to be large: e.g. economics models related to optimal growth and sustainable development, biological models such as the optimal control of interacting species and pest control, stabilization of controlled mechanical systems...The recent expectations of sustainable development raise new optimization problems that take into account auxiliary outputs, such as bio-gas production, that were neglected in the past. It appears that mathematical problems that come from the modeling of these processes are often difficult to solve, and one objective of the proposal is to develop new mathematical methods in order to address these issues. More precisely, the objective of the project is to study the following issues:

- Optimization of bioprocess over an infinite horizon.
- Development of accurate methods in order to deal with uncertainties that affects the chemostat model (uncertainties come from unknown parameters or noise from the measurements).
- Stabilization of the chemostat model including delay in the system.

8.2.3. INRA-MIA methodological networks

The team is involved in two new networks of the MIA (Applied Mathematics and Informatics) Department of INRA:

- MEDIA [0] (Modèles d'Équations DIfférentielles et Autres systèmes dynamiques pour l'écologie),
- REM [0] (RÉduction de Modèles),

that have been launched last year.

8.3. International Initiatives

8.3.1. Inria International Labs

Inria Chile
Associate Team involved in the International Lab:

8.3.1.1. DYMECOS2

Title: Modeling of microbial ecosystems, bioprocesses control and numerical simulations

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Center for Mathematical Modeling (CMM) - Hector Ramirez

Start year: 2014

See also: https://sites.google.com/site/eadymecos/

The objective is to develop, from expert knowledge and experimental observations, models of microbial ecosystems that are simple enough to carry out the determination of explicit "control laws", and realistic enough to represent real bio-processes. One of the difficulties is to identify the limits of the validity of these models, in terms of spatial heterogeneity and microbial population size. We aim also to obtain outcomes of the modeling for the optimal design of waste-water treatment plants.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

CESAME, Univ. Louvain, Belgium : D. Dochain

3BIO, Univ. Mons, Belgium : A. Vande Wouver

Univ. Neuchâtel, Switzerland : M. Benaim

Univ. Newcastle, U.K. : M. Wade

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[0]http://www.netvibes.com/reseaumiamedia
[0]https://sites.google.com/site/reseaurem2/

MOMAT, Univ. Madrid, Spain : B. Ivorra

Univ. Sevilla, Spain : T. Caraballo

8.3.3. Participation In other International Programs

8.3.3.1. CIB (Centre Interfacultaire Bernoulli)

Program: Bernoulli workshops

Title: The role of mathematics and computer science in ecological theory

Inria principal investigator: MODEMIC (C. Lobry),

Partners: EPFL, Lausanne (Switzerland).

Duration: July 2014 to Feb 2015

Abstract: A former collaboration of Inria with ecologists (the COREV network presently animated by R. Arditi) initiated (at the beginning of the 90s) by J-L. Gouzé and C. Lobry within the framework of the Inria project team COMORE, pursued then by MERE and COMORE raised an important event: the half-year *Mathematics and computer sciences in theoretical ecology* which we co-organize with R. Arditi (associated with D. de Angelis and L. Ginzburg) at the Federal Polytechnical School of Lausanne (Centre Interfacultaire Bernoulli).

The program lasted from July 1 to December 31, 2014 (see the 2014 activity report), but a follow-up workshop has been organized in February 2015 on the Persistence of population models in temporally fluctuating environments. This workshop has led to the writing of a review paper [31] in common.

Web-site: http://mathcompecol.epfl.ch/

8.3.3.2. TREASURE

Program: Euromediterranean 3+3

Title: Treatment and Sustainable Reuse of Effluents in semiarid climates

Inria principal investigator: MODEMIC (J. Harmand),

Partners: Centre de Biotechnology de Sfax, Department of environmental engineering (Tunisia), Ecole Nationale des Ingénieurs de Tunis, Dept. de Mathématiques (Tunisia), Institut National de la Recherche Agronomique, Dept. EA, MICA et MIA (France), National Research Center, Water Pollution Control (Egypt), University of Patras, Process Control Laboratory (Greece), University of Tlemcen, Automatic control (Algeria), University of santiago de compostella, Environmental engineering (Spain) Université Cadi Ayyad de Marrakech, Faculté des Sciences de Semlalia, Dépt. de Mathématiques (Morocco), Centre National de Recherche sur l'Eau et l'Energie, Université Française d'Egypte (Egypt)

Duration: Jan 2012 - Dec 2015

Abstract: The TREASURE network aims at integrating knowledge on the modeling, the control and the optimization of biological systems for the treatment and reuse of waste-waters in countries submitted to semi-arid climates under both socio-economical and agronomic constraints within the actual context of global changes. A special focus of the actual project concerns the integration of technical skills together with socio-economical and agronomic studies for the integrated solutions developed within the network to be evaluated and tested in practice in the partner's countries and, as possible as it may be within the context of the actual research network, valorizing these proposed technologies with the help of industrial on site in partners from South.

Web-site: https://project.inria.fr/treasure

8.3.3.3. TASSILI

Program: Hubert Curien Program

Title: Procédés membranaires pour le traitement anaérobie des eaux usées - Modélisation, commande et optimisation

Inria principal investigator: MODEMIC (J. Harmand),

Partners: LBE-INRA (Narbonne), Univ. Tlemcen (Algeria)

Duration: 3 years since 2014

Abstract: This project aims at promoting collaborations with our historical Algerian partners of the department of automatic control of the University of Tlemcen. The objectives of the project are to develop research on the modeling and the control of anaerobic systems through the co-advising of Zeyneb Khedim (PhD 'co-tutelle' between UM2 and Univ. Tlemcen).

8.3.3.4. MOSTICAW

Program: STIC AmSud

Title: MOdeling the Spread and (opTImal) Control of Arboviroses by Wolbachia

Inria principal investigator: P.A. Bliman (Inria Rocquencourt and Fundção Vargas, Rio de Janeiro, Brazil)

Partners: Inria (Rocquencourt and Metz), UPMC, CIRAD, MISTEA, Fundção Vargas (Brazil), Univ. Fed. Fluminense (Brazil), Fiocruz (Brazil), Univ. Buenos Aires (Argentina), UTFSM (Chile), Univ. de Chile, Univ. de Quindio (Colombia), Univ. Aut. de Occidente (Colombia), Nat. Univ. Nac. Mayor de San Marcos (Peru), Univ. of Asuncion (Paraguay).

Duration: 2016-2017

Abstract: The present project is concerned with new method of control of dengue fever, and potentially other severe diseases transmitted by mosquitoes Aedes (chikungunya, yellow fever). The goal of the project is to elaborate and analyze related models, along with control strategies, with the aim of testing concepts and estimating feasibility. The team is mainly involved in the modeling of interactions of bacteria Wolbachia with mosquitoes, and control systems tools (observers and optimal control).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Matthieu Sebbah

Subject: Optimal control for lagoon management

Date: from June 2015 until Sept 2105

Institution: Univ. Tecnico Federico Santa Maria, Valparaiso, Chile.

8.4.1.1. Internships

Maria Crespo (PhD)

Subject: Consideration of inhomogeneity in activated sludge bioreactors for the bioremediation of water resources

Date: Feb 2015

Institution: Univ. Complutense, Madrid (Spain)

Pascale Cuevas (MsC)

Subject: Numerical simulation of the heterogeneity in transport diffusion with nutrients

Date: from Sep 2015 until Nov 2015

Institution: Univ. Santiago (Chile)

Yessmine Daoud (PhD)

Subject: Mathematical analysis of anaerobic digestion models

Date: from Mar 2015 until Jul 2015

Institution: LAMSIN, Tunis (Tunisia)

Alejandro Rojas-Palma (PhD)

    Subject: Study of some problems related to modeling and optimization of bioprocesses

    Date: from May 2015 until Oct 2015

    Institution: Univ. of Chile

Victor Riquelme (PhD)

    Subject: Optimal control for the preservation of exploited water resources

    Date: from April 2015 until Nov 2015

    Institution: Univ. of Chile

Camila Romero (MsC)

    Subject: Minimal time crisis problem for Lotka-Volterra prey-predator model.

    Date: from Jan 2015 until Mar 2015

    Institution: Univ. of Chile

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

B. Cloez has spent one month in Switzerland at Univ. Neuchâtel and at CIB-EPFL, Lausanne.

<h1 style="text-align:center;color:red">MOKAPLAN Project-Team</h1>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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/.

8.1.2. 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/

8.2. European Initiatives

8.2.1. 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.

8.3. International Initiatives

8.3.1. Inria Associate Teams not involved in an Inria International Labs

8.3.1.1. 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 investigate new modelization and numerical resolution methods i using the theory of Optimal Transportation.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Jun Kitagawa (University of Toronto) visited Q. Mérigot and B. Thibert from June 1st to 10th, 2015. They worked on theoretical properties of Newton's algorithm for semi-discrete optimal transport problems arising in geometric optics.

Marco Cuturi (Kyoto Univ.) visited MOKAPLAN as invited professor at Paris-Dauphine during the summer 2015 (2 months), to work on applications of optimal transport to machine learning.

8.4.1.1. Internships

Kévin Degraux, a PhD candidate from the Université Catholique de Louvain (Belgium) has visited MOKA-PLAN from November 2015 to January 2016. His work focusses on sparse signal reconstruction.

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Q. Mérigot visited Jose-Antonio Carrillo at Imperial College, to start a collaboration on the discretization of Wasserstein gradient flows using Voronoi diagrams.

F.-X. Vialard was invited for one month at the semester on geometric mechanics and stochastic analysis at EPFL Bernoulli institute in april to work with Darryl D. Holm and other researchers.

F.-X. Vialard was invited for the semester on Riemannian geometry in infinite dimension in Vienna in january and february.

G. Carlier has spent six month at U. Victoria visiting Prof. Martial Agueh.

Gabriel Peyré visited the laboratory of Marco Cuturi (Kyoto Univ.) as invited professor during April 2015, to work on applications of optimal transport to machine learning.

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. BIS-Japan Idex Université de Bordeaux

- Project acronym - BIS-Japan Idex

- Duration - 2015

- Coordinator - C. Poignard

- Abstract - The project proposes to gather the skills of the Japanese partner on cell migration modeling, molecular pathways in cancer and theoretical aspects of partial differential equations with the experience of the Bordeaux team MONC (Modeling in ONCology), which involves researchers from University of Bordeaux, IPB, CNRS and Inria, in cancer modeling. More particularly, the team MONC is invoved in the derivation of tumor growth models and of accurate finite volume numerical schemes to solve the partial differential equations in order to provide a deep multiscale knowledge of the tumor development at the cell scale. The overall aim of this project is to propose a comprehensive study of the metastatic processes at the cell scale, by highlithing the molecular pathways and the main chemical processes involved in cancer cell migration and division.

8.2. National Initiatives

8.2.1. Plan cancer DYNAMO

- Project acronym - Plan Cancer DYNAMO

- Partners - Lab Ampère-Lyon, Lab. Vectorologie et thérapies anticancéreuses- Villejuif and Equipe Inria MONC-Talence

- Duration - from sep. 2015 to sep 2018

- Coordinator - R. Scorretti, Lab. Ampère / Local coordinator - C. Poignard

- Team participants - C. Poignard

- Abstract - Electroporation (EPN) is a method which allows either killing the cells in a target region (tumors) by a nonthermal mechanism (irreversible EPN, or IRE) or allowing non permeant molecules (drugs, DNA) to penetrate the cells. EPN opens new perspectives for cancer treatment (electrochemotherapy, or ECT) and for gene therapy. In spite of its advantages, applications of EPN are still limited because of the scarcity of quantitative data concerning the reaction of tissues following electric pulses. Moreover, due to the lack of reliable tools for treatment planning, most clinical applications deal with superficial tumors in patients treated in more than 130 EU cancer centers using validated standard operating procedures. However the more difficult treatment of deep-seated tumors is still at the stage of academic research and a crucial challenge for forthcoming cancer therapies. This project aims at investigating how EPN can be effectively modeled, from the scale of cell up to the scale of tissue, and how molecular uptake holds and is enhanced by electric field delivery. To develop a dynamic model of tissue EPN, two approaches will be followed: one derived from the macroscopic scale (ad hoc tissue model) and the other from the microscopic scale using homogenization techniques. In order to enable accurate elaboration of the models, experiments will be carried out on raw potato tubers, HEK-293 (Human Embryonic Kidney) cell aggregates and on mice liver and muscle. The transport of molecules through the tissue, which is also a bottleneck, will be overcome thanks to a porous medium approach, which will provide qualitative and quantitative behaviour of the transport in the tissue.

8.2.2. Plan Cancer METASIS

- Project acronym - Plan Cancer METASIS
- Partner - Laboratory of Biology, Bordeaux University
- Duration - from 2013 to 2015
- Coordinator - A. Bikfalvi
- Team participants - S. Benzekry, Th. Colin, C. Poignard, O. Saut
- Title - Modeling the Interaction of the (Metastasis) Vascular/Tumor Niche Using a Systems Biology Approach

8.2.3. Plan Cancer 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

8.2.4. 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

8.2.5. PEPS CNRS

- Project acronym - PEPS Electroporation
- Partners - Lab Ampère-Lyon and Equipe Inria MONC-Talence
- Duration - June-Dec 2015
- Leader - D. Voyer, Lab. Ampère / Local leader - C. Poignard

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

LIA EBAM

- Title - LIA EBAM
- Partners - University of Ljubljana, IPBS, Institut Gustave Roussy, XLim, Institute of Oncologie, Ljubljana and Equipe Inria MONC-Talence
- Duration - 2015-2019 (renewal)
- Leader - L.M. Mir / Local leader - C. Poignard

- The main aim of the LIA EBAM is to use an interdisciplinary approach, integrating biology, chemistry, physics, biophysics, mathematics, computational modelling and engineering, through the expertise of its members in order to 1- Enhance our understanding on the mechanisms of classical electropermeabilization and of the new nanopermeabilization (electropermea-bilization using nanosecond electric pulses), as well as on the mechanisms of transmembrane transport of molecules into electroporated cells and tissues on a microscopic and macroscopic scale. 2- Contribute to a better and safer implementation of the electropermeabilization-based applications, and to the development of new applications. 3- Develop new devices and new equipment for the nanopermeabilisation at cell and tissue levels. 4- Develop new approaches like treatment planning in existing applications, such as antitumor electrochemotherapy and in vivo gene transfer for therapeutic purposes. 5- Disseminate the knowledge and the applications in the scientific community and in the society, through publications, a one-week course (already implemented) co-directed by the LEA directors, internal and external training, and through other means that the LEA will develop and/or will apply for (to the EC programs for example). Partners participating in the project possess complementary knowledge and skills, which only if brought together will allow for successful accomplishments of the above objectives.

JSPS Core-to-Core Program on Establishing International Research Network of Mathematical Oncology

- Title - JSPS Core-to-Core Program on Establishing International Research Network of Mathematical Oncology
- Partners - Osaka University, Vanderbilt University, Dundee university and Equipe Inria MONC-Talence
- Duration - 2015-2019 (renewal)
- Leader - T. Suzuki, Osaka University / Local leader - C. Poignard
- Establishing International Research Network of Mathematical Oncology

Collaboration with John Ebos, Roswell Park Cancer Institute, Buffalo, NY, USA. Quantification of metastatic potential and differential effect of anti-angiogenenic therapies on primary tumor and metastasis, in a preclinical setting.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Tadeja Forjanic (PhD Student Ljubljana), 2 weeks in jan. 2015. *Tumor growth modeling after electroporation* (Local supervisor: C. Poignard)
- Ariff Admon (PhD Student Osaka University), 1month June 2015. *Free boundary problem for invadopodia.* (Local supervisor: C. Poignard)

MORPHEME Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Renal tumor classification*
Participants: Alexis Zubiolo, Eric Debreuve, Xavier Descombes.

Informal collaboration with the team TIRO, CEA/UNS (Philippe Pognonec), and the histopathology department of the CHU Pasteur (Damien Ambrosetti), Nice.

8.2. National Initiatives

8.2.1. *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 Grégoire Malandain participated in the selection committee for LabeX PhD programme students.

8.2.2. *ANR MOTIMO*
Participants: Laure Blanc-Féraud, Xavier Descombes, Eric Debreuve, Huei Fang Yang, Ana Rita Lopes Simoes.

In collaboration with Institut de Mathématiques de Toulouse, INRA, Institut de Mécanique des Fluides de Toulouse, Laboratoire J-A Dieudonné, et IMV Technologies (PME). Details on the (website)

8.2.3. *ANR POXADRONO*
Participants: Florence Besse [PI], Xavier Descombes, Laure Blanc-Féraud.

The young researcher ANR project POXADRONO is in collaboration with Caroline Medioni, Hélène Bruckert, Giovanni Marchetti, Charlène Perrois and Lucile Palin from iBV. It aims at studying ARN regulation in the control of growth and axonal guidance by using a combination of live-imaging, quantitative analysis of images, bio-informatic analysis and genetic screening.

8.2.4. *ANR DIG-EM*
Participants: Grégoire Malandain, Xavier Descombes.

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.

8.2.5. 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.

8.2.6. 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 modelling. 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-characterised plant systems.

8.2.7. 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).

8.3. International Initiatives

8.3.1. Participation In other International Programs

ECOS-NORD PROJECT C15M01. In 2015 was the beginning of the execution of this project. The main work on this year was concentrated to understand clearly the DIC system located at UIS, its image formation model and phase recovery by simulations (joint paper accepted at ISBI 2016), and to acquire real data from it to be able to validate the simulated models.

Xavier Descombes was PI of a collaboration with the IITP in Moscow within a CNRS/RAS Grant (EDC26091) on the subject "Statistical Analysis of Images: mathematical modeling and applications".

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Elena Zhizhina, Evgueny Pechersky and Serguei Komech from IITP Moscow (Russian Academy of Science) were invited one week respectively in october and in november.

Arturo Plata-Gomez, professor at the University Industrial of Santander (UIS) in Bucaramanga (Colombia) has visiting Morpheme from April 6 to April 24.

Simone Rebegoldi, Ph.D. student of the Department of Mathematics and Computer Science in University of Ferrara (Italy) spent 3 months in Morpheme group form may 1st to July 31.

8.4.2. Visits to International Teams

Laure Blanc-Feraud visited Universidad Industrial de Santander (UIS) in Colombia from December 3-11.

8.4.2.1. Research stays abroad

Laure en Colombie

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MORPHEO Project-Team

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9. Partnerships and Cooperations

9.1. 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. *Motion analysis of laboratory rodents*

In order to evaluate the scalabililty of previous work on motion analysis of laboratory rodents, a collaboration has been initiated with the Institut Clinique de la Souris (ICS), in Institut de Génétique et de Biologie Moléculaire et Cellulaire (IGBMC). This institute is dedicated to phenotypying of mice and requires reliable motion analysis tools. A multicamera plateform has been deployed at ICS and will be exploited next year for tests ranging from one to two hundreds mice.

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. Analyzing video data of humans, collected for complex real-world events–extracting high-fidelity content, transferring raw data into knowledge–, detecting, reconstructing or understanding human motion are problems of key importance for the advancement of a variety of technological fields, including video coding, entertainment, culture, animation and virtual reality, intelligent human-computer interfaces, protection and security. The visual analysis of humans in real-world environments, indoors and outdoors, faces major scientific and computational challenges however. The proportions of the human body vary largely across individuals, any single human body has many degrees of freedom due to articulations, and individual limbs deform due to moving muscles and clothing. Finally, real-world events involve multiple interacting humans occluded by each other or by other objects, and the scene conditions may also vary due to camera motion or lighting changes. All these factors make appropriate models of human structure, motion and action difficult to construct and difficult to estimate from images. 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 was kicked off on November 26th, 2015, in Bucharest, Romania.

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 specialised in multi-camera acquisition systems, the SIP company specialised 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. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Re@ct

Type: FP7 COOPERATION

Defi: IMMERSIVE PRODUCTION AND DELIVERY OF INTERACTIVE 3D CONTENT

Instrument: Specific Targeted Research Project

Objectif: Networked Media ans Search Systems

Duration: December 2011 - November 2014 (Evaluation January through March 2015)

Coordinator: BBC (UK)

Partner: BBC (UK), Fraunhofer HHI (Germany), University of Surrey (UK), Artefacto (France), OMG (UK).

Inria contact: Jean-Sébastien Franco, Edmond Boyer

Abstract:RE@CT will introduce a new production methodology to create film-quality interactive characters from 3D video capture of actor performance. Recent advances in graphics hardware have produced interactive video games with photo-realistic scenes. However, interactive characters still lack the visual appeal and subtle details of real actor performance as captured on film. In addition, existing production pipelines for authoring animated characters are highly labour intensive. RE@CT aims to revolutionise the production of realistic characters and significantly reduce costs by developing an automated process to extract and represent animated characters from actor performance capture in a multiple camera studio. The key innovation is the development of methods for analysis and representation of 3D video to allow reuse for real-time interactive animation. This will enable efficient authoring of interactive characters with video quality appearance and motion. The project builds on the latest advances in 3D and free-viewpoint video from the contributing project partners. For interactive applications, the technical challenges are to achieve another step change in visual quality and to transform captured 3D video data into a representation that can be used to synthesise new actions and is compatible with current gaming technology.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Declared Inria International Partners

9.4.1.1.1. Joint projects with the Forestry Commission, UK

Two common works with an ecophysiologist from the British Forestry Commission, Eric Casella, are currently carried out. The first one aims at detecting, analysing and correcting acquisition noise from terrestrial laser scans (t-LiDAR) of plants and trees. The second one aims at reconstructing accurate virtual models of forest trees, for biomass measurement purposes. Both projects are funded by the University of Grenoble Alpes, through the AGIR framework. A PhD student, Romain Rombourg, is working on them.

9.4.1.2. Informal International Partners

The long term collaboration with TU Munich and Slobodan Ilic on human motion capture is ongoing with the work of Paul Huang [4] and [12] that was published at CVPR and IJCV this year. The work contributes with an approach that identifies and takes benefit of key poses when tracking shapes and 4D modeling.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

Victoria Fernández Abrevaya

Date: 29th June 2015 - 27th September 2015

Institution: Universidad de Buenos Aires (Argentina)

Supervisor: Franck Hétroy-Wheeler

9.5.2. Visits to International Teams

9.5.2.1. Sabbatical programme

Reveret Lionel

Date: Jul 2014 - June 2015

Institution: Brown University (United States)

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MULTISPEECH Project-Team

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9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. EQUIPEX ORTOLANG

Project acronym: ORTOLANG [0]

Project title: Open Resources and TOols for LANGuage

Duration: September 2012 - May 2016 (phase I, signed in January 2013)

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 is 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 text-speech alignment and speech visualization tools.

9.1.2. ANR-DFG IFCASL

Project acronym: IFCASL

Project title: Individualized feedback in computer-assisted spoken language learning

Duration: March 2013 - February 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.

The work involved the design and recording of a French-German learner corpus. French speakers were recorded in Nancy, wheras 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.

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[0]http://www.ortolang.fr

9.1.3. ANR ContNomina

Project acronym: ContNomina

Project title: Exploitation of context for proper names recognition in diachronic audio documents

Duration: February 2013 - July 2016

Coordinator: Irina Illina, MULTISPEECH

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).

9.1.4. ANR DYCI2

Project acronym: DYCI2 [0]

Project title: Creative Dynamics of Improvised Interaction

Duration: March 2015 - February 2018 (signed in October 2014)

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.

9.1.5. ANR JCJC KAMoulox

Project acronym: KAMoulox

Project title: Kernel additive modelling for the unmixing of large audio archives

Duration: January 2016 - January 2019 (signed in October 2015)

Coordinator: Antoine Liutkus, MULTISPEECH

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.

9.1.6. 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.

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[0]http://repmus.ircam.fr/dyci2/

[0]http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx_lwmsuivibilan_pi2[CODE]=ANR-12-CORP-0005

In this project, we are 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).

9.1.7. FUI RAPSODIE

Project acronym: RAPSODIE [0]

Project title: Automatic Speech Recognition for Hard of Hearing or Handicapped People

Duration: March 2012 - February 2016 (signed in December 2012)

Coordinator: eRocca (Mieussy, Haute-Savoie)

Other partners: CEA (Grenoble), Inria (Nancy), CASTORAMA (France)

Abstract: The goal of the project is to realize a portable device that will help a hard-of-hearing person to communicate with other people. To achieve this goal the portable device will access a speech recognition system, adapted to this task. Another application of the device will be environment vocal control for handicapped persons.

In this project, MULTISPEECH is involved for optimizing the speech recognition models for the envisaged task, and contributes also to 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.

9.1.8. 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.

9.1.9. ADT Plavis

Project acronym: Plavis

Project title: Platform for acquisition and audiovisual speech synthesis

Duration: January 2015 - December 2016

Coordinator: Vincent Colotte, MULTISPEECH

Abstract: The objective of this project is to develop a platform acquisition and audiovisual synthesis system (3D animation of the face synchronously with audio). The main purpose is to build a comprehensive platform for acquisition and processing of audio-visual corpus (selection, acquisition and acoustic processing, 3D visual processing and linguistic processing). The acquisition is performed using a motion capture system (Kinect-like) or from Vicon system or EMA system. We also propose to develop a 3D audiovisual synthesis system text to audio and 3D information of a talking head. The system will incorporate an animation module of the talking head to reconstruct the face animated with audio. During the first year of the project, we are setting up and testing the acquisition techniques that will be used. We have developed several tools to acquire the audiovisual data and to process it. A synchronization step was developed.

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[0]http://erocca.com/rapsodie

9.1.10. ADT VisArtico

Project acronym: VisArtico

Project title: Software for Processing, analysis and articulatory data visualization

Duration: November 2013 - October 2015

Coordinator: Slim Ouni, MULTISPEECH

Abstract: The Technological Development Action (ADT) Inria Visartico aims at developing and improving VisArtico, an articulatory vizualisation software (see 6.5). In addition to improving the basic functionalities, several articulatory analysis and processing tools are being integrated.

9.1.11. 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: S. Ouni, MULTISPEECH

Cofunded by Inria and Région Lorraine

Abstract: The main objective of this project is 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 signal). The main purpose is to acquire, process and analyze the corpus and to study the expressiveness; the results will be used for the expressive audiovisual speech synthesis system.

9.1.12. LORIA exploratory project

Project title: Acquisition and processing of multimodal corpus in the context of interactive human communication

Duration: June 2015 - May 2016

Coordinator: S. Ouni, MULTISPEECH

Abstract : The aim of this project is the study of the various mechanisms involved in multimodal human communication that can be oral, visual, gestural and tactile. This project focuses 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. We will set up and integrate hardware and software acquisition. Thereafter, we will acquire and structure the multimodal data.

9.2. European Initiatives

9.2.1. Collaborations with major european organizations

Jon Barker: University of Sheffield (UK)

Robust speech recognition [25].

9.3. International Initiatives

9.3.1. Inria international partners

9.3.1.1. Informal international partners

Nobutaka Ono: National Institute for Informatics (NII, Tokyo, Japan)

Machine learning and source separation [14], [58], [69] (former Inria associate team).

Jonathan Le Roux, Shinji Watanabe, John R. Hershey: Mitsubishi Electric Research Labs (MERL, Boston, USA)

> Source separation [19], [21], [24].

Bryan Pardo, Northwestern University (Evanston, IL, USA)

> Audio source separation [52].

Derry Fitzgerald, Nimbus Center, Cork Institute of Technology (Ireland)

> Audio source separation [43], [67].

Taylan Cemgil, Bosphorus University (Istambul, Turkey)

> Multimodal data analysis [44] and source separation [16].

Dayana Ribas Gonzalez, Ramón J. Calvo: CENATAV (Habana, Cuba)

> Robust speaker recognition [53], [54].

9.3.2. Participation in other international programs

9.3.2.1. 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
>
> National Coordinators: Juan Carlos GÓMEZ (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.

9.3.2.2. 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 corpora, 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.

9.4. International Research Visitors

9.4.1. Visits of international scientists

9.4.1.1. Internships

> Liu Jen-Yu
>
> > Date: Apr 2015 - Sep 2015
> >
> > Institution: NTU (Taiwan)

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. 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/

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. 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.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

8.3.1.1. Internships

- S. Mohammadyari, master intern, Politecnico di Torino, Italy, March to July 2015.
- Zachary Bischof, doctoral intern, Northwestern University, USA, July to September 2015.

MUTANT Project-Team

8. Partnerships and Cooperations

8.1. National Projects

8.1.1. ANR INEDIT Project

Title: Interactivity in the Authoring of Time and Interactions

Project acronym: INEDIT

Type: ANR Contenu et Interaction 2012 (CONTINT)

Instrument: ANR Grant

Duration: September 2012 - November 2015

Coordinator: IRCAM (France)

Other partners: Grame (Lyon, France), LaBRI (Bordeaux, France).

Abstract: 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*. This coupling allows the development of novel dimensions in interacting with new media. Our approach lies within a formal language paradigm: An interactive piece can be seen as a virtual interpreter articulating locally synchronous temporal flows (audio signals) within globally asynchronous event sequence (discrete timed actions in interactive composition). Process evaluation is then to respond reactively to signals and events from an environment with heterogeneous actions coordinated in time and space by the interpreter. This coordination is specified by the composer who should be able to express and visualize time constraints and complex interactive scenarios between mediums. To achieve this, the project focuses on the development of novel technologies: dedicated multimedia schedulers, runtime compilation, innovative visualization and tangible interfaces based on augmented paper, allowing the specification and realtime control of authored processes. Among posed scientific challenges within the INEDIT project is the formalization of temporal relations within a musical context, and in particular the development of a GALS (Globally Asynchronous, Locally Synchronous) approach to computing that would bridge in the gap between synchronous and asynchronous constraints with multiple scales of time, a common challenge to existing multimedia frameworks.

8.1.2. ANR EFFICACe Project

Florent Jacquemard participates 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 participant consider computer-aided composition out of its traditional "offline" paradigm, and try to integrate compositional processes in structured interactions with their external context. These interactions can take place during executions or performances, or at the early compositional stages (in the processes that lead to the creation of musical material). There are particular focus on a number of specific directions, such as the reactive approaches for computer-aided composition, the notion of dynamic time structures in computation and music, rhythmic and symbolic time structures, or the interactive control, visualisation and execution of sound synthesis and spatialization processes [23].

8.1.3. Other National Initiatives

Jean-Louis Giavitto participates in the SynBioTIC ANR Blanc project (with IBISC, University of Evry, LAC University of Paris-Est, ISC - Ecole Polytechnique).

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

8.2. European Initiatives

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

Program: PHC Amadeus ()

Project acronym: LETITBE

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

Duration: 01/2015 - 12/2016

Coordinator: Florent Jacquemard, Christoph Kirsch

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

Abstract: The objective of this 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.

8.3. International Initiatives

8.3.1. *Inria International Labs projects*

MuTant team hosted a Master Level student from the Inria Chile Center in partnership with the *Pontificia Universidad Catolica de Chile*. The project, undertaken by Nicolas Schmidt Gubbins and supervised by Arshia Cont and Jean-Louis Giavitto, ended in the first prototype of an embedded *Antescofo* engine (see 7.7) with internal audio processing on Raspberry PI and UDOO mini-computers (See Presentation Video). A publication of preliminary results is underway and early results reported in [29].

8.3.2. *Informal International Partners*

- 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) [14], [17].

- We are collaborating with Slawek Staworko (LINKS, currently on leave at U. Edinburgh), and more generaly the Algomus group at Lille, in the context of our projects on rhythm transcription described at Sections 6.4 and 7.10 .

- 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 6.2) and two publications [12], [13].

- MuTant team collaborated with researchers at National Institute of Informatics of Tokyo on real-time Symbolic Alignment of music data resulting in the publication in [19].

8.4. International Research Visitors

Masahiko Sakai (Professor at the University of Nagoya) visited MuTant for two weeks in September 20154, for collaboration on term rewriting techniques applied to tree-structured symbolic representations of rhythm.

Slawek Staworko (LINKS, on leave at U. of Edinburgh) visited MuTant for two weeks in September and December 2015, for collaborations on the problem of automatic rhythm transcription.

Professor Miller Puckette (UCSD) visited MuTant for two weeks in May 2015, participating in the PhD defense of José Echeveste and collaborating with the team on the new Audio Processing engine for embedded mini-computers.

8.4.1. Internships

The MuTant team hosted an International Internship from *Pontificia Universidad Catolica de Chile*, Nicolas Schmidt, working on the first instances of embedded Antescofo Audio Engine (See Presentation Video) (see also 7.7) [29].

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MYCENAE Project-Team

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7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Jonathan Touboul is member of the Kibord (KInetic models in Biology Or Related Domains) project obtained in 2014.

Mathieu Desroches is the coordinator of the SloFaDyBio (SLOw-FAst Dynamics applied to the BIOsciences) network mounted in 2014.

7.1.2. National Networks

- GdR REPRO (member of the direction board, F. Clément)
- MIA REM network: Réduction de modèles (PI Béatrice Laroche, INRA Jouy)

7.1.3. National Collaborations

- UMR Physiologie de la Reproduction et des Comportements, INRA Tours (Bios and Bingo teams)
- Jacques-Louis Lions Laboratory, Pierre & Marie Curie University (Jean-Pierre Françoise, Marie Postel)
- Developmental Biology Laboratory, Pierre & Marie Curie University (Alice Karam, Sylvie Schneider Maunoury), in the framework the NeuroMathMod, Sorbonne-Universités Émergence call
- Center for Interdisciplinary Research in Biology, Collège de France (Alain Prochiantz)
- Centre de Recherche en Mathématiques de la Décision, Paris Dauphine University (Stéphane Mischler)
- Computational Biology and Biomathematics, Jacques Monod Institute, Paris Diderot University (Khashayar Pakdaman)
- Département d'Informatique de l'ENS, équipe DATA, Paris-Nord University (Gilles Wainrib)
- Unité de Neurosciences, Information & Complexité (UNIC), CNRS Gif-sur-Yvette (Alain Destexhe)

7.2. International Initiatives

7.2.1. Informal International Partners

- **USA**: Florida State University (Richard Bertram, Patrick Fletcher, Joël Tabak), University of Pittsburgh (Bard Ermentrout, Jonathan Rubin), Princeton University (William Bialek, Thibault Taillefumier, Simon Levi)
- **Spain**: University of the Balearic Islands (Antonio .E. Teruel, Rafel Prohens), Polytechnic University of Catalunya (Toni Guillamon), University of Sevilla (Enrique Ponce)

MYRIADS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Security Monitoring of Clouds, collaboration with DGA-MI in the framework of the Cybersecurity Pole of Excellence (2014-2018)*

Participants: Anna Giannakou, Christine Morin, Jean-Louis Pazat, Louis Rilling, Amir Teshome Wonjiga.

Our study 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.

9.1.2. *CominLabs EPOC project (2013-2016)*

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. *EcoPaaS, Brittany region SAD project(2014-2015)*

Participants: Maria Del Mar Callau Zori, Anne-Cécile Orgerie, Guillaume Pierre.

Many research efforts have been dedicated to reducing cloud energy consumption, in particular by optimizing the Infrastructure-as-a-Service layer of the Cloud. Infrastructure-as-a-Service (IaaS) is the layer in charge of the virtualization of physical resources, and therefore has direct control over energy-related elements. However, the IaaS layer has no knowledge about the nature of applications which run over these resources, which limits the scope of decisions it can take.

The EcoPaaS project therefore aim at making the IaaS layer (in charge of resources) and the PaaS layer (in charge of applications) collaborate to further reduce the Cloud energy consumption. The idea is to define standard interfaces that allow both layers to exchange relevant information and to coordinate their actions. Exchanging information will for example allow the PaaS layer to estimate the energy consumption of each application it is running. Coordinating actions will in turn allow the system to avoid situations where both layers simultaneously take mutually-damaging actions. This project has been funding Maria del Mar Callau-Zori's postdoc.

9.1.4. 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.

9.2. National Initiatives

9.2.1. Inria ADT GinFlow (2014-2016)

Participants: Christine Morin, Javier Rojas Balderrama, Matthieu Simonin, Cédric Tedeschi.

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 Héctor 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 IPL Discovery (2015-2019)

Participants: Anne-Cécile Orgerie, 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.

9.2.3. 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 2015, Christine Morin contributed to the preparation of the MOOC entitled *Villes Intelligentes : défis technologiques et sociétaux* (Smart cities : technological and social challenges) to be run on the FUN platform starting in January 2016. She prepared eight sequences on urban data management in clouds.

9.2.4. MIHMES ANR Investissements d'Avenir (2012 - 2018)

Participants: Yvon Jégou, Christine Morin.

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[0] http://b-com.org/wp/

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 will provide software tools to efficiently manage and ease the use of a distributed computing infrastructure for the execution of different simulation applications.

In 2015, we developed a distributed framework which allows do 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. A first version is available since summer 2015. The framework is currently being repackaged to facilitate its reuse for new workloads.

9.2.5. 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.

9.2.6. 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. Fed4FIRE

Participants: Julien Lefeuvre, David Margery.

Type: FP7

Defi: Future internet experimental facility and experimentally-driven research

Instrument: Integrated Project

Objectif: ICT-2011.1.6 Future Internet Research and Experimentation (FIRE) with a specific focus on b) FIRE Federation

Duration: October 2012 - September 2016

Coordinator:Interdisciplinary institute for broadband technology (iMinds, Belgium)

Partners: Interdisciplinary institute for broadband technology (iMinds, Belgium), University of Southampton (It Innovation, United Kingdom) Universite Pierre et Marie Curie - paris 6 (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: David Margery

Abstract: 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. The baseline architectural choice for this project is to use the key concepts of the Slice Federation Architecture (SFA) to provision resources on experimental platforms, a Control and Management Framework for Networking Testbeds named OMF for experiment control and OML, the OMF Measurement library for data collection. We investigate whether these can be used to run experiments on BonFIRE and how they need to be extended to support the operating model of BonFIRE or Grid'5000.

9.3.1.2. HARNESS

Participants: Ancuta Iordache, Guillaume Pierre, Damian Serrano, Genc Tato, Georgios Ioannidis, Guillaume Pierre.

Type: COOPERATION

Defi: Pervasive and Trusted Network and Service Infrastructures

Instrument: Small or medium-scale focused research project

Objectif: ICT-2011.1.2 Cloud Computing, Internet of Services and Advanced Software Engineering

Duration: October 2012 - September 2015

Coordinator: Imperial College London (IMP, United Kingdom)

Partner: Ecole polytechnique fédérale de Lausanne (EPFL, Switzerland), Université de Rennes 1 (UR1, France), Konrad-Zuse-Zentrum für Informationtechniek Berlin (ZIB, Germany), Maxeler Technologies (MAX, United Kingdom), SAP AG (SAP, Germany)

UR1 contact: Guillaume Pierre

Abstract: The HARNESS FP7 project aims to incorporate innovative hardware and network technologies seamlessly into data centres that provide platform-as-a-service cloud infrastructures.

The dominant approach in offering cloud services today is based on homogeneous commodity resources: large numbers of inexpensive machines, interconnected by off-the-shelf networking equipment, supported by stock disk drives. However, cloud service providers are unable to use this platform to satisfy the requirements of many important and high-value classes of applications.

Today's cloud platforms are missing out on the revolution in new hardware and network technologies for realising vastly richer computational, communication, and storage resources. Technologies such as Field Programmable Gate Arrays (FPGA), General-Purpose Graphics Processing Units (GPGPU), programmable network routers, and solid-state disks promise increased performance, reduced energy consumption, and lower cost profiles. However, their heterogeneity and complexity makes integrating them into the standard Platform as a Service (PaaS) framework a fundamental challenge.

The HARNESS project brings innovative and heterogeneous resources into cloud platforms through a rich programme of research, validated by commercial and open source case studies.

9.3.1.3. PaaSage

Participants: Christine Morin, Nikolaos Parlavantzas, Aboozar Rajabi, Arnab Sinha.

Type: COOPERATION

Objectif: ICT-2011.1.2 Cloud Computing, Internet of Services and Advanced Software Engineering

Instrument: Collaborative Project

Duration: October 2012 - September 2016

Coordinator: GEIE ERCIM (France)

Partner: SINTEF (Norway), Science and Technology Facilities Council (UK), University of Stuttgart (Germany), Inria (France), Centre d'Excellence en Technologies de l'Information et de la Communication (Belgium), Foundation for Research and Technology Hellas (Greece), BE.Wan SPRL (Belgium), EVRY AS (Norway), SysFera SAS (France), Flexiant Limited (UK), Lufthansa Systems AG (Germany), Gesellschaft fur Wissenschaftliche Datenverarbeitung MBH Gottingen (Germany), Automotive Simulation Center Stuttgart (Germany), University of Ulm (Germany), Akademia Górniczo-Hutnicza im. Stanislawa Staszica (Poland), University of Cyprus (Cyprus), IBSAC-Intelligent Business Solutions ltd (Cyprus), University of Oslo (Norway)

Inria contact: Nikolaos Parlavantzas

See also: http://www.paasage.eu/

Currently there exist several open source and commercial services at the Infrastructure as a Service (IaaS) level. Software developers targeting the cloud would ideally want to develop their software once and be able to deploy it on any of the available services, reaping the benefits of a cloud market without losing on performance, availability, or any other service properties. The impediment to this objective is that IaaS platforms are heterogeneous, and the services and APIs that they provide are not standardized. Porting an existing application to one of these platforms or switching between platforms is thus a challenging task and involves a high risk that the results do not meet the expected requirements.

PaaSage delivers a development and deployment platform, with an accompanying methodology, with which developers of enterprise systems can access services of cloud platforms in a technology neutral approach while guiding developers to configure their applications for best performance. The consortium brings together ERCIM for management and STFC as scientific coordinator together with experts in different aspects of clouds ranging from software and services (SINTEF), High Performance Computing (HLRS) and systems development environments (Inria) to a group of SMEs working on cloud systems and end-user organisations with requirements in the cloud domain.

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: Professor 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.

9.3.2.2. MC-DATA

Participants: Teodor Crivat, Guillaume Pierre.

Program: EIT Digital

Project acronym: MC-DATA

Project title: Multi-cloud data management

Duration: Jan-Dec 2015

Coordinator: Dr. Peter Pietzuch, Imperial College London

Other partners: SICS, U-Hopper, VTT, Proxible.

Abstract: The goal of this activity is to increase developer uptake and commercial exploitation of the previously-developed MC-ConPaaS mobile edge cloud platform through new products in the area of location-based advertising services. The activity will (a) integrate MC-ConPaaS with the Android mobile platform to encourage mobile developer adoption; (b) pilot a location-based interactive advertising service with augmented reality and 3D tracking; (c) commercialise the pilot, demonstrating the business value of a mobile edge cloud model; and (d) model and shape the ecosystem of mobile edge cloud services, enabling new revenue streams for mobile operators.

9.4. International Initiatives

9.4.1. *Inria International Labs*

Christine Morin contributed to the edition of the 2011-2014 activity report of the Inria@SiliconValley Inria International Lab (https://project.inria.fr/siliconvalley/files/2015/06/Inria@SV_Activity_Report_2011_2014.pdf).

Christine Morin was one of the co-organizers of the BIS 2015 workshop held in Berkeley in May 2015 in the framework of the Inria@Silicon Valley Inria International Lab. Deb Agarwal co-chaired the panel on Big Data Science. Christine Morin chaired one of the two keynotes sessions.

9.4.2. *Inria Associate Teams*

9.4.2.1. DALHIS

Participants: Christine Morin, Anne-Cécile Orgerie, Javier Rojas Balderrama, Matthieu Simonin, Arnab Sinha, Cédric Tedeschi.

Title: Data Analysis on Large Heterogeneous Infrastructures for Science

International Partner (Institution - Laboratory - Researcher):

Lawrence Berkeley National Laboratory, Berkeley, USA

Data Science and Technology department

French PI: Christine Morin

American PI: Deb Agarwal, head of the Data Science and Technology department

Duration: 2013 - 2015

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

The worldwide scientific community is generating large datasets at increasing rates causing data analysis to emerge as one of the primary modes of science. Existing data analysis methods, tools and infrastructure are often difficult to use and unable to handle the "data deluge". A scientific data analysis environment needs to address three key challenges: a) programmability: easily composable and reusable programming environments for analysis algorithms and pipeline execution, b) agility: software that can adapt quickly to changing demands and resources, and, c) scalability: take advantage of all available resource environments including desktops, clusters, grids, clouds and HPC environments. The goal of the DALHIS associated team is to coordinate research and create together a software ecosystem to facilitate data analysis seamlessly across desktops, HPC and cloud

environments. Specifically, our end goal is to build a dynamic environment that is user-friendly, scalable, energy-efficient and fault tolerant through coordination of existing projects. We plan to design a programming environment for scientific data analysis workflows that will allow users to easily compose their workflows in a programming environment such as Python and execute them on diverse high-performance computing (HPC) and cloud resources. We will develop an orchestration layer for coordinating resource and application characteristics. The adaptation model will use real-time data mining to support elasticity, fault-tolerance, energy efficiency and provenance. We investigate how to provide execution environments that allow users to seamlessly execute their dynamic data analysis workflows in various research environments.

The work done in 2015 on scientific workflows and energy efficiency is described respectively in 7.6.1 and 7.4.2 .

The recent results of the DALHIS associate team were presented by Lavanya Ramakrishnan from LBNL during the working session on Scientific and Large Scale Computing. Christine Morin, Anne-Cécile Orgerie and Deb Agarwal participated in the BIS 2015 workshop held in Berkeley in May 2015.

Deb Agarwal has been awarded an Inria International Chair for the 2015-2019 period enabling long visits in the Myriads team. She was hosted in Myriads team during 2.5 months from May 1st to July 10th 2015. During this visit, we initiated the work on the design of a mobile application for reliable field data collection for FluxNet. Critical to the interpretation of global Fluxnet carbon flux dataset is the ancillary information and measurements taken at the measurement tower sites (e.g. vegetation species, leaf area index, instrument calibrations, etc). The submission and update of this data using excel sheets is difficult and error prone. In 2015, the team developed some initial sketches of the User Interface design for a mobile application for the reliable collection of FluxNet data and Arnab Sinha, Deb Agarwal, and Christine Morin performed an initial usability feedback interview with Chris Flechard (INRA Rennes), a CarboEurope participant who collects carbon flux data at several sites in Brittany. M. Sandesh (LBL) simultaneously performed a couple of usability interviews at Berkeley. We updated the design based on the combined feedback. Currently, the mobile application prototype development is in progress. The design was presented by Dario Papale at the ICOS meeting in September 2015. The expectation is that the design will be adopted by ICOS (European flux towers) and AmeriFlux (flux towers in the Americas). A first basic working demonstration prototype has been developed.

9.4.3. Inria International Partners

Northeastern University   We started a collaboration with Professor Gene Cooperman, Northeastern University, Boston, USA on the design of a cloud agnostic checkpointing service on top of IaaS clouds for reliable application execution, inter-cloud application migration and easing application "cloudification". Gene Cooperman was hosted in Myriads team during a week in June 2015.

ORNL/TTU   We collaborate on cloud computing with Stephen Scott, Professor at Tennessee Tech University (TTU) and researcher at Oak Ridge National Laboratory (ORNL) in the USA. He participated in Anna Giannakou's mid-PhD thesis defense in October 2015.

University of Guadalajara   Nikolaos Parlavantzas is collaborating with the team of Prof. Héctor Duran-Limon of the University of Guadalajara, Mexico, on adaptive resource management in cloud environments.

VU University Amsterdam   We collaborate with Thilo Kielmann's research group at VU University Amsterdam on research and development around the ConPaaS system. This collaboration has lead to a joint publication this year [24].

EPFL   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. This collaboration has been supported thanks to the extended visit of Georgios Ioannidis in Rennes in the context of the HARNESS project, and it is expected to continue after the end of HARNESS. At least one joint publication on this topic is currently in preparation.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Gene Cooperman, Professor at the Northeastern University (Boston, USA), made a one-week visit in Myriads team in June 2015.

Georgios Ioannidis (PhD student at EPFL, Switzerland) made a 7-months visit in the Myriads team (Jun-Dec 2015). The goal was to reinforce the collaboration between the two teams in the context of the HARNESS FP7 project.

Carlos Ruiz Diaz (PhD student at the University of Guadalajara, Mexico) is visiting Myriads for 6 months (Sep 2015-Feb 2016) in the context of his PhD thesis, directed by Héctor Duran-Limon and co-advised by Nikolaos Parlavantzas. The visit is supported by a grant from Rennes Metropole.

Palakiyem Wallah, assistant professor at the University of Kara (Togo) visited Myriads team from September to December 2015 in the framework of his PhD thesis, which is co-advised by Cédric Tedeschi and Jean-Louis Pazat.

Anita Sobe, post-doctoral researcher at the University of Neuchâtel (Switzerland) visited Myriads team for two weeks in April 2015 in the context of the Nesus COST Action. During her stay, she has worked with Anne-Cécile Orgerie and their work has been accepted in the PDP 2016 conference.

9.5.1.1. Internships

Philippe Fabian (M1 Université Rennes 1) did his internship of first year of Master under the supervision of Marin Bertier and Cédric Tedeschi. Philippe devised and tested in a simulator heuristics for speeding-up the execution of chemical programs on top of an unstructured decentralized platform.

Timothée Haudebourg (L3 ENS Rennes) has done a two-month internship (June - July 2015) under the supervision of Anne-Cécile Orgerie. He has worked on quantifying the energy-efficiency of green leverages in wired networks.

David Guyon (M2 Université Rennes 1) has done his master internship under the supervision of Anne-Cécile Orgerie and Christine Morin. He has worked on energy-efficient cloud elasticity for data-driven applications. He has presented this work at the IEEE GreenCom conference (December 2015).

Ghada Moualla (M2 Université Rennes 1) has done his master internship under the supervision of Christine Morin and Matthieu Simonin. She has worked on reliable and efficient data processing in a cloud environment.

Akshat Puri (M2, EIT ICT Labs, Université Rennes 1) has done his internship under the supervision of Nikolaos Parlavantzas and Guillaume Pierre. He worked on elasticity of cloud applications and approaches for application migration across different cloud vendors.

Benjamin Soulas (M2 Université Rennes 1) did its internship of second year of Master under the supervision of Matthieu Simonin and Cédric Tedeschi. Benjamin developed the *Storm Watcher* prototype, a tool exposing monitoring information about the execution of programs running within the Storm framework.

9.5.1.2. Research stays abroad

Following a first visit which took place in 2014, Ancuta Iordache visited Maxeler Technologies (London, U.K.) again from February 2015 to April 2015. This visit reinforced the collaboration between the two teams in the context of the HARNESS E.U. project, and was funded by the EIT Digital Doctoral Training Center. A concrete outcome of this visit is a joint research paper which is currently under evaluation.

Ismael Cuadrado Cordero, who is a student of the EIT ICT Labs Doctoral School, visited the Queen Mary University of London (UK) for a research internship from June to August 2015. He was hosted in Chris Phillip's team working on micro-clouds architectures for neighborhood services. A joint research paper is currently under review on this topic.

NACHOS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *Inria Project Lab*

7.1.1.1. *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.

7.1.2. *ANR project*

7.1.2.1. *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.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. 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.

7.2.1.2. 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.

7.3. International Initiatives

7.3.1. Inria Associate Teams not involved in an Inria International Labs

7.3.1.1. HOMAR

Title: High performance Multiscale Algorithms for wave pRopagation problems

International Partner (Institution - Laboratory - Researcher):

Laboratório Nacional de Computação Científica (Brazil) - Coordenação 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.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

Prof. Liang Li, School of Mathematical Sciences, University of Electronic Science and Technology of China, Chengdu.

Dr. Maciej Klemm, University of Bristol, Communication Systems & Networks Laboratory, Centre for Communications Research, United Kingdom

Prof. Hugo Enrique Hernandez Figueroa, Universidade Estadual de Campinas, Faculdade de Engenharia Elétrica e de Computação, São Paulo, and Prof. Carlos Henrique da Silva Santos, Instituto Federal de Educação, Ciência e Tecnologia de São Paulo, Brazil

Dr. Urs Aeberhard and Dr. Markus Ermes, Theory and Multiscale Simulation, IEK-5 Photovoltaik, Forschungszentrum Jülich, Germany

7.3.3. Participation In other International Programs

7.3.3.1. CNPq-Inria HOSCAR project

Participants: Reza Akbarinia [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Rossana Andrade [CSD/UFC], Hélène Barucq [MAGIQUE-3D project-team, Inria Bordeaux - Sud-Ouest], Alvaro Coutinho [COPPE/UFR], Julien Diaz [MAGIQUE-3D project-team, Inria Bordeaux - Sud-Ouest], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Antônio Tadeu Gomes [LNCC], Pedroedro Leite Da Silva Dias [LNCC, Coordinator of the project on the Brazilian side], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri [Coordinator of the project on the French side], Alexandre Madureira [LNCC], Nicolas Maillard [INF/UFRG], Florent Masseglia [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Marta Mattoso [COPPE/UFR], Philippe Navaux [INF/UFRG], Esther Pacitti [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Fabio Porto [LNCC], Bruno Raffin [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Pierre Ramet [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Jean-Louis Roch [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Patrick Valduriez [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Frédéric Valentin [LNCC].

Since July 2012, the team is coordinating the HOSCAR http://www-sop.inria.fr/hoscar Brazil-France collaborative project. he HOSCAR project is a CNPq - Inria collaborative project between Brazilian and French researchers, in the field of computational sciences. The project is also sponsored by the French Embassy in Brazil.

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models (Group 1), (ii) scientific data management (Group 2), and (iii) high-performance software systems (Group 3). Several Brazilian institutions are participating to the project among which: LNCC (Laboratório Nacional de Computaçäo Científica), COPPE/UFRJ (Instituto Alberto Luiz Coimbra de Pós-Graduaçäo e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), INF/UFRGS (Instituto de Informática, Universidade Federal do Rio Grande do Sul) and LIA/UFC (Laboratórios de Pesquisa em Ciência da Computação Departamento de Computação, Universidade Federal do Ceará). The French partners are research teams from several Inria research centers.

NANO-D Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

We have funding from the Rhone-Alpes region through an ARC6 grant for the development of parallel algorithms for adaptively restrained particle simulations. This grant is funding Krishna Kant Singh's PhD project.

8.2. National Initiatives

8.2.1. 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).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ADAPT

Type: ERC Starting Grant

Title: Theory and Algorithms for Adaptive Particle Simulation

Programm: FP7

Duration: September 2012 - August 2017

Coordinator: Inria

Inria contact: Stephane Redon

8.4. International Initiatives

8.4.1. Inria Associate Teams not involved in an Inria International Labs

8.4.1.1. PPI-3D

Title: Structure Meets Genomics

International Partner (Institution - Laboratory - Researcher):

Boston University (United States) - 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%§ 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.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

- The Reiher group at ETH Zurich
- The Cherezov Lab, UCS USA
- The Katritch Lab, UCS USA
- ICS-5 FZJ Juelich, Juelich, Germany
- Laboratory for Advanced Studies of Membrane Proteins, MIPT, Moscow, Russia Laboratory of Structural Biology of G-protein Coupled Receptors, MIPT Moscow, Russia

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Aleksandr Katrutsa.

Subject: Convex relaxation for non-convex quadratic optimization problems with applications to side-chain prediction in protein structures.

Institution: MIPT Moscow, Russia.

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Emilie Neveu visited the Kozakov group at Stony Brook University, NY, USA for three weeks in November 2015.
- Alexandre Hoffmann visited the Kozakov group at Stony Brook University, NY, USA for two weeks in November 2015.

<h1 style="text-align:center;color:red">NECS Project-Team</h1>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PEPS META-TRAM

META-TRAM is a PEPS-CNRS project funded for two years (2013-2015). It aims at studying tensor methods for analyzing traffic data. Indeed, for a better management of mobility in modern cities (avoid or better control episodes of congestion, accurately predict traffic trends, finely analyze urban and suburban trips via multimodal networks), it is necessary to develop appropriate analytic tools that integrate multimodality and heterogeneity of networks from inherently multidimensional measures. Three areas are studied: tensor modeling for estimating origin-destination matrices, dynamic clustering flow and synthesis of distributed algorithms adapted to large volume of data, diversity of sensors, and their spatial dispersion. This project involves also I3S Lab (Sophia Antipolis) and CRAN (Nancy).

9.1.2. Projet exploratoire Persyval LOCATE-ME

LOCATE-ME (LOcalization teChniques for pedestriAn navigaTion based on inErtial MEasurements in indoor environments) is a Persyval project funded from April 2014 to August 2015. It aims at proposing a new and fresh look on innovative technologies for localization. It constructs the scientific foundations for development of a prototype of a pedestrian indoor localization system, which has the ability to monitor and track the positions of pedestrians in an indoor environment, where GPS is not available. LOCATE-ME brings some answers on how to advance the current pedestrian navigation solutions for the critical domains, using robust software. The specific contribution of LOCATE-ME is the development of a novel fusion algorithm merging two different methods of localization (INS and SHS) to obtain a concrete improvement on tracking position. This project involves also Tyrex team (LIG, Inria Grenoble). The collaboration has also included a visit to Grenoble of Valérie Renaudin (IFSTTAR, Nantes), in March 2015.

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

9.3. 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.

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. Subrhakanty Dey (University of Uppsala, Sweden) visited the team from June 6th to July 7th, for reserach discussions, in particular with F. Garin and A. Kibangou on privacy issues in cyber-physical systems.

- Prof. Gerhard Hancke (Dept of Electrical, Electronic and Computer Engineering, University of Pretoria, South Africa) visited the team and the Doctoral college of UGA in order to set up student exchange program in July 2015.

- Prof. Paolo Frasca (University of Twente, Enschede, The Netherlands) visited the team for two weeks in October, for research discussions with team members, and in particular with C. Canudas de Wit on open problems in social dynamics related to traffic drivers.

- Prof. Joao Cesar Moura Mota (Universidade Federal do Ceara, Brazil) visited the team in December 2015 within the framework of the French-Brazilian CAPES-COFECUB project TICO-MED.

9.4.1.1. Internships

- Tomas Manuel Pippia from University of Pavia, Italy, made his reserach internship for his master thesis in the team, from March to July.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

- A. Kibangou visited UC Berkeley during the BIS workshop (Berkeley-Inria-Stanford, May 12-15). During this stay, A. Kibangou participated as a member for the panel dedicated to Urban mobility. He had discussions with G. GOMES (UC Berkeley) on different topics about traffic including flow prediction and interfacing traffic micro-simulator such as AIMSUM with Matlab.

- C. Canudas de Wit visited UC Berkeley for a week in October. He had research meetings with faculty and students at ITS an PATH, and in particular with prof. Horowitz and dr. Gomes. On Oct 23rd he gave an invited lecture at Institute of Transpsortation Studies (ITS) and the Transportation Program of the Civil and Enviromental Engineering Department at the University of California, Berkeley, in the ITS transportation seminar program.

- Various team members attended the IPAM Long Program New Directions in Mathematical Approaches for Traffic Flow Management (http://www.ipam.ucla.edu/programs/long-programs/new-directions-in-mathematical-approaches-for-traffic-flow-management), at UCLA, Los Angeles. IPAM long programs are a collection of one-week workshops, intertwined with study periods, where participants are encouraged to pursue their own research while interacting with other participants.

  - A. Ladino, 26 Sept. to 24 Oct. (Workshops I Mathematical Foundations of Traffic and II Traffic Estimation, and a study period)
  - P. Grandinetti, 25 Oct. to 20 Nov. (Workshops III Traffic Control and IV Decision Support for Traffic, and a study period)
  - C. Canudas de Wit, Oct. 10-16 and 25-31 (Workshops II Traffic Estimation and III Traffic Control)
  - F. Garin, Oct. 25-30 (Workshop III Traffic Control)

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

7. Partnerships and Cooperations

7.1. 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".

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. KEOPS

See section "International Initiatives" below.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. MATHEMACS

Title: MATHEmatics of Multi-level Anticipatory Complex Systems

Programm: FP7

Duration: October 2012 - September 2015

Coordinator: Max Planck Institute for Mathematics in the Sciences

Partners:

see the webpage of the project.

Inria contact: Olivier Faugeras

The MATHEMACS project aims to develop a mathematical theory of complex multi-level systems and their dynamics. In addition to considering systems with respect to a given level structure, as is natural in certain applications or dictated by available data, the project has the unique goal of identifying additional meaningful levels for understanding multi-level systems. This is done through a general formulation based on the mathematical tools of information and dynamical systems theories.

To ensure that the theoretical framework is at the same time practically applicable, three key application areas are represented within the project, namely neurobiology, human communication, and economics. These areas not only provide us with some of the best-known epitomes of complex multi-level systems, but also constitute a challenging test bed for validating the generality of the theory since they span a vast range of spatial and temporal scales.

Furthermore, they have an important common aspect; namely, their complexity and self-organizational character is partly due to the anticipatory and predictive actions of their constituent units. The MATHEMACS project contends that the concepts of anticipation and prediction are particularly relevant for multi-level systems since they often involve different levels. Thus, as a further unique feature, the project includes the mathematical representation and modeling of anticipation in its agenda for understanding complex multi-level systems.

For validating the theory on large heterogeneous data sets, the project has a specific component with exclusive access to a wide range of data from human movement patterns to complex urban environments.

In this way, MATHEMACS provides a complete and well-rounded approach to lay the foundations of a mathematical theory of the dynamics of complex multi-level systems.

7.3.1.2. 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 (United Kingdom)

> Institute of Neuroscience, University of Newcastle Upon Tyne (United Kingdom)

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.

7.3.1.3. HBP

Title: The Human Brain Project

Programm: FP7

Duration: October 2013 - March 2016

Coordinator: EPFL

Partners:
see the webpage of the project.

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.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Paul Bressloff, a Professor of Applied Mathematics at the University of Utah visited the team in June-July as part of his Inria International chair.
- Ruben Herzog, Master student in Valparaiso, with A. Palacios, Centro Interdisciplinario de Neurociencia de Valparaíso, Univ de Valparaíso, Valparaíso. From May 4 th 2015 until May 29 th 2015.

7.4.1.1. Internships

Roberta Evangelista

During her internship (May 2015-September 2015, funded by *Action Transverse*) supervised by E. Tanré (Tosca) and R. Veltz (Neuromathcomp), Roberta Evangelista worked on "A stochastic model of gamma phase modulated orientation selectivity".

Neurons in primary visual cortex (V1) are known to be highly selective for stimulus orientation. Recent experimental evidence has shown that, in awake monkeys, the orientation selectivity of V1 neurons is modulated by gamma oscillations. In particular, neurons' firing rate in response to the preferred orientation changes as a function of the gamma phase of spiking. The effect is drastically reduced for non-preferred orientations. We have introduced a stochastic model of a network of orientation-dependent excitatory and inhibitory spiking neurons. We have found conditions on the parameters such that the solutions of the mathematical model reproduce the experimental behavior.

Quentin Cormier

Quentin is co-supervised by E. Tanré (Tosca) and R. Veltz (Neuromathcomp). He is a Master 1 student from ENS Lyon.

We study numerically and theoretically a model of spiking neuron in interaction with plasticity. The synaptic weights evolve according to biological law of plasticity. We study the existence of separable time scales. We are also interested in the characterization of invariant distribution for the activity of the network and the distribution of the synaptic weights. During his internship, Quentin Cormier also develop a numerical code to simulate large networks of neurons evolving according to this dynamics.

NEUROSYS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

In the *Contrat de Plan 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

- Inria Technological development action (ADT): OpenViBE-NT
  This is a three-year multi-site project (2012–2015) to develop OpenViBE further on several fronts such as usability, new algorithms and scope of applicability. Teams of the ADT are Hybrid(Rennes), Athena (Sophia), Potioc (Bordeaux) and Neurosys. Coordinator is Laurent Bougrain.

- Multidisciplinary Exploratory Project (PEPS 2014) Bio-Maths-Info (BMI): *Characterising the laminar profile of motor cortical oscillatory synchronization during visuomotor behavior with new analysis tools.*
  Oscillations are omnipresent in the brain, but their function is still disputed. In motor cortex, beta and gamma oscillations are often observed, but their proposed roles in sensorimotor behavior are largely overlapping. While much is known on the laminar distribution of oscillations in sensory areas, the very sparse data on the laminar profile of motor cortical oscillations largely limits their functional interpretations. The 2-years project studies the layer specificity of monkey motor cortical oscillations and oscillatory interactions between the primary motor cortex (M1) and the dorsal premotor cortex (PMd) during visuomotor behavior. Extending conventional tools, such as coherency analysis, Neurosys develops a new method to quantify short-lasting partial amplitude and phase synchronization in single-trial data, based on wavelets, exploiting the predefined vicinity of contacts on the laminar probes. The application of this new method to the data recorded in Marseille will reveal instantaneous amplitude and phase synchronization between cortical layers and between the brain areas *M*1 and *P*Md, providing novel insights into the functional roles of beta and gamma oscillations in visuomotor behavior. The experimental partner at the *Institut de Neurosciences de la Timone* in Marseille is Bjork Kilavik. The contact in Neurosys is Axel Hutt.

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 next 4 years. Neural Engineering brings together engineering, physics, neuroscience and mathematics to design and develop brain-computer interface systems, cognitive computers and neural prosthetics. Neurosys organized a NETTworkshop about *Neural Engineering in Medicine and related fields* in Nancy, 2-3 July 2015. Neurosys hosted a PhD-student, Maciej Jedynak, from Pompeu Fabra university (Spain) for one month in fall 2015. Contact is Axel Hutt.

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[0]http://www.neural-engineering.eu/

9.3.2. Collaborations in European Programs, except FP7 & H2020

Program: ERC Starting Grant
Project acronym: MATHANA
Project title: Mathematical Modeling of Anaesthesia
Duration: January 2011 – October 2015
Coordinator: Axel Hutt
Abstract: MATHANA aims to study mathematically spatially extended neural systems and reveal their spatio-temporal dynamics during general anaesthesia.

9.3.3. Collaborations with Major European Organizations

Lifestyle Research Association (LIRA): Philips (Netherlands), Fraunhofer (Germany), Inria
Sleep is an essential part of a healthy life, but many people have trouble getting enough uninterrupted sleep. Special sensors installed in a mobile phone or bed can analyze activities, stress patterns and sleep sequences and provide ideas for new strategies and, eventually, products that support a healthier night's sleep. NEUROSYS has a Post-doc project running merging all sensor signals in a single data analysis technique to improve existing sleep monitors.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- We collaborate with Jamie Sleigh (University of Auckland, New Zealand), who provides us with experimental EEG-data obtained in humans during anaesthesia (A. Hutt).
- In the collaboration with Flavio Frohlich (University of North Carolina - Chapel Hill), we receive experimental data measured intracranially in ferrets and analyse them on spectral properties (A. Hutt).
- In the collaboration with Jérémy Lefebvre (University of Lausanne), we have been working out together a stochastic delayed neural field analysis leading to new insights into the effects of additive noise (A. Hutt).
- The collaboration with Peter beim Graben (Humboldt University Berlin) on recurrence data analysis has led to analysis techniques to detect meta-stable states in EEG-signals (A. Hutt).
- We have an ongoing collaboration with Pr. 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 Pr. 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

- We have hosted Peter beim Graben (Humboldt University Berlin) in April and May on recurrence data analysis has led to analysis techniques to detect meta-stable states in EEG-signals.
- Jérémie Lefebvre, 10 days, Scientist at Toronto Western Research Institute, University Health Network, and Assistant Professor at Department of Mathematics, University of Toronto: *Shaping oscillations in the damaged brain.*
- Fatiha Hendel, three weeks, Assistant professor at Université des Sciences et de la Technologie d'Oran :

9.5.1.1. Internships

- Kanishka Basnayake, first year master student (July 5th 2015-September 6th 2015): EPFL summer Internship. *Modelling of gamma oscillation in networks of adaptive exponential integrate-and-fire neurons.*

<p align="center">**NON-A Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project ARCIR «Estimation distribuée de systèmes dynamiques en réseaux», coordinator Prof. Mihaly Petreczky, URIA – Mines de Douai, 2013–2015
- CPER CIA, "Internet of Things", 2011–2015
- CPER CISIT (becoming ELSAT 2020 in 2015), "Campus international sur la securite et intermodalite de transport", project "CONTRAERO" with LML and IEMN, 2011–2015 (becoming CONTRATECH 2016-2020 with LML, IEMN, LAMIH and ONERA)

8.2. National Initiatives

- ANR project Finite4SoS (Finite time control and estimation for Systems of Systems), coordinator Prof. Wilfrid Perruquetti (NON-A team, Inria): 2015-2020
- ANR project WaQMoS (Coastal waters quality surveillance using bivalve mollusk-based sensors), coordinator Dr. Denis Efimov (NON-A team, Inria): 2015-2020
- ANR project TourboTouch (High-performance touch interactions), coordinator Prof. Géry Casiez (MJOLNIR team, Inria): 2014-2019
- ANR project ChaSliM (Chattering-free Sliding Modes), coordinator Prof. B. Brogliato (BIBOP team, Inria): 2012-2015
- ANR project ROCC-SYS (Robust Control of Cyber-Physical Systems), coordinator Dr. L. Hetel: 2013-2018
- ANR project MSDOC (Multidimentional System: Digression od Stability), coordinator Bachelier Olivier (Poitiers University) : 2014-2017
- 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).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

- UCoCoS "Understanding and Controling Complex Systems", European Joint Doctorate, starting from April 2016, partners KU Leuven (Belgium), TU/e (Netherlands) and Centrale Lille (France).

8.4. International Initiatives

8.4.1. Inria Associate Teams not involved in an Inria International Labs

- Associate team with Norwegian University of Science and Technology (Tronheim, Norway) and UMEA university (Sweden), 2013-2016
  Subject: "Dynamical precision improvement for industrial robots"

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

- Tel Aviv University, Israel
- Sliding Mode Control Lab., UNAM, Mexico
- Department Control Automatico, CINVESTAV-IPN, Mexico
- National Polytechnic Institute, Mexico
- Department of Control Systems and Informatics, Saint Petersburg State University of Information Technologies Mechanics and Optics (ITMO), Russia

8.4.3. Participation In other International Programs

- CNRS GDRI DelSys (http://www.cnrs.fr/ins2i/spip.php?article1799)

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Professor Arie Levant, Tel Aviv University, Israel (Inria, 4 months)
- Professor Emilia Fridman, Tel Aviv University, Israel (Ecole Centrale de Lille, 1 month)
- Dr. Francisco Bejarano, National Polytechnic Institute, Mexico (Ecole Centrale de Lille, 1 month)

8.5.1.1. Internships

- Ivan De Jesus Salgado Ramos, National Polytechnic Institute, Mexico, till Apr 2015
  Subject:PID control design based on the different differentiation techniques

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Gang Zheng, 2 months visit to Nanjing University of Sicence and Technology

NUMED Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

- Paul Vigneaux: collaborative project of the Fédération Mathématique Rhone-Alpes-Auvergne, on the growth of biological tissue.
- Emmanuel Grenier and Paul Vigneaux: Member of a collaborative project of the Fédération Mathématique Rhone-Alpes-Auvergne headed by Adeline Samson, on PDE and Statistics.

6.2. National Initiatives

6.2.1. ANR.

Thibault Bourgeron is part of "Keyboard" (head: Laurent Desvillettes)

6.3. European Initiatives

6.3.1. FP7 & H2020 Projects

Vincent Calvez: ERC starting grant Mesoprobio "Mesoscopic models for propagation in biology". 2015-2020

6.3.1.1. DDMoRE

Title: DDMORE

Programm: FP7

Duration: February 2011 - January 2016

Coordinator: Pfizer

Inria contact: Marc Lavielle

6.4. International Research Visitors

6.4.1. *Visits to International Teams*

6.4.1.1. Explorer programme

Bouin Emeric

Date: Jan 2015 - Apr 2015

Institution: Stanford (United States)

6.4.1.2. Research stays abroad

Thibault Bourgeron visited Granada University in october 2015.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Content Management Techniques for Fact-Checking: Models, Algorithms, and Tools (ContentCheck) is a 4-year project starting in January 2016, supported by ANR under DEFI 7 - Société de l'information et de la communication. The project is coordinated by Ioana Manolescu; Bogdan Cautis and Michaël Thomazo also participate. Other partners are U. Rennes 1, INSA Lyon, Le Monde's fact-checking team, and the LIMSI lab of Université Paris Sud. The project aims at establishing fact-checking as a data management problem, and endow it with the appropriate fundamental models, algorithm and tools, validated in interaction with the journalists.

Apprentissage Adaptatif pour le Crowdsourcing Intelligent et l'Accès à l'Information (ALICIA) is a 4-year project, started in February 2014, supported by the ANR CONTINT call. The project is coordinated by Bogdan Cautis, with Nicole Bidoit, and Ioana Manolescu; other partners include LIG (Grenoble) and the Vodkaster company. Its goal is to study models, techniques, and the practical deployment of adaptive learning techniques in user-centric applications, such as social networks and crowdsourcing.

Cloud-Based Organizational Design (CBOD) is a 4-year ANR started in 2014, coordinated by prof. Ahmed Bounfour from UNIV. PARIS-SUD. 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.

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.

8.1.2. LabEx, IdEx

Structured, Social and Semantic Search 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.

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 cloud services, and from the cloud to outside the cloud.

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 Inria Saclay (OAK). 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. 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".

8.2. International Initiatives

8.2.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

8.2.1.1. OAKSAD

Title: Languages and techniques for efficient large-scale Web data management

International Partner (Institution - Laboratory - Researcher):

University of California, San Diego (United States) - Computer Science and Engineering (CSE) - Alin Deutsch

Start year: 2013

See also: https://team.inria.fr/oak/oaksad/

Data on the Web is increasingly large and complex. The ways to process and share it have also evolved, from the classical scenario where users connect to a database, to today's complex processes whereas data is jointly produced on the Web, disseminated through streams, corroborated and enriched through annotations, and exploited through complex business processes, or workflows. The OAK and San Diego teams work together to devise expressive languages, efficient techniques and scalable platforms for such applications. Our work in 2015 has focused on scalable hybrid stores [9], [18]. The OAKSAD team ended with 2015 but we continue collaborating on this topic.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Erietta Liarou, Harvard University, May 2015
- Helena Galhardas, University of Lisbon, March 2015
- Paolo Papotti, Qatar Computing Research Institute, February 2015
- Puya - Hossein Vahabi, Yahoo Labs, January 2015
- Yanlei Diao, University of Massachusetts Amherst, January 2015

8.3.2. Visits to International Teams

8.3.2.1. Sabbatical programme

Bogdan Cautis went on a sabbatical to Hong Kong starting in September 2015, for a duration of one year.

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

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Inria International Labs:SNOWFLAKE

Participants: Adrien Coulet [contact person], Malika Smaïl-Tabbone.

Inria@SiliconValley

Associate Team involved in the International Lab: SNOWFLAKE

> 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

> See also: http://snowflake.loria.fr/

Snowflake (http://snowflake.loria.fr/) 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 LOD (Linked Open Data). Such a connection would 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. The considered use case is related to pharmacogenomics drugs, i.e., drugs known to cause variable effects depending on the genetic profile of patients. Data associated with pharmacogenomics drugs and their mechanisms are available in LOD and, once connected to EHRs, they can be used to classify drugs and then patients showing a specific reaction profile to a given group of drugs.

8.1.2. Participation In other International Programs: Ciência Sem Fronteiras

Participant: Amedeo Napoli [contact person].

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.

8.1.3. STIC AmSud: Autonomic Knowledge Discovery (AKD)

Participants: Victor Codocedo, Amedeo Napoli [contact person].

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 projects targets 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.

8.1.4. Miscellaneous

Participants: Mehwish Alam, Aleksey Buzmakov, Victor Codocedo, Adrien Coulet, Amedeo Napoli [contact person], Chedy Raïssi, Jean-Sébastien Sereni, Mario Valencia.

- An on-going collaboration involves the Orpailleur team and Sergei Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory several times (with the support of HSE) while Sergei Kuznetsov visited Inria Nancy Grand Est several times too. The collaboration is materialized by the joint supervision of the thesis of Aleksey Buzmakov and the organization of scientific events, and in particular the workshop FCA4AI whose fifth edition should take place this year in August at ECAI 2016 (see http://www.fca4ai.hse.ru).

- 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.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. HEREDIA

Participant: Jean-Sébastien Sereni [contact person].

HEREDIA (http://www.liafa.univ-paris-diderot.fr/~sereni/Heredia/) is an ANR JCJC ("Jeunes Chercheurs") focusing on hereditary properties of graphs, which provide a general perspective to study graph properties. Several important general theorems are known and the approach offers an elegant way of unifying notions and proof techniques. Further, hereditary classes of graphs play a central role in graph theory. Besides their theoretical appeal, they are also particularly relevant from an algorithmic point of view. With Jean-Sébastien Sereni, the HEREDIA project involves Pierre Charbit (LIAFA, Paris), Louis Esperet (G-SCOP, Grenoble) and Nicolas Trotignon (LIP, Lyon).

8.2.1.2. Hybride

Participants: Adrien Coulet, Luis-Felipe Melo, Amedeo Napoli, Matthieu Osmuk, Chedy Raïssi, My Thao Tang, Mohsen Sayed, Yannick Toussaint [contact person].

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 and 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).

8.2.1.3. ISTEX

Participants: Luis-Felipe Melo, Amedeo Napoli, Yannick Toussaint [contact person].

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. Thus ISTEX is in concern with a massive acquisition of documentation 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 the ATILF laboratory and the INIST Institute (both in Nancy). ISTEX-R aims at developing new tools for querying full-text documentation, analyzing content and extracting information. A platform is currently under development to provide robust NLP tools for text processing, as well as methods in text mining and domain conceptualization.

8.2.1.4. Termith

Participants: Luis-Felipe Melo, Yannick Toussaint [contact person].

Termith (http://www.atilf.fr/ressources/termith/) is an ANR Project which involves the following laboratories: ATILF, LIDILEM, LINA, INIST, Inria Saclay and Inria Nancy Grand Est. 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.

8.2.2. FUI PoQemon

Participants: Matthieu Osmuk, Chedy Raïssi [Contact Person], Mickaël Zehren.

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 trade-off 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 involves the following partners: Altran, DataPublica, GenyMobile, HEC, IP-Label, Next Interactive Media, Orange and Université Paris-Est Créteil, along with Inria Nancy Grand Est.

8.2.3. PEPS

8.2.3.1. PEPS Approppre

Participants: Mehwish Alam, Quentin Brabant, Aleksey Buzmakov, Victor Codocedo, Miguel Couceiro [Contact Person], Adrien Coulet, Esther Galbrun, Amedeo Napoli, Chedy Raïssi, Yannick Toussaint.

This PEPS Approppre research project (see http://www.cnrs.fr/ins2i/spip.php?article1183) is aimed at setting a framework for characterizing the mining of preferences in massive data. Such a unified framework for the mining of qualitative preferences is not yet existing and can be related to recent studies in decision theory (aggregation models and consensus), machine learning and data mining. A particular focus will be done on the aggregation model of Sugeno integral which can be applied on a symbolic representation of preferences for two main operations, reduction of dimensionality (feature selection) and prediction.

8.2.3.2. PEPS Confocal

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 planning to adapt 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

Participants: Mehwish Alam, Quentin Brabant, Aleksey Buzmakov, Victor Codocedo, Adrien Coulet, Miguel Couceiro [Contact Person], Esther Galbrun, Amedeo Napoli, Chedy Raïssi, 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. For leading such a process, which actually is a loop, an analyst who is most of the time an expert of the data domain, is present. This materializes the fact that the KD process requires interaction and iteration. However, it appears that until recently the most important progress were made on the second step of the KD process, i.e. data mining, and especially form the algorithmic point of view. This gave birth to a variety of efficient and fast algorithms. This second step is in between the two other steps whose importance is now becoming very clear as the analyst is facing very large amounts of data and even larger amounts of resulting patterns. Actually, KDDK is one possible way of tackling such a problem as the principle is to push domain knowledge for improving 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 some original and generic pattern which can be considered as a reference for going farther and to search the pattern space w.r.t. this original pattern linked to some preferences of the analyst. In this way, the interesting pattern space is much more concise and of much lower size. Moreover, the PEPS Prefute project contributes also to consolidate the place of the analyst in the KD process. In particular this means that more studies have to be carried out on the possible interactions with the analyst and on the importance of preferences and domain knowledge in this interaction. In addition, visualization tools associated to KD systems have to be improved for being able to work with the actual large amounts of data and patterns as well (see https://www.greyc.fr/fr/node/2207).

8.3. Regional Initiatives

8.3.1. PEPS Mirabelle EXPLOD-Biomed

Participants: Adrien Coulet [contact person], Malika Smaïl-Tabbone.

This project has initiated a collaboration with geneticists from the Hospital of Nancy, namely Philippe Jonveaux and Céline Bonnet. The aim of the EXPLOD-Biomed project is to propose novel knowledge discovery methods applied to Linked Open Data for discovering gene that could be responsible for intellectual deficiencies. Linked Open Data are available on-line, interconnected and encoded in a format which can be straightforwardly mapped to ontologies. Thus they offer novel opportunities for knowledge discovery in biomedical data. Here, geneticists play the role of experts and guide the knowledge discovery process at different steps.

8.3.2. *Hydreos*

Participant: Jean-François Mari [contact person].

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 (see § 6.2.2) 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. Currently, various display tools are under study and implementation for providing the agrnomy expert an easier interpretation of the clustering outputs http://www.loria.fr/~jfmari/App/Arpentage/Yar.avi.

8.3.3. *PEPS Truffinet*

Participant: Chedy Raïssi [contact person].

The Truffinet PEPS project aims at developing new graph mining methods and tools to support knowledge discovery from the truffle's complex network of interactions happening in the soil between different bacterias and the subterranean Ascomycete fungus. This work uses Log-Linear Analysis (LogLA) which is a well established statistical technique for finding associations between discrete variables in data. The general objective of LogLA is to select a model that satisfactorily explains the observed frequencies of a given categorical dataset. General approaches to LogLA are exponential with respect to the number of variables. Recently, new approaches based on multiplicative log-linear models and using notions from graph theory have been developed. We applied successfully these methods in the case of the truffle bacterial environment to discover new associations in our data.

The Truffinet PEPS project involves several partners among which Intitut Elie Cartan de Lorraine (IECL), Intitut National de Recherche en Agronomie (INRA) and Centre de Recherche en Automatique de Nancy (CRAN) along with Inria Nancy Grand Est.

PANAMA Project-Team

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, . . .).

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. OSEO-FUI: S-POD: "Assistance à personnes en danger potentiel"

Participants: Frédéric Bimbot, Romain Lebarbenchon, Ewen Camberlein, Jérémy Paret, Vincent Soupé.

Duration: August 2012-December 2015

Research axis: 3.2

Partners: ERYMA, CAPT/FOTON, CASSIDIAN, KAPTALIA, KERLINK, le LOUSTIC and Telecom Bretagne

Coordinator: ERYMA

Description: S-POD gathers research teams and industrial partners to that aim at setting up a framework to process and fuse audio, physiological and contextual data. The goal is to design an embedded autonomous system able to detect situations of potential danger arising in the immediate environment of a person (military, police, CIT, fire, etc.)

Contribution of PANAMA: PANAMA is in charge of R&I activities related to the qualitative and quantitative analysis of information from the acoustic environment (intensity, direction of arrival, nature of noise sounds, properties of voices, etc.) as well as to the exploitation of these analyses. The need for real-time embedded processing induces specific constraints.

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, Pierre Machart, Luc Le Magoarou, Nancy Bertin, Nicolas Keriven, Yann Traonmilin, Laurent Albera, Gilles Puy, Thomas Gautrais, 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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Pierre Vandergheynst, in July, Professor of Signal and Image Processing, EPFL (Chaire Internationale Inria)
- Gitta Kutyniok, in April, Professor, Technical University of Berlin

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. 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.

9.1.2. SUBSAMPLE Digiteo chair

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Alexandre Abraham.

Parietal is associated with this Digiteo Chair by Dimitris Samaras, in which we will address the probabilistic structure learning of salient brain states (PhD of Alexandre Abraham, 2012-2015).

Cognitive tasks systematically involve several brain regions, and exploratory approaches are generally necessary given the lack of knowledge of the complex mechanisms that are observed. The goal of the project is to understand the neurobiological mechanisms that are involved in complex neuro-psychological disorders. A crucial and poorly understood component in this regard refers to the interaction patterns between different regions in the brain. In this project we will develop machine learning methods to capture and study complex functional network characteristics. We hypothesize that these characteristics not only offer insights into brain function but also can be used as concise features that can be used instead of the full dataset for tasks like classification of healthy versus diseased populations or for clustering subjects that might exhibit similarities in brain function. In general, the amount of correlation between distant brain regions may be a more reliable feature than the region-based signals to discriminate between two populations e.g. in schizophrenia. For such exploratory methods to be successful, close interaction with neuroscientists is necessary, as the salience of the features depends on the population and the observed effects of psychopathology. For this aim we propose to develop a number of important methodological advances in the context of prediction of treatment outcomes for drug addicted populations, e.g. for relapse prediction.

9.1.3. Medilearn/braincodes Inria-MSR project

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Andrés Hoyos Idrobo.

Neuroimaging is accumulating large functional MRI datasets that display –among artefacts and noise– brain activation patterns giving access to a meaningful representation of brain spatial organization. This ongoing accumulation is intensified via new large-scale international initiatives such as the *Human Connectome Project* (www.humanconnectomeproject.org). but also to existing open repositories of functional neuroimaging datasets (https://openfmri.org/) or http://www.fmridc.org/. These datasets represent a very significant resource for the community, but require new analytic approaches in order to be fully exploited. The MediLearn/BrainCodes project strives to provide a synthetic picture of the brain substrate of human cognition and its pathologies. In practice, this can be achieved by learning from large-scale datasets a brain atlas that summarizes adequately these functional activation maps drawing from a large number of protocols and subjects. Once learned, such an atlas is extremely useful to understand the large-scale functional organization of the brain: it is a tool for understanding *brain segregation*, the different encoding of many cognitive parameters into different brain regions, as well as *brain integration*, *i.e.* how remote brain regions co-activate across subjects and experiments.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. BrainPedia project
Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Yannick Schwartz.

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.

9.2.1.2. Niconnect project
Participants: Bertrand Thirion, Gaël Varoquaux [Correspondant], Alexandre Abraham.

- **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

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. HBP

Title: The Human Brain Project
Programm: FP7
Duration: October 2013 - April 2016
Coordinator: EPFL
Partners: See https://www.humanbrainproject.eu/fr/discover/the-community/partners
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.

9.4. International Initiatives

9.4.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

9.4.1.1. 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.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Danilo Bzdok (Forschungszentrum Jülich and University of Aachen) visited Parietal several months in 2015 (January- December), to develop collaborations on the use of machine learning techniques to model behavioral variables and find data-driven characterization of brain diseases.

9.5.1.1. Internships

- Jacob Schreiber (Univ. Washington), went for an internship (June-September) to develop fas methods for three-based regression with Scikit-Learn.

- Giorgio Patrini (Australian National University) developed some tools for online learning during his internship (July-November) in Scikit-Learn.

- Daniel Alcala Lopez (Univ. Aachen) joined us for a three month internship to discover the use of machine learning for neuroimaging in psychiatry (June-September 2015).

PARKAS Project-Team

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

Program: 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

Program: 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.

8.2.1.3. COPCAMS

Title: COgnitive & Perceptive CAMeraS

Program: FP7

Duration: April 2013 - March 2016

Coordinator: ___COORDINATOR___???

Partners:

Aselsan Elektroniknayi Ve Ticaret A.S. (Turkey)

Application Solutions (electronics and Vision) Ltd (United Kingdom)

Bs Spolka Z Ograniczona Odpowiedzialnoscia Spolka Komandytowa (Poland)

Concatel Sl (Spain)

Commissariat A L Energie Atomique et Aux Energies Alternatives (France)

Centre Tecnologic de Telecomunicacions de Catalunya (Spain)

Politechnika Gdanska (Poland)

Information and Image Management Systems (Spain)

Institut Jozef Stefan (Slovenia)

Iquadrat Informatica Sl (Spain)

"kolektor Group D.O.O., Vodenje in Upravljanje Družb" (Slovenia)

Queen Mary University of London (United Kingdom)

Danmarks Tekniske Universitet (Denmark)

Sogilis (France)

Squadrone System (France)

Stmicroelectronics Grenoble 2s (France)

Fundacion Tecnalia Research & Innovation (Spain)

Tedesys Global Sociedad Limitada (Spain)

Thales Communications & Securitys (France)

Thales (France)

Thales Research & Technology (uk) (United Kingdom)

Universidad de Cantabria (Spain)

Wavelens (France)

Inria contact: Albert Cohen

'Vision systems are becoming ubiquitous in our daily lives. Complex analysis of images from multiple cameras will become the norm in the future, from cars to industrial systems, from smart cities to facility monitoring, aimed at extracting meaningful, context-dependent information. Today's market is dominated by a combination of relatively simple, fixed function, configurable cameras that stream video to PC-based (and in some cases small embedded) gateways. These systems cannot scale beyond a certain size because of power consumption and the aggregate networking bandwidth required to stream videos to servers, where aggregated video analysis is performed. So the trend for visual analytics functions is that they get executed at the edge of these complex vision systems, e.g. in the cameras themselves. The Cognitive and Perceptive Camera Systems (COPCAMS) proposal leverages recent advances in embedded computing platforms to design, prototype and field-test full large-scale vision systems. It aims at exploiting a new many-core programmable accelerator platform to power a new generation of vision related devices (smart cameras and gateways), able to extract relevant information from captured images and autonomously react to the sensed environment by interoperating at large scale in a distributed manner. Date of approval by ARTEMIS JU: 7/04/2015.'

8.2.1.4. EMC2

Title: Embedded Multi-Core Systems for Mixed Criticality Applications in Dynamic and Changeable Real-Time Environments

Program: FP7

Duration: April 2014 - March 2917

Coordinator: Infineon Technologies

Partners:

Aicas (Germany)

Avl Software and Functions (Germany)

Denso Automotive Deutschland (Germany)

Elektrobit Automotive (Germany)

Evision Systems (Germany)

Nxp Semiconductors Germany (Germany)

Tttech Computertechnik (Austria)

"kompetenzzentrum - Das Virtuelle Fahrzeug, Forschungsgesellschaft Mbh" (Austria)

Frequentis (Austria)

Thales Austria (Austria)

Blueice Bvba (Belgium)

Freescale Polovodice Ceska Republika Sro (Czech Republic)

Institut Mikroelektronickych Aplikaci S.R.O. (Czech Republic)

Sysgo Sro (Czech Republic)

Silkan Rt (France)

"united Technologies Research Centre Ireland," (Ireland)

Mbda Italia Spa (Italy)

Fornebu Consulting As (Norway)

Westerngeco As (Norway)

Simula Research Laboratory As (Norway)

Ixion Industry and Aerospace Sl (Spain)

Visure Solutions Sl (Spain)

Seven Solutions Sl (Spain)

Telvent Energia (Spain)

Instituto Tecnologico de Informatica (Spain)

Ambar Telecomunicaciones Sl (Spain)

Sics Swedish Ict (Sweden)

Arcticus Systems (Sweden)

Arccore (Sweden)

Xdin Stockholm (Sweden)

Systemite (Sweden)

Stichting Imec Nederland (Netherlands)

Tomtom International Bv (Netherlands)

Infineon Technologies Uk Ltd (United Kingdom)

Sundance Multiprocessor Technology Ltd (United Kingdom)

Systonomy (United Kingdom)

Ensilica Ltd (United Kingdom)

Test and Verification Solutions Ltd (United Kingdom)

Abb (Sweden)

Ait Austrian Institute of Technology (Austria)

Alenia Aermacchi Spa (Italy)

Avl List (Austria)

Airbus Defence and Space (Germany)

Bayerische Motoren Werke Aktiengesellschaft (Germany)

Consorzio Interuniversitario Nazionale Per l'Informatica (Italy)

Critical Software (Portugal)

Chalmers Tekniska Hoegskola (Sweden)

Danfoss Power Electronics As (Denmark)

Ericsson (Sweden)

Centro Ricerche Fiat (Italy)

Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

Hi Iberia Ingenieria Y Proyectos Sl (Spain)

Harokopio University (Greece)

Infineon Technologies Austria (Austria)

"inesc Id - Instituto de Engenhariade Sistemas E Computadores, Investigacao E Desenvolvimento Em Lisboa Associacao" (Portugal)

Infineon Technologies (Germany)

Integrasys (Spain)

Instituto Superior de Engenharia Do Porto (Portugal)

Kungliga Tekniska Hoegskolan (Sweden)

Lulea Tekniska Universitet (Sweden)

Magillem Design Servicess (France)

Nxp Semiconductors Netherlands Bv (Netherlands)

Offis E.V. (Germany)

Politecnico di Torino (Italy)

Philips Medical Systems Nederland Bv (Netherlands)

Quobis Networks Sl (Spain)

Rockwell Collins France (France)

Rigas Tehniska Universitate (Latvia)

Selex Es Spa (Italy)

Siemens Aktiengesellschaft (Germany)

Systematic Paris Region Association (France)

Sysgo (Germany)

Thales Alenia Space Italia Spa (Italy)

"thales Alenia Space Espana," (Spain)

Technolution B.V. (Netherlands)

Thales Avionicss (France)

Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek Tno (Netherlands)

Technische Universitaet Wien (Austria)

Technische Universiteit Eindhoven (Netherlands)

Technische Universitat Braunschweig (Germany)

Technische Universiteit Delft (Netherlands)

Technische Universitat Dortmund (Germany)

Universitetet I Oslo (Norway)

Technische Universitaet Kaiserslautern (Germany)

University of Limerick (Ireland)

Universita Degli Studi di Genova (Italy)

Universita Degli Studi Dell'aquila (Italy)

University of Bristol (United Kingdom)

The University of Manchester (United Kingdom)

"ustav Teorie Informace A Automatizace Av Cr, V.V.I." (Czech Republic)

Vector Fabrics Bv (Netherlands)

Volvo Technology (Sweden)

Vysoke Uceni Technicke V Brne (Czech Republic)

Inria contact: Albert Cohen

Embedded systems are the key innovation driver to improve almost all mechatronic products with cheaper and even new functionalities. Furthermore, they strongly support today's information society as inter-system communication enabler. Consequently boundaries of application domains are alleviated and ad-hoc connections and interoperability play an increasing role. At the same time, multi-core and many-core computing platforms are becoming available on the market and provide a breakthrough for system (and application) integration. A major industrial challenge arises facing (cost) efficient integration of different applications with different levels of safety and security on a single computing platform in an open context. The objective of the EMC^2 project (Embedded multi-core systems for mixed criticality applications in dynamic and changeable real-time environments) is to foster these changes through an innovative and sustainable service-oriented architecture approach for mixed criticality applications in dynamic and changeable real-time environments. The EMC2 project focuses on the industrialization of European research outcomes and builds on the results of previous ARTEMIS, European and National projects. It provides the paradigm shift to a new and sustainable system architecture which is suitable to handle open dynamic systems. EMC^2 is part of the European Embedded Systems industry strategy to maintain its leading edge position by providing solutions for: . Dynamic Adaptability in Open Systems . Utilization of expensive system features only as Service-on-Demand in order to reduce the overall system cost. . 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 Approved by ARTEMIS-JU on 12/12/2013 for EoN. Minor mistakes and typos corrected by the Coordinator, finally approved by ARTEMIS-JU on 24/01/2014. Amendment 1 changes approved by ECSEL-JU on 31/03/2015.

8.2.2. Collaborations in European Programs, except FP7 & H2020

8.2.2.1. EMC2

Title: Affordable Safe & Secure Mobility Evolution – ASSUME

Program: Eureka ITEA3

Duration: April 2014 - March 2917

Coordinator: Siemens

Partners:

Inria

ENS Paris

Thales RT

Airbus

Esterel Technologies

Kalray

And many European partners

Inria contact: Dumitru Potop-Butucaru

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. In order to realize this vision, the need for computing power will drastically increase beyond what can be provided by conventional sequential single-core hardware. While the required efficiency and scalability makes it mandatory for future embedded micro-controllers to rely on multi- and many-core architectures, the change in hardware architecture also entails fundamental changes to state of the art software development methodology. Replacing today's essentially sequential technology by omnipresent communication between cores poses the tremendous challenge in software development to identify and exploit opportunities for concurrency in a way which still guarantees reliable and predictable behavior. Aside from the evolution of new hardware architectures, software development must address the increasing level of complexity of new highly automatic mobility solutions. For automotive, the self-driving car is the next big revolution and it is still unclear how functional and non-functional guarantees can be given for this new class of assistance functions. European industry heavily relies on the premium market segments. In these segments, innovative functions are the most important factor to influence buying decisions. New competitors, e.g. Google, enter the stage and challenge the established industry with eager visions. However, 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. The ASSUME algorithm portfolio will be the key technology to bring innovative solutions from sandboxes into consumers' daily lives. ASSUME provides a seamless engineering methodology to overcome this roadblock. The problem is addressed on the constructive and on the analytic side. For efficient construction and synthesis of embedded systems, the project provides new tools, standards and methodologies to cover most of the challenges by design. In addition, ASSUME provides a well-integrated sound static analysis solution that allows proving the absence of problems even in a multi-core environment. New algorithms will be integrated in exploitable tools. New interoperability standards and requirements formalization standards will facilitate cooperation between different market players. The ASSUME consortium includes leading European industry partners for mobility solutions, tool and service providers for embedded system development as well as leading research institutes for static analysis for model-driven and traditional embedded systems development.

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. Inria Associate Teams not involved in an Inria International Labs

8.3.1.1. 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: 2013

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

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 such as C, where computation is specified in terms of statements with zero or more nested loops and other control structures around them. 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 system analysis, modeling and design, in embedded reactive control. They also underline the construction of many domain-specific languages and compiler intermediate representations. The copy and execution semantics of data-flow languages impose a different set of challenges. We plan to bridge this gap by studying techniques that could enable extraction of a polyhedral representation from data-flow programs, transform them, and synthesize them from their equivalent polyhedral representation.

An extension for 3 more years has been requested. It may be partly funded by CEFIPRA.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

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

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.

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.

8.3.3. Participation In other International Programs

The POLYFLOW associate team has been extended for up to 3 years on January 1st 2016, in collaboration with CEFIPRA (http://cefipraonline.in).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Prof. Michael Mendler, Univ. Bamberg, Germany, spent one month as an invited professor in the team in March 2015.

Dr. Artjoms Sinkarovs, Heriot Watt University, UK, spent 2 months as an visiting scholar in Summer 2015.

8.4.1.1. Internships

Abhishek Jain, 4th year student from IIT Delhi, visited us for 1 and a half months in January 2015.

Chaitanya Malaviya, 3rd year student from Nanyang Technological University, visited us for 2 months in July and August 2015.

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Marc Pouzet spent 15 days in the group of Prof. M. Mendler at Bamberg University in July 2015.

Albert Cohen spent 1 month in the group of Prof. P. Sadayappan at Ohio State University, in April–May 2015. One paper was accepted to the ACM PLDI 2016 conference as a result of this collaboration.

Timothy Bourke spent 1 week in the group of Prof. C. Tinelli at The University of Iowa in December 2015.

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

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.'

8.2. International Research Visitors

8.2.1. *Visits of International Scientists*

Professor Chuck Liang visited the team from 25 May to 15 June 2015 in order to continue his collaborations with team members on basic questions of proof theory. This collaboration resulted in a paper that appears in LPAR 2015 on the topic of subexponentials and the Curry-Howard interpretation of logic.

8.2.1.1. Internships

Leonardo Lima is an intern funded by ProofCert during 1 Oct 2015 – 28 Feb 2016. He is a student of Prof. Vivek Nigam from Federal University of Paraíba, Brazil. He is working on formalizing the proof theory of linear logic within the Abella theorem prover.

8.2.2. *Visits to International Teams*

8.2.2.1. Research stays abroad

Graham-Lengrand spent 6 months, from March 2015 to August 2015 at SRI International, USA. This visit was to start a collaboration with N. Shankar and B. Dutertre on new algorithms and new architectures for automated and interactive theorem proving.

PERCEPTION Project-Team

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 MIX-CAM 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 Roboticss (France)

Ben-Gurion University of the Negev (Israel)

Friedrich Alexander Universitat, Erlangen, Nurenberg (Germany)

Imperial College London (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 multimodal 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 interaction. 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 interaction, 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.

8.2.2. Inria International Partners

8.2.2.1. Informal International Partners

- Professor Sharon Gannot, Bar Ilan University, Tel Aviv, Israel,
- Professor Yoav Schechner, Technion, Haifa, Israel,
- Dr. Miles Hansard, Queen Mary University London,
- Dr. Thomas Hueber, Gipsa Lab, CNRS, Grenoble,
- Professor Daniel Gatica Perez, IDIAP Institute, Martigny, Switzerand,
- Professor Nicu Sebe, University of Trento, Trento, Italy,
- Professor Adrian Raftery, University of Washington, Seattle, USA.
- Dr. Zhengyou Zhang, Microsoft, Redmond WA, USA.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Professor Sharon Gannot (Bar Ilan University), February and October 2015.
- Dr. Romain Sérizel (Telecom Paris Tech), February 2015.
- Dr. Christine Evers (Imperial College), March 2015.
- Dr. Xavier Alameda-Pineda (University of Trento), November 2015.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. HomeAssist: Platform for Assisted Living

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 (Bordeaux University) 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.

This work is funded by CARSAT Aquitaine ("Caisse d'Assurance Retraite et de la Santé au Travail"), Aquitaine Region and Conseil Général de la Gironde.

8.1.2. HomeAssist 500 – Populational Study

HomeAssist is an assisted living platform developed by the Phoenix research group at Inria. This platform has been applied to the domain of assisted living for the past two years. From the start, computer scientists and researchers in Ageing and Occupational Therapy have conducted this research effort in close collaboration with the stakeholders of aging in place. An initial set of applications has been developed, relying on a basic set of entities (sensors, actuators and web services). HomeAssist has been deployed in the homes of 24 older adults (matched with 24 control counterparts not equipped) and is currently being assessed. Although ongoing, the preliminary results of this field study show that the platform is well adopted (highly accepted and usable) by the older adults and their families or caregivers. Additionally, benefits from HomeAssist intervention have been demonstrated in terms of well-being, autonomy as well as quality of life (psychological health).

8.1.2.1. A Randomized Controlled Trial (RCT) of HomeAssist

This RTC will be conducted with older adults, ranging from autonomous to mildly cognitively impaired (e.g., cognitive or physical frailty) 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.

8.1.2.2. Expected Impact on Elderly Care

Prolonging ageing in place. Our 12-month field study of a large group of participants, combined with a control group, will give a statistical basis to assess the efficacy of our platform to prolong ageing in place for a range of older adults, including participants with mild cognitive impairment. Functional status and nursing needs will be assessed through statistical analyses over the duration of the field study. Subjective and objective measures will be done using such tools as the Multilevel Assessment Instrument or Lawton Scale and the Time-Based IADL. These traditional assessments will be completed by longitudinal in situ actimetric data recorded at home via HomeAssist, for measuring the actual IADL performance.

Secondary criteria of technology efficacy will also be studied, including general cognitive status, memory and executive functioning.

Improving well-being. Socialization activities have proven to be a key factor in well-being. To promote socialization activities, our platform offers a variety of services ranging from the main tablet, running a digital picture frame connected to online albums, to a simplified email client, allowing responses to be voice-recorded, instead of typed on a keyboard. Our platform also supports autonomous realization of daily tasks, which is known to be related to older adult well-being. Additionally, to improve well-being, applications support self-regulation and self-determination in helping the users to conform to their own daily routines via sensor-based activity monitoring and assistive supports (e.g., activity reminders or prompters). Specific assessment tools will be used to measure the well-being and the self-efficacy of the participants over the duration of the study.

Improving the efficiency of the caregiving environment. The actions of the caregiving environment are often limited or impeded by the lack of a proxy at the older adult's home. Such a proxy is needed for a number of actions, including mutualizing the planning of care services, gathering information on older adult activities, reminding of activities and appointments, monitoring potentially unsafe activities and situations. Our online catalog already offers applications materializing a caregiving proxy; the HomeAssist project will expand this catalog with an emphasis on older adults with cognitive impairment. Questionnaires will be administered to caregivers to assess the reassurance impact of our platform in their daily delivery of services (e.g., feeling of burden assessment, Psychological health of caregivers).

8.1.2.3. Expected Impact on Pervasive Computing

Robustness. The DiaSuiteBox platform will be deployed at a large scale, serving 500 users. This deployment will allow to further test the robustness of DiaSuiteBox beyond the current 24 users in Bordeaux. Various runtime logs will be collected to measure the performance and the behavior of DiaSuiteBox.

Development of assistive applications. Our existing experience in developing assistive applications will be significantly expanded by considering users with cognitive impairment. This situation will result in taking into account additional parameters in the user interactions. We will formalize and report on a methodology to assess users' need and develop assistive applications, leveraging our current experience and the one of HomeAssist.

A validated assistive platform. An outcome of the HomeAssist project is the validation of the DiaSuiteBox technology as a platform for assisted living. The project will provide a solid basis on which a technology transfer can be achieved. In particular, the following factors will be key measures of the readiness and potential of DiaSuiteBox: diversity of users participating in our field study, the range of applications developed, the variety of devices utilized. The questionnaires administered to the participants will be valuable information for elaborating marketing strategies of the DiaSuiteBox technology.

8.1.2.4. Technology Transfer

An outcome of the HomeAssist-500 project is the validation of the DiaSuiteBox technology as a platform for assisted living. The project will provide a solid basis for the creation of a startup to market the technology. In particular, the following factors will be key measures of the readiness and potential of DiaSuiteBox: diversity of users participating in our field study, range of applications developed, variety of devices utilized, deployment in 500 homes for a period of 12 months. The questionnaires administered to the participants will be valuable information for elaborating marketing strategies for the DiaSuiteBox technology. Inria, which owns the intellectual property of DiaSuiteBox, is committed to providing the Inria Phoenix group with support to turn this technology into a marketable product.

8.1.3. ANDDI

Five percent of the population have Intellectual Disabilities (ID). Individuals with ID have significant socio-adaptive limitations in a variety of daily activities, at home (task planification and execution, medication, home safety, etc.) as well as outside (route planning, itinerary in public transportation, etc.). Individuals with ID, their families, health institutions, caregiving services, and dedicated organizations strive to find ways in which these individuals can live as independently as possible, while promoting their social inclusion in every respect of their life (housing, professional training, employment, leisure, culture, etc.).

The research project 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 platform relies on DiaSuite, our suite of tools for developing applications that orchestrate networked objects, and DiaSuiteBox, our platform that runs an open-ended set of applications, sensors, actuators and web services.

ANDDI addresses users with Down syndrome aiming to live independently; it pursues the following goals:

1. determining the key obstacles to perform daily activities autonomously and collecting the needs in assistive support expressed by individuals with ID and their family and caregivers;

2. developing and adapting assistive services available in HomeAssist across an iterative assessment (period of 6 months) of experiences of each individual;

3. evaluating the efficacy of our developed assistive services across the stages experienced by individuals progressively becoming independent in their daily life (pre-post comparison after 12 months of HomAssist intervention).

This project is the outcome of the OPALI project, described in Section 8.3.1.1 , and is funded by the Aquitaine Region and "Trisomie 21 France" .

8.1.4. Certification of an open platform

The purpose of this project is to define concepts and tools for developing certifying open platforms. This certification process must ensure a set of critical properties (e.g., safety, confidentiality, security) by certifying each tier application. These guarantees are essential to ensure that openness does not come at the expense of the user's well-being. To preserve the innovation model of open platforms, this certification process should also be as automatic as possible. Indeed, the success of open platforms is mainly due to the low development cost of a new application. The case study of this thesis will be the domain of home automation. The results of this thesis will be put into practice in the DiaSuiteBox open platform.

This project is funded by Aquitaine Region.

8.2. National Initiatives

8.2.1. Objects' World: design-driven development of large-scale smart spaces

There are an abundance of research and industry initiatives that have been undertaken with the aim of promoting the emergence of Internet of Things. In line with this goal, the Object's World project brings together stakeholders from different domains to build and support the emergence of an IoT sector in France and beyond. The project is lead by SIGFOX, the world's first cellular network operator dedicated to low-bandwidth wireless objects. The cooperation between industry and research partners (e.g., sensor manufacturers, computer science and electrical engineering research labs) is of uttermost importance in overcoming technological barriers. This issue is currently hindering the development of an IoT sector. The main objectives of this project are the development of

- expertise in the low-bandwidth network sector,
- low-cost transmitter/receiver chips,
- low-energy autonomous sensors, and
- software frameworks which cover the entire lifecycle of IoT applications.

Network infrastructures that support huge numbers of objects open up a range of opportunities for innovative services. Critically, these new opportunities rely on the ability to address the software engineering challenges of this new sector. We promote an approach that revolves around software frameworks. In areas such as mobile and web development, this approach has already been shown to facilitate software development by abstracting over implementation details and guiding the programmer.

Our objective is to propose concepts and tools for developing reliable applications orchestrating large-scale smart spaces of networked entities. The industrial partners of the Objects' World project will provide us with real-size case studies in various application domains (e.g., smart cities, tracking of vehicles, healthcare, energy management).

This work is funded by the OSEO national agency.

8.2.2. 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.

8.3. International Initiatives

8.3.1. Inria Associate Teams not involved in an Inria International Labs

8.3.1.1. OPALI

Title: OPen Assistive-technology platform for independent LIving

International Partner (Institution - Laboratory - Researcher):

Université du Québec à Trois Rivières (Canada) - Self-Determination Assistive Technologies Research Chair (TSA Chair) - Dany Lussier-Desrochers

Start year: 2013

See also: http://phoenix.inria.fr/opali

The goal of the OPALI project is to develop an Open Platform for Assisted Living targeting users with cognitive disabilities. It is a cross-disciplinary project combining expertise in (1) Computer Science focusing in development of applications orchestrating networked devices and (2) Psychology focusing in assistive technologies for users with cognitive disabilities. Furthermore, this project will leverage a unique research vehicle created by the University of Trois-Rivières consisting of a full-fledged apartment equipped with a range of networked devices and dedicated to experimental studies. The outcome of the project will include a large catalog of assistive applications allowing to match each user's project life.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Faustina HWang visited in June 2015. She is a professor at Reading University (UK). Her research interests concern assistive technologies, mainly for older adults and people with learning disabilities.

Matthew Goodwin visited in July 2015. He is a founding and key faculty member of a new doctoral program in Personal Health Informatics (PHI) and Director of the Computational Behavioral Science Laboratory (CBSL) at Northeastern University.

Myra Fernandes visited in September 2015. She is a professor at Waterloo University. Her research interests incude memory, aging, Parkison disorder, and virtual reality.

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

7. Partnerships and Cooperations

7.1. National Initiatives

Alexis Saurin (coordinator) and Yann Régis-Gianas are members of the four-year RAPIDO ANR project accepted in 2014 and starting 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 PPS, David Baelde from LSV, ENS-Cachan, and Pierre Clairambault, Damien Pous and Colin Riba from LIP, ENS-Lyon.

Pierre-Louis Curien (coordinator), Yves Guiraud and Philippe Malbos are members of the three-year Focal project of the IDEX Sorbonne Paris Cité, started in June 2013. 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 members of the LAGA (Laboratory of Mathematics, Univ. Paris 13).

Pierre-Louis Curien (coordinator), Yves Guiraud and Philippe Malbos 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 algebra, combinatorial group theory and theoretical computer science. This project is joint with members of the LAGA (Univ. Paris 13), the LIX (École Polytechnique), the ICJ (Univ. Lyon 1 and Univ. Saint-Étienne), the I2M (Univ. Aix-Marseille) and the IMT (Univ. Toulouse 3).

Pierre-Louis Curien, Yves Guiraud (local coordinator) and Matthieu Sozeau are members of the Groupement de Recherche 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, motivic homotopy, string theory.

Matthieu Sozeau, Hugo Herbelin, Lourdes del Carmen González Huesca and Yann Régis-Gianas were members of the ANR Paral-ITP, which started in November 2011 and ended in June 2015, and aimed at preparing the Coq and Isabelle interactive theorem provers to a new generation of user interfaces thanks to massive parallelism and incremental type-checking.

Hugo Herbelin is the coordinator of the PPS site for the ANR Récré accepted in 2011, which started in January 2012 and will end 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 is funded by the CoqHoTT ERC.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, except FP7 & H2020

Pierre-Louis Curien, Yves Guiraud and Philippe Malbos are collaborators of the Applied and Computational Algebraic Topology (ACAT) networking programme of the European Science Foundation.

7.3. International Initiatives

7.3.1. Inria Associate Teams not involved in an Inria International Labs

Pierre-Louis Curien and Claudia Faggian (external collaborator) participate 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).

7.3.2. Inria International Partners

7.3.2.1. 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, the University of Cambridge, and Universidad Nacional de Córdoba.

7.3.3. 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.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Andrej Bauer (University of Novi Sad) visited πr^2 and PPS for one month in September 2015 to collaborate with Matthieu Sozeau.

7.4.2. Internships

Akira Yoshimizu had a six-month Inria international internship (Nov 2014 - April 2015). He worked on abstract machines for the geometry of synchronisation, a variation of Girard's geometry of interaction that incorporates synchronisation and that is fit for dealing with quantum primitives added to a functional language, and coauthored a paper at LICS 2015 with Ugo Dal Lago, Claudia Faggian, and Benoît Valiron [56].

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

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. 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.

7.2. International Initiatives

7.2.1. Inria International Partners

7.2.1.1. 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).

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Rodrigo Assar, assistant professor in the ICBM Human Genetics Program of the School of Medicine of the University of Chile, was invited by PLEIADE in the context of an ongoing collaboration on hybrid, stochastic modeling of complex biological systems.

7.3.1.1. Internships

Leyla Mirvakhabova, student at the National research University Higher School of Economics, Moscow, was invited by PLEIADE for an internship to work on faster mathematical methods for nonlinear mapping, to be applied to very large distance matrices.

Ulysse Guyet, Masters student in Bioinformatique-Biostatistique at the University of Nantes, was invited by PLEIADE for an intership to work on software components for transferring DNA sequence annotations from reference genomes to newly sequenced strains.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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 : 10/01/2015 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 : december 2016. Administrator : Inria. Coordinator: Marc Bonnet.
- ANR project *ARAMIS: Analyse de méthodes asymptotiques robustes pour la simulation numérique en mécaniques*
  Partners: Université de Pau, Université technologique de Compiègne
  Start : January 2013. End : December 2016. Administrator : Université de Pau. Participant for POEMS: 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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. 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.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. 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)

8.3.2. Participation In other International Programs

Groupement De Recherche Européen : GDRE-US

This European Research Network (GDRE) entitled *Wave Propagation in Complex Media for Quantitative and Non Destructive Evaluation* aims at giving opportunities for interactions between researchers on the occasion of informal meetings, workshops and colloquia, alternatively in France and in the UK. It linked groups of academics and researchers in Ultrasonic Wave Phenomena with each other, and with industrial research centres and companies. The teams involved focused particularly on the theoretical end of the research spectrum, and include mathematicians, physicists and engineers.

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

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).

- **ANR Grant GeoLMI: Geometry of Linear Matrix Inequalities (2011-2015).** GeoLMI project aims at developing an algebraic and geometric study of linear matrix inequalities (LMI) for systems control theory. It is an interdisciplinary project at the border between information sciences (systems control), pure mathematics (algebraic geometry) and applied mathematics (optimisation). The project focuses on the geometry of determinantal varieties, on decision problems involving positive polynomials, on computational algorithms for algebraic geometry, on computational algorithms for semi-definite programming, and on applications of algebraic geometry techniques in systems control theory, namely for robust control of linear systems and polynomial optimal control (Participants: J.-C. Faugère, M. Safey El Din [contact], E. Tsigaridas).

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: ICT COST Action IC1403

Project acronym : CRYPTACUS)

Project title: Cryptanalysis of ubiquitous computing systems

Duration: 12/2014 – 12/2018

Coordinator: Prof 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.

Program: COST Action IC1306

Project acronym : CryptoAction

Project title: Cryptography for Secure Digital Interaction

Duration: 04/2014 – 04/2018

Coordinator: Dr. 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.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. Inria@SiliconValley

See https://project.inria.fr/siliconvalley/fr/

Associate Team involved in the International Lab:

GOAL

Title: Geometry and Optimization with ALgebraic methods.

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Dept. of Mathematics - Bernd Sturmfels

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.

The kickoff workshop was held at UC Berkeley in May 2015, see https://math.berkeley.edu/~bernd/GOALworkshop.html.

Both Carlos Améndola Cerón and Kaies Kubjas visited the team one month through the associated team.

8.3.1.2. Sino-European Laboratory of Informatics, Automation and Applied Mathematics (LIAMA)

See http://liama.ia.ac.cn/.

Associate Team involved in the International Lab:

ECCA

Title: Exact/Certifed Computation with Algebraic Systems

International Partner (Institution - Laboratory - Researcher):

KLMM – Chinese Academy of Sciences, Lihong Zhi.

Start year: 2012

See also: http://liama.ia.ac.cn/research/liama-projects/current/265-ecca-project-description-and-achievements.html

Exact/Certifed Computation with Algebraic Systems (ECCA) is a project run within the LIAMA Consortium as a cooperation project between CNRS/Inria/LIP6, KLMM, SKLOIS and LMIB. The main scientific objective of this project is to study and compute the solutions of nonlinear algebraic systems and their structures and properties with target applications to computational geometry, algebraic cryptanalysis, global optimization, and algebraic biology.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Carlos Améndola Cerón

Date: Sept. 2015

Institution: Technische Universität Berlin, Germany

Kaie Kubjas

Date: Oct. 2015

Institution: Aalto Science Institute, Finland

Cordian Riener

Date: May 2015

Institution: Aalto Science Institute, Finland

Igor Shparlinski

Date: Sept. 2015

Institution: The University of New South Wales, Australia

Rekha Thomas

Date: Feb. 2015

Institution: University of Washington, USA.

8.4.1.1. Internships

Matías Bender

Date: Sep 2014 - Feb 2015

Institution: Universidad de Buenos Aires (Argentina)

Supervisor: Jean-Charles Faugère

Jérôme Govinden

Date: Feb. 2015 - Sept. 2015

Institution: UPMC

Supervisors: Jean-Charles Faugère, Ludovic Perret

POPIX 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 is 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. Inria International Partners

9.2.1.1. Informal International Partners

POPIX has a collaboration with the Faculty of Pharmacy of Manchester University (UK).

POPIX is Adjunct Professor at the Faculty of Pharmacy of Florida University (USA).

POPIX is Adjunct Professor at the Faculty of Pharmacy of Buffalo University (USA).

9.2.2. Participation In other International Programs

Indo French Centre for the promotion of advanced research (CEFIPRA): Marc Lavielle was invited to participate to the the IFCAM Workshop in Statistics in Bangalore (July 2015).

POSET Team

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

- 4 *Arts & Science* projects of Bordeaux eventually granted in 2015 by the Initiative of Excellence (Idex) of Bordeaux,

9.2. National Initiatives

9.2.1. ANR

- ANR INEDIT, *Interactivité dans l'Ecriture De l'Interaction et du Temps*, coordinated by Ircam (Paris), 3 years, from 2012 to 2015, together with GRAME (Lyon); this project aimed at developing and integrating the existing formalisms to represent and perform interactive pieces of art,

- ANR OSSIA, *Open Scenario System for Interactive Application*, coordinated by GMEA (Albi), 3 years, from 2012 to 2015, together with Blue Yeti (Royan), ENJMIN (Poitiers), RSF (Toulouse); this project aimed at offering software services, especially within the Jamoma platform, to design, implement and perform open, non-linear and multi-user scenarios.

9.3. International Initiatives

9.3.1. Inria International Partners

PoSET members have regular though often informal collaboration with various international teams including:

- Camillo Rueda, Universidad Javaneria, Cali, Colombia,
- Paul Hudak, University of Yale, New-Haven, USA,
- Gregory M. Kobele, University of Chicago, USA,
- Makoto Kanazawa, National Institute of Informatics, Tokyo, Japan.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Shlomo Dubnov, UCSD (USA), visiting Scholar from November 2015 until June 2016,
- Eduardo Mirando, University of Plymouth, UK, invited professor from May the 15th until June the 15th.

9.4.2. Visits to International Teams

- D. Janin visiting Stuart Margolis, Bar Illan (Israël), April 2015,

<h1 style="text-align:center;color:red;">POSTALE Team</h1>

8. Partnerships and Cooperations

8.1. National Initiatives

- **EDF**: Contract with EDF on improving performance and designing algorithms of iterative solvers on parallel machines with accelerators (Marc Baboulin). This contract enables to hire a postdoc researcher in October 2014.
  Participants: Marc Baboulin, Amal Khabou.

- **Inserm** Contract with Paris X / INSERM U669 (Christophe Genolini) in the R++ project. R++ is an open source effort to modernize and increase performance of the R language used by scientists to develop statistical analysis tools. Funding for one research engineer has been received to support this project.
  Participant: Joël Falcou.

- **followup of the ANR Cosinus project PetaQCD - Towards PetaFlops for Lattice Quantum ChromoDynamics** Collaboration with Lal (Orsay), LPT (Orsay), LABRI (Bordeaux). About the design of architecture, software tools and algorithms for Lattice Quantum Chromodynamics.
  Participants: Christine Eisenbeis, Konstantin Petrov.

8.2. International Initiatives

8.2.1. Inria Associate Teams not involved in an Inria International Labs

8.2.1.1. R-LAS

Title: Randomized Linear Algebra Software

International Partner (Institution - Laboratory - Researcher):

> University of Tennessee, Knoxville (United States) - Innovative Computing Laboratory (ICL) - Jack Dongarra

Start year: 2014

See also: https://www.lri.fr/~baboulin/r-las.html

The objective of the associate team between Inria and University of Tennessee is to develop a class of fast algorithms and software based on randomization to enhance linear algebra calculations in high-performance computing (HPC) applications. The first application will focus on FFT-like randomization techniques to avoid pivoting in dense and sparse matrix factorizations and thus removing the communication cost due to pivoting. The second application is related to the computation of statistical condition estimates for linear algebra problems in order to assess the numerical quality of solutions computed by HPC applications. The targeted architectures are large scale multicore systems with accelerators. The ultimate goal of the project is to make the randomized solvers designed by the associate team accessible to end-users thanks to a public domain software library.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Masha Sosonkina, Old Dominion University, USA.
- Hartwig Anzt, University of Tennessee, USA.
- Nick Higham, University of Manchester, UK.
- Jean-Luc Gaudiot, UC Irvine, USA.

8.3.2. *Visits to International Teams*

8.3.2.1. Research stays abroad

- Marc Baboulin,
    - Invitation at Old Dominion University, Norfolk, USA, (October 2015)
    - Invitation at National Institute of Informatics, Tokyo, Japan (August 2015)
    - Invitation at Académie des Sciences de Prague, République Tchèque (June 2015)
    - Invitation at Inria Bordeaux- équipe Hiepacs (March 2015)

<h1 style="text-align:center; color:red">POTIOC Project-Team</h1>

9. Partnerships and Cooperations

9.1. Regional Initiatives

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://team.inria.fr/potioc/scientific-subjects/papart/

Cap Sciences:
- Potioc has strong relationships with the Cap Sciences museum (http://www.cap-sciences.net/), especially through its Living Lab. In 2015, we have co-supervised a Master thesis on augmented interactive maps that was partly done at Cap Sciences and Inria-Potioc. We are currently investigating how this map prototype can be used in a smart city project with Cap Sciences.

Immersion:
- Potioc has strong relationships with Immersion. In 2015, Immersion and Potioc notably co-supervised a Master student (Maxime Daniel) on the topic "Évaluation de la charge de travail, de l'attention, et de la reconnaissance d'erreur dans un environnement interactif par analyse EEG".

9.2. National Initiatives

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.

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.

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 (e.g. a ball on the figure). 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 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)
- Project around BCI in the evaluation process, first meeting with all the partners was in October 2013
- 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: 2014-2015
- 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 will focus 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. Collaborations in European Programs, except FP7 & H2020

Assessing and Optimising Human-Machine Symbiosis through Neural signals for Big Data Analytics:

- duration: 2014-2018
- partners: Ulster University (UK)
- funding: DGA-DSTL project
- This project objective is to design new tools for Big Data analysis, and in particular visual analytics tools that tap onto human cognitive skills as well as on Brain-Computer Interfaces. The goal is to enable the user to identify and select relevant information much faster than what can be achieved by using automatic tools or traditional human-computer interfaces. More specifically, this project will aim at identifying in a passive way various mental states (e.g., different kinds of attention, mental workload, relevant stimulus perception, etc.) in order to optimize the display, the arrangement of the selection of relevant information.

9.3.2. Collaborations with Major European Organizations

Collaboration with the University of Sussex, Brighton, Interact Lab, UK (Head: Pr. Sriram Subramanian)

- We have strong relationships with Sriram Subramanian. This has led to joint paper publications, numerous visits and a co-supervision of a PhD thesis (Camille Jeunet).

Bordeaux Idex project "Conception de Système d'interfaces cerveau-ordinateur prenant en compte les facteurs humains afin d'optimiser l'apprentissage de l'utilisateur" for international PhD project

- partners: Bordeaux Segalen University (Handicap & Système nerveux team), Bristol University (BIG team)
- duration: October 2013 - September 2016

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- Pr. Roger N'KAMBOU, department of Computer Sciences at the UQAM (Université du Québec à Montréal) who is a specialist of Intelligent Tutoring Systems (ITS). We are collaborating with him to develop such a system in order to optimise human learning in Brain-Computer Interfaces (BCI), and thus improve the performances with such systems.

- We are collaborating with Dr. Cuntai Guan (I2R, Singapore), Pr. Jonathan Bromberg (Kansas University, USA) and Pr. Gerwin Schalk (Wadsworth center, USA) on ElectroCorticoGraphic (ECoG) signal analysis.

- We are collaborating with Prof. Johannes Schoening (Univ. Hasselt, Belgium), Prof. Beat Signer (Vrije Universiteit Brussel, Belgium) and Dr. Brent Hecht (University of Minnesota, USA) on customization of geographic maps.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Pr. Pierre Dillenbourg, EPFL, visited team Potioc in April, 2015

- Dr. Thorsten Zander, group leader at TU Berlin, Germany, visited team Potioc from November to December 2015 with two of his students (Lena M. Andreessen and Laurens R. Krol)

- Pr. Sriram Subramanian, University of Sussex, visited team Potioc in December 2015

9.5.2. Visits to International Teams

9.5.2.1. Research stays abroad

- Jérémy Frey was working at the INRS in Montreal, Canada, in the MuSAE (Multimedia/Multimodal Signal Analysis and Enhancemen) laboratory of Prof. Tiago H. Falk, from October to November 2015

- Camille Jeunet was working at the University of Sussex, Brighton, UK, in the Interact Lab of Pr. Sriram Subramanian, from November 2015 to January 2016.

- Fabien Lotte was working at the Sugiyama Laboratory, The University of Tokyo, Japan, from July to August 2015

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

8. Partnerships and Cooperations

8.1. Nationally Funded Projects

8.1.1. ANR project Involved

Participants: Amr Al-Zouhri Al-Yafi, Patrick Reignier [correspondant].

The partners are G-SCOP, LIG (Prima, IIHM), CEA Liten, PACTE, Vesta Systems and Elithis.

The project focuses on bringing solutions to building actors for upcoming challenges in energy management in residential buildings. Many technical solutions have been proposed so far, but without sufficiently considering sufficiently actors as key. It is generally considered that energy management can be done by measurement and computation means with few contributions of actors. The project explores a new paradigm: a user centric energy management system, where user needs and tacit knowledge drive the search of solutions. These are calculated thanks to 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

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 Neuro-Science. The aim of this project is to experimentally evaluate and compare current theories for mental modeling 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 provided a structured environment that we will use for experimental evaluation of current theories of mental modelling and emotional response during problem solving and social interaction.

The project is organised 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 which elicit particularly strong physiological reactions. In the final phase, we will use these recordings to evaluate the effectiveness of competing techniques for mental modelling 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, multi-modal 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.

8.1.3. EquipEx AmiQual4Home - Ambient Intelligence for Quality of Life

Participants: Stanislaw Borkowski, Sabine Coquillart, Joelle Coutaz, James Crowley [correspondant], Alexandre Demeure, Thierry Fraichard, Amaury Negre, Patrick Reignier, Dominique Vaufreydaz, Nicolas Bonnefond, Remi Pincent.

Ambient Intelligence, Equipment d'Excellence, Investissement d'Avenir

The AmiQual4Home Innovation Factory is an open research facility for innovation and experimentation with human-centered services based on the use of large-scale deployment of interconnected digital devices capable of perception, action, interaction and communication. The Innovation Factory is composed of a collection of workshops for rapid creation of prototypes, surrounded by a collection of living labs and supported by a industrial innovation and transfer service. Creation of the Innovation Factory has been made possible by a 2.140 Million Euro grant from French National programme "Investissement d'avenir", together with substantial contributions of resources by Grenoble INP, Univ Joseph Fourier, UPMF, CNRS, Schneider Electric and the Commune of Montbonnot. The objective is to provide the academic and industrial communities with an open platform to enable research on design, integration and evaluation of systems and services for smart habitats.

The AmiQual4Home Innovation Factory is a unique combination of three different innovation instruments: (1) Workshops for rapid prototyping of devices that embed perception, action, interaction and communication in ordinary objects based on the MIT FabLab model, (2) Facilities for real-world test and evaluation of devices and services organised as open Living Labs, (3) Resources for assisting students, researchers, entrepreneurs and industrial partners in creating new economic activities. The proposed research facility will enable scientific research on these problems while also enabling design and evaluation of new forms of products and services with local industry.

The core of the AmiQual4Home Innovation Factory is a Creativity Lab composed of a collection of five work-shops for the rapid prototyping of devices that integrate perception, action, interaction and communications into ordinary objects. The Creativity Lab is surrounded by a collection of six Living Labs for experimentation and evaluation in real world conditions. The combination of fabrication facilities and living labs will enable students, researchers, engineers, and entrepreneurs to experiment in co-creation and evaluation. The AmiQual4Home Innovation Factory will also include an innovation and transfer service to enable students, researchers and local entrepreneurs to create and grow new commercial activities based on the confluence of digital technologies with ordinary objects. The AmiQual4Home Innovation Factory will also provide an infrastructure for participation in education, innovation and research activities of the European Institute of Technology (EIT) KIC ICTLabs.

The AmiQual4Home Innovation Factory enables a unique new form of coordinated ICT-SHS research that is not currently possible in France, by bringing together expertise from ICT and SHS to better understand human and social behaviour and to develop and evaluate novel systems and services for societal challenges. The confrontation of solutions from these different disciplines in a set of application domains (energy, comfort, cost of living, mobility, well-being) is expected to lead to the emergence of a common, generic foundation for Ambient Intelligence that can then be applied to other domains and locations. The initial multidisciplinary

consortium will progressively develop interdisciplinary expertise with new concepts, theories, tools and methods for Ambient Intelligence.

The potential impact of such a technology, commonly referred to as "Ambient Intelligence", has been documented by the working groups of the French Ministry of Research (MESR) [29] as well as the SNRI (Stratégie Nationale de la Recherche et de l'Innovation).

The Amiqual4Home Innovation Factory has been constructed with the Atelier Numerique Technology incubator across the street from the Inria Grenoble Rhone-Alpes Research Center in Monbonnot. The workshops, storage space and multi-functional workspace occupy 300 square meters on the ground floor. The LovelyLoft smart home technologies living lab occupies the apartment on the ground and 1st floor formerly occupied by the building guardian. The entire building has been equipped with an extensive suite of sensors and an open building management system and is currently used as the smart energy living lab.

8.1.4. IRT Silver Economy

IRT Silver economy is a multi-year collaboration between the PRIMA team of Inria, Université Grenoble Alpes, CEA LETI and Schneider Electric to develop smart devices and services for healthy ageing. The project is funded by the IRT nanoelec and has begun during the final months of 2015.

Within this project, Inria PRIMA and Schneider Electric are have begun development of a smart LW infrared imaging sensor for fall detection. The target system would build on a embedded integrated sensor system constructed by PRIMA with Schneider electric in 2014 and 2015.

8.1.5. FUI PRAMAD

Participants: Maxime Portaz, Amaury Negre, Dominique Vaufreydaz [correspondant].

Pramad is a collaborative project about *Plateforme Robotique dÁssistance et de Maintien à Domicile*. There are seven partners:

- R&D/industry: Orange Labs (project leader) and Covéa Tech (insurance company),
- Small companies: Interaction games (game designer, note that Wizardbox, the original partner was bought by Interaction games) and Robosoft (robot).
- Academic labs: Inria/PRIMA, ISIR (Paris VI) and Hôpital Broca (Paris).

The objectives of this project are to design and evaluate robot companion technologies to maintain frail people at home. Working with its partners, PRIMA research topics are:

- social interaction,
- robotic assistance,
- serious game for frailty evaluation and cognitive stimulation.

8.2. International Initiatives

8.2.1. Inria International Labs

Anne Spalanzani is implied in the iceira lab (in cooperation with the CNRS laboratories LAAS, ISIR and Taiwan). The laboratory is hosted by the National University of Taiwan, it is supported for 5 years (2013-2018), and the collaborative research focuses on Human centered Robotics.

8.2.2. Inria Associate Teams

Sampen is a associate team managed by Anne Spalanzani and Ren Luo (NTU Taipei) and involves other inria researchers (David Daney for Inria Bordeaux and Marie Babel from Lagadic-Rennes). In the scope of thi associate team, Anne Spalanzani gave a seminar à NTU in may 2015. Vishnu Narayanan (PhD student co-directed by Anne Spalanzani and Marie Babel) and Aurélien Mallein (PhD student supervised by David Daney) spent 3 months at the Iceira Lab (Taipei) to work respectively on Navigation following conventions and Localization using heterogenous sensors.

8.3. European Projects

8.3.1. CATRENE Project AppsGate - Smart Home Application Gateway

Duration: june 2012 - June 2015

Coordinator: ST Microelectronics

Other partners: Pace, Technicolor, NXP, Myriad France SAS, 4MOD Technology, HI-IBERIA Ingenieria y Proyectos, ADD Semiconductor, Video Stream Network, SoftKinetic, Optrima, Fraunhofer, Vsonix, Evalan, University UJF/LIG, and Institut Telecom.

The Prima Project team has worked with 15 other partners to develop a new generation of set-top box for smart home applications. In close collaboration with ST Microelectronics and Immotronics, Prima has developed the core middleware components for plug and play integration of smart home devices for distributed smart home services, as well as interactive tools for End User Development of Smart Home services.

AppsGate has developed an Open Platform to provide integrated home applications to the consumer mass market. The set-top box is the primary point of entry into the digital home for television services including cable TV, satellite TV, and IPTV. AppsGate will transform the set-box into a residential gateway, capable of delivering multiple services to the home, including video, voice and data. PRIMA is involved in designing End User Development tools dedicated for the Smart Home

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Sabbatical programme

Fraichard Thierry

Date: May 2014 - June 2015

Institution: BIU (Israel)

PRIVATICS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. FUI

8.1.1.1. XDATA

Title: XDATA.

Type: FUI.

Duration: April 2013 - April 2015.

Coordinator: Data Publica

Others partners: Inria, Orange, EDF, LaPoste, Hurance, Cinequant, IMT.

See also: http://www.xdata.fr/.

Abstract: The X-data project is a "projet investissements d'avenir" on big data with Data Publica (leader), Orange, La Poste, EDF, Cinequant, Hurence and Inria (Indes, Privatics and Zenith) . The goal of the project is to develop a big data plaftform with various tools and services to integrate open data and partners's private data for analyzing the location, density and consuming of individuals and organizations in terms of energy and services. In this project, the Zenith team leads the workpackage on data protection and anonymization.

8.1.1.2. 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.

8.1.2.2. BLOC

Title: Analysis of block ciphers dedicated to constrained environments.

Type: ANR.

Duration: October 2013 - September 2015.

Coordinator: INSA-Lyon (France).

Others partners: CITI Laboratory XLIM Laboratory, University of Limoges, Inria Secret, CryptoExperts (PME).

See also: http://bloc.project.citi-lab.fr/.

Abstract: BLOC aims at studying the design and analysis of block ciphers dedicated to constrained environments. The four milestones of BLOC are: security models and proofs, cryptanalysis, design and security arguments and performance analyzes and implementations of lightweight block ciphers. The aims of the project are the following ones: Security models and proofs Cryptanalysis Design C library of lightweight block ciphers We also aim at providing at the end of the project a lightweight block cipher proposal.

8.1.2.3. 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.

8.1.2.4. CAPPRIS

Title: CAPPRIS

Type: Inria Project Lab

Duration: January 2011 - 2014.

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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. PRIPARE

Title: PReparing Industry to Privacy-by-design by supporting its Application in REsearch

Programm: FP7

Duration: October 2013 - September 2015

Coordinator: France-Trialog

Inria contact: Daniel Le Métayer

The mission of PRIPARE is twofold: facilitate the application of a privacy and security-by-design methodology that will contribute to the advent of unhindered usage of Internet against disruptions, censorship and surveillance, support its practice by the ICT research community to prepare for industry practice; foster risk management culture through educational material targeted to a diversity of stakeholders. To this end PRIPARE will specify a privacy and security-by-design software and systems engineering methodology, using the combined expertise of the research community and taking into account multiple viewpoints (advocacy, legal, engineering, business), prepare best practices material (guidelines, patterns, success stories) for the development and implementation of products and services of ICT-based systems and use-cases in the area of cloud computing, mobile services and the management of cyber incidents, support FP7 and Horizon 2020 research projects through training workshops and practical support in applying PRIPARE best practices in their environment. It also provides educational material on approaches for risk management of privacy and create awareness on the need for risk management culture among users. Material consistent with PRIPARE methodology will be structured in a modular way in order to fit to different targets (policy makers, users, ICT students and professional). Identify gaps and provide recommendations on privacy and security-by-design practices, support of unhindered usage of Internet and on the creation of a risk management culture. A research agenda will be proposed. PRIPARE consists of a consortium of 11 partners with strong links with the privacy community (data protection authorities/policy makers, privacy advocacy organisations, technology, engineering). In order to prepare for the longer term adoption by the industry, a representative advisory board will be set up. The support action duration is 24 months.

8.2.2. Collaborations in European Programs, except FP7 & H2020

8.2.2.1. 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.

8.3. Regional Initiatives

8.3.1. Privamov'

Title: Privamov'

Type: Labex IMU.

Duration: September 2013 - 2015.

Coordinator: LIRIS.

Others partners: EVS-ITUS, Inria Urbanets.

Abstract: The objective of this project is to provide researchers the IMU community traces of urban mobility allowing further their research and validate their assumptions and models. Indeed, many communities need to know the modes of urban transport : sociologists, philosophers, geographers, planners or computer scientists. If these traces are an important feature for researchers or industrial, they are more for users who have helped to build: attacks jeopardize the privacy of users. Anonymization techniques developed within the project will make available to the greatest number of these traces, while ensuring that the entire process (from collection to data analysis) will be made in respect of the privacy of users involved.

8.3.2. SCCyPhy

Title: SCCyPhy

Type: Labex Persyval.

Duration: September 2013 - 2015.

Coordinator: Institut Fourier.

Others partners: Inria MOAIS, Verimag, CEA/LETI, LIG, GIPSA-Lab, TIMA.

Abstract: A main motivation of this action-team is to provide a structure to the Grenoble community in computer security and cryptography in the spirit of the PERSYVAL-lab Labex. Our emphasize, within the PCS workpackage, is around complementary areas of research with high impact for science and technology, with the following target applications: embedded systems (including smartphones and sensors network), at both software and hardware levels, distributed architectures (including "cloud" and "sky"), privacy and protection of information systems against cyberattacks of various origins.

8.3.3. 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).

<h2 style="text-align:center; color:red;">PROSECCO Project-Team</h2>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ProSe

Title: ProSe: Security protocols : formal model, computational model, and implementations (ANR VERSO 2010.)

Other partners: Inria/Cascade, ENS Cachan-Inria/Secsi, LORIA-Inria/Cassis, Verimag.

Duration: December 2010 - December 2014.

Coordinator: Bruno Blanchet, Inria (France)

Abstract: The goal of the project is to increase the confidence in security protocols, and in order to reach this goal, provide security proofs at three levels: the symbolic level, in which messages are terms; the computational level, in which messages are bitstrings; the implementation level: the program itself.

9.1.1.2. 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.

9.1.2. FUI

9.1.2.1. Pisco

Title: PISCO

Partners: Bull, Cassadian, CEA, CS, Saferiver, Serpikom, Telecom Paristech

Duration: January 2013 - December 2014.

Coordinator: Liliana Calabanti, Bull (France)

Abstract: The goal of the project is to develop a prototype of a new secure applicance based on a virtual machine architecture accessing an HSM. The role of PROSECCO is to contribute to the analysis of security http://www.systematic-paris-region.org/en/projets/pisco

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. CRYSP

Title: CRYSP: A Novel Framework for Collaboratively Building Cryptographically Secure Programs and their Proofs

Programm: FP7

Duration: November 2010 - October 2015

Coordinator: Inria

Inria contact: Anne-Lise Chenet-Pflieger

The goal of CRYSP is to use recent advances in software verification and dependent type systems and apply them to the verification of cryptographic protocol implementations written in a variety of languages. We want to enable the collaborative development of such programs and their specifications. Our target is to be able to verify mainstream implementations of the Transport Layer Security Protocol.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. 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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Deepak Garg from the Max Planck Institute for Software Systems in Saarbruecken visited the group from 10-12 June and gave a seminar.
- Udit Dhawan from the University of Pennsylvania visited the group from 10-14 March and gave a seminar.
- Cedric Fournet and Nikhil Swamy from Microsoft Research visited the group multiple times to work on joint projects.

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

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 will run till september 2016. It is composed of the members of the QUANTIC project-team. In this project we plan to develop 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.

7.1.2. *PSL* structuring project TOCOSUQI*

In the framework of the creation of the QUANTIC project-team, we have benefited from a 2-year PSL* funding from september 2013 to August 2015. The PSL* project TOCOSUQI (Tools of the control of superconducting quantum circuits) aims at developing new system theory tools for preparing, manipulating and protecting non-classical states of a microwave field in the framework of quantum Josephson circuits and circuit quantum electrodynamics, and applying them directly in the experiments. This project was led by Benjamin Huard.

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 TIQS*

This three-year young researcher ANR project, entitled "Thermodynamics of quantum information with superconducting circuits" and led by Benjamin Huard was run between September 2012 and August 2015. We realized two versions of Maxwell's demon either classical or quantum, and based on superconducting circuits. This opens the way to different types of thermal machines in the quantum regime. In addition, we developed the best amplifier that is non-degenerate at radiofrequency in terms of noise and bandwidth. Finally, we have demonstrated experimentally the duality between preparation and post-selection in quantum mechanics.

7.2.3. ANR project EMAQS

Pierre Rouchon is a participant to this "Projet Blanc" entitled "Evaluation and Manipulation At Quantum Scale" EMAQS. This 4-year project started on January 2012. The participants of the project are Karine Beauchard (coordinator, ENS-Rennes), Vahagn Nersesyan and Jean-Pierre Puel (univ. Versailles), Gabriel Turinici and Julien Salomon (univ. Paris-Dauphine), Grigoriu Andrea and Yvon Maday (univ Pierre et Marie Curie), Michel Brune (College de France) and Claude Le Bris (Ecole des Ponts, Matherials project-team). The project is based on 3 thematic axis: open loop control, feedback stabilization and estimation with a specific effort towards quantum systems of infinite dimension and/or subject to decoherence.

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.

Partner 3: University of Liverpool.

P. Rouchon is collaborating with Jason Ralph from the Department of Electrical Engineering and Electronics at the University of Liverpool on the numerical schemes for efficient quantum filtering in real-time feedback strategies. These collaborations have recently led to a publication in Physical Review A [23].

7.4. International Initiatives

7.4.1. Inria Associate Teams not involved in an Inria International Labs

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 [74] and preparation of non-classical field states through single photon Kerr effect [77] to the design of new experiments on single qubit cooling [69] and stabilization of maximally entangled states of superconducting qubits [8] by reservoir engineering techniques. Through these collaborations, Zaki Leghtas and Mazyar Mirrahimi have introduced a new direction for hardware-efficient universal quantum computation [84], [93]. These theoretical proposals have already led to groundbreaking experiments [10], [9], [4]. We are intending to formalize these collaborations through the creation of an Inria associated team in the framework of Inria@EastCoast program.

Partner 2: University of SaoPaulo and Federal University of Santa Catarina

Pierre Rouchon is collaborating with P. S. Pereira da Silva (Escola Politécnica – PTC, University of SaoPaulo, Brazil) and H. B. Silveira Federal (University of Santa Catarina (UFSC), Florianópolis, Brazil) on the system theory problems behind the experiment on the feedback stabilization of the photon box. These collaborations have recently led to a publication in IEEE Conference on Decision and Control [33].

7.5. International Research Visitors

7.5.1. Visits to International Teams

7.5.1.1. Research stays abroad

Mazyar Mirrahimi spent four months in the Quantronics Laboratory of Michel H. Devoret and in the Rob Schoelkopf Lab at Yale University. In this framework Joachim Cohen also spent three months in the same group. Finally, Nicolas Didier also spent two weeks at Yale University and two weeks at the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara.

RAP Project-Team

6. Partnerships and Cooperations

6.1. International Initiatives

6.1.1. Inria Associate Teams not involved in an Inria International Labs

6.1.1.1. RNA

An Associate Team between RAP and McGill university provides funding for a project on the theoretical and applied aspects of connectivity in random networks. The co-funding at McGill financed by the via the CARP FQRNT team grant of L. Addario-Berry, L. Devroye and B. Reed (2013-2015)

The bilateral project PHD Procope funded by Campus France (formerly Egide) obtained in 2014 jointly between the LIX at Ecole Polytechnique (PI Marie Albenque) and the Mathematics institute of Frankfurt's university is still running for 2015. The team RAP is associated to the LIX for this contract.

Title: Connectivity and distances in models of random networks and applications

International Partner (Institution - Laboratory - Researcher):

Start year: 2013

See also: http://algo.inria.fr/broutin/aap-rna.html

The projet will shed some new light on two complementary aspects of connectivity and the structure of distances in models of random networks. - We will first explore the nature and universality of phase transition and critical phenomena in random graphs, and more generally for high-dimensional percolation systems. Phase transitions are crucial in statistical physics, but also in the theory of computing where one observes that constraints satisfaction problem exhibit such a sudden change whose understanding is believed to yield important information about hardness of computation. - We will also investigate the connectivity of geometric models of random graphs which are at the core of modelling of wireless networks. In particular we will focus on some global aspects such as the quantification of connectivity, sparsity, and the behavior of diffusion algorithms. We will also design of distributed algorithms to initiate the network which guarantee efficiency and scalability.

6.2. International Research Visitors

6.2.1. Visits of International Scientists

- Louigi Addario-Berry (McGill)
- Cecile Mailler (Bath)
- Jean-Francois Marckert (LaBRI, Bordeaux)
- Leonardo Rolla (Buenos Aires)

6.2.1.1. Internships

- Plinio Santini Dester, M1 student at Polytechnique (Avril-July 2015).

6.2.2. 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.

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 - December 2016.

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 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.

9.2.3. *PEPS égalité*

I. Lacroix-Violet was the coordinator of the project *Theoretical and numerical study of the quantum Navier-Stokes system* supported by the Institute for Mathematical Sciences and Interaction (INSMI) of the French National Center for Research (CNRS) the in the framework of the PEPS égalité call for proposal. In this project, the members have considered the quantum Navier-Stokes equations with a linear density dependent viscosity from a numerical and a theoretical point of view. From a theoretical point of view, I. Lacroix-Violet, M. Gisclon and D. Bresch studied the limit of the system when the viscosity parameter tends to zero. This work is still en progress. From a numerical point of view, following the recent work of D. Bresch, F. Couderc, P. Noble et J.-P. Vila, I. Lacroix-Violet and A. Jüngel have tried to design some numerical methods for the simulation of the complete model.

   Title: Theoretical and numerical study of the quantum Navier-Stokes system

   Coordinator: I. Lacroix-Violet

   Members-: M. Gisclon (Université Savoie Mont-Blanc) & A. Jüngel (Technische Universität Wien)

   Duration: January 2015 June 2015

9.3. International Research Visitors

9.3.1. *Visits of International Scientists*

We have a long-time collaboration with Ansgar Jüngel's research group from TU Wien. We hosted several PhD students during the last years and Ansgar Jüngel came for a one week research stay in 2015.

Patrick Dular from Liège University (Belgium) was invited in Lille from May, 15 to June, 15 on a Labex CEMPI support.

Ezzeddine Zahrouni from Nabeul University (Tunisia) was invited in Lille from Mai, 27 to Juin, 10 on a Lille University support.

9.3.2. Visits to International Teams

Thomas Rey visited Lorenzo Pareschi (March 9-14, 2015) and Giacomo Dimarco (June 23-27, 2015) in the Department of Mathematics and Computer Science of the University of Ferrara (Italy) to work on hyperbolic balance laws and on semi-lagrangian methods for the Boltzmann equation respectively.

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

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 Comupting simulations.

See also: http://infra-songs.gforge.inria.fr/

9.3. International Initiatives

9.3.1. Inria Associate Team

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) & Universidad Adolfo Ibanez (Chile)

Start year: 2011-13 and 2014-16

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

- Alexander Lazarev (Russia) visited us in Bordeaux in January 2015.
- Eduardo Uchoa (Brasil) visited us in Bordeaux on the second week of January 2015.
- Michael Poss visited us in Bordeaux on the first week of May 2015.
- Eduardo Moreno (Chile) visited us in Bordeaux for 10 days in November 2015.

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)

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

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 2,5 years.

8.1.2. InfraJVM - (2012–2015)

Members: LIP6 (Regal), Ecole des Mines de Nantes (Constraint), IRISA (Triskell), LaBRI (LSR).

Funding: ANR Infra.

Objectives: The design of the Java Virtual Machine (JVM) was last revised in 1999, at a time when a single program running on a uniprocessor desktop machine was the norm. Today's computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE.

The coordinator of InfraJVM is Gaël Thomas, who left the team in 2014. Infra-JVM brings a grant of 202 000 euros from the ANR to UPMC over three years.

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 - September 2016

Coordinator: Inria

Partners:

Basho Technologies (United Kingdom)

Faculdade de Ciencias e Tecnologia da Universidade Nova de Lisboa (Portugal)

Koç University (Turkey)

Rovio Entertainment Oy (Finland)

Trifork As (Denmark)

Université Catholique de Louvain (Belgium)

Technische Universitaet Kaiserslautern (Germany)

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.

8.3. 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. PHC Maimonide

Title: Application dependent intrusion (byzantine) detection in Dynamic cloud systems

International Partner (Institution - Laboratory - Researcher):

Technion Haifa - Prof. Roy Friedman

Duration: 2014–2015

The goal of this project is to study the ability to tolerate Byzantine failures in dynamic environments. The Byzantine model allows arbitrary behaviour of a certain fraction of nodes. Our goal is to provide both a theoretical framework and performance evaluation to tolerate Byzantine behaviour in dynamic distributed environments. We consider "bag of tasks" (BoT) applications characterized by trivial parallelism where a large computational problem is broken into a large number of independent tasks. These tasks can be spread on commodity hardware and operating systems. We target different executions environments: (1) Clouds: tasks are submitted to virtual machines hosted at cloud providers, (2) Desktop grid: tasks are submitted to federate large pool of donated machines hosted at user home, (3) Hybrid cloud: combining both cloud and desktop nodes.

8.3.2.2. 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Dastagiri Reddy MalikiReddy

Date: May—Aug. 2015

Institution: IITKGP (India)

Alvarez Colombo Santiago Javier

Date: Jul. 2015—Jan. 2016

Institution: Universidad de Buenos Aires (Argentina)

<div align="center">

REO Project-Team

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9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Project "EXIFSI"

Participants: Benoit Fabrèges, Miguel Ángel Fernández Varela [Principal Investigator], 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-sructure 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 modelling and simulation solutions and provide to 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, Irène Vignon-Clementel [co-Principal Investigator].

Period: 2013-2017.

This ANR-TecSan, co-managed by Eric Vibert (Paul Brousse Hospital) and Irène 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

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 several algorithms included in the shelddon and Modulef library, in particular shell elements and domain decomposition methods.

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.

9.3. International Initiatives

9.3.1. Inria International Labs

Participants: Céline Grandmont, Jessica Oakes, Irène Vignon-Clementel [correspondant].

Period: 2014-2015

Jessica Oakes was awarded an Inria@SiliconValley Grant for a post-doc at UC Berkeley to work on aerosol deposition in the lung.

9.3.2. Trans-Atlantic Network of Excellence for Cardiovascular Research

Participants: Jean-Frédéric Gerbeau, Sanjay Pant, Irène Vignon-Clementel [correspondant].

Period: 2010-2015

This network, funded by the Leducq fondation, is working on the multi-scale modeling of single ventricle hearts for clinical decision support.

Other partners: see http://modelingventricle.clemson.edu/home.

9.3.3. German BMBF national project Lungsys II

Participant: Irène Vignon-Clementel.

Period: 2012-2015

"Systems Biology of Lung Cancer: Dynamic Properties of Early Spread and Therapeutic Options". In collaboration with Dirk Drasdo (EPI Mamba).

Other partners: see http://www.lungsys.de.

9.3.4. Participation In other International Programs

- Laurent Boudin
  - Member of the French-Italian Galileo PHC on the kinetic modelling and numerical simulation of gaseous mixtures and plasmas, supervised by F. Charles (UPMC) for France.
  - Member of a French-Serbian CNRS PICS on the kinetic modelling of gaseous mixtures, supervised by B. Grec (Université Paris-Descartes) for France.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

Visiting PhD student: Stephanie Lindsey, Cornell University (May 4th - May 20th)

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. 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.

9.1.1.2. 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.

9.1.2. FUI

9.1.2.1. 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.

9.1.3. 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 Pierre Merdrignac, Younes Bouchaala, Fernando Garrido Carpio and Zayed Alsayed.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. CityMobil2

Type: COOPERATION (TRANSPORTS)

Instrument: Large-scale integrating project

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/

9.2.1.2. Mobility2.0

Title: Co-operative ITS systems for enhanced electric vehicle mobility

Type: COOPERATION (TRANSPORTS)

Duration: September 2012 - February 2015

Coordinator: Broadbit (Slovakia)

Partners: ETRA (Spain), Barcelona Digital (Spain), ICCS (Greece), MRE (Italy), Armines (France), University of Twente (Netherlands), Privé (Italy), NEC (United Kingdom)

Inria contact: Jean-Marc Lasgouttes

Abstract: Mobility2.0 will develop and test an in-vehicle commuting assistant for FEV mobility, resulting in more reliable and energy-efficient electro-mobility. In order to achieve a maximum impact, Mobility2.0 takes an integrated approach of addressing the main bottlenecks of urban FEV mobility: "range anxiety" related to the limited FEV range, scarcity of parking spaces with public recharging spots, and the congestion of urban roads. Our integrated approach means the application developed by Mobility2.0 will utilize co-operative systems to simultaneously consider these bottlenecks, so that such an optimization can be achieved which still guarantees reliable transportation for each FEV owner. Mobility2.0 will focus on assisting the daily urban commute, which represents the bulk of urban mobility.

See also: http://mobility2.eu/

9.2.1.3. DESERVE

Title: DEvelopment platform for Safe and Efficient dRiVE

Duration: September 2012 - August 2015

Coordinator: VTT (Finland)

Partners: CRF (Italy), Armines (France), CONTINENTAL AUTOMOTIVE FRANCE SAS (France), FICOSA (Italy), Inria (France), TRW (Great Britain), AVL (Austria), BOSCH (Germany), DAIMLER (Germany), VOLVO (Sweden),...(26 partners)

Inria contact: Fawzi Nashashibi

Abstract: To manage the expected increase of function complexity together with the required reduction of costs (fixed and variable) DESERVE will design and build an ARTEMIS Tool Platform based on the standardization of the interfaces, software (SW) reuse, development of common non-competitive SW modules, and easy and safety-compliant integration of standardized hardware (HW) or SW from different suppliers. With innovative design space exploration (DSE) methods system design costs can be reduced by more than 15%. Hence, DESERVE will build an innovation ecosystem for European leadership in ADAS embedded systems, based on the automotive R&D actors, with possible applications in other industrial domains.

See also: https://artemis-ia.eu/project/38-deserve.html

9.2.1.4. AutoNet2030

Title: Co-operative Systems in Support of Networked Automated Driving by 2030

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

9.2.1.5. FURBOT

Title: Freight Urban RoBOTic vehicle

Type: FP7

Instrument: Specific Targeted Research Project

Duration: November 2011 - December 2015

Coordinator: Genova University (Italy)

Partner: Bremach (Italy), ZTS (Slovakia), Universite di Pisa (Italy), Persico (Italy), Mazel (Spain), TCB (Portugal), Inria (France).

Inria contact: Fawzi Nashashibi

Abstract: The project proposes novel concept architectures of light-duty, full-electrical vehicles for efficient sustainable urban freight transport and will develop FURBOT, a vehicle prototype, to factually demonstrate the performance expected.

9.2.2. 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. See also: http://www.imobilitysupport.eu/imobility-forum/working-groups/automation

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. 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. This year RITS hosted Sakriani Watiasri Sakti, assistant professor at NAIST.

- 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.

- Technical University of Sophia – Bulgaria: RITS is conducting a close partnership with the Technical University of Sophia (Department of Mechanical Engineering). Since 2009, Professor Plamen Petrov has been a visiting professor at Inria. He contributed in conducting common advanced researches with RITS researchers in the field of dynamic modeling and adaptive motion control for vehicles and robots. Joint works have been also driven to develop and validate platooning concepts for normal speed driving of automated vehicles.

9.3.2. Participation In other International Programs

- ASIA-ITC (STIC-ASIE) programme: project SIM-CITIES (2015-2016), "Sustainable and Intelligent Mobility for Smart Cities", coordinated by F. Nashashibi.
  Partners: RITS, IRCCyN/CNRS, NTU (Singapore), Dept. of Computer Science and Electrical Engineering Graduate School of Science and Technology Kumamoto University (Japan), Department of Automation of the Shanghai Jiao Tong University (SJTU University, China) and the Information and Communication Engineering and the MICA Lab (Vietnam). 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).
- ECOS Nord international program: cooperation between Simon Bolivar University – Venezuela and RITS. This program started effectively in 2014 with the visit of two researchers and a PhD student from each institute to the other institute. This year, Adriana Zurita Villamizar engineer (trainee) from SBU made several months stay at RITS. She worked in the field of intelligent control.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- **Plamen Petrov**, professor at Sofia University, Bulgaria, from July 2015 until September 2015.
- **Sakriani Watiasri Sakti**, assistant professor at NAIST, from February 2015. A part of the work done during her stay has been published in [38].

9.4.1.1. Internships

- **Aidos Ibrayev**, from Al-Farabi Kazakh National University, Kazakhstan.
- **Jose Emilio Traver Becerra and Myriam Vaca Recalde** from Universidad de Extremadura, Spain.
- **Jaycee Holmes** from Spelman College, U.S.A.
- **Adriana Zurita Villamiza** from Simon Bolivar University, Venezuela.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

We have signed a convention with the CAR team led by Noury Bouraqadi of Ecole des Mines de Douai. In this context we co-supervized three PhD students (Mariano Martinez-Peck, Nick Papoylias and Guillermo Polito). The team is also an important contributor and supporting organization of the Pharo project.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

MEALS FP7 Marie Curie Research Staff Exchange Scheme

MEALS (Mobility between Europe and Argentina applying Logics to Systems) is a mobility project financed by the 7th Framework programme under the Marie Curie International Research Staff Exchange Scheme. It involves seven academic institutions from Europe and four from Argentina, and a total of about 80 researchers to be exchanged. The project started on the 1st of October, 2011, and it has a duration of 4 years. Nr: FP7-PEOPEL-2011-IRSES

http://www.meals-project.eu

9.2.2. Collaborations in European Programs, except FP7 & H2020

9.2.2.1. ERCIM Software Evolution

We are involved in the ERCIM Software Evolution working group since its inception. We participated at his creation when we were at the University of Bern.

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 International Partners

9.3.2.1. Declared Inria International Partners

Participants: Marcus Denker [correspondant], Stéphane Ducasse [RMoD], Nicolas Anquetil [RMoD], Diego Garbervetsky [UBA,LAFHIS], Gabriela Arevalo [Universidad Nacional de Quilmes)], Nicolas Passerini [Uqbar].

Uqbar - Argentina

Uqbar is a foundation of researchers teaching in several universities of the Buenos Aires area. Universidad Tecnologica Nacional (FRBA) Universidad Nacional de Quilmes, Universidad Nacional de San Martin,Universidad Nacional del Oeste. LAFHIS is a research laboratory from the University of Buenos Aires. More information at (http://www.uqbar-project.org).

9.3.2.2. Informal International Partners

Pharo in Research: We are building an ecosystem around Pharo with international research groups, universities and companies. Several research groups (such as Software Composition Group – Bern, and Pleaid – Santiago) are using Pharo. Many universities are teaching OOP using Pharo and its books. Several companies worldwide are deploying business solutions using Pharo.

University of Mons, Belgium Julien Delplanque is a student in the master M1 program from Mons University. He is working on SQL parsers and code critics.

9.3.3. Participation In other International Programs

9.3.3.1. STIC AmSud

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.

Nicolas Anquetil visited one week the ASERG team of Pr. Marco Tulio Valente at Federal University of Minas Gerais (Brazil), and another week the team of Pr. Alexander Bergel at University of Chile.

9.3.3.2. European Lab with Delft

We have a Lille Nord Europe European Lab with A. Bachelli from Delft University. We are working on infrastructure and tools for code reviewing. We have exchange of staff and presented a paper at SANER 2015.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

In the context of the PLOMO2 associated Team with the University of Chile:

- Johan Fabry (January 2015 for Pharo Days Lille, PLEIAD funded)
- Alexandre Bergel (01/07/2015 until 27/07/2015)
- Johan Fabry (July 2015 for ESUG, PLEIAD funded)
- Pierre Chanson (July 2015 and September 2015)
- Miguel Campusano (20/09/2015-07/10/2015)
- Alexandre Bergel (Dec 2015)

In the context of MEALS:

- Guido Chari visited RMoD in March 2015.

Other visitors:

- Glenn Cavarle, Jun 2015. Pharo MOOC.

- Skip Lentz, Delft University of Technology, Delft, the Netherlands, September 2015 to January 2016. Internship/Research project.

- Matthieu Lacaton, Thales, April 2015.

- Alain Plantec, Univ. Bretagne Occidentale, until June 2015. Bloc UI Project.

- Klérisson Vinícius Ribeiro da Paixão, Federal University of Uberlândia, Uberlândia (MG), Brazil, from September, 2015 to July, 2016. Stic-Amsud MineAPI.

- Markiyan Rizun, Ivan Franko National University of Lviv, Ukraine, From 11 January 2015 to 5 February 2015 and 4 July 2015 7 August 2015. Rewrite Tool.

- Nicolás Passerini, Uqbar / Universidad Nacional de Quilmes, Buenos Aires, Argentina, 24/11/2015 to 27/11/2015.

- Pablo Tesone, Thesis Relay from August 2015.

- Abdelghani ALIDRA, University 20 Aout 55, Skikda. Algeria. One month in June-July and November 2015 to December 2016.

- Leonardo Silva, PhD student from Brazil (Federal University of Minas Gerais), did a 6 months internship within for his PhD. From January 2015 to June 2015. SticAmsud Project Dynarchi.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

- Guillermo Polito: 25.05.2015 SOFT Languages Lab Vrije Universiteit Brussel, Brussels. Visit to present the work of the laboratory and look for collaborations.

- Guillermo Polito: 23.07.2015 Universidad de Quilmes, Buenos Aires. Visit to present the work of the laboratory.

- Nicolas Anquetil visited one week the ASERG team of Pr. Marco Tulio Valente at Federal University of Minas Gerais (Brazil), and another week the team of Pr. Alexander Bergel at University of Chile.

- Marcus Denker: 02.11-02.12.2015 PLEIAD DCC University of Chile, Santiago de Chile. Visit in the context of the Inria Associated Team PLOMO2.

- Marcus Denker: 02.01-20.01.2015 PLEIAD DCC University of Chile, Santiago de Chile. Visit in the context of the Inria Associated Team PLOMO2.

- Damien Cassou and Gustavo Santos. 02.02.2015. Visited for one week the University of Uberlandia (Brazil). Project MineAPI (SticAmSud).

- Olivier Auverlot and Anne Etien 16.12.15. University of Namur, Belgium. Visit to present the SQL project.

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

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.

9.1.2. 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.

9.2. National Initiatives

9.2.1. ANR

ANR White Project RESCUE (2010-2015), 4 years. The ANR White Project RESCUE was launched in November 2010, for a duration of 48 months (and was later extended for 6 additional months, up to June 2015). It gathers three Inria partners (ROMA, Grand-Large and Hiepacs) and is led by ROMA. The main objective of the project is to develop new algorithmic techniques and software tools to solve the *exascale resilience problem*. Solving this problem implies a departure from current approaches, and calls for yet-to-be-discovered algorithms, protocols and software tools.

This proposed research follows three main research thrusts. The first thrust deals with novel *checkpoint protocols*. The second thrust entails the development of novel *execution models*, i.e., accurate stochastic models to predict (and, in turn, optimize) the expected performance (execution time or throughput) of large-scale parallel scientific applications. In the third thrust, we will develop novel *parallel algorithms* for scientific numerical kernels.

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.

9.2.2. *Inria Project Lab C2S@Exa - Computer and Computational Scienecs at Exascale*

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

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. 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.

9.3. 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: Nikolaos Bellas

Partners: CERTH, Greece; EPFL, Switzerland; RWTH Aachen University, Germany; The Queen's University of Belfast, UK; IMEC, 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

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

- Laure Gonnord and Maroua Maalej are involved in the PROSPIEL Associate Team (Inria/ Brasil, 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. Specifically, Laure Gonnord and Maroua Maalej are in charge of designing static analyses for GPUs. In Feb.-Apr. 2016, ROMA will host one student coming from the Brasilian team.

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. Since September 2015, this collaboration led to one publication, see Section 7.27 .
- Anne Benoit and Yves Robert have a regular collaboration with Padma Raghavan from Penn State University (USA). They have achieved several publications in 2015, see Sections 7.8 and 7.26 .

- 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. They have achieved one publication in 2015, see Section 7.1 .

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Fernando M. Pereira was invited in Jan. 2015 to work with Maroua Maalej and Laure Gonnord on static analyses for pointers.
- Oliver Sinnen was invited for two months (Sept./Oct. 2015) to work with Loris Marchal, Bertrand Simon and Frédéric Vivien on scheduling malleable task trees.
- 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

- Anne Benoit and Yves Robert advised the M2 internship of Loic Pottier on resilient application co-scheduling with processor redistribution.
- Christophe Alias advised the M2 internship of Adilla Susungi on the compilation of pipelined parallelism on multi-GPU.
- Guillaume Aupy and Loris Marchal advised the L3 internship of Clément Brasseur on memory minimization for the parallel processing of task trees.
- Julien Herrmann and Yves Robert advised the L3 internship of Nicolas Vidal on the evaluation of the makespan of stochastic computational workflows.

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.
- Bertrand Simon spent six months (Feb.-Jul. 2015) at Stony Brooks University (USA) to work with Michael Bender.

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. *ANR-MN: H2MNO4 project*

Participants: Yvan Crenner, Benjamin Delfino, Jean-Raynald de Dreuzy, Jocelyne Erhel, Lionel Lenôtre, Géraldine Pichot.

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 organized a project meeting in February.

9.1.2. *Inria Project Lab: C2S@EXA project*

Participants: Édouard Canot, Yvan Crenner, Jocelyne Erhel, Géraldine Pichot.

Title: C2S@EXA - Computer and Computational Scienecs at Exascale
Duration: from January 2012.
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.

9.1.3. *GENCI: project on advanced linear solvers*

Participants: Yvan Crenner, Jocelyne Erhel, David Imberti, Lionel Lenôtre, Géraldine Pichot.

Title: Numerical models for hydrogeology
Duration: 2015
Coordination: J. Erhel and G. Pichot.
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.

9.1.4. *GDR MOMAS: projects on multiphase flow and reactive transport*

Participants: Benjamin Delfino, Jocelyne Erhel.

Title: Workshops on multiphase flow and reactive transport
Duration: 2015
Coordination: J. Erhel
Partner: IFPEN

Webpage: http://www.irisa.fr/sage/RTworkshop and https://www.ljll.math.upmc.fr/cances/gdrmomas/
Abstract: The working group MOMAS includes many partners from CNRS, Inria, universities, CEA, ANDRA, EDF and BRGM. It covers many subjects related to mathematical modeling and numerical simulations for nuclear waste disposal problems. The team participated in a workshop on multiphase flow and organized an international workshop on reactive transport, in Paris, with IFPEN.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects: EXA2CT project
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. 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.

9.2.2. FP7 & H2020 Projects: 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).

9.3. International Initiatives

9.3.1. Inria International Labs: LIRIMA Afrique, EPIC team (Tunisia)
Participants: Édouard Canot, Jocelyne Erhel.

Program: Laboratoire International de Recherche en Informatique et Mathématiques Appliquées

Title: Problèmes Inverses et Contrôle

Inria principal investigator: Houssem Haddar, Defi team

International Partner (Institution - Laboratory - Researcher): ENIT, University of Tunis, Tunisia - LAMSIN - Amel ben Abda

Duration: 2011-2015

See also: http://www.lirima.uninet.cm/index.php/recherche/equipes-de-recherche/epic

Abstract: The team deals with nonlinear and inverse problems.

9.3.2. International Program ECOS Sud (Chili): ARPHYMAT project
Participant: Édouard Canot.

Program: CONICYT

Title: Processus de formation et transformation de structures de combustion archéologique : un regard interdisciplinaire

Inria principal investigator: Édouard CANOT

International Partner (Institution - Laboratory - Researcher): Universidad de Tarapaca (Chili)

Duration: Jan 2014 - Dec 2016

Abstract: Multidisciplinary study of prehistoric fire traces in South America, by means of different approaches: taphonomy of the soil, physical processes involved during the heat transfer, modeling and numerical simulations.

9.3.3. Inria Euromediterranean: HYDRINV project

Participants: Édouard Canot, Jocelyne Erhel.

Program: Euromediterranean 3+3

Title: Direct and inverse problems in subsurface flow and transport

Coordination: H. ben Ameur, ENIT, Tunisia and J. Jaffré, Inria, Paris

Inria-Rennes principal investigator: Jocelyne Erhel

Duration: Jan 2012 - Dec 2015

International Partners (Institution - Laboratory - Researcher):

Université Ibn Tofail - Faculté des Sciences de Kénitra (Morocco) - Laboratoire Interdisciplinaire en Ressources Naturelles et en Environnement - Zoubida Mghazli

Ecole Nationale d'Ingénieurs de Tunis (Tunisia) - Laboratoire de Modélisation en Hydraulique et Environnement - Rachida Bouhlila

Universidad de Sevilla (Spain) - Department Ecuaciones Diferenciales y Anâlisis Numérico - Tomas Chacon Rebollo

Universitat Politècnica de Catalunya (Spain) - Department of Geotechnical Engineering and Geo-Sciences - Xavier Sànchez Vila

University Centre of KHEMIS MILIANA (Algeria) - Laboratoire de l'Energie et des Systèmes Intelligents - Mohammed Hachama

Ecole Mohammadia d'Ingénieurs (Morocco) - LERMA - Rajae Aboulaich

Ecole Nationale d'Ingénieurs de Tunis (Tunisia) - Laboratoire de Modélisation Mathématique et Numérique dans les Sciences de l'Ingénieur - Hend Ben Ameur

The management of water resources is a problem of great importance in all countries, and is particularly acute around the Mediterranean sea. The goal is to find a reasonable balance between these resources and demand while preserving the quality of water. Towards this goal it is essential to understand and simulate flow and transport in the subsurface. The science corresponding to this topic is hydrogeology. Since models become more and more complicated and quantitative answers must be given, numerical modeling become more and more sophisticated and mathematicians must also be involved. This project brings together hydrogeologists and mathematicians from France, Spain, Algeria, Morocco and Tunisia in order to develop, analyze, and validate numerical methods for several problems arising from modeling flow and transport in the subsurface. The emphasis is put on direct nonlinear problems (air-water flow, density driven flow related to salinization, transport with chemistry) and on inverse problems.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Nabil Nassif, American University of Beirut, Lebanon, April, 1 week
- Lamia Guellouz, ENIT, Tunisia, May, 1 week

9.4.2. Internships (Joint supervision of Ph-D students)

- Marwen ben Refifa, University of Tunis, 5 months, April-July 2015
- Salwa Mansour, Lebanese University, 8 months, Feb-Sep 2015

9.4.3. Visits to International Teams

- Lionel Lenôtre visited Pr. Dr. Sylvie Roelly and her students at Potsdam University, Potsdam, Germany, one week, December 2015.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Songs

Title: Simulation of Next Generation Systems

Program: Infra 13

Duration: January 2012 - December 2015

Coordinator: Inria (Nancy, Grenoble, Bordeaux)

Others partners: IN2P3 Villeurbanne, LSIIT Strasbourg, I3S Sophia-Antipolis, LINA Nantes

See also: http://infra-songs.gforge.inria.fr/

Abstract: SONGS (2012-2015) is the continuity of SIMGRID project (2009-2012), in the ANR INFRA program. The aim of SONGS is to continue the development of the SimGrid simulation platform for the study of large distributed architectures, including data grids, cloud computing facilities, peer-to-peer applications and HPC/exascale architectures.

8.1.2. FUI CloudForce (now OpenCloudWare)

Program: FSN, labelled by Minalogic, Systematic and SCS.

Duration: January 2012 - September 2015

Coordinator: France-Telecom Research

Others partners: ActiveEon, Armines, Bull, eNovance, eXo Platform, France Telecom (coordinator), Inria, IRIT-INP Toulouse, Linagora, OW2, Peergreen, Télécom Paris Tech, Télécom Saint Etienne, Thales Communications, Thales Services, Université Joseph Fourier, Université de Savoie - LISTIC, UShareSoft

See also: http://www.opencloudware.org/

Abstract: 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.

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) for their deployment, orchestration, performance testing, self-management (elasticity, green IT optimisation), and provisioning. Applications will be deployed potentially on multi IaaS (supporting either one IaaS at a time, or hybrid scenarios).The results of the project will be made available as open source components through the OW2 Open Source Cloudware initiative.

8.1.3. Oseo-Isis Spinnaker

Duration: June 2011 - September 2015

Coordinator: Tagsys-RFID

Others partners: SMEs: Inside-Secure, STIC, Legrand; Academic: IPG, ENS des Mines de St Etienne, Un. du Maine, Un, F. Rabelais Tours, AETS ESEO Angers, Un. Marne la Vallée, Un. Paris 6, Un. Rennes 1, Inria.

See also: http://www.spinnaker-rfid.com/

Abstract: The objective of Spinnaker is to really allow RFID technology to be widely and easily deployed. The role of the OASIS team in this project is to allow the wide scale deployment and management of the specific RFID application servers in the cloud, so to build an end-to-end robust and flexible solution using GCM technology.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. DC4Cities

Type: COOPERATION

Defi: FP7 Smartcities 2013

Instrument: Specific Targeted REsearch Project

Objectif: ICT-2013.6.2: Data Centers in an energy-efficientand environmentally friendly Internet

Duration: September 2013 - February 2016

Coordinator: Freemind Consulting (BE)

Partners: U. Mannheim (DE), U. Passau (DE), HP Italy Innovation Center (IT), Create-Net (IT), ENEA (IT), CESCA Catalunia (ES), Gas Natural SA (ES), Inst. Munic. Informatica Barcelona (ES), Inria (FR)

Inria contact: Eric Madelaine

See also:

Abstract: Data centres play two different and complementary roles in Smart Cities' energy policies: as ICT infrastructures supporting Smart City resource optimization systems - more in general, delivering ICT services to the citizens - and as large energy consumers. Therefore there are huge expectations on data centres being able to run at the highest levels of renewable energy sources: this is the great challenge of DC4Cities project.
The goal of DC4Cities is to make existing and new data centres energy adaptive, without requiring any modification to the logistics, and without impacting the quality of the services provided to their users. Finally new energy metrics, benchmarks, and measurement methodologies will be developed and proposed for the definition of new related standards. DC4Cities will promote the data centres role as an " eco-friendly" key player in the Smart Cities energy policies, and will foster the integration of a network of local renewable energy providers (also interconnected with local Smart Grids and Micro Grids) to support the pursued increase of renewable energy share.

8.2.2. Collaborations with Major European Organizations

Program: EIT Digital

Project acronym: Data Science programme, Activity 15 327 from Master School action line (MSL)

Project title: EIT Digital Data Science Master

Duration: submitted in 2014, funded from 2014 onwards

Coordinator: Farideh Heidari, Technische Universiteit Eindhoven

Other partners (besides UNS, with Françoise Baude as local coordinator): Univ. Politechnico Madrid, Univ. Trento, Politechnico Milano, Tech. Univ. Berlin, KTH

Abstract: The activity has successfully launched a new major for the EIT Digital KIC called "Data Science", with the purpose of breeding a new generation of ICT professionals, equipped with advanced technical and entrepreunarial skills in the key area of data science and data engineering. There is a tremendous demand in industry/society for data scientists, and hence a huge market potential for DS programs. DS positions in the industry requires a different educational program, with next to technical skills, more emphasis on awareness of multifaceted challenges and improving business efficiency based on the challenge outcomes. Expected impact is that DS graduates will be quickly recruited for attractive positions as they can help EU ICT industry achieve a higher rate of innovation successes.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. CIRIC Chili

Ciric research line: Telecommunications

Inria principal investigator: Eric Madelaine

Duration: 2012 - 2021

This CIRIC activity is loosely coupled with our (now terminated) SCADA associated team with the Universidad de Chile (UdC). We have some research collaboration with our chilean colleagues, in particular on new usages of the GCM component model for cloud management[7].

8.3.1.2. LIAMA Shanghai

Liama project: CASCADES

Inria principal investigator: Vania Joloboff

SCALE researchers involved: Eric Madelaine, Ludovic Henrio,

AOSTE researchers: Robert de Simone, Julien DeAntoni, Frederic Mallet

International Partner (Institution - Laboratory - Researcher):

> East China Normal University (ECNU) Shanghai - Software Engineering Institue - MOE International Lab of Trustworthy Software : Jifeng HE, Changbo WANG, Huibiao ZHU, Min ZHANG, Yixiang CHEN.

Duration: 2016 - 2017

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 Scale team is involved in particular, with our chinese partners, on studies of semantics and compositional properties, and on the development of software tools supporting the Model-Driven Engineering approaches.

This LIAMA project is tighly linked with our FM4CPS Associated team (Inria principal investigator: Robert de Simone, SCALE participants: Eric Madelaine, Ludovic Henrio, Oleksandra Kulankhina).

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

- Advanced Real-Time Simulation Laboratory, Carleton University, Ottawa Canada: collaboration on simulation methodology, the DEVS formalism, and SDN Networks [16], [8], [15]

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Alexandros Tsantilas. *Fuzzing a VM Scheduler*. Co-supervised by Ludovic Henrio. Master 2 Ubinet 2014-15

- Wafa Khlif. *How sustainable data centres can be ?* Co-supervised by Fabien Hermenier. Master 2 IFI 2014-15

- Mario Taddei. *An integrated system for building and running reproducible research*. Supervised by Olivier Dalle. Master 2 Ubinet, 2014-2015;

8.4.1.2. Research stays abroad

- Olivier Dalle visited Carleton University (Ottawa, Canada) for one month (Dec 2015 - Jan 2016)

- Eric Madelaine visited East China Normal University in Shanghai for 3 weeks (July and November)

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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 CLE** ($10/13 \rightarrow 12/15$)
  Cryptography from learning with errors
  ANR program: Jeunes Chercheurs, SIMI2
  Coordinator: Vadim Lyubashevsky (Inria, project-team Cascade)
  The aim of this project is to combine algorithmic and algebraic techniques coming from asymmetric and symmetric cryptology in order to improve some attacks and to design some symmetric primitives which have a good resistance to side-channel attacks.

- **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.

8.1.2. Others

- **French Ministry of Defense** ($10/12 \rightarrow 09/15$)
  Funding for the supervision of Audrey Tixier's PhD.
  30 kEuros.

- **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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. 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)
>
> 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 healthcare 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.

8.2.2. 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.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

Title: Discrete Mathematics, Codes and Cryptography

International Partner (Institution): Indian Statistical Institute, Kolkata (India)

Start year: 2014

This collaboration investigates the three following topics: Quantum information and cryptography; Design and maintenance of primitives for symmetric cryptography; Low-cost cryptography designs from coding theory and combinatorics.

8.3.1.2. 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Georgi Ivanov, Bulgarian Academy of Science, Sofia, Bulgaria, visiting PhD student (COST CryptoAction), Jan.-Feb. 2015
- Sumanta Sarkar, ISI Kolkata, India, visiting scientist, Feb.-March 2015
- Dimitrios Simos, SBA Research, Vienna, Austria, visiting scientist, July 2015
- Nastja Cepak, University of Primoska, Koper, Slovenia, visiting PhD student, from Sept. 2015.
- Enes Pasalic, University of Primoska, Koper, Slovenia, visiting scientist, Oct. 2015.

8.4.1.1. Internships

- Rodolfo Canto Torres, Univ. Bordeaux (M2), March-Aug. 2015
- Yann Rotella, MPRI and Telecom ParisTech (M2), March-Sept. 2015
- Aurélie Phesso, Univ. Bordeaux (M1), June-Aug. 2015
- Victoire Dupont de Dinechin, HEC (L3), June 2015

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Pascal Massart co-organizes a working group at ENS (Ulm) on statistical learning.

Gilles Celeux and Christine Keribin have a collaboration with the Pharmacoepidemiology and Infectious Diseases (PhEMI, INSERM) groups.

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 Seattle (USA).

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research stays abroad

Jean-Michel Poggi visited Anestis Antoniadis at the University of Cape Town (South Africa), Department of Statistical Sciences, 16-26 February 2015

SEMAGRAMME Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Participants: Maxime Amblard [coordinator], Philippe de Groote, Sylvain Pogodalla, Karën Fort.

SLAM: Schizophrenia and Language, Analysis and Modeling

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 SLAM project starts for three years at the Maison des Sciences de l'Homme de Lorraine (MSH–Lorraine, USR 3261). While this year work was dedicated to the test protocol definition, the coming years will be devoted to building an open-access corpus of pathological uses of language.

The first transcriptions of pathological interviews are analyses. The management chain was implemented for disfluencies and POS. Moreover, we have focused on implementing the treatment of lexicography issues and proposed an interface for SDRT-annotations.

Other participants are: Denis Apotheloz (ATILF, Université de Lorraine),Valérie Aucouturier (Centre Léo Apostel, Université Libre de Bruxelles), Katarina Bartkova (ATILF, Université de Lorraine), Fethi Bretel (CHS Le Rouvray, Rouen), Michel Musiol (InterPSY, Université de Lorraine), Manuel Rebuschi (Archives Poincaré, Université de Lorraine).

The SLAM project was supported by the MSH–Lorraine, USR 3261, and won a PEPS project HuMaIn (mission pour l'interdisciplinarité du CNRS). The CNRS part of the budget allowed the organization of the third workshop which gathers linguists, psychologists and computer scientists in December: http://discours. loria.fr.

The SLAM project was chosen for the bi-annual report of the CNRS MI as a major illustration.

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). 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.

The complexity of the phenomena, of their formal description, and of their interactions, require to set up a testing and development environment for linguistic modeling. It will consist in extending and stabilizing a software implementing the functionalities of the ACG framework. It will provide a tool for experimentation and validation of the approach.

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.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Sabbatical programme

Pogodalla Sylvain

   Date: Aug 2014 - Jul 2015
   Institution: HHU (Germany)

The objective of the research project dealt with studying the syntax-semantics interface. It was relying on two alternative approaches of this interface for mCSG: a unification based approach for Lexicalized Tree Adjoining Grammars (LTAG) [48], [49] as proposed in [44], [51], and a type-theoretic approach using Abstract Categorial Grammars (ACG) [6], [72], [73].

On the semantic side, the project focused on the modeling of quantification in Frame Semantics [40], [31], [59]. We proposed to use Hybrid Logic (HL) [27]. We developed a syntax-semantics interface with ACG to model scope ambiguity [18], as well as a syntax-semantics interface in LTAG for iterative events [23].

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[0]http://www.loria.fr/~pogodall/cauld/

SEQUEL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Participant: Olivier Pietquin.

- *Title*: Sniper, Guerrilla, Shark, Razor et les autres
- *Type*: PICTANOVO
- *Coordinator*: Association P.A.S. (Emmanuelle Grangier)
- *Duration*: 2015
- *Abstract*:

  "Sniper, Guerrilla, Shark et les autres" is an interactive physical setting as well as a choreographic performance for four dancers /performers and two types of robots behaving as a swarm (some of them flying, others being on the floor). The context is high frequency trading from which emerges a world where human performers and non-humanoid robots live together. Their behaviour are depending on the same basic rules working at a non-temporal scale and a macro-temporal scale of share prices fluctuation.

9.2. National Initiatives

9.2.1. 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 focused on how to effectively transfer knowledge from an external expert as in apprenticeship learning. This is an important step towards automatic transfer because it digs into the problem of how knowledge of an expert can be integrated into the learning process. This investigation led to the publication of two papers at IJCAI'15. In 2015 a number of activities has also started. Ronan Fruit has been recruited for a PhD started in December. The main focus of the PhD will be related to transfer in multi-armed bandit, in particular in systems which are non-stationary where the task can change multiple times. Pierre-Victor Chaumier will start a long internship on transfer in RL with focus on applications to Atari games. Romain Warlop started in July a Cifre PhD (co-supervised by A. Lazaric, J. Mary, and Ph. Preux) with focus on how to use transfer learning in recommendation systems. We expect these activities to significantly advance the research in the project within 2016.

9.2.2. 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.

9.2.3. 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).

9.2.4. National Partners

- Inria Bordeaux - Sud-Ouest
  - B.Piot and O.Pietquin worked with T.Munzer and M.Lopes on Inverse Reinforcement Learning with Relational Domains. It led to a publication in IJCAI 2015 [24].
- CentraleSupélec
  - B.Piot and O.Pietquin worked with M.Geist on Inverse Reinforcement Learning with Relational Domains and Dialogue Management. It led to a conference publication in IJCAI 2015 [24] and a workshop publication in MLIS 2015 [29].
- 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 ICML 2015 [28].
- CMLA - ENS Cachan.
  - Julien Audiffren *Collaborator*
    M. Valko, A. Lazaric, and M. Ghavamzadeh work with Julien on Semi-Supervised Apprenticeship Learning. We finalized and published a max-entropy algorithm that outperforms the approach without unlabeled data.
- LTCI, Institut Télécom-ParisTech, France.
  - Charanpal Dhanjal, Stefan Clemençon*Collaborator*
    Romaric Gaudel collaborates with Charanpal and Stefan since 2010 on topics related to *Matrix Factorization*. In the past we applied our work to sequential recommendation and to sequential clustering. This year, the collaboration has led to a publication in AAAI'15 conference [16].

9.3. European Initiatives

9.3.1. Collaborations in European Programs, except FP7 & H2020

9.3.1.1. CHIST-ERA IGLU

Participants: Olivier Pietquin, Bilal Piot, Jérémie Mary.

Program: CHIST-ERA

Project acronym: IGLU

Project title: Interactive Grounding of Language Generation

Duration: 10/2015 - 9/2018

Coordinator: Jean-Rouat (Univ. Sherbrooke)

Other partners: Univ. Lille, CRIStAL (France) - Inria, Flowers (France) - UMONS, Numédiart (Belgium) - KTH, TMH (Sweden) - Universidad de Zaragoza, I3A (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.

9.4. International Initiatives

9.4.1. Inria Associate Teams not involved in an Inria International Labs

9.4.1.1. CWI

In the end of 2015 SEQUEL started an Inria Associate team with CWI, Amsterdam. This project is called "Universal algorithms for sequential forecasting and bandit problems" and is led by Daniil Ryabko from the SEQUEL side, and by Peter Grunwald from the CWI side.

9.4.1.2. EduBand

Title: Educational Bandits

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Department of Computer Science, Theory of computation lab - Emma Brunskill

Inria investigators: A. Lazaric, M. Valko

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.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

9.4.2.1.1. Montanuniverstat Leoben

Montanuniverstat Leoben (MUL), Austria, is an international partner of SEQUEL. The work in 2015 has been mostly on representation learning in reinforcement learning. The partnership involves Ronald Ortner and Peter Auer on the MUL side.

9.4.2.2. 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.

+ Politecnico di Milano (Italy)

   Nicola Gatti *Collaborator*

   A. Lazaric finalized a work with N. Gatti on the application of MAB on sponsored search auctions and mechanism design.

+ Universität Potsdam (Germany)

   Alexandra Carpentier *Collaborator*

   M. Valko collaborates with A. Carpentier on scaling bandits to large dimensions and structures.

+ Adobe Research, California

   Branislav Kveton *Collaborator*
   M. Valko and B. Kveton collaboration for sequential learning at recommendation for the entertainment content that features diversity.

+ Boston University, USA

   Venkatesh Saligrama *Collaborator*
   M. Valko, R. Munos collaborated with V. Saligrama and M. Hanawal, on cost-effective spectral sensing, useful in radars.

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Sabbatical programme

Ryabko Daniil

Date: Jan 2014 - Jan 2015

Institution: CMM (Chile)

9. Partnerships and Cooperations

9.1. Regional Initiatives

GT Elfic (Labex DigiCosme, 2014–2016): "Programmes d'éléments finis formellement vérifiés", with TOCCATA (Inria Saclay - Île-de-France), CEA LIST, LIPN (Université de Paris 13), and LMAC (Université de Technologie de Compiègne).

The research on a posteriori error estimates, unified frameworks, robustness, adaptivity, and stopping criteria of M. Vohralík was carried out with Alexandre ERN from CERMICS, Ecole Nationale des Ponts et Chaussées, see [14], [24].

A posteriori error estimates for eigenvalue problems were derived in collaboration with Geneviève DUSSON, Yvon MADAY, and Benjamin STAMM from the Laboratoire Jacques-Louis Lions and Eric CANCÈS, CERMICS, see [21] and [22].

A posteriori error estimates for problems with sign-changing coefficients describing electromagnetism for interfaces between dielectrics and negative metamaterials have been derived in collaboration with P. Ciarlet from the project-team POEMS, see [23].

9.2. National Initiatives

9.2.1. ANR

ANR GEOPOR: "Geometrical approach for porous media flows: theory and numerics", with Laboratoire Jacques-Louis Lions (University Paris VI).

ANR MANIF: "Mathematical and numerical issues in first-principle molecular simulation", with CERMICS (Ecole Nationale des Ponts et Chaussées), and Laboratoire Jacques-Louis Lions (University Paris VI).

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. 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 partners are HIEPACS, Laboratoire Analyse, Géométrie et Application, Maison de la Simulation, and ANDRA. The coordiinator of the project is M. Kern.

C2S@Exa (Computer and Computational Sciences at Exascale)   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 supports in particular the Ph.D. of N. Birgle (supervised by. J. Jaffré) which is part of an Inria-Andra collaboration.

9.2.2. FUI

Projet P (2011–2015) is funded by the French FUI (*Fonds Unique Interministériel*). Project P aims at supporting the model-driven engineering of high-integrity embedded real-time systems by providing an open code generation framework. The contribution of team Serena is in the domain of language translation and block-schema modelization semantics. This project supports the work of C. Franchini, under the supervision of P. Weis.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, except FP7 & H2020

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

Other partners: Institute of Mathematics, Academy of Sciences of the Czech Republic; Oxford Centre for Nonlinear Partial Differential Equations, Great Britain.

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, see http://more.karlin.mff.cuni.cz/.

9.4. International Initiatives

9.4.1. Participation In International Programs

Serena is part of the EuroMediterranean 3+3 program with the project HYDRINV (2012–2015): Direct and inverse problems in subsurface flow and transport. Besides Inria, institutions participating in this project are: Universitat Politècnica de Catalunya (Barcelona, Spain), Universidad de Sevilla (Spain), École Mohamedia d'Ingénieurs (Rabat, Morocco), Université Ibn Tofaïl (Kenitra, Morocco), University Centre of Khemis Miliana (Algeria), and École Nationale d'Ingénieurs de Tunis (Tunisia).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Josef Málek, professor, Mathematical Institute, Charles University in Prague. February 2–6, 2015.

Iuliu Sorin Pop, professor, Department of Mathematics and Computer Science, Eindhoven University of Technology. March 2–6, 2015.

H. Ben Ameur, professor at IPEST and member of ENIT-Lamsin, Tunis, Tunisia. November 9–20, 2015.

Carol Woodward, computational mathematician in the Center for Applied Scientific Computing (CASC) at Lawrence Livermore National Laboratory, USA, December 4, 2015.

SERPICO Project-Team

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.

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.

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

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. Inria International Partners

9.4.1.1. Informal International Partners

Collaboration with UT Southwestern Medical Center, Dallas (TX), Prof. Gaudenz Danuser: Object tracking in video-microscopy.

Collaboration with Max-Planck Institute, Martinsried (Germany), Dr. Julio Ortiz: Detection and segmentation of macromolecules in cryo-electron tomography.

Collaboration with Aalborg University (Denmark), Prof. Jesper Møller: Modeling aggregation on the large scale and regularity on the small scale in spatial point pattern datasets (visit of Frédéric Lavancier from 26-30 January 2015).

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR: Calibration

Participant: Sylvain Arlot.

Titre: Statistical calibration

Coordinator: University Paris Dauphine

Leader: Vincent Rivoirard

Other members: 34 members, mostly among CEREMADE (Paris Dauphine), Laboratoire Jean-Alexandre Dieudonné (Université de Nice) and Laboratoire de Mathématiques de l'Université Paris Sud

Instrument: ANR Blanc

Duration: Jan 2012 - Dec 2015

Total funding: 240 000 euros

Webpage: https://sites.google.com/site/anrcalibration/

9.1.2. CNRS: BeFast

Participant: Sylvain Arlot.

Titre: BeFast

Coordinator: University Lille 1

Leader: Alain Celisse

Other members: Tristan Mary-Huard, Guillem Rigaill, Guillemette Marot, and Julien Chiquet.

Instrument: PEPS

Duration: Mar 2015 – Dec 2015

Total funding: 9 000 euros

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. SIPA

Type: FP7

Defi: NC

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.

9.2.1.2. SpaRTaN

Title: Sparse Representations and Compressed Sensing Training Network

Type: FP7

Defi: NC

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

9.2.1.3. 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.

9.3. International Research Visitors

9.3.1. *Visits of International Scientists*

Visit from Chiranjib Bhattacharyya, Indian Institute of Science, Bangalore, May 2014.

9.3.1.1. Internships

Visit from Raman Sankaran, Indian Institute of Science, Bangalore, January 2014.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

- T. Maugey has received a grant for scientific intallation from Rennes Metropole.
- The postdoc of Xin Su on multi-view data representation and compression is partly funded (at the level of 75%) by the Brittany region.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

- The study on guided image inpainting is carried out in collaboration with Prof. Pascal Frossard from EPFL (Ecole Polytechique Federal de Lausanne).
- The study on adaptive clustering with Kohonen self-organizing maps for second-order prediction has been carried out in collaboration with Prof. Philippe Salembier from UPC (Universitat Politecnica De Catalunya).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Pr. Reuben Farrugia from Malta University, is spending one sabbatical year in the team from Sept. 2015 until August 2016.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

The team have strong links with Bordeaux CHU ("Centre Hospitalier Universitaire").

8.2. National Initiatives

8.2.1. Labex Vaccine Research Institute (VRI)

There are strong collaborations with immunologists involved in the Labex Vaccine Research Institute (VRI) as RT is leading the Biostatistics/Bioinformatics division.

8.2.2. Expert Appraisals

Expertise of a project for Institut de Recherche en Santé Publique IRESP (MA)

RT is a member of the scientific advisory board of the Ebola VSV ring trial (published in New England Journal of Medicine in August 2015) and of the Pierre Louis Institute of Epidemiology and Public Health (Paris)

RT is a member of the Systems biology and cancer comity (Plan Cancer)

8.2.3. Partnership with the french swimming federation

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 ?"

8.2.4. Partnership with ANSM

DRUGS-SAFE platform funded by ANSM.

8.3. European Initiatives

8.3.1. 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: Rdolphe 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.

8.4. International Initiatives

8.4.1. Participation In International Programs

RT is participating to the EUROCOORD network on HIV cohort collaborations as :
a member of the scientific committee of IWHOD International Workshop on HIV Observational Databases from 2013,
a project leader on defining references for the CD4 count response to antiretrovirals.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

David Conesa (Associate Professor of Biostatistics, "Spatial and Temporal Statistics in Epidemiology and Environment" Research Group, Universitat de Val encia, Spain) visited the team through the Erasmus+ program.

Following the RHOMEO project (ANR-BBSRC Systems biology 2007 call, 2007-2011) steered by RT, a strong collaboration has been established with Pr Robin Callard (UCL Immunology) who is visiting the team in Bordeaux one month each year, Andy Yates (Physicists, Glasgow Univ) and Ben Seddon (NIMR, UCL Immunology).

Also, several other international collaboration have been initiated through the Labex:
Raphael Gottardo, Zoe Moodie, Steve Self in Seattle (HVTN HIV vaccine Trial Network, Fred Hutchinson cancer centre)
Marcus Altfeld (Immunologists, Hambourg & Harvard).

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

BL was on sabbatical in Queensland University, Australia until Sep 2015.

8.5.2.2. Research stays abroad

Chloé Pasin visited (from 11/10/14 to 10/04/15) Steve Self at HVTN, Seattle.

Chariff Alkhassim (from 07/04/15 to 10/04/15) visited François Caron at Oxford University, United-Kingdom.

MA (from 24/02/15 to 10/03/15) and 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".

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR KISS (Dec. 2011 - Dec. 2015)

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.

8.1.2. CAPPRIS Project-Lab (Dec. 2011 - Dec. 2015)

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.

8.1.3. CityLab@Inria, Inria Project Lab (May 2014 -).

Inria Partners: ARLES-MIMOVE, CLIME, DICE, FUN, MYRIADS, OAK, 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/

8.1.4. 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 align="center">**SOCRATE Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Equipex FIT- Future Internet of Things (2011-..., 1.064 keuros)

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 should be used as test-bed for SDR terminals and cognitive radio experiments. This should be operational in 2013 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 - Cormoran - "Cooperative and Mobile Wireless Body Area Networks for Group Navigation" (2012-2015, 150 keuros)

Cormoran project targets to figure out innovative communication functionalities and radiolocation algorithms that could benefit from inter/intra-BAN cooperation. More precisely, the idea is to enable accurate nodes/body location, as well as Quality of Service management and communications reliability (from the protocol point of view), while coping with inter-BAN coexistence, low power constraints and complying with the IEEE 802.15.6 standard. The proposed solutions will be evaluated in realistic applicative scenarios, hence necessitating the development of adapted simulation tools and real-life experiments based on hardware platforms. For this sake, Cormoran will follow an original approach, mixing theoretical work (e.g. modelling activities, algorithms and cross-layer PHY/MAC/NWK design) with more practical aspects (e.g. channel and antennas measurement campaigns, algorithms interfacing with real platforms, demonstrations).

8.1.3. ANR - MetalibM - "Automatic Generation of Function and Filters" (2014-2017, 200 keuros)

The goal of the Metalibm 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).

8.1.4. FUI SMACS - "SMart And Connected Sensors" (2013-2016, 267 keuros)

The SMACS projet 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)

8.1.5. ADT Sytare (Développement d'un SYsTème embArqué faible consommation à mémoiRE persistante) ADT Inria 2015-2017

The SYTARE project 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.

8.1.6. ADT CorteXlab, ADT Inria 2015-2017

The Socrate project-team is in charge of the FIT/CorteXlab platform (section 5.6). This platform 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.

8.1.7. Taiwan III - research proposal on 5G M2M 2015-2016

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 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. This document described in more detail the research proposal.

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 - Marie Skłodowska-Curie Actions - Individual Fellowships

Duration: June 2015 - June 2017

Coordinator: Inria

Recipient: Samir 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.

8.3. International Initiatives

8.3.1. CoWIN

Title: CoWin: Cognitive Wireless Networks from Theory to Implementation

International Partners:

Princeton University (N.J., United States) - School of Engineering and Applied Science - Prof. H. Vincent Poor

Rutgers University (N.J., United States) - Winlab - Dr. Ivan Seskar.

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.

8.3.2. Inria International Partners

8.3.2.1. 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 Perlaza has been appointed as Visiting Research Collaborator at the EE Department for the academic period 2016-2017. Scientific-Leaders at Inria: Samir Perlaza and Jean-Marie Gorce.

- **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 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 Perlaza.

- **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 Perlaza.

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- **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 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.

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

Prof. Ioannis Krikidis from the Department of Electrical and Computer Engineering, University of Cyprus, was appointed as Visiting Professor at the Department of Telecommunications at the INSA de Lyon hosted at the CITI Lab by Samir Perlaza.

Prof. Guiseppe Durisi from the Chalmers University of Technology, Sweden was visiting our group and delivered the following talk: "Towards Low-Latency Wireless Communications: The Art of Sending Short Packets".

Prof. Michèle Wigger from Télécom ParisTech, France, was visiting our group and delivered the following talk: "New Results on Cache-Aided One-to-Many Compression and Communication"

Prof. Albert Guillén i Fabregas from Universitat Pompeu Fabra, Spain, was visiting our group and delivered the following talk: "Hypothesis Testing and Error Probability in Information Theory"

Prof. Iñaki Esnaola from University of Sheffield, UK was visiting our group and delivered the following talk: "The Impact of Prior Knowledge in Data Injection Attacks"

Ivan Seskar from Rutgers University, USA was visiting our group and delivered the following talk: "ORBIT Testbed"

8.4.2. *Visits to International Teams*

Samir Perlaza was visiting the Department of Automatic Control and Systems Engineering at the University of Sheffield, UK, hosted by Prof. Iñaki Esnaola.

Samir Perlaza was visiting the Department of Electrical and Electronic Engineering at Imperial College London, UK hosted by Prof. Deniz Gunduz.

Yasser Fadlallah was visiting the Department of Electrical and Telecommunications Engineering at the University of Naples Federico II, hosted by Prof. Antonia M. Tulino .

Jean-Marie Gorce was visiting the Electrical Departement at Princeton university, hoster by Prof. Vincent Poor Dean of School of Engineering and Applied Science of Princeton University.

Tanguy Risset and Leonardo Sampaio Cardoso were visiting the Winlab research lab at Rutgers University, hosted by Ivan Seskar Associate Director of Information Technology of Winlab.

<div align="center">

SPADES Project-Team

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8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

8.1.1.1. REVER (ANR project)
Participant: Jean-Bernard Stefani.

The REVER project aims to develop semantically well-founded and composable abstractions for dependable distributed computing on the basis of a reversible programming model, where reversibility means the ability to undo any program execution and to revert it to a state consistent with the past execution. The critical assumption behind REVER is that by combining reversibility with notions of compensation and modularity, one can develop systematic and composable abstractions for dependable programming.

The REVER work program is articulated around three major objectives:

- To investigate the semantics of reversible concurrent processes.
- To study the combination of reversibility with notions of compensation, isolation and modularity in a concurrent and distributed setting.
- To investigate how to support these features in a practical (typically, object-oriented and functional) programming language design.

The project partners are Inria (FOCUS and SPADES teams), Université de Paris VII (PPS laboratory), and CEA (List laboratory). The project ended in November 2015.

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 actively participates 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.

8.3. International Initiatives

8.3.1. *Inria International Labs*

Inria@SiliconValley
Associate Team involved in the International Lab:

8.3.1.1. RIPPES

Title: RIgorous Programming of Predictable Embedded Systems

International Partner (Institution – Laboratory – Researcher):

University of California Berkeley (United States) – Electrical Engineering and Computer Science Department (EECS) – Edward Lee

University of Auckland (New Zealand) – Electrical Computer Engineering Department (ECE) – Partha Roop

Start year: 2013

See also: https://wiki.inria.fr/rippes

The RIPPES associated teams gathers the SPADES team from Inria Grenoble Rhône-Alpes, the PTOLEMY group from UC Berkeley (EECS Department), and the Embedded Systems Research group from U. of Auckland (ECE Department). The planned research seeks to reconcile two contradictory objectives of embedded systems, more predictability and more adaptivity. We have addressed these issues by exploring two complementary research directions: (1) by starting from a classical concurrent C or Java programming language and enhancing it to provide more predictability (see Section 6.2.1), and (2) by starting from a very predictable model of computation (SDF) and enhancing it to provide more adaptivity (see Section 6.2.3).

8.3.2. Inria Associate Teams not involved in an Inria International Labs

8.3.2.1. 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

- Atena 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).

<p align="center">**SPECFUN Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

> **ParalITP** (ANR-11-INSE-001).
> Goal: Improve the performances and the ergonomics of interactive provers by taking advantage of modern, parallel hardware.
> Leader: B. Wolff (University of Orsay, Paris Paris-Sud). Participants: A. Mahboubi, C. Tankink.
> Website: http://paral-itp.lri.fr/.
>
> **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: A. 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.

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- David Dos Santos Ferreira is the coordinator (PI) of a Young Researcher Programme of the French National Research Agency (ANR) :
  Project Acronym : iproblems
  Project Title : Inverse Problems
  Duration : 48 months (2013-2017)
  Abstract: Inverse problems is a field in full expansion as shown by the numerous resident programs hosted in the different research institutes throughout the world, several striking breakthroughs achieved in the recent years and the flow of PhD students attracted by the subject. Strong groups and schools have appeared in Finland, the United States and Japan. In spite of its history in Analysis and Partial differential equations (in particular in microlocal analysis and control theory, both fields having strong interactions with Inverse Problems), the emergence of an organised group of mathematicians interested in the theoretical aspects of inverse problems has not yet occured in France. The ambition of this proposal is to structure a core of analysts with a strong interest in this field, to help them investigate several central questions related to geometric and analytic inverse problems, and to favor interactions between them, as well as with foreign partners and experts in the field.
  Inverse problems deal with the recovery of an unknown quantity, typically a coefficient in a partial differential equation, from knowledge of specific measurements, for instance the Cauchy data on the solutions of the given equation. They are motivated by applications to Physical Sciences but give rise to many interesting and challenging mathematical problems which lie at the crossroad of analysis (partial differential equations, harmonic and microlocal analysis, control theory, etc.) and geometry (Riemannian and Lorentzian geometries). This project mainly focuses on Caldero´n's inverse conductivity problem and other closely related geometric and analytic problems. In particular, it aims at investigating identifiability issues for anisotropic problems, but also in the case where only partial data is available, as well as stability issues for those problems. It will also consider injectivity problems on geodesic ray transforms.

- 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
  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
  Duration: 48 months (starting on october 15th, 2013)
  URL: http://bond.math.cnrs.fr

9.2. International Initiatives

9.2.1. Informal International Partners

Most of the SPHINX members are involved in long term cooperation with international partners. The most important one at this time is our informal partnership with Université de Liège (Belgium). In particular, the recently released software program GetDDM, is based on the paper [25] co-authored by Xaver Antoine and Christophe Geuzaine.

<p style="color:red; text-align:center">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 granted 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 eSurgeon
Participants: Maxime Colmant, Loïc Huertas, Romain Rouvoy [correspondant].

ADT eSurgeon (2013–15) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of the POWERAPI software library (see Section 6.2) for measuring and monitoring the energy consumption of middleware and software systems.

9.1.2.2. 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.

9.1.2.3. North European Lab LLEX
Participants: Benoit Cornu, 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. North European Lab SOCS
Participants: Maria Gomez Lacruz, Christophe Ribeiro, Romain Rouvoy [correspondant], Lionel Seinturier.

North European Lab SOCS (2013–15) is an international initiative supported by the Inria Lille - Nord Europe Center that takes place in the context of a well-established collaboration between Inria and *Universitetet i Oslo* (UiO) initiated in 2008. SOCS (Self-Optimization of Cyber-physical Systems) focuses on the self-optimization issues in cyber-physical systems. Cyber-Physical Systems (CPS) are complex systems-of-systems that blend hardware and software to fulfill specific missions. However, traditional CPS are statically configured to achieve predefined goals, which not only limit their sharing and their reuse, but also hinder their sustainability. We believe that this waste of resources stems from the lack of agility of CPS to adapt to change in their environment or objectives. The SOCS Inria Lab takes advantage of the technologies developed as part of the APISENSE$^{®}$ crowd-sensing platform (see Section 6.1) to leverage the development of agile CPS.

9.1.2.5. 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 Hermes
Participants: Laurence Duchien, Romain Rouvoy, Lionel Seinturier [correspondant].

Hermes is a 41-month project funded by FUI and labelized by the PICOM (Pôle des Industries du COMmerce) competitivity cluster which has started in August 2012. The partners are Norsys (leader), Keynosoft, Numsight, Cylande, Auchan, Brand Alley, Kiabi, Leroy Merlin, Univ. Lille 1, LIPN, LITIS. The goal of the project is to define a modular and context-aware marketing platform for the retail industry. The focus is put on the interactions with customers in order to extract and mine relevant informations related to shopping habits, and on a multi-device, cross-canal, approach to better match customer usages.

9.2.3. Programme Investissement d'Avenir (PIA)

9.2.3.1. PIA Datalyse
Participants: Filip Krikava, 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: Clive Ferret-Canape, Julien Duribreux, Maria Gomez Lacruz, Christophe Ribeiro, 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.

9.2.5. Other National Initiatives

9.2.5.1. ADEME Web Energy Archive 2
Participants: Maxime Colmant, Loïc Huertas, Filip Krikava, Romain Rouvoy [correspondant], Lionel Seinturier.

Web Energy Archive 2 (WEA2) is a 12-month project funded in 2015 by ADEME. The purpose of the project is to define innovative solutions for measuring the energy consumption of web sites as experienced by users. The output of the project can be consulted on http://webenergyarchive.com where web sites are ranked based on their energy profile (from A to G, where A denotes web sites that are the more energy friendly). This project contributes to the development of our PowerAPI library (see Section 6.2).

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 [correspondant], Romain Rouvoy, Lionel Seinturier.

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], Matias Martinez.

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. Inria International Partners

9.4.2.1. Declared Inria International Partners

9.4.2.1.1. University of Los Andes, Bogota, Colombia

We have a long term collaboration since 2005 with this university. Over the years, four PhD thesis (Carlos Noguera, Carlos Parra, Daniel Romero Acero, Gabriel Tamura) have been defended in our team with students who obtained their MSc in this university. The first three were full French PhD, whereas the last one was a co-tutelle with this university. Professor Rubby Casallas from University of Los Andes is frequently visiting our team. The most recently defended PhD thesis, that of Gabriel Tamura, deals with QoS (quality-of-service) contract preservation in distributed service-oriented architectures. A formal theory to perform, in a safe way, the process of self-adaptation in response to quality-of-service (QoS) contracts violation has been proposed. The results have been published in [90], [88] and in the PhD thesis document itself [87].
Participants: Laurence Duchien [correspondant], Daniel Romero Acero, Romain Rouvoy, Lionel Seinturier.

9.4.2.1.2. University of Oslo, Norway

The scientific collaboration with this international partner deals with complex distributed systems that have to seamlessly adapt to a wide variety of deployment targets. This is due to the fact that developers cannot anticipate all the runtime conditions under which these systems are immersed. A major challenge for these software systems is to develop their capability to continuously reason about themselves and to take appropriate decisions and actions on the optimizations they can apply to improve themselves. This challenge encompasses research contributions in different areas, from environmental monitoring to real-time symptoms diagnosis, to automated decision making. The collaboration has been supported by the SEAS Inria associated team (2012-14).
Participants: Maria Gomez Lacruz, Daniel Romero Acero, Romain Rouvoy [correspondant], Lionel Seinturier.

9.4.3. Participation In other International Programs

9.4.3.1. STIC AmSud - Project MineAPI

Participants: Benoit Cornu, Maria Gomez Lacruz, Matias Martinez, 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 the Inria/Lille1 project-team 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

9.5.1.1. Internships

Mayank Gupta

Date: May 2015 - Jul 2015

Institution: Indian Institute of Technology Delhi (India)

Supervisor: Romain Rouvoy

Spyros Lalos

Date: August 2015 - October 2015

Institution: Technical University Munich (Germany)

Supervisor: Romain Rouvoy

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. 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.

9.1.1.2. 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.

9.1.2. Investment of Future

9.1.2.1. Az@GAME

Program: DGCIS

Project acronym: Az@GAME

Project title: Medical diagnosis aid tool for Alzheimer desease and similar pathologies (un outil d'aide au diagnostic médical sur l'évolution de la maladie d'Alzheimer et les pathologies assimilées).

Duration: January 2012- December 2015

Coordinator: Groupe Genious

Other partners: IDATE (FR), Inria(Stars), CMRR (CHU Nice) and CobTek(Nice University).

See also: http://www.azagame.fr/

Abstract: This French project aims at providing evidence concerning the interest of serious games to design non pharmacological approaches to prevent dementia patients from behavioral disturbances, most particularly for the stimulation of apathy.

9.1.3. FUI

9.1.3.1. 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.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. CENTAUR

Title: Crowded ENvironments moniToring for Activity Understanding and Recognition

Programm: FP7

Duration: January 2013 - December 2016

Coordinator: Honeywell

Partners:

> Computer Vision Laboratory, Ecole Polytechnique Federale de Lausanne (Switzerland)
>
> honeywell, Spol. S.R.O (Czech Republic)
>
> Data Centric Technologies Group, Neovision Sro (Czech Republic)
>
> Centre for Intelligent Sensing, Queen Mary University of London (United Kingdom)

Inria contact: François Brémond

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.

9.2.1.2. PANORAMA

Title:Ultra Wide Context Aware Imaging

Programm: FP7

Duration: April 2012 - March 2015

Coordinator: Philips

Inria contact: François Brémond

PANORAMA aims to research, develop and demonstrate generic breakthrough technologies and hardware architectures for a broad range of imaging applications. For example, object segmentation is a basic building block of many intermediate and low level image analysis methods. In broadcast applications, segmentation can find people's faces and optimize exposure, noise reduction and color processing for those faces; even more importantly, in a multi-camera setup these imaging parameters can then be optimized to provide a consistent display of faces (e.g., matching colors) or other regions of interest. PANORAMA will deliver solutions for applications in medical imaging, broadcasting systems and security & surveillance, all of which face similar challenging issues in the real time handling and processing of large volumes of image data. These solutions require the development of imaging sensors with higher resolutions and new pixel architectures. Furthermore, integrated high performance computing hardware will be needed to allow for the real time image processing and system control. The related ENIAC work program domains and Grand Challenges are Health and Ageing Society - Hospital Healthcare, Communication & Digital Lifestyles - Evolution to a digital lifestyle and Safety & Security - GC Consumers and Citizens security.

9.2.1.3. DEM@CARE

Title: Dementia Ambient Care: Multi-Sensing Monitoring for Intelligent Remote Management and Decision Support

Type: FP7

Defi: Cognitive Systems and Robotics

Instrument: Industry-Academia Partnerships and Pathway

Objective: development of a complete system providing personal health services to persons with dementia

Duration: November 2011-November 2015

Coordinator: Centre for Research and Technology Hellas (G)

Other partners: Inria Sophia-Antipolis (FR); University of Bordeaux 1(FR); Cassidian (FR), Nice Hospital (FR), LinkCareServices (FR), Lulea Tekniska Universitet (SE); Dublin City University (IE); IBM Israel (IL); Philips (NL); Vistek ISRA Vision (TR).

Inria contact: François Brémond

Abstract: The objective of Dem@Care is the development of a complete system providing personal health services to persons with dementia, as well as medical professionals, by using a multitude of sensors, for context-aware, multiparametric monitoring of lifestyle, ambient environment, and health parameters. Multisensor data analysis, combined with intelligent decision making mechanisms, will allow an accurate representation of the person's current status and will provide the appropriate feedback, both to the person and the associated medical professionals. Multi-parametric monitoring of daily activities, lifestyle, behavior, in combination with medical data, can provide clinicians with a comprehensive image of the person's condition and its progression, without their being physically present, allowing remote care of their condition.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. Informal International Partners

9.3.1.1.1. 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.

9.3.1.1.2. Collaboration with U.S.A.:

Stars collaborates with the University of Southern California.

9.3.1.1.3. Collaboration with Europe:

Stars collaborates with Multitel in Belgium, the University of Kingston upon Thames UK, and the University of Bergen in Norway.

9.3.1.2. Other IIL projects

The ANR SafEE (see section 9.1.1.2) 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).

9.4. International Research Visitors

9.4.1. 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;
- Jesse Hoey, University of Waterloo, Canada;
- Adlen Kerboua, University of Skikda, Algeria;
- Caroala Strumia, University of Genova, Italy.

9.4.1.1. Internships

Ujjwal Ujjwal

Date: June 2015 - Nov 2015

Institution: International Institute of Information, Hyderabad (India)

Supervisor: François Brémond

Ghada Bahloul

Date: Jul 2015 - Sept 2015

Institution: Ecole Polytechnique de Sousse (Tunisia)

Supervisor: Rachid Guerchouche

Kanishka Nithin Dhandapani

Date: June 2015 - Nov 2015

Institution: IIT Madras (India)

Supervisor: Carlos Fernando Crispim Junior

Ramiro Leandro Diaz

Date: Jul 2015

Institution: UNICEN, Buenos Aires, Argentina

Supervisor: Carlos Fernando Crispim Junior

Alvaro Gomez Uria Covella

Date: Jan 2015 - Apr 2015

Institution: Universidad Nationale de Rosario, Argentina

Supervisor: Carlos Fernando Crispim Junior

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

Piotr Bilinski

- Date:Apr 2015- Aug 2015
- Institution: Honeywell, Spol. S.R.O (Czech Republic)

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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.

8.1.2. 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.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

REGION AQUITAINE - CEA   The Aquitaine Region Council together with CEA is funding PhD thesis of Marc Sergent (2013-2016) on Scalability for Task-based Runtimes

Labex CPU   The Labex CPU local cluster from the University of Bordeaux is funding the engineer position of Adrien Cassagne (2015-2016) to explore the optimization Error Correction Code (ECC) algorithms and simulation chains from IMS Laboratory using STORM software and expertize, for designing the upcoming 5G mobile phone communication technology.

9.2. National Initiatives

9.2.1. 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.

9.2.2. 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.

9.2.3. 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).

9.2.4. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. 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.

9.3.1.2. Mont-Blanc 2

Title: Programming Model INTERoperability ToWards Exascale

Programm: H2020

Duration: Sep. 2013 - Sep. 2016

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.

9.3.2. Collaborations with Major European Organizations

PRACE (Europe): Two-days training session on runtime systems, as part of the Prace Advanced Training Center Program (together with *La Maison de la Simulation*).

9.4. International Initiatives

9.4.1. Inria Associate Teams not involved in an Inria International Labs

MORSE   Matrices Over Runtime Systems at Exascale
  – Inria Associate-Teams program: 2011-2016
  – Coordinator: Emmanuel Agullo (Hiepacs)
  – Parners: Inria (Runtime & Hiepacs), University of Tennessee Knoxville, University of Colorado Denver and KAUST.

– Abstract: The Matrices Over Runtime Systems at Exascale (MORSE) associate team has vocation 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. With Inria Hiepacs, University of Tennessee, Knoxville and University of Colorado, Denver.

SUMO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

ANR VACSIM: Validation of critical control-command systems by coupling simulation and formal analysis, 2011-2015, web site
Partners: EDF R&D, Dassault Systèmes, LURPA, I3S, LaBRI, and Inria SUMO.
The project aims at developing both methodological and formal contributions for the simulation and validation of control-command systems. SUMO contributes to quantitative analysis and its application to testing, monitoring of timed systems, and verification of communicating timed automata.

ANR Ctrl-Green: Autonomic management of green data centers, 2011-2014, web site
Partners: UJF/LIG, INPT/IRIT, Inria SUMO, EOLAS, Scalagent.
This project aims at developing techniques for the automatic optimal management of reconfigurable systems in the context of data centers using discrete controller synthesis methodology applied in the synchronous paradigm.

ANR STOCH-MC: Model-Checking of Stochastic Systems using approximated algorithms, 2014-2018, web 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.

9.1.2. National informal collaborations

We collaborate with Yliès Falcone (VaSCO - LIG) and Antoine Rollet (Labri) on the enforcement of timed properties.

We collaborate with Arnaud Sangnier (LIAFA) on the parameterized verification of probabilistic systems.

We collaborate with B.Bérard (LIP6) on problems related to security.

We collaborate with 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/)

9.2. International Initiatives

9.2.1. Inria International Labs

Éric Badouel is member of the team Aloco (Architecture logicielle à composants) of LIRIMA, the Inria International Lab in Africa. This collaboration is on the development of artifact-centric business process models.

9.2.2. Inria Associate Teams not involved in an Inria International Labs

9.2.2.1. DISTOL

Title: Distributed systems, stochastic models and logics

International Partner (Institution - Laboratory - Researcher):

CMI (India) - Madhavan Mukund

Start year: 2013

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

The context of this project is formal modeling, and analysis of behaviors of distributed systems. We want to address verification and supervision of distributed systems through formal modeling and automated reasoning on models. By distributed systems, we mean software architectures made of several independent communicating entities. In the 90?s the kind of system addressed was mainly telecommunication protocols. Nowadays, distributed systems are frequently web-based systems such as Web Services, but several aspects of distributed systems can be found in biological applications. Within this context, a challenge is to propose formal tools with potential applications to real systems. We want to address this challenge along three main axes: The first one is realism of models. Models are often an abstraction of real systems. We want to build and study properties of models that are close enough from their implementations, and with robust properties. By robustness, we mean that properties checked on a model (for instance safety properties) should still hold for implementations of this model. The second one is quantitative analysis of systems. Rather that considering boolean answers to formal properties, one can consider the probability that such property holds on a run of the system, and return answers of probabilistic form ("almost surely, a call to a service is successful") or quantitative ("the average failure rate is lower than 0.01"). One possibility to obtain a probability is to compute its exact value. Such questions have answers for markovian models and some quantitative logics (PCTL). However, such computations are expensive, and one can divide the problem into sub-components at the cost of some approximation. We plan to develop efficient algorithms for quantitative analysis of systems. The third one is unification of control theories. There are many proposals for supervisory control, including distributed control with communications. However, none of them seems fully satisfactory. We want to consider connections between control theory, epistemic reasoning (which seems to solve some problems raised by communications between local supervisors), and game theory (which emphasizes the notion of goal to be achieved in a problem), and give a unified framework for supervision of distributed systems.

9.2.3. Inria International Partners

9.2.3.1. 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.

In the context of LIRIMA, the Inria International Lab in Africa, we have strong collaborations with University of Yaoundé I on an artifact-centric model of workflow system based on guarded attribute grammars. In particular with the co-supervision of the PhD thesis of Robert Nsaibirni.

We collaborate with Laurie Ricker (Mount Allison University, Canada) on the control of distributed systems and the enforcement of opacity

9.2.4. Participation In other International Programs

AVeRTS is an Indo-French project on the algorithmic verification of real-time systems. The project is funded by CNRS on the french side, and by DST on the Indian side, under the CEFIPRA - Indo-French Program in ICST 2014-2016. From SUMO, Nathalie Bertrand and Blaise Genest are involved and contribute on stochastic games. In the context of this project, Miheer Dewaskar, a CMI (Chennai Mathematical Institute) master student did an internship in our team on the control of a population of Markov decision processes.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

S. Akshay visited the SUMO team for three weeks in May 2015.

Robert Nsaibirni (University of Yaoundé) visited SUMO from March to May 2015 on the use of the Guarded Attribute Grammar formalism for the description of the workspaces of actors of a disease surveillance system.

9.3.1.1. Internships

Achille Aknin

Date: May 2015 - July 2015

Institution: ENS Ulm (France)

Alexandre Blanche

Date: May 2015 - July 2015

Institution: ENS Rennes (France)

Miheer Dewaskar

Date: May 2015 - July 2015

Institution: Chennai Mathematical Institute (India)

André Gueney

Date: April 2015 - September 2015

Institution: CNAM (France)

9.3.2. Visits to International Teams

9.3.2.1. Research stays abroad

Eric Fabre visited Michele Pinna during 2 weeks (Univ. of Cagliari, Italy). This collaboration focuses on the design of compact unfoldings for Petri nets.

TACOMA Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Pervasive_RFID

- Partner: IETR
- Starting: July 2013; ending: July 2016

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.

7.1.2. GLIE - Guidage Lumineux par l'Intelligence de l'Environnement

- Partner: OyaLight
- Starting: December 2014; ending: April 2016

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.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

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.

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.

8.1.2. IPL - Inria Project Lab

MULTICORE - Large scale multicore virtualization for performance scaling and portability

> **Participants:** Emmanuel Jeannot.
>
> 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.

8.2. European Initiatives

8.2.1. 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.

8.2.2. Collaborations with Major European Organizations

Partner 1: INESC-ID, Lisbon, (Portugal)

Subject 1: Application modeling for for hierarchical memory system

Partner 2: ETH Zurich (Switzerland)

Subject 2: Topology mapping

Partner 3: BSC, Barcelona (Spain)

Subject 3: High-performance communication on new architectures; load-balancing and meshing.

8.3. International Initiatives

8.3.1. Inria International Labs

JLPC Inria joint-Lab on Extreme Scale Computing:

Coordinators: Franck Cappello and Marc Snir.

Other partners: Argonne National Lab, Inria, 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.

8.3.2. Inria International Partners

8.3.2.1. 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: UWLAX (Wisconsin)

Subject 3: network topology modeling

Partner 4: Intel

Subject 4: modeling many-core platforms and next-generation memory architectures

Partner 5: University of Tokyo and Riken

Subject 5: Adaptation of MPI and runtime systems to MIC processors.

Partner 6: Lawrence Livermore National Laboratory

Subject 6: 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).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Ivan Cores from Universidade da Coruña, Spain, visited us for 4 months and have worked on topology-aware malleability of MPI programs.
- Guillaume Houzeaux and Mariano Vazquez from BSC visited us for several days to work on particule and mesh based applications and new architectures.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **TIMCO**, 2012-2015 (432 kEuros)
  Coordinator: Bull SAS
  Participants: Cécile Germain-Renaud, Julien Nauroy, Karima Rafes, Lovro Ilisajic, Gaetan Marceau Caron

- **ROM** *Model Reduction and Multiphysics Optimization*, 2014-2016 (50 Keuros)
  Coordinator: IRT System X
  Participants: Marc Schoenauer, Michèle Sebag, François Gonard (PhD)

- **ISN** *A Collaborative Filtering Approach to Matching Job Openings and Job Seekers*, 2013-2016 (105 kEuros)
  Related to Thomas Schmitt's PhD (funded by ISN).
  Participants: Michèle Sebag, Thomas Schmitt

- **AutoML** *An empirical approach to Machine Learning*, 2014-2017 (104 kEuros)
  Related to 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, Michèle Sebag

9.2. National Initiatives

- **SIMINOLE** 2010-2015 (1180kEuros, 250kEuros for TAO). Large-scale simulation-based probabilistic inference, optimization, and discriminative learning with applications in experimental physics, ANR project, Coordinator B. Kégl (CNRS LAL).

  Participants: Emmanuel Benazera, Nikolaus Hansen, Marc Schoenauer, Cécile Germain-Renaud

- **NUMBBO** 2012-2016 (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).

  Participants: Philippe Caillou

9.2.1. Other

- **POST** 2014-2018 (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
- **FSN 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)
  Participants: Guillaume Charpiat

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

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.

9.4. International Initiatives

9.4.1. Inria Associate Teams not involved in an Inria International Labs

9.4.1.1. 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)

9.4.1.2. 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.

9.4.2. Inria International Partners

9.4.2.1. 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, 400 k$-AUS.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Holger Hoos, University of British Columbia, Canada, 3 weeks in February 2015, follow-up of his 3-months visit at Fall 2014, funded my MSR-Inria joint lab.
- Isabelle Guyon, Chalearn. April-July 2015, 1 month by University Paris Sud, 3 months with TIMCO.
- Youhei Akimoto, Shinshu University, September 2015, a month funded by Digiteo.
- Aditya Gopalan, Indian Institute of Science Bangalore, April 2015, three weeks funded by Digiteo.
- Edgar Galvan Lopez, University College Dublin, April 2015 - March 2016, funded with the ELEVATE Fellowship, the Irish Research Council's Career Development Fellowship co-funded by Marie Curie Actions.

9.5.1.1. Internships

Lin Ching-Nung

> Date: Apr - Oct 2015
> Institution: NDHU (Taiwan)
> Supervisor: Olivier Teytaud

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. 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.

9.1.2. Atlanstic

Participants: Raphael Chenouard, Laurent Granvilliers, Christophe Jermann, Frédéric Lardeux, Éric Monfroy, Frédéric Saubion.

Title: Atlanstic project about problem modelisation, conversion, and transformation.

Duration: 2014-2015.

Budget: 8000 Euros.

Others partners: LERIA, IRCYNN.

Topic: modelling and model transformation.

9.1.3. Search

Participants: Nicolas Galvez, Éric Monfroy, Frédéric Saubion.

Title: Hybrid Algorithms for Search Based Software Engineering.

Others partners: LERIA.

Topic: hybrid algorithms for search.

9.2. National Initiatives

9.2.1. IBEX

Participants: Ignacio Araya, Clément Carbonnel, Gilles Chabert, Benoit Desrochers, Luc Jaulin, Bertrand Neveu, Jordan Ninin, Gilles Trombettoni.

Title: Development of IBEX.

Others partners: ENSTA Bretagne, ENPC PariTech, Lirmm, LAAS, University Federico Santa Maria, Chile.

Development of IBEX (see Section 6.3).

9.2.2. 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 responsable for the constraint part.

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

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.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- One visit regarding time-series constraints of Mats Carlsson, Andreina Francisco RodriguezHelmut Simonis, Pierre Flener and Justin Pearson in Nantes.
- One visit in Nantes of Andreas Schutt from NICTA in the context of the TASCMELB associated team.

9.5.1.1. Internships

- Master thesis : Ekaterina Arafailova (February-June 2015), *reformulation of automata with accumulators as linear programs*.
- Master thesis : Julien Fradin (February-June 2015), *extensions to the GHOST library*.
- Master thesis : Adrien Bodineau (January-April 2015), *extensions to the GHOST library*.
- Internship : Guillaume Legru (April-May 2015), *IA for combat games*.

9.5.2. *Visits to International Teams*

Three visits to Insight Cork, Centre for Data Analytics and to Uppsala University were done to continue the work with Helmut Simonis, Pierre Flener and Mats Carlsson on time-series constraints. An extra visit took place in Nantes. Two visits of Nicolas Beldiceanu and Charlotte Truchet in Melbourne to Peter Stuckey and Marck Wallace took place.

<p style="text-align:center; 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 synthesised from different physical locations.

9.1.2. Competitivity Clusters

Program: FUI

Project acronym: P

Project title: Project P

Duration: March 2011 - Sept. 2015

Coordinator: Continental Automotive France

Other partners: 19 partners (Airbus, Astrium, Rockwell Collins, Safran, Thales Alenia Space, Thales Avionics...)

URL: http://www.open-do.org/projects/p/

Abstract:

The aim of project P is 1/ to aid industrials to deploy model-driven engineering technology for the development of safety-critical embedded applications, 2/ to contribute on initiatives such as ITEA2 OPEES and Artemisia CESAR to develop support for tools inter-operability, and 3/ to provide state-of-the-art automated code generation techniques from multiple, heterogeneous, system-levels models. The focus of project P is the development of a code generation toolchain starting from domain-specific modeling languages for embedded software design and to deliver the outcome of this development as an open-source distribution, in the aim of gaining an impact similar to GCC for general-purpose programming, as well as a kit to aid with the qualification of that code generation toolchain.

The contribution of project-team TEA in project P is to bring the necessary open-source technology of the Polychrony environment to allow for the synthesis of symbolic schedulers for software architectures modeled with P in a manner ensuring global asynchronous deterministic execution..

9.1.3. 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...

URL: http://www.corac-ame.com/

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 modelling 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 [0] 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 [00], 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.

This year, we published a joint paper at the 52nd. Digital Automation Conference in San Francisco [19].

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

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[0]ACM-IEEE MEMOCODE conference series
[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

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 modelling and virtual prototyping in cyber-physical systems.

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 stabilisation and synchronisation 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 modelling 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 to International Teams

9.3.1.1. Research stays abroad

Jean-Pierre Talpin was awarded a visiting researcher grant by USAF OSR in 2014. In this context, he visited the Arlington and Falls Church VT campuses in Spring, Summer of 2015, and UC San Diego in Autumn 2015.

Thierry Gautier was invited to visit NUAA (Nanjing University of Aeronautics and Astronautics), Nanjing, China, in September 2015.

TITANE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. *Grand Emprunt*

Culture 3D Clouds (started in October 2012, duration 3 years) is a national project aimed at devising a cloud computing platform for 3D scanning, documentation, preservation and dissemination of cultural heritage.

Information and communication technologies in the world offer new possibilities for cultural exchange, creation, education and shared knowledge to greatly expand the access to culture and heritage. Culture 3D Cloud is part of a process that aims to create a technical breakthrough approach in the field of digitization of heritage artifacts to allow the emergence of new viable business models. Today the field of 3D scanning artifacts heritage evolves slowly and only provides resources for researchers and specialists and the technology and equipment used for 3D scanning are sophisticated and require highly specialized skills. The cost is significant and limits the practicality. Culture 3D Clouds project aims at empowering the photographers and the distribution to the agencies and image banks that will develop a value chain to commercialize 3D reproductions demand for their customers and expand the market valuation of business assets (commercial publishers, public).

Partners: IGN, CMN, RMN, Inria, EISTI, CNRS-MAP, UCP-ETIS, CEA, HPC Project, ValEISTI, BeIngenious.

Web site: http://c3dc.fr/.

9.2. European Initiatives

9.2.1. *FP7 & H2020 Projects*

9.2.1.1. IRON - Robust Geometry Processing

Type: IDEAS

Instrument: ERC Starting Grant

Duration: January 2011 - December 2015

Coordinator: Pierre Alliez

Inria contact: Pierre Alliez

Abstract: The purpose of this project is to bring forth the full scientific and technological potential of Digital Geometry Processing by consolidating its most foundational aspects. Our methodology draws from and bridges the two main communities (computer graphics and computational geometry) involved in discrete geometry to derive algorithmic and theoretical contributions that provide both robustness to noisy, unprocessed inputs, and strong guarantees on the outputs. The intended impact is to make the digital geometry pipeline as generic and ironclad as its Digital Signal Processing counterpart.

9.3. International Research Visitors

9.3.1. *Visits of International Scientists*

9.3.1.1. Internships

Venkata Kusupati (IIT Bombay): design of anisotropic metrics on surfaces.

Hao Fang (Ecole Centrale Paris): scale-space analysis of mesh simplification for urban scenes.

Guillaume Matheron (ENS Paris): an efficient approach to compute the optimal transportation cost for surface reconstruction.

TOCCATA Project-Team

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.

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).

9.2. 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.

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.

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], Évelyne Contejean, 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.

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], Évelyne Contejean, 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 [104]. 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 Versaco 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).

9.3. 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 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

- Andrew Tolmach, from Portland State University, visited the team as a one-year Digiteo Chair, in collaboration with other groups in the Paris area (LRI/Univ. Paris-Sud, LIX/Polytechnique, Inria Saclay and Rocquencourt). The project is to initiate a new research effort to develop principles, techniques, and tools for large-scale proof engineering. It is focused on the Coq proof assistant and is designed to take advantage of the deep pool of expertise available in the Paris area concerning both the use and the development of Coq. Initial results include: a precise description of requirements for large proof management; sample prototype tools addressing one or more of these requirements; and a technical survey of relevant proof representation options [106].

TONUS Team

9. Partnerships and Cooperations

9.1. 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.

9.2. National Initiatives

9.2.1. ANR

- ANR project GYPSI (2010-2015), https://sites.google.com/site/anrgypsi/: coordinator Philippe Ghendrih (CEA Cadarache), other participants, University of Marseille, Universities of Strasbourg and Nancy (CALVI and then TONUS project-team). The aim is to understand the physics of turbulence in magnetically confined plasma using numerical simulation
  Participants: Philippe Helluy [local coordinator], Michel Mehrenberger.
- ANR project "PEPPSI" in Programme Blanc SIMI 9 – Sciences de l'ingénierie (Edition 2012) started in 2013.
  Participants: Giovanni Manfredi [coordinator], Sever Adrian Hirstoaga.

9.2.2. IPL FRATRES

The TONUS project belongs to the IPL FRATRES and there was an annual meeting, on 15-16 October 2015, with talks of Emmanuel Franck, Philippe Helluy, Sever Adrian Hirstoaga, Michel Mehrenberger.

9.2.3. IPL C2S@exa

The TONUS and HIEPACS project have obtained the financial support of the PhD thesis of Nicolas Bouzat thanks to the IPL C2S@exa. Nicolas Bouzat works at CEA Cadarache and is supervised locally by Guillaume Latu; the PhD advisors are Michel Mehrenberger and Jean Roman.

9.2.4. Competitivity clusters

- GENCI projet : t2015067387 "Simulation numérique des plasmas par des méthodes semi-lagrangiennes et eulériennes adaptées" 800 000 scalar computing hours on CURIE_standard (January 2015-February 2016); use: 300 000 heures.
  Participants: Sever Adrian Hirstoaga, Guillaume Latu, Michel Mehrenberger [coordinator], Thi Nhung Pham, Christophe Steiner.
- GENCI projet : t2016067580 "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

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. 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.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Michel Mehrenberger has a collaboration with Bedros Afeyan (Pleasanton, USA) to work on KEEN wave simulations.

9.4.2. Participation In other International Programs

Participants: 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 paralelized and hybrid solvers for plasma physics. One of our objective 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="text-align:center; color:red;">TOSCA Project-Team</h1>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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).

- A. Lejay is member of the ANR H2MNO4 (Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology, ANR Cosinus, 2012–2015) coordinated by Joceyline Erhel (IRISA, Rennes).

- E. Tanré is member of the ANR SloFaDyBio (Slow Fast Dynamics in Biology, ANR-14-CE25-0019, 2015-2017) coordinated by M. Desroches (EPI NEUROMATHCOMP, Inria Sophia Antipolis).

9.1.2. Contract with ADEME

Participants: Mireille Bossy, Sélim Kraria.

Modéol Since April 2013, M. Bossy was the coordinator of the MODÉOL collaboration project funded by the French Environment and Energy Agency (ADEME), and involving the IPSL (CNRS) and the French company Maïa Eolis. The overall goal of the project concerns the modeling and prediction of wind potential in France, in particular the quantification of uncertainties and the analysis of multi-scale variability.

Concerning the Inria workpackage, in collaboration with Antoine Rousseau, from the team LEMON, we completed the SDM code with complex terrain description. We also improved the downscaling procedure that allows SDM to downscale its own simulation outputs.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- J. Inglis is a member of the European project MatheMACS (European Union Seventh Framework Programme no. 318723).

9.3. International Initiatives

9.3.1. Inria International Labs

Inria Chile
Associate Team involved in the International Lab:

9.3.1.1. 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.anestoc.cl/es/?page_id=1112

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. 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.

Mireille Bossy is managing the WINDPOS project, in collaboration with Antoine Rousseau (LEMON team) and two engineers of Inria Chile, Cristian Paris and Jacques Morice. Based on the stochastic Lagrangian modeling of the wind at small scale (see SDM SOFTWARE), WINDPOS aims to develop a wind farm simulator software, able to provide fine statistical information for the managing of electricity production.

This year the WINDPOS project focused on the validation of the approach by comparison with measurements. We also tested the simulation of a 10 mills farm in complexe terrain with strong elevation.

Antoine Lejay is working with Rolando Rebolledo (PUC) on the stochastic modeling of the Oscillating Water Column to transform waves into energy.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- L. Beznea (Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucarest) has been visiting TOSCA Nancy for 10 days in March.

- B. Cloez (INRA Montpellier) has been visiting TOSCA Nancy for 3 days in January.

- J. Claisse (Ecole Polytechnique) has been visiting TOSCA Nancy for 3 days in January.

- F. Campillo (LEMON team, Inria Sophia) has been visiting TOSCA Nancy for one week in August.

- M. Andrade Resptrepo (Univ. Paris 7) has been visiting TOSCA Nancy for 3 days in December.

- The TOSCA *seminar* organized by J. Inglis and A. Richard in Sophia Antipolis has received the following speakers: Cédric Bernardin (Laboratoire Dieudonné, Université Nice Sophia-Antipolis), Romuald Elie (Ceremade, Université Paris Dauphine), Roberta Evangelista (NEUROMATHCOMP-TOSCA, Inria Sophia-Antipolis), José R. León (Inria Grenoble, UCV de Venezuela), Soledad Torres (CIMFAV – Valparaiso, Chile), Arnulf Jentzen (ETH Zurich), Marielle Simon (PUC, Rio de Janeiro), Philip Protter (Columbia University), Jean-François Jabir (CIMFAV – Valparaiso, Chile), Sean Ledger (University of Oxford), Alexandre Brouste (Université du Maine, Le Mans).

9.4.1.1. Internships

CHIKHAOUI Maroua

Subject: Gestion de risque de portefeuille : Estimation de VaR et CVaR

Date: May 2015 - Sept. 2015

Institution: ESPRIT (Ecole Supérieure Privée d'Ingénierie et de Technologie, Tunisie) et Polytech'Nice-Sophia.

CORMIER Quentin

Subject: Réseaux de neurones à décharge avec phénomènes de plasticité

Date: Oct. 2015 - Feb. 2016

Institution: ENS Lyon.

EVANGELISTA Roberta

Subject: A stochastic model of gamma phase modulated orientation selectivity

Date: May 2015 - Sept. 2015

Institution: the Master in computational neuroscience, at the BCCN Berlin.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

- A. Richard has spent two weeks in Valparaíso and Santiago (Chile) in January, and two weeks in Santiago in June, working with R. Rebolledo and S. Torres.

TYREX Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. 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.

7.1.2. ANR

Typex

Title: Typeful certified XML: integrating language, logic, and data-oriented best practices

Call: Programme Blanc

Duration: January 2012 - December 2015

Coordinator: PPS (CNRS - Paris 7 Diderot)

Others partners: LRI (Orsay)

See also: http://typex.lri.fr

Abstract: The highly ambitious and final goal of this project is to produce a new generation of XML programming languages stemming from the synergy of integrating three approaches into a unique framework:

- a logical approach based on solvers
- a programming language (PL) approach
- a data-oriented approach

These languages will feature precise and polymorphic type systems that merge PL typing techniques with logical-solver-based type inference. They will be implemented efficiently using the latest research on tree automata and formally certified using modern theorem prover technology. They will offer the capacity to specify and formally verify invariants, business rules, and data integrity, and will have a direct and immediate impact on standardization processes.

7.1.3. Transfer Contracts with Startups

Oppidoc

Title: Study of Potential Benefits of Introducing Static Analyses in the Oppidum Development Process

Duration: November - December 2015

Coordinator: Pierre Genevès

Abstract: The Oppidoc startup develops "Oppidum": an XQuery web application framework which simplifies the development of XML-REST-XQuery applications (XRX) with the full XML technology stack (XQuery, XSLT, native XML database). It relies on a RESTful approach and on a well defined application model using concepts (routes, conventions, pipelines) popularized in other frameworks such as Ruby On Rails, Orbeon Forms and more recently Express on nodejs. Our collaboration concerns a study about the introduction of advanced static analyses techniques in the Oppidum development process.

7.2. International Research Visitors

7.2.1. Internships

Martì Bosch Padros from Universitat Politècnica de Catalunya (UPC) Spain spent six months in the team to work on Automated Refactoring for Size Reduction of CSS Style Sheets.

Joel Ferreira Dos Santos from Universidade Federal Fluminense, UFF, Brasil spent a one year sandwich PhD in the team to work on the formal verification of multimedia presentations.

URBANET Team

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: Patrice Raveneau, 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, and TUBA, 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.

9.2. National Initiatives

9.2.1. ANR

- ANR ABCD 10/2013-04/2017.
  Participants: Diala Naboulsi, Marco Fiore, 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. 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.

9.2.3. 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. The first deployment is scheduled early 2015.

9.2.4. Inria Project lab

- CityLab
  Urbanet is involved in the CityLab Inria Project Lab lead by Valérie Issarny. Within this project, Hervé Rivano is the networking referent for the PhD thesis of Raphael Ventura, advised by Vivien Mallet, in the Clime Inria team.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

- DTN for IOT - Bilateral contract with III Taiwan 2015.
  This collaboration, funded by III, focuses on the feasibility to implement Delay Tolerant Network protocols within the Internet Of Things context. The motivation for using generic protocols able to handle the constraints of the Intenet of Things is highlighted with the choice of the Bundle Protocol. A study of existing implementations of this protocol is realized within a sensor context and a tailored implementation is proposed. This collaboration has partially funded the postdoc of Patrice Raveneau.

9.3.1.2. Informal International Partners

- **Ecole Polytechnique de Montréal, QC, Canada**. Cooperation on subjects related to mobile networks with the group of Prof. Samuel Pierre.
- **University of Waterloo, ON, Canada**. Joint publications and visits to/from the group of Prof. Catherine Rosenberg.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Dennis Chen,Research Engineer, III, Taiwan: one week visit (June 2015).
- Ling-Jyh Chen, Associate Research Fellow, Academia Sinica, Taiwan: one week visit (December 2015).
- Mario Gerla, Professor, UCLA, USA: one day visit (March 2015).
- Roch Glitho, Associate Professor, Concordia University, Montreal, Canada: one week visit (September 2015).
- Catherine Rosenberg, Professor, University of Waterloo, Canada: two days visit (July 2015).

9.4.1.1. Internships

- F. Bernardo Duarte, intern, University of Lisbon, Portugal: Comfortable workplace using sensor motes (3 months).
- A. Boubrima, MS thesis, ESI Algiers, Algeria: Optimal deployment of wireless sensor networks for air pollution monitoring (6 months).
- A. Dobre, intern,Polytechnic University of Bucharest, Romanial: Comfortable workplace using sensor motes (3 months).

- A. Hanganu, intern, Polytechnic University of Bucharest, Romania: Comfortable workplace using sensor motes (3 months).

- J. Lallana, intern, Universidad Politécnica de Madrid, Spain: Performance evaluation of RPL resiliency using Cooja (5 months)

- D. Martella, intern, Politecnico di Torino, Italy: Coordination of robots fleet (6 months).

- M. Iliushkina, intern, University of Saint Petersburg, Russia: Comfortable workplace using sensor motes (3 months).

- Z. Plokhovska, intern, University of Pittsburgh, PA, USA: Combining DSRC and VLC in Safety Vehicular Networks (3 months).

<h2 style="color:red; text-align:center">VEGAS Project-Team</h2>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *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 will end in march 2016. It is coordinated by Xavier Goaoc who moved from the Vegas team to Marne-la-Vallée university in 2013.

Project website: http://webloria.loria.fr/~moroz/ANR-Presage.

7.1.2. *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.

In 2015, the project funded the postdoc position of Rémi Imbach.

Project website: https://project.inria.fr/singcast/.

7.2. International Research Visitors

7.2.1. *Visits to International Teams*

Monique Teillaud was invited at the Workshop on Computational Geometric and Algebraic Topology, *Mathematisches Forschungsinstitut Oberwolfach*, where she presented CGAL, the Computational Geometry Algorithms Library. https://www.mfo.de/occasion/1542/www_view

VERIDIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Participants: Pablo Dobal, Pascal Fontaine.

The PhD thesis of Pablo Federico Dobal was jointly funded by Région Lorraine and the ANR-DFG project SMArT (section 9.2) between September 2014 and August 2015.

9.2. National Initiatives

9.2.1. *ANR-DFG Project SMArT*

Participants: Haniel Barbosa, David Déharbe, Pablo Dobal, Pascal Fontaine, Maximilian Jaroschek, 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 partners are both the French and German parts of VeriDis 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. Arithmetic reasoning is one strong direction of research at MPI, and the state-of-the-art tool Redlog (section 6.1) is mainly developed by Thomas Sturm. The SMT solver veriT (section 6.4), developed in Nancy, serves as an experimentation platform for theories, techniques and methods designed within this project.

In September 2014, Pablo Federico Dobal was hired as a PhD student in joint supervision with Saarland University, co-funded by the SMArT project and the Région Lorraine. For personal reasons, his thesis has been put on hold in September 2015.

More information on the project can be found on http://smart.gforge.inria.fr/.

9.2.2. *ANR Project IMPEX*

Participants: Manamiary Andriamiarina, Souad Kherroubi, Dominique Méry.

The ANR Project IMPEX is an INS ANR project that 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 [28], 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 [13] is to offer rigorous mechanisms for handling domain knowledge in design models.

9.2.3. 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, 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 (EPI Toccata) and Inria Rennes (EPI Celtique), among others. Simon Cruanes was hired in October 2015 and has started the development of Nunchaku, whereas Blanchette has developed a preliminary version of the Isabelle frontend. We expect a first release in early 2016.

9.2.3.1. Inria ADT PLM (2014-2016)
Participants: Martin Quinson, Matthieu Nicolas.

Joint work with Gérald Oster (project-team Coast, Inria Nancy – Grand Est).

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 heavily refactored the software into a web application, to grow the user community amongst learners and thus gather more learning analytics. We also added the ability to solve PLM exercises by assembling code blocks as in Scratch. Finally, we started working on an integrated exercise editor in the hope of growing the user community amongst teachers that will be able to propose their own exercises on top of PLM.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. MEALS

Title: Mobility between Europe and Argentina applying Logics to Systems

Programm: FP7

Duration: October 2011 – September 2015

Coordinator: Université de la sarre

Partners:

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

Rheinisch-Westfälische Technische Hochschule Aachen (Germany)

Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Dresden (Germany)

University of Leicester (United Kingdom)

Universität des Saarlandes (Germany)

Universidad de Buenos Aires (Argentina)

Universidad Nacional de Córdoba (Argentina)

Universidad Nacional de Rio Cuarto (Argentina)

Instituto Tecnológico Buenos Aires (Argentina)

Inria contact: Castuscia Palamidessi

The MEALS project funds staff exchanges between institutions in Europe and Argentina. It is structured in five work packages (Quantitative Analysis of Concurrent Program Behaviour, Reasoning Tasks for Specification and Verification, Security and Information Flow Properties, Synthesis in Model-based Systems Engineering, Foundations for the Elaboration and Analysis of Requirements Specifications). Our team mainly cooperates with the group led by Carlos Areces in Córdoba within work package 2. In 2015, the project funded visits by Raúl Fervari and Guillaume Hoffmann in Nancy.

9.3.2. Collaborations with Major European Organizations

9.3.2.1. Cooperation with EPFL

Participants: Haniel Barbosa, Jasmin Christian Blanchette, Simon Cruanes, Pascal Fontaine.

We cooperate with Andrew Reynolds from the École polytechnique fédérale de Lausanne, Switzerland, on improving SMT solvers and bridging the gap between SMT solvers and proof assistants. This cooperation started in 2014 between Blanchette and Reynolds and has been pursued in 2015, with mutual one-week visits. The outcomes are manifold:

- We developed a decision procedure that combines reasoning about datatypes and codatatypes and implemented it in the SMT solver CVC4 [31]. This procedure is useful both for proving theorems and for model finding (counterexample generation).

- We designed an encoding of recursive and corecursive function definitions on datatypes and codatatypes that makes it possible to employ finite model finding techniques on functions with infinite domains, as long as they satisfy a wide, semantic criterion [36]. We started the development of a model finder for higher-order logic, called Nunchaku, based on this idea.

- We started work on a general framework for handling quantified formulas in SMT solving. Its focus is on the derivation of instances conflicting with a ground context, redefining the approach introduced by Reynolds et al. [68]. We enhanced the classical congruence closure algorithm so that it can handle free variables [34]. We expect the fruits of this research to be implemented in veriT and CVC4.

9.3.2.2. Cooperation with NUI Maynooth, Ireland

Participant: Dominique Méry.

The project *Building Reliable Systems: Software Refinement meets Software Verification* was a one-year project funded by PHC Ulysses. The academic Irish partner is Rosemary Monahan of NUI Maynooth. The verification of software requires the specification of preconditions and postconditions as well as other properties of the code. These properties are expressed as annotations and provide a detailed understanding of how the software is implemented. In program verification, the annotation process is often done *a posteriori*, with verification tools used to check that annotations are sound according to the semantics of the program. Determining the correct annotations to provide a complete specification is difficult, especially when specifying invariant properties of the code. *A priori* techniques for developing correct software are based on the correct-by-construction paradigm. The refinement-based approach is such a technique, providing for the construction of a correct program through the step-by-step refinement of an initial high-level model of the software. In this way, the program specification is developed alongside the code, discharging the conditions that need to be proved. We focus on combining these two software engineering techniques, to benefit from the strengths of both. We have proposed a framework for integrating the *a posteriori* paradigm Spec# and the *a priori* paradigm Event-B. This integration induces a methodology that bridges the gap between software modeling and program verification in the software development life cycle. For validating this methodology, we have designed the Rodin plugin EB2RC that implements transformations of Event-B models into algorithms.

9.4. International Initiatives

9.4.1. Participation In other International Programs

9.4.1.1. STIC AmSud MISMT

Participants: Haniel Barbosa, David Déharbe, Pablo Dobal, Pascal Fontaine, Stephan Merz.

VeriDis has a close working relationship with two South American teams at Universidade Federal do Rio Grande de Norte (UFRN), Brazil (more specifically with Prof. David Déharbe), and at Universidad Nacional de Córdoba, Argentina (more specifically with Prof. Carlos Areces). The STIC AmSud MISMT project, including both teams and VeriDis, started in 2014. It complements the MEALS project (section 9.3) and extends it to cooperation with UFRN.

The project is centered around Satisfiability Modulo Theories, with a focus on applications to Modal Logic [37]. Notably, the project supports the development of the veriT solver (section 6.4), of which David Déharbe and Pascal Fontaine are the main developers.

The project helped fund the stay of Haniel Barbosa in Natal (PhD in joint supervision between Nancy and Natal) from October to December, 2015. The project has been terminated prematurely due to funding problems.

9.4.1.2. Cooperation with NASA Ames Research Center, U.S.A.
Participant: Dominique Méry.

Joint work with Didier Fass of LORIA, Nancy.

Didier Fass and Dominique Méry have started a close working relationship with Brian Gore and his colleagues at the NASA Ames Reseach Center, Human Systems Integration Division (HSI). It is anticipated that collaboration among the researchers at NASA Ames and LORIA will lead to more formal understanding of the methods required to optimize human-systems integration issues in the design of complex human-automation systems.

VIRTUAL PLANTS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Agropolis computational plant seminar*
Participants: Yann Guédon, Thierry Fourcaud [CIRAD, AMAP], Christine Granier [INRA, LEPSE], Soazig Guyomarc'H [Montpellier 2 University, DIADE], Laurent Laplaze [IRD, DIADE].

Funding: Agropolis foundation (Contractor for Virtual Plants: CIRAD. From 2013 to 2016)

In the context of the creation of a world-level pole on plant science in the region Languedoc-Roussillon, we created a monthly seminar on plant modeling and its applications. The seminar is organized by Yann Guédon, Thierry Fourcaud (CIRAD, AMAP), Christine Granier (INRA, LESPE), Soazig Guyomarc'h (Montpellier 2 University, DIADE) and Laurent Laplaze (IRD, DIADE) with the support of Agropolis International and Agropolis Foundation. In 2015, we organized a two-day workshop devoted to the modeling of plant development from the cellular to the organ scale.

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;

8.1.4. *SegmentationEvaluation*
Participants: Sophie Ribes, Benjamin Gilles [LIRMM], Guillaume Baty, Alizon Konig, Guillaume Cerutti.

Funding: IBC (Contractor for Virtual Plants: UM, 2015)

The goal of this project is to develop a framework allowing a robust validation for image segmentation. Segmentation is an ill-posed problem, and conventional validation approaches are corrupted by both intra and inter observer variabilities. We plan to develop: efficient tools allowing a creation of gold standard segmentation data (Alizon Konig, master internship under the supervision of Sophie Ribes); robust metrics to quantify differences between ground truth and algorithmic results.

Partners: ICAR, LIRMM, Montpellier.

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, 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. MARS-ALT 2.0
Participants: Guillaume Baty, Christophe Pradal, Christophe Godin.

Funding: Inria ADT (Contractors for Virtual Plants: Inria from 2013 to 2015)

The goal of this project is to integrate in a single software platform all the software tools and algorithms that have been developed in various projects about meristem modeling in our teams. More precisely, we aim at building 3D models of meristem development at cellular resolution based on images obtained with confocal or multiphoton microscopy. This set of components will be used by biologists and modelers making it possible to build such meristem structures, to explore and to program them. This platform is embedded in the OpenAlea framework and is based on the imaging components of the platform MedInria. Asclepios, RDP ENS-Lyon/INRA, PHIV CIRAD

8.2.5.2. 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.

8.2.5.3. Echap
Participants: Christophe Pradal, Christian Fournier, Corinne Robert [INRA, EGC].

Funding: ONEMA (Contractor for Virtual Plants: INRA, From 2012 to 2014)

The objective of the ECHAP project is to reduce the frequency of treatments and the doses of pesticides applied on crops by taking advantage of natural mechanisms of disease escape related to crop architecture and by optimizing interception of pesticides by plant canopies. It focuses on the development of an integrative, yet modular, modeling tool on the OpenAlea plateform that couples wheat architectural development, the interception and fate of fungicides and the dynamics of a pathogen. Various scenarios combining climate x architecture x fungicide treatment will be simulated to identify and propose efficient strategies of pesticide applications. Partners: UMR EGC (Paris-Grignon), UMR LEPSE (Montpellier), ARVALIS (Institut du végétal, France), ALTERRA (Research Institute for the Green World, The Nederlands) , ADAS Intitute (UK), CNRS, and IRSTEA .

8.2.5.4. Morphogenetics

Participants: Christophe Godin, Frédéric Boudon, Christophe Pradal, Grégoire Malandain, François Faure, Jan Traas, François Parcy, Arezki Boudaoud, Teva Vernoux.

Funding: Inria Project Lab (From 2013 to 2016)

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).

8.2.5.5. Rose

Participants: Christophe Godin, Frédéric Boudon, Christophe Pradal.

Funding: INRA - Projet de Pari Scientifique (From 2012 to 2015)

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

8.3. International Initiatives

8.3.1. ANR-DFG

8.3.1.1. 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)

8.3.2. *Inria International Partners*

8.3.2.1. *Informal International Partners*

An important collaboration with the CIRAD research unit HortSys at the Reunion island and in particular Frédéric Normand has been established for several years. The topic of the collaboration is the study of the phenology of mango tree. Three members of the team have been visiting our collaborators during the year. This is a tripartite collaboration that also involves Pierre-Eric Lauri of the AGAP/AFEF team.

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 [21]. 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.

8.3.2.2. *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. International Research Visitors

8.4.1. *Visits of International Scientists*

The team received several visitors from foreign research groups in 2015:

- Farah Ben Naoum, from Sidi Bel Abbes University, Algeria, visited the team last summer for 1 month.
- Yoan Coudert, from University of Cambridge, UK, visited the team for 3 months.
- David Ford, from University of Washington, USA, visited the team for 1 week.
- Winfried Kurth of the University of Goettingen, Germany, visited the team for 1 week in June.
- Dennis Shasha, from Courant Institute of Mathematics, New York University, in the context of an Inria international chair, visited the team during its stay.
- Julia Pulwicki, PhD student if the University of Calgary visited the team 2 weeks in May-June.

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

- Frédéric Boudon visited Frédéric Normand of the UR Hortsys at the CIRAD La Réunion two weeks in April.
- Christophe Pradal visited Frédéric Normand of the UR Hortsys and Ian Bally and Paula Ibell of the University of Queensland at the CIRAD La Réunion two weeks in May.
- Christophe Pradal visited Professor Kurth of the University of Goettingen, Germany one week in November.

VISAGES Project-Team

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: Elise 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 will continue over 2 years.

9.1.3. Fondation de l'Avenir - Depression, suicide and fMRI

Participants: Elise Bannier, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot.

initial duration: 12 months from November 2012. Project extended in 2015.

In collaboration with EA 4712 "Comportement et Noyaux Gris Centraux" of the University of Rennes I, a complementary funding (20 000€) was obtained to support an ongoing fMRI research project on emotions, impulsivity and suicide. The study protocol and the fMRI task was finalized. Inclusions started in early 2013. The project was extended in 2014 to recruit more patients.

9.1.4. Fondation de l'Avenir - Stroke, rehabilitation and fMRI

Participants: Elise 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 protocol was setup, the task developed and validation on volunteers is ongoing. Patient inclusions started in spring 2013. This project was also extended to 2014 to recruit more patients. Group analysis on the control group was performed and a paper will be submitted soon.

9.1.5. Projet Fondation de France: EPMR-MA

Participants: Pierre-Yves Jonin, Elise Bannier, Christian Barillot, Isabelle Corouge, Quentin Duché, Jean-Christophe Ferré.

duration: 2 years from July 2015

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 wil start early 2016.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR "TRANSLATE-MS-REPAIR", RPIB 2012 program
Participants: Laurence Catanese, Olivier Commowick, Isabelle Corouge, Jean-Christophe Ferré, Elise Bannier, Gilles Edan, Christian Barillot.

It is now commonly admitted that MS is not only an inflammatory disease but a neurodegenerative disease as well. This project is devoted to show that the olesoxime molecule is not only neuroprotective, but it has the ability to promote the maturation of oligodendrocyte progenitor cells (OPCs) into myelinating oligodendrocytes. However, before considering a large-scale clinical trial to assess efficacy. An important aspect is that to date, no treatment for neuroprotection / remyelination has reached the stage of clinical proof of concept that aims Trophos company who is leading this project. It appears that the best criteria for assessing neuroprotective/remyelinating effect of the drug candidate, are MRI criteria. However, these imaging criteria have not yet been validated for use in multicentre trials - so we will also check the feasibility of such measures under this condition. In addition to Trophos company, the partners of this project are AP-HM/CNRSCEMEREM-CRMBM, CHU Rennes, CHU Reims, and Inria-VISAGES.

9.2.1.2. ANR "MAIA", 2015 generic projects program
Participants: Maia Proisy, Pierre Maurel, Olivier Commowick, 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: Elise Bannier, 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 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, Florent Leray, Michael Kain, Yao Yao.

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, Elise Bannier, Christian Barillot, Olivier Commowick, Gilles Edan, Isabelle Corouge, 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

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[0] https://iww.inria.fr/cominlabs-newsletter/april-2013-four-projects-selected/#hemisfer

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.

9.2.3. Collaboration with the CEA (Commissariat à l'Energie Atomique): Standardization of Arterial Spin Labeling acquisitions and imaging data quality assessment in the context of dementia related studies

Participants: Elise Bannier, Christian Barillot, Isabelle Corouge, Jean-Christophe Ferré, Cédric Meurée.

duration: from August 2014 to December 2015

Around 900,000 people are affected by various forms of dementia in France. As an early and reliable diagnosis remains difficult to provide, neuroimaging is crucial as a diagnosis assistance by analyzing structural and functional brain abnormalities related to these diseases. The CATI (Centre pour l'Acquisition et le Traitement des Images) is a multicenter neuroimaging network dedicated to the management of dementia related imaging protocols. As VisAGeS and the Neurinfo platform are recognized for their expertise in Arterial Spin Labeling (ASL) acquisition and post-processing, a collaboration contract was signed between Inria and CEA, the coordinator of the CATI initiative, in order to host an engineer in the VisAGeS team for one year. The collaboration resulted in the standardization of the ASL acquisition parameters of the CATI protocols, the setup of these parameters on the scanneres participating in the CATI studies, as well as the development and the integration of post-processing and quality assessment tools into qualiCATI, the quality control software of the CATI.

9.2.4. PEPS JCJC CNRS INS2I: FastMicroDiff: Fast acquisition for microstructure-enabled diffusion MRI

Participants: Elise Bannier, Emmanuel Caruyer.

duration: from January 2015 to December 2015 Diffusion MRI is a unique tool for the observation of brain white matter structure in vivo. Several studies have shown that it is possible to estimate intrinsic tissue parameters from diffusion, such as axonal diameter, axonal density, orientation dispersion, compartment-specific diffusion coefficients, etc. However, the reconstruction of these parameters requires specific acquisition protocols, which are to date very long and therefore poorly compatible with in vivo applications. Besides, recent development have shown that a higher sensitivity to some microstructural paramters could be obtained using non-conventional diffusion gradient sequences, such as oscillating gradient waveforms. This project aims at developping faster acquisition methods, using sparse representation for microstructure-enabled diffusion signal and time-varying diffusion sensitizing gradients.

In cooperation with the Neurinfo imaging platform and Siemens, a modification of the protocol to enable the use of non-rectangular gradient pulses has been developped and is being tested on phantom. A group of 6 healthy subjects will be scanned using this novel protocol, and acquisition will be repeated 3 times for each subject so that we can evaluate the reproducibility of the technique.

9.2.5. PHRC EMISEP: Evaluation of early spinal cord injury and late physical disability in Relapsing Remitting Multiple Sclerosis

Participants: Elise Bannier, Christian Barillot, Emmanuel Caruyer, Olivier Commowick, Gilles Edan, Jean-Christophe Ferré, Anne Kerbrat.

duration: from January 2014 to December 2017 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 focuses 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, this 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 a 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 to perfom 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 on the 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, 40 of the 80 subjects have been included. A PhD student started in November 2015 to work on diffusion imaging in the spinal cord.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. EuroBioimaging

Type: CAPACITIES

Defi: 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, C. 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.

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. COST-AID

Program: COST

Project acronym: AID (oc-2010-2-8615)

Project title: Arterial spin labeling Initiative in Dementia

Acceptation date: 18/05/2011

Coordinator: X. Golay, UCL, London, UK

Other partners: Ghent University (BE), Liege University (BE), Hospital Cantonal de Geneve (CH), Fraunhofer MEVIS (D), Freiburg University (D), Max Planck Institute for Human Cognitive & Brain Sciences (D), Glostrup Hospital (DK), Hospital Santa Creu I Sant Pau (ES), Universidad Rey Juan Carlos (ES), University of Narvarra (ES), INSERM U836 Grenoble (FR), University of Rennes I (FR), Centro San Giovanni di Dio - Fatebenefratelli (IT), Fondazione Instituto Neurologico Besta (IT), Leiden University Medical Center (NL), UMC Utrecht (NL), VU University Medical Centre (NL), Instituto Superior Técnico (PT), University of Porto (PT), Lund University Hospital (SE), Uppsala University Hospital (SE), Skane University Hospital (SE), Bogazici University (TR), King's College London (UK), University College London (UK), University of Nottingham (UK), University of Oxford (UK)

Abstract: Dementia is a major clinical challenge with care costs approaching 1% of global GDP. Recent estimates suggest that delaying disease onset by 5 years would halve its prevalence. As new disease-modifying treatments will be specific to causative diseases, expensive and bear significant side effects, early diagnosis of dementia will be essential. Current diagnostic criteria include the use of image-based biomarkers using radiotracers. The AID Action aims at coordinating the development of an alternative and cost-effective tool based on an MRI technique, Arterial Spin Labeling (ASL), to obtain reproducible brain perfusion measurements in dementia patients by bringing together scientists and clinicians from across Europe through the flexibility of the COST mechanism. The scientific program is centered around four work packages and three workgroups aiming at developing standards, improving the reliability of the technique and as establishing it as a possible clinical trial outcome measure. Development of MRI methods, post-processing tools, protocols of cross-validation, statistical analyses and launch of clinical and comparative studies will be undertaken. The main benefit of this Action will be to provide a cost-effective alternative to radiotracer-based biomarkers, and help care providers throughout Europe balancing the need for early diagnosis of dementia with the necessary healthcare cost containment. The Visages team is involved in the workgroups ASL data acquisition (E. Bannier), ASL data analysis (C. Barillot, I. Corouge, P. Maurel, C. Meurée) and clinical validation of ASL in cognitive impairment (J.-C. Ferré).

9.3.2.2. 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. C. 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: 2012 (renewed 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.

In 2015, Renaud Hedouin had a 3 month visit in Boston in the context of the BARBANT associated team

9.4.1.2. Informal International Partners

- Collaboration with Duke University, NC : From November 2014 to February 2015, Hrishikesh Deshpande visits Duke University (in Durham, North Carolina, United States) to collaborate with Professor Guillermo Sapiro on classification using Dictionary Learning. This visit was partially founded by a mobility grant from the doctoral school MATISSE.

- Collaboration with the MS Center, Dpt. of Neurology and Center for Clinical Neuroscience, Charles University in Prague on Brain atrophy in Multiple Sclerosis. O. Commowick, C. Barillot, A. Kerbray and G. Edan had a two-days visit in April 2015.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Within the BARBANT associate team, P. Simon K. Warfield, Dr. Benoit Scherrer and Dr. Maxime Taquet (Computational Radiology Laboratory, Harvard Medical School) visited us for a workshop on multiple sclerosis and diffusion image processing.

9.5.2. Visits to International Teams

- Several members of the Visages team (Christian Barillot, Olivier Commowick, Renaud Hédouin, Yogesh Karpate) visited the Computational Radiology Laboratory (Harvard Medical School) for an associate team (BARBANT) meeting to discuss new research topics.

9.5.2.1. Explorer programme

Hédouin Renaud

Date: Sep 2015 - Dec 2015

Institution: Boston Children's Hospital (United States)

Renaud Hédouin visited the Computational Radiology Laboratory at Boston Children's Hospital, United States, for a 3 month exchange within the BARBANT associate team working on distortion correction topic.

9.5.2.2. Research stays abroad

- From November 2014 to February 2015, Hrishikesh Deshpande visits Duke University (in Durham, North Carolina, United States) to collaborate with Professor Guillermo Sapiro on classification using Dictionary Learning. This visit was partially founded by a mobility grant from the doctoral school MATISSE.

WHISPER Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

InfraJVM - (2012 - 2015)

Members: LIP6 (Regal-Whisper), Ecole des Mines de Nantes (Constraint), IRISA (Triskell), LaBRI (LSR).

Coordinator: Gaël Thomas

Whisper members: Julia Lawall, Gilles Muller

Funding: ANR Infra, 202 000 euros.

Objectives: The design of the Java Virtual Machine(JVM) was last revised in 1999, at atime when a single program running on a uniprocessor desktop machine was the norm. Today's computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE. The PhD of Florian David was supported in part by InfraJVM.

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.

9.1.2. 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 and 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.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

David Lo, of Singapore Management University, is an expert in the use of statistical methods in understanding software and associated artifacts, with over 140 publications in this area. Julia Lawall has worked with Lo over the past 5 years, exploiting the complementarity of her expertise in Linux code and in program analysis with Lo's expertise in statistical methods, resulting in 10 joint publications [47], [44], [66], [70], [71], [72], [73], [69], [76]. This collaboration has been reinforced in the form of a Merlion collaboration grant from the Institut Français for the years 2013 and 2014, resulting in the exchange of researchers and PhD students between Whisper and Singapore Management University.

Wouter Swierstra is lecturer in the Software Technology Group of Utrecht University. His work lies at the crossroad between dependent type theory, generic programming, and domain-specific languages embedded in type theory. As part of his PEPS JCJC, Pierre-Évariste Dagand visited him to apply for a joint Van Gogh grant on the topic of extending type theory with language interoperability, allowing unsafe operations to be performed in a type-safe framework.

Timothy Roscoe is a Professor in the Institute for Pervasive Computing at ETH Zurich. His research areas are operating systems, distributed systems, and networking. As part of his PEPS JCJC, Pierre-Évariste Dagand visited the Systems group at ETH to explore avenues for collaboration on applying synchronous programming concepts to the design and implementation of network stacks.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Greg Kroah-Hartman visited the Whisper team in March and April 2015, as an Inria invited researcher. Kroah-Hartman is one of the leading developers of the Linux kernel, and at the time only one of two developers employed by the Linux Foundation, with the other being Linus Torvalds. During his visit, he gave a number of courses and seminars at UPMC, Paris Diderot University, and Ecole Normale Supérieur, and a keynote in a conference on the Internet of Things organized by the GTLL. He also participated throughout his visit in the activities of the Whisper team around the use of Coccinelle and research projects related to the Linux kernel.

9.3.1.1. Internships

Iago Abal, a PhD student at the IT University in Copenhagen, Denmark, visited the Whisper team from January 14, 2015 to March 1, 2015.

9.3.1.2. Research stays abroad

As part of Academics Without Borders, Pierre-Évariste Dagand was a visiting researcher at the University of Cape Coast (Ghana) during 2 months. Aside from his teaching duties, his role was to foster the research activity of the university's Computer Science department. He was thus in charge of the organisation of a weekly research seminar, whose purpose was to perform scientific dissemination and to transmit academic best practices.

WILLOW Project-Team

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.'

9.2.4. EIT-ICT labs: Mobile visual content analysis (Inria)

Participants: Ivan Laptev, Josef Sivic.

The goal of this project within the European EIT-ICT activity is to mature developed technology towards real-world applications as well as transfer technology to industrial partners. Particular focus of this project is on computer vision technology for novel applications with wearable devices. The next generation mobile phones may not be in the pocket but worn by users as glasses continuously capturing audio-video data, providing visual feedback to the user and storing data for future access. Automatic answers to "Where did I leave my keys yesterday?" or "How did this place look like 100 years ago?" enabled by such devices could change our daily life while creating numerous new business opportunities. The output of this activity is new computer vision technology to enable a range of innovative mobile wearable applications.

This is a collaborative effort with S. Carlsson (KTH Stockholm) and J. Laaksonen (Aalto University).

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) has visited Willow for one month in 2015. Prof. John Canny (UC Berkeley) has visited Willow during three months in 2015 within the framework of Inria's International Chair program.

9.4.1.1. Internships

Filip Srajer (Czech Technical University) has been a visiting MSc student at Willow in Feb 2015. Nishant Agrawal (IIIT, India) has been a visiting intern at Willow for three months in 2015. Yumin Suh (Seoul National Univ., South Korea) has been a visiting intern at Willow for five months in 2015. Michail Nikita (Moscow State Univ., Russia) has been a visiting intern at Willow for three weeks in 2015.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Seminar with UNS

We organize a seminar with Lise Arena (UNS, Gredeg) and Bernard Conein (UNS, Gredeg) between Inria and Univ. Nice-Sophia Antipolis on *Digital artifacts and materialities*. We organize a seminar on *Law, Philosophy and Digitality* between UNS faculties of Law and Philosophy and Inria. Alexandre Monnin will address the impact of digital technologies on law itself.

8.1.2. PEPS GéoIncertitude

We participated in the CNRS PEPS GéoIncertitude, with researchers of the UMR 7300 ESPACE of Nice and of the IRIT of Toulouse on the modeling of uncertainty in Geography using fuzzy logic and possibility theory, which was re-financed for a second year.

8.1.3. 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.

8.1.3.1. 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.

8.1.3.2. SPARKS ELK Axis

Wimmics contributes to the SPARKS ELK research axis (Knowledge Learning and Extracting). Andrea Tettamanzi is co-animator of ELK. Elena Cabrio, Tom Bosc and Farhad Nooralahzadeh contribute on it.

8.1.3.3. 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.

8.1.4. HCI Group (I3S)

Participant: Alain Giboin.

The HCI Group animated by Anne-Marie Dery brings together I3S researchers 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 SPARKS. The group establishes collaborations between researchers in the design and implementation of experiments. This year Wimmics collaborated in the design, running and analysis of two experiments aiming at identifying and testing a set of principles for designing tabletop applications. One of the experiment involved Alzheimer people.

Wimmics also contributed to a working paper on the teaching of task modeling in the HCI curriculum of Polytech (with Philippe Renevier, Anne-Marie Dery and Gaëtan Rey). This paper was requested by the AFIHM working group "Enseignement sur l'analyse de tâches : leçons acquises et nouveaux défis".

8.1.5. 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 co-animator of this group-project with Lise Arena (GREDEG). 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." During the first workshop organized this year on this topic, a talk was given by Alain Giboin on "Mesurer l'acceptabilité des collecticiels : de l'observation et/ou de la théorisation des activités collectives à l'élaboration de critères de mesure de l'acceptabilité". Alexandre Monnin is co-animator (with Lise Arena and Bernard Conein (GREDEG)) of a series of seminars on "Digital Artifacts and Materialities." During the first seminar, talks were given by Alexandre Monnin on "Quelques réflexions autour des couples artefacts/objets et numérique/matérialité", and by Alain Giboin on "Les personas comme artefacts substituts des utilisateurs dans un processus de conception".

8.2. National Initiatives

8.2.1. *BPI funded project : 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*, using Web technologies such as WebRTC and semantic Web technologies. The project started September 15th 2014. The first step of the project will be the evaluation/benchmarking of video and data solutions over internet, based on the WebRTC technology. The second step will consist in helping the robotic partner in the project (the Robosoft company) to implement these solutions on a real mobile robot that will be deployed in museums or in homes for helping seniors in their daily tasks. Semantic Web technologies, will be used in the project for describing the services, the context of the application domain, the content transmitted, etc.

This year, Wimmics main contributions were: a state-of-the-art on the techniques for transferring Web-based data/audio/video ; prototypes based on the technologies selected from the state-of-the-art ; a procedure and quantitative and qualitative criteria for benchmarking the prototypes.

8.2.2. *ANR LabCom SMILK*

Participants: Farhad Nooralahzadeh, Elena Cabrio, Fabien Gandon.

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.

8.2.3. *Ministry of Culture: DBpedia.fr*

Participants: Raphaël Boyer, Fabien Gandon.

This project named "DBpedia.fr" proposes the creation of a French chapter of the base DBpedia used in many English applications, in particular for the publication of cultural collections. Because DBpedia is focused on the English version of Wikipedia it ignores some of the French topics and their data. This project aims at extracting a maximum of RDF data from the French version and providing a stable and scalable end-point for them. We now consider means to improve both the quantity and the quality of the data. The DBpedia.fr project was the first project of the Semanticpedia convention signed by the Ministry of Culture, the Wikimedia foundation and Inria.

A new complete DBpedia extraction has been performed, together with a technical documentation to reproduce it and a documentation for the users has been done too. In addition we have included the last community user interface and adapted it for French DBpedia. This version is more ergonomic and detailed, but also integrates a new SPARQL editor named Flint for students and beginners. A new DBpedia service from the community has been adapted for the French version: it's called "fragments", a service made for minimizing server processing.

Some scripts have been developed, one for generation of statistics based on log, others for grouping the abstracts of each language, based on redirections and interlanguages linked data. Also to increase our amount of available data, we created a new extractor that can extract historic and make statistics of modifications of each Wikipedia article.

Web site: http://wimmics.inria.fr/projects/dbpedia

8.2.4. *Ministry of Culture: GT 6*
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.

8.2.5. *ANR OCKTOPUS*
Participants: Fabien Gandon, Catherine Faron-Zucker, Zide Meng.

OCKTOPUS is an ANR project (2012-2016). The objective of OCKTOPUS is 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 believe that 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 will focus 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 will take 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

8.2.6. *GDRI Zoomathia*
Participants: Olivier Corby, Catherine Faron-Zucker, Alexandre Monnin, Andrea Tettamanzi.

Wimmics is partner of 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 started to work on 1) the translation of manual annotations of middle-age structured texts from XML to RDF, 2) the automatic extraction of RDF annotations from text using NLP techniques and 3) 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/

8.2.7. *Semantic EDUCLOUD Carnot Project*

Participants: Oscar Rodriguez Rocha, Catherine Faron-Zucker.

Partner : GAYAtech. This project was just accepted this year on the topic of *semantic Web for e-learning*. This is a joint project with Gayatech on the recommendation of pedagogical resources adapted to user profile and context in the EDUCLOUD 06 Serious Game. To get help in his quests and various quiz testing his knowledge, the gamer can use external digital resources (books, video, TV, Web) and an in-game social network to work with his teacher and comrades. In this context, and to meet the needs of GAYATECH developing edutainment solutions, the Semantic EDUCLOUD project aims to improve the recommendation of educational resources to learners in EDUCLOUD 06, by using semantic Web and social Web models and techniques.

8.2.8. *Carnot Project Vigiglobe*

Participants: Elena Cabrio, Serena Villata.

Partner : Vigiglobe.

This project was just accepted this year on the topic of *Natural Language Argumentation on Twitter: Retrieval of Argumentative Structures and Reasoning*. this is a joint project with Vigiglobe on the natural language processing of argumentation on Twitter to retrieve argumentative structures and reason on them. The goal of the project is to : (1) Automate the selection and annotation of tweets, i.e., retrieval of those tweets that can be considered as arguments (2) Automate the assignment of labels to the type of relation holding between arguments - positive relation or negative relation. (3) Create an argumentation graph illustrating the relations between the arguments about a certain subject, and the further application of argumentation semantics to compute the set of "winning" arguments This graph-based visualization provides a summary of the ongoing discussion on Twitter.

8.2.9. *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) 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.

This year, Wimmics main contributions were: a state-of-the-art on user-centered privacy and security (leading to the identification of the security and privacy aspects to be taken into account, from a user's point of view, in the design of a mobile device used to communicate personal data and documents); a field study of users performing administrative procedures from the point of view of security and privacy; and the functional mock-ups of the GUIs of the PadDOC mobile application to be used by the client of a commercial or administrative service.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. 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: http://www.dis.uniroma1.it/~aloof

8.4. International Initiatives

8.4.1. Inria International Labs

We participate to the LIRIMA Africa (Laboratoire international de recherche en informatique et mathématiques appliquées) where we have a long term collaboration with University Gaston Berger in Saint-Louis, Senegal, with Pr. Moussa Lo. We host two PhD students in co-supervision with UBG: Papa Fary Diallo and Oumy Seye [60].

8.4.2. Inria Associate Teams not involved in an Inria International Labs

8.4.2.1. SEEMPAD
Participants: Elena Cabrio, Serena Villata, Valerio Basile, Fabien Gandon, Claude Frasson.

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

Team site: 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.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Lautaro Petaccio

Title: Design and development of a fact-checking framework based on argumentation theory and Natural Language Processing techniques.

Date: August 2015-December 2015

Institution: Universidad de Buenos Aires (Argentina)

Supervisor: Elena Cabrio, Serena Villata

Clémence Chauvet

Title: GUI for a requirement system
Date: from June 2015 until August 2015
Univ. Nice
Supervisor: Isabelle Mirbel et Serena Villata

Molka Dhouib
Title: Integration and enrichment of cultural heritage metadata on the Web of Data.
Date: until September 2015
Univ. Nice, Master 2
Supervisor: Catherine Faron-Zucker, Elena Cabrio

Raphael Gazzotti
Title: Checking OWL profile conformance with SPARQL Template Transformation Language
Date: from May 2015 until September 2015
Univ. Nice, Master 2
Supervisor: Olivier Corby

Racha Gouareb
Title: Semantic Annotation of Lyrics
Date: from May 2015 until October 2015
Univ. Nice
Supervisor: Michel Buffa, Catherine Faron-Zucker

Ahmed Missaoui
Title: Integration and enrichment of cultural heritage metadata on the Web of Data
Date: October 2014 - February 2015
Univ. Nice
Supervisor: Elena Cabrio, Catherine Faron-Zucker and Serena Villata

Baffoue Kangah
Title: Robot Navigation Web Control
Date: from May 2015 until October 2015
Univ. Nice
Supervisor: Michel Buffa, Catherine Faron-Zucker

Garance Vallat
Title: Semantic Web based platform for bibliography query and visualisation
Date: from June 2015 until August 2015
Univ. Nice, Master 1
Supervisor: Olivier Corby, Mireille Blay-Fornarino (I3S)

Reda Zarhbouch
Title: From user requirement to BPMN service composition modeling
Date: from May 2015 until October 2015
Univ. Nice, Master MIAGE
Supervisor: Isabelle Mirbel

Konstantina Poulida
Title: Extraction of Zoological Knowledge from Ancient and Middle-Age Scientific Texts
Date: from November 2015 to January 2016
Inria, University of Patras, Greece
Supervisor: Catherine Faron-Zucker, Andrea Tettamanzi

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

Catherine Faron-Zucker spent the month of July at the Hasso Platner Institute (HPI) in Potsdam, Germany. She presented her research work in a seminar of the Semantic Web group.

Alexandre Monnin spent the month of November at the Digital Cultures Research Center (Leuphana University, Lüneburg, Germany), as a Research Fellow, to participate in the discussions on the semester's topic ("Non-knowledge and Digital Cultures"). Among other things he did a response to a talk delivered by Jeannie Moser's on "Mistrust", did two interviews on digital cultures, and participate in the non-knowledge seminar organized in Braunschweig, Germany.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Labex NUMEV, Montpellier

URL: http://www.lirmm.fr/numev

We are participating in the Laboratory of Excellence (labex) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences) headed by University of Montpellier 2 in partnership with CNRS, University of Montpellier 1, 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 NUMEV 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 (with Pascal Poncelet) the theme on scientific data.

9.1.2. Institut de Biologie Computationnelle (IBC), Montpellier

URL: http://www.ibc-montpellier.fr

IBC is a 5 year project 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. Datascale (2013-2015), 250Keuros

Participants: Reza Akbarinia, Florent Masseglia, Saber Salah, Patrick Valduriez.

The Datascale project is a PIA on big data with Bull (leader), CEA, ActiveEon SAS, Armadillo, Twenga, IPGP, Xedix and Inria (Zenith) . The goal of the project is to develop the essential technologies for big data, including efficient data management, software architecture and database architecture, and demonstrate their scalability with representative applications. In this project, the Zenith team works on data mining with Hadoop MapReduce.

9.2.1.2. Xdata (2013-2015), 125Keuros

Participants: Julien Diener, Patrick Valduriez.

The X-data project is a PIA with Data Publica (leader), Orange, La Poste, EDF, Cinequant, Hurence and Inria (Indes, Planete and Zenith) . The goal of the project is to develop a big data plaftform with various tools and services to integrate open data and partners's private data for analyzing the location, density and consuming of individuals and organizations in terms of energy and services. In this project, the Zenith team heads the workpackage on data integration.

9.2.1.3. PIA Floris'Tic (2015-2018), 430Keuro.

Participants: Julien Champ, Alexis Joly.

Floris'tic is a PIA aimed 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 and the TelaBotanica social network.

9.2.2. Others

9.2.2.1. CIFRE INA/Inria (2013-2016), 100Keuros
Participants: Alexis Joly, Valentin Leveau, Patrick Valduriez.

This CIFRE 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. CNRS INS2I Mastodons (2013-2015), 90Keuros
Participants: Alexis Joly, Florent Masseglia, Esther Pacitti [leader], Patrick Valduriez.

This project deals with the problems of big data in the context of life science, where masses of data are being produced, e.g. by Next Generation Sequencing technologies or plant phenotyping platforms. In this project, Zenith addresses the specific problems of large-scale data analysis and data sharing.

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

Accessing and managing large amounts of data is becoming a major obstacle to developing new cloud applications and services with correct semantics, requiring tremendous programming effort and expertise. CoherentPaaS addresses this issue in the cloud PaaS landscape by 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 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 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 will 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 industry. 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. In this project, Zenith is working on Big Data management and analysis of numerical simulations.

9.4. International Initiatives

9.4.1. Inria Associate Teams

9.4.1.1. 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/

The cloud has become a good match for managing big data since it provides unlimited computing, storage and network resources on demand. 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.

9.4.1.2. BIGDATANET

Title: A hybrid P2P/cloud for big data
Inria principal investigator: Patrick Valduriez
International Partner : University of California at Santa Barbara (USA) - Amr El Abbadi and Divy Agrawal
Duration: 2013 - 2015
See also: https://team.inria.fr/zenith/projects/international-projects/bigdatanet/

The main objective of this research and scientific collaboration is to develop a hybrid architecture of a computational platform that leverages the cloud computing and the P2P computing paradigms. The resulting architecture will enable scalable data management and data analysis infrastructures that can be used to host a variety of next-generation applications that benefit from computing, storage, and networking resources that exist not only at the network core (i.e., data-centers) but also at the network edge (i.e., machines at the user level as well as machines available in CDNs – content distribution networks hosted in ISPs).

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).
- Asia: National Univ. of Singapore (Beng Chin Ooi, Stéphane Bressan), Wonkwang University, Korea (Kwangjin Park)
- Europe: Univ. of Amsterdam (Hamideh Afsarmanesh), 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)

9.4.3. Inria International Labs

The Bigdatanet associated team takes part of the Inria@SiliconValley lab.

9.4.4. Participation In other International Programs

We are involved in the following international actions:

- CNPq-Inria project Hoscar (HPC and data management, 2012-2015) with LNCC (Fabio Porto), UFC, UFRGS (Philippe Navaux), UFRJ (Alvaro Coutinho, Marta Mattoso) to work on data management in high performance computing environments.

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.

9.5.2. Visits to International Teams

Maximilien Servajean visited UCSB in june, in the context of the Bigdatanet associated team.