RESEARCH CENTER
Grenoble - Rhône-Alpes

FIELD

Activity Report 2019

Section Partnerships and Cooperations

Edition: 2020-03-21

AGORA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- FIL Grant, 2019
  Participants: Razvan Stanica
  The partners of this project, supported by the *Fédération d'Informatique de Lyon*, are: CITI, LIP.
  WLANs (Wireless Local Area Networks) are typically based on IEEE 802.11 (known as WiFi). However, WLANs are prone to performance issues such as unfairness and inefficiencies. 802.11 includes a Rate Adaptation (RA) mechanism that allows user devices to change their transmission rate with regard to the current quality of the radio channel. The RA mechanism is based on preset values that may lead to suboptimal WLAN performance. Our goal is to address this issue by making fine adjustments to the parameters related to the RA mechanism. The search for an adequate setting is made complex due to the vast number of parameters to be considered that precludes the finding of general closed-form expressions. We propose to explore a data-driven approach based on techniques from Machine Learning to design an adaptive and distributed solution.
- Labex IMU 3M'Air 2018-2021
  Participants: Walid Beckhit, Ahmed Boubrima, Manoel Dahan, Mohamed Anis Fekih, Ichrak Mokhtari, Hervé Rivano.
  The partners in this project are: EVS, LMFA, Métropole de Lyon, Ville de Lyon , Atmo AURA, Météo France, Lyon Météo. Inria Agora is the leader of this project.
  The 3M'Air project explores the potential of participatory sensing to improve local knowledge of air quality and urban heat islands. The main aim of this project is therefore to equip citizens with low-cost mobile sensors and then ensure an efficient real-time data collection and analysis. This allows to obtain a finer spatiotemporal granularity of measurements with lighter installation and operational costs while involving citizens.
- ARC6 Robot fleet mobility under communication constraints, 2016-2019.
  Participant : Fabrice Valois.
  This work is a joint project with the Inria Chroma research group. Considering a fleet of drones moving in a 3D area, looking for a given target, we focus on how to maintain the wireless connectivity of the network of drones while the drones patrol autonomously. The other partners in this project are University of Grenoble and Viameca.
- Labex IMU Veleval, 2017-2019
  Participant: Hervé Rivano.
  The partners in this project are: EVS, LIRIS, LLSETI and CITI, with LAET leading the project.
  The goal of this pluridisciplinary project is to study, understand and model the behavior of cyclists in an urban environment with a methodology combining quantitative measurements of mobility traces and image analysis with qualitative information from reactivation interviews. In particular the input of Agora is to provide crowdsourcing tools for gathering mobility data that are optimized for the practice of urban cycling.

9.2. National Initiatives

9.2.1. ANR

- ANR CANCAN 2019 - 2022
  Participants: Solohaja Rabenjamina, Razvan Stanica.
  The partners in this project are: CEDRIC, Inria, Orange Labs, with Thalès Communications & Security leading the project.
  The ANR CANCAN (Content and context based adaptation in mobile networks) targets the following objectives: *i)* collecting novel measurement datasets that describe mobile network data traffic at unprecedented spatial and temporal accuracy levels, and for different mobile services separately. The datasets will be gathered in an operational nationwide network, *ii)* evaluating existing analytics for classification, prediction and anomaly detection within real-world high-detail per-service mobile network data, and tailoring them to the specifications of the management of resources at different network levels, and *iii)* demonstrating the integration of data analytics within next-generation cognitive network architectures in several practical case studies.
- ANR MAESTRO 5G 2019 - 2022
  Participants: Hervé Rivano, Razvan Stanica.
  The partners in this project are: CEDRIC, Inria, L2S, LIA, Nokia Bell Labs, TSP, with Orange Labs leading the project.
  The ANR MAESTRO 5G (Management of slices int he radio access of 5G networks) is expected to provide: *i)* a resource allocation framework for slices, integrating heterogeneous QoS requirements and spanning on multiple resources including radio, backhauling/fronthauling and processing resources in the RAN, *ii)* a complete slice management architecture including provisioning and reoptimization modules and their integration with NFV and SDN strata, *iii)* a business layer for slicing in 5G, *iv)* a demonstrator showing the practical feasibility as well as integration of the major functions and mechanisms proposed by the project, on a 5G Cloud RAN platform. The enhanced platform is expected to support the different 5G services.
- ANR CoWorkWorlds 2018 - 2020.
  Participants: Solohaja Rabenjamina, Razvan Stanica.
  The ANR CoWorkWorlds (Sustainability and spatiality in co-workers' mobility practices) project is led by ENTPE. Its focus is on the study of co-working environments, and more precisely on the mobility behavior of users of such spaces. Our role in the project is to collect and analyse mobility data from a set of users, using the PrivaMov smartphone application.

9.2.2. GDR CNRS RSD - Pôle ResCom

- Ongoing participation (since 2006)
  Communication networks, working groups of GDR ASR/RSD, CNRS (https://gdr-rsd.cnrs.fr/pole_rescom). 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 reproductions 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. Agora will have the opportunity to test some of its capillary networking solutions in a very realistic but controlled urban environment. A proof of concept test site has been built in 2015. We have deployed an experiment on low cost sensor network for vehicle detection and one on atmospheric pollution sensor calibration. The operational site is built, the information system is operational since April 2018.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

- Herve Rivano is member of European COST action CA18204 - Dynamics of placemaking and digitization in Europe´s cities on behalf of Ecole Urbaine de Lyon and Labex IMU.

  Program: Interreg Med

  - Project acronym: ESMARTCITY
  - Project title: Enabling Smarter City in the MED Area through Networking
  - Duration: 02/2018 - 07/2020
  - Coordinator: Abruzzo Region, Italy
  - Other partners: ARIC and RWG (Greece), APEGR (Spain), RAIS (Bosnia and Herzegovina), ENA (Portugal), MCM and PoliMi (Italy), Capergies (France)
  - Abstract: The project has its primary objective in improving the innovation capacity of MED cities by creating innovation ecosystems, which involve actors of the quadruple helix (Citizens, Businesses Operators, Research, Universities and Public Authorities), and in applying the Smart City concept, which utilizes digital and energy saving technologies to allow better services for the citizen with less impact on the environment, producing furthermore new employability and living scenarios. To achieve this goal, the project envisages the pilot testing of the Smart City concept to provide specific services to citizens in the field of intelligent urban districts, energy efficiency of buildings and smarter public lighting.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- **University of Waterloo, ON, Canada**. Joint publications and visits to/from the group of Prof. Catherine Rosenberg.
- **Digital Catapul, London, UK**. Collaboration around LoRa experiments with Dr. Ramona Marfievici.
- **CNR-IEIIT, Turin, Italy**. Joint publications and projects with Dr. Marco Fiore.
- **Trento University, Italy**. Collaboration around routing for IoT networks with the group of Prof. Gian Pietro Picco.
- **Rice University**. Collaboration around network deployment and data assimilation for air quality monitoring with the group of Prof. Edward W. Knightly.
- **University of Edinburgh, UK**. Joint publications and visits to/from the group of Dr. Paul Patras.
- **Biskra University, Algeria**. Joint publications and visits from Prof. Abdelmalik Bachir.

9.4.2. Participation in Other International Programs

9.4.2.1. PHC Campus France

- **University College Cork, Ireland**. PHC Ulysses (2019-2021) on real-world characterisation of long range wireless newtorks, a collaboration with Khaled Abdelfadeel.
- **INPT Rabat, Morocco**. PHC Toubkal (2019-2021) on efficient data collection for smart building and smart city applications, a collaboration with the group of Prof. Loubna Echabbi.
- **University of Cluj-Napoca, Romania**. PHC DRONEM (2017-2019) on monitoring using connected fleet of drones, a collaboration with the group of Prof. Gabriela Czibula.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Abdelmalik Bachir, Professor, Biskra University, Algeria: visiting professor at INSA Lyon (november, 2019).
- Ravi Mazumdar, Waterloo University, Canada, visiting scientist at INSA Lyon (february, 2019).
- Priscilla Solis, Professor, Brasilia University, Brazil, visiting the Agora team to prepare a sabbatical.

9.5.1.1. Internships

- Sami Abdelatif, PhD student, Biskra University, Algeria: visiting professor at INSA Lyon (november, 2019).

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Mihai Popescu visited the group of Prof. Gabriela Czibula, at University of Cluj-Napoca, Romania (2 periods of 1 month duration: April and July 2019).
- Fabrice Valois visited Prof. Catherine Rosenberg, University of Waterloo, Canada (6 weeks between January and March 2019).

AIRSEA Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

C. Prieur is co-leader of work-package 3 of the cross-disciplinary-project Trajectories from Idex Grenoble.

8.2. National Initiatives

8.2.1. ANR

A 4-year contract : ANR COCOA (COmprehensive Coupling approach for the Ocean and the Atmosphere). PI: E. Blayo. (Jan. 2017 - Dec. 2020). Other partners: Laboratoire des Sciences du Climat et de l'Environnement (UMR8212, Gif-sur-Yvette), Laboratoire de Météorologie Dynamique (UMR8539, Paris), Laboratoire d'Océanographie Physique et Spatiale (UMR6523, Brest), Centre National de Recherche Météorologique (UMR3589, Toulouse), Cerfacs (Toulouse). This project aims at revisiting the overall representation of air-sea interactions in coupled ocean-atmosphere models, and particularly in climate models, by coherently considering physical, mathematical, numerical and algorithmic aspects.

A 4-year contract : ANR HEAT (Highly Efficient ATmospheric modelling) http://www.agence-nationale-recherche.fr/?Project=ANR-14-CE23-0010.

A 4-year contract : ANR ADOM (Asynchronous Domain decomposition methods)

A 5-year contract : ANR MELODY (Bridging geophysics and MachinE Learning for the modeling, simulation and reconstruction of Ocean DYnamic)

A 5-year contract with the French Navy (SHOM) on the improvment of the CROCO ocean model http://www.croco-ocean.org.

C. Prieur and E. Arnaud are involved as experts in project High-Tune http://www.agence-nationale-recherche.fr/Projet-ANR-16-CE01-0010 funded by ANR.

8.2.2. Inria Challenge

Sea Uncertainty Representation and Forecast (SURF),

Coord : Airsea (A. Vidard),

Partenaires Inria : Ange, Cardamom, Fluminance, Lemon, Mingus, Defi

Partenaires extérieurs: BRGM, Ifremer, SHOM

8.2.3. 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 5.3 .

C. Prieur is co-advising the PhD thesis of Henri Mermoz Kouye, ine the framework of the Inria-INRA collaboration.

C. Prieur chaired GdR MASCOT NUM 2010-2017, in which are also involved M. Nodet, E. Blayo, C. Helbert, E. Arnaud, L. Viry, S. Nanty, L. Gilquin. She is still strong involved in the group (co-chair). In particular, she will co-chair next GdR annual meeting in Aussois (May 2020). http://www.gdr-mascotnum.fr/doku.php.

LEFE/GMMC CASIS, Coupled Assimilation Strategies for the Initialisation of an ocean- atmospheric boundary layer System, A. Vidard en collaboration avec Mercator océan

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

H2020 project IMMERSE (Improving Models for Marine EnviRonment SErvices) is funded from 2018-12-01 to 2022-11-30 (Inria contact: Florian Lemarié, coordinator: J. Le Sommer, CNRS). The overarching goal of the project is to ensure that the Copernicus Marine Environment Monitoring Service (CMEMS) will have continuing access to world-class marine modelling tools for its next generation systems while leveraging advances in space and information technologies, therefore allowing it to address the ever-increasing and evolving demands for marine monitoring and prediction in the 2020s and beyond. See also https://cordis.europa.eu/project/rcn/218810/factsheet/fr and https://immerse-ocean.eu/

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: C3S

Project acronym: ERGO

Project title: Enabling an Ensemble of Data Assimilation for the Ocean

Duration: Février 2019 - juillet 2021

Coordinator: Arthur Vidard

Other partners: Cerfacs (France), Met Office (U.K.), CMRE (int, Italie)

Abstract: The scope of this contract is to improve ocean data assimilation capabilities at ECMWF, used in both initialization of seasonal forecasts and generation of coupled Earth System reanalyses. In particular it shall focus on i) improving ensemble capabilities in NEMO and NEMOVAR and the use of their information to represent background error statistics; ii) extend NEMOVAR capabilities to allow for multiple resolution in multi-incremental 3D-Var; iii) make better use of ocean surface observations. It shall also involve performing scout experiments and providing relevant diagnostics to evaluate the benefit coming from the proposed developments.

8.3.3. Collaborations with Major European Organizations

Partner: European Center 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 : SAMO board

SAMO board is in charge of the organization of the SAMO (sensitivity analysis of model outputs) conferences, every three years. It is strongly supporter by the Joint Research Center of the European Commission. In 2019, Clémentine Prieur, which is part of this board, as also co-chair of a satellite event on the future of sensitivity analysis. A position paper is under construction, as a synthesis of the discussions hold in Barcelona (autumn 2019).

8.4. International Initiatives

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

8.4.1.1. UNQUESTIONABLE

Title: UNcertainty QUantification is ESenTIal for OceaNic & Atmospheric flows proBLEms.

International Partner: Massachusetts Institute of Technology (United States) - Aerospace Computational Design Laboratory - Youssef Marzouk

Start year: 2018

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

The ability to understand and predict the behavior of geophysical flows is of greatest importance, due to its strong societal impact. Numerical models are essential to describe the evolution of the system (ocean + atmosphere), and involve a large number of parameters, whose knowledge is sometimes really poor. The reliability of the numerical predictions thus requires a step of parameter identification. The Inria-AIRSEA team has a strong expertise in variational approaches for inverse problems. An alternative is the use of particle filters, whose main advantage is their ability to tackle non-gaussian frameworks. However, particle filters suffer from the curse of dimensionality. The main objective of the collaboration we propose between the Inria-AIRSEA team and the MIT UQ group is the understanding of potential low-dimensional structure underlying geophysical applications, then the exploitation of such structures to extend particle filter to high-dimensional applications.

8.4.2. Inria International Partners

F. Lemarié and L. Debreu collaborate with Hans Burchard and Knut Klingbeil from the Leibniz-Institut für Ostseeforschung in Warnemünde (Germany) [32], [12].

C. Prieur collaborates with Jose R. Leon (Universdad de la república de Uruguay, Montevideo).

C. Prieur collaborates with K. Bertin (CIMFAV, Valparaíso).

F.-X. Le Dimet is a Honorary Professor of the Institut of Mechanics, Ac.Sci. Vietnam.

F.-X. Le Dimet is a Honorary Professor of the Institut of Numerical Mathematics, Russian Ac.Sci.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Alistair Adcroft (Princeton Univ.) visited the team in Jan. 2019

Jose R. León was visiting the team during two weeks. He is working with Clémentine Prieur, in collaboration with Pierre Etoré and Adeline Samson (DATA department of LJK) on UQ for models described by SDE.

Nicholas Kevlahan, from McMaster University (Canada) was a visiting scientist of the AIRSEA team for 10 months in 2018-2019.

Victor Shutyaev, from the Institut of Numerical Mathematics (Moscow, Russian Ac.Sci.) was visiting the team during two weeks to collaborate with F.-X. Le Dimet [17].

ARIC Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR FastRelax Project

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

FastRelax stands for "Fast and Reliable Approximation". It is a four year ANR project (started in October 2014 and extended till September 2019). 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.

9.1.2. ANR ALAMBIC Project

Participants: Benoît Libert, Fabien Laguillaumie, Ida Tucker.

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

9.1.3. RISQ Project

Participants: Chitchanok Chuengsatiansup, Rikki Amit Inder Deo, Hervé Tale Kalachi, Fabien Laguillaumie, Benoît Libert, Damien Stehlé.

RISQ (Regroupement de l'Industrie française pour la Sécurité Post – Quantique) is a BPI-DGE four-year project (started in January 2017) focused on the transfer of post-quantum cryptography from academia to industrial poducts. The web page of the project is http://risq.fr. It is headed by Secure-IC and, besides AriC, also involves teams from ANSSI (Agence Nationale de la Sécurité des Systèmes d'Information), Airbus, C& S (Communication et Systèmes), CEA (CEA-List), CryptoExperts, Gemalto, Orange, Thales Communications & Security, Paris Center for Quantum Computing, the EMSEC team of IRISA, and the Cascade and Polsys Inria teams. The outcome of this project will include an exhaustive encryption and transaction signature product line, as well as an adaptation of the TLS protocol. Hardware and software cryptographic solutions meeting these constraints in terms of security and embedded integration will also be included. Furthermore, documents guiding industrials on the integration of these post-quantum technologies into complex systems (defense, cloud, identity and payment markets) will be produced, as well as reports on the activities of standardization committees.

9.2. European Initiatives

9.2.1. PROMETHEUS Project

Participants: Fabien Laguillaumie, Benoît Libert, Octavie Paris, Damien Stehlé.

PROMETHEUS (Privacy-Preserving Systems from Advanced Cryptographic Mechanisms Using Lattices) is a 4-year European H2020 project (call H2020-DS-2016-2017, Cybersecurity PPP Cryptography, DS-06-2017) that started in January 2018. It gathers 8 academic partners (ENS de Lyon and Université de Rennes 1; CWI, Pays-Bas; IDC Herzliya, Israel; Royal Holloway University of London, United Kingdom; Universitat Politècnica de Catalunya, Spain; Ruhr-Universität Bochum, Germany; Weizmann Institute, Israel), 4 industrial partners (Orange, Thales, TNO, Scytl). The goal of this project is to develop a toolbox of privacy-preserving cryptographic algorithms and protocols (like group signatures, anonymous credentials, or digital cash systems) that resist quantum adversaries. Solutions will be mainly considered in the context of Euclidean lattices and they will be analyzed from a theoretical point of view (i.e., from a provable security aspect) and a practical angle (which covers the security of cryptographic implementations and side-channel leakages). The project is hosted by ENS de Lyon and Benoît Libert is the administrative coordinator while Orange is the scientific leader.

9.3. International Initiatives

9.3.1. Participation in Other International Programs

9.3.1.1. IFCPAR grant: "Computing on Encrypted Data: New Paradigms in Functional Encryption"

Participants: Benoît Libert, Damien Stehlé.

3-year project accepted in July 2018. Expected beginning on January 1, 2019. Benoît Libert is co-PI with Shweta Agrawal (IIT Madras, India). Budget on the French side amounts to 100k€.

Functional encryption is a paradigm that enables users to perform data mining and analysis on encrypted data. Users are provided cryptographic keys corresponding to particular functionalities which enable them to learn the output of the computation without learning anything about the input. Despite recent advances, efficient realizations of functional encryption are only available for restricted function families, which are typically represented by small-depth circuits: indeed, solutions for general functionalities are either way too inefficient for pratical use or they rely on uncertain security foundations like the existence of circuit obfuscators (or both). This project will explore constructions based on well-studied hardness assumptions and which are closer to being usable in real-life applications. To this end, we will notably consider solutions supporting other models of computation than Boolean circuits – like Turing machines – which support variable-size inputs. In the context of particular functionalities, the project will aim for more efficient realizations that satisfy stronger security notions.

9.3.1.2. Inria International Chairs

- **TUCKER Warwick**
- Department of Mathematics - Uppsala University - Sweden
- Title: Attracteur de Hénon et intégrales abéliennes liées aux 16e problème de Hilbert
- 2018 – 2022

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Ron Steinfeld, Monash University (June)
- Amin Sakzad, Monash University (June)
- Shi Bai, Florida Atlantic University (June and July)
- David Wu, University of Virginia (July)
- Olivier Bernard, Université Rennes 1 and Thalès (October and November)
- Gautier Eberhart, Université Rennes 1 (October and November)
- Federico Savasta, Università degli Studi di Catania (October)

AVALON Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CPER

Participants: Thierry Gautier, Laurent Lefèvre, Christian Perez.

The LECO experimental platform is a new medium size scientific instrument deployed in Grenoble in 2018 and in Lyon in 2019. It was funded by the CPER 2015-2020 LECO++ to investigate research related to BigData and HPC.

8.1.2. Action Exploratoire Inria: EXODE

Participant: Thierry Gautier.

In biology, the vast majority of systems can be modeled as ordinary differential equations (ODEs). Modeling more finely biological objects leads to increase the number of equations. Simulating ever larger systems also leads to increasing the number of equations. Therefore, we observe a large increase in the size of the ODE systems to be solved. A major lock is the limitation of ODE numerical resolution software (ODE solver) to a few thousand equations due to prohibitive calculation time. The AEx ExODE tackles this lock via 1) the introduction of new numerical methods that will take advantage of the mixed precision that mixes several floating number precisions within numerical methods, 2) the adaptation of these new methods for next generation highly hierarchical and heterogeneous computers composed of a large number of CPUs and GPUs. For the past year, a new approach to Deep Learning has been proposed to replace the Recurrent Neural Network (RNN) with ODE systems. The numerical and parallel methods of ExODE will be evaluated and adapted in this framework in order to improve the performance and accuracy of these new approaches.

8.2. National Initiatives

8.2.1. Inria Large Scale Initiative

8.2.1.1. DISCOVERY, DIStributed and COoperative management of Virtual EnviRonments autonomouslY, 4 years, 2015-2019

Participants: Maverick Chardet, Jad Darrous, Christian Perez.

To accommodate the ever-increasing demand for Utility Computing (UC) resources, while taking into account both energy and economical issues, the current trend consists in building larger and larger Data Centers in a few strategic locations. Although such an approach enables UC providers to cope with the actual demand while continuing to operate UC resources through centralized software system, it is far from delivering sustainable and efficient UC infrastructures for future needs.

The DISCOVERY initiative aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet in order to deliver widely distributed platforms that can better match the geographical dispersal of users as well as the ever increasing demand. Critical to the emergence of such locality-based UC (LUC) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote the LUC Operating System (OS), a unified system in charge of turning a complex, extremely large-scale and widely distributed infrastructure into a collection of abstracted computing resources which is efficient, reliable, secure and at the same time friendly to operate and use.

To achieve this, the consortium is composed of experts in research areas such as large-scale infrastructure management systems, network and P2P algorithms. Moreover two key network operators, namely Orange and RENATER, are involved in the project.

By deploying and using such a LUC Operating System on backbones, our ultimate vision is to make possible to host/operate a large part of the Internet by its internal structure itself: A scalable set of resources delivered by any computing facilities forming the Internet, starting from the larger hubs operated by ISPs, government and academic institutions, to any idle resources that may be provided by end-users.

8.2.1.2. HAC SPECIS, High-performance Application and Computers, Studying PErformance and Correctness In Simulation, 4 years, 2016-2020

Participants: Dorra Boughzala, Idriss Daoudi, Thierry Gautier, Laurent Lefèvre, Frédéric Suter.

Over the last decades, both hardware and software of modern computers have become increasingly complex. Multi-core architectures comprising several accelerators (GPUs or the Intel Xeon Phi) and interconnected by high-speed networks have become mainstream in HPC. Obtaining the maximum performance of such heterogeneous machines requires to break the traditional uniform programming paradigm. To scale, application developers have to make their code as adaptive as possible and to release synchronizations as much as possible. They also have to resort to sophisticated and dynamic data management, load balancing, and scheduling strategies. This evolution has several consequences:

First, this increasing complexity and the release of synchronizations are even more error-prone than before. The resulting bugs may almost never occur at small scale but systematically occur at large scale and in a non deterministic way, which makes them particularly difficult to identify and eliminate.

Second, the dozen of software stacks and their interactions have become so complex that predicting the performance (in terms of time, resource usage, and energy) of the system as a whole is extremely difficult. Understanding and configuring such systems therefore becomes a key challenge.

These two challenges related to correctness and performance can be answered by gathering the skills from experts of formal verification, performance evaluation and high performance computing. The goal of the HAC SPECIS Inria Project Laboratory is to answer the methodological needs raised by the recent evolution of HPC architectures by allowing application and runtime developers to study such systems both from the correctness and performance point of view.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Energy oriented Centre of Excellence for computing applications (EoCoE-II)

Participants: Thierry Gautier, Christian Perez.

Program: H2020 RIA european project, call H2020-INFRAEDI-2018-1

Project acronym: EoCoE-II

Project title: Energy oriented Centre of Excellence for computing applications

Duration: 2018-2021

Coordinator: CEA

Other partners: CEA, FZJ, ENEA, BSC, CNRS, Inria, CERFACS, MPG, FRAUNHOFER, FAU, CNR, UNITN, PSNC, ULB, UBAH, CIEMAT, IFPEN, DDN, RWTH, UNITOV

Abstract: Europe is undergoing a major transition in its energy generation and supply infrastructure. The urgent need to halt carbon dioxide emissions and prevent dangerous global temperature rises has received renewed impetus following the unprecedented international commitment to enforcing the 2016 Paris Agreement on climate change. Rapid adoption of solar and wind power generation by several EU countries has demonstrated that renewable energy can competitively supply significant fractions of local energy needs in favourable conditions. These and other factors have combined to create a set of irresistible environmental, economic and health incentives to phase out power generation by fossil fuels in favour of decarbonized, distributed energy sources. While the potential of renewables can no longer be questioned, ensuring reliability in the absence of constant conventionally powered baseload capacity is still a major challenge.

The EoCoE-II project will build on its unique, established role at the crossroads of HPC and renewable energy to accelerate the adoption of production, storage and distribution of clean electricity. How will we achieve this? In its proof-of-principle phase, the EoCoE consortium developed a comprehensive, structured support pathway for enhancing the HPC capability of energy-oriented numerical models, from simple entry-level parallelism to fully-fledged exascale readiness. At the top end of this scale, promising applications from each energy domain have been selected to form the basis of 5 new Energy Science Challenges in the present successor project EoCoE-II that will be supported by 4 Technical Challenges

8.3.1.2. PRACE 6th Implementation Phase Project (PRACE6-IP)

Participants: Marcos Dias de Assunção, Laurent Lefèvre, Christian Perez.

Program: H2020 RIA european project, call H2020-INFRAEDI-2018-1

Project acronym: PRACE-6IP

Project title: PRACE 6th Implementation Phase Project

Duration: May 2019-Dec 2021

Coordinator: FZJ

Other partners: HLRS, LRZ, GENCI, CEA, CINES, CNRS, IDRIS, Inria, EPCC, BSC, CESGA, CSC, ETH-CSCS, SURFsara, KTH-SNIC, CINECA, PSNC, CYFRONET, WCNS, UiOsingma2, GRNET, UC-LCA, Univ MINHO, ICHEC, UHEM, CASTORCm NCSA, IT4I-VSB, KIFU, UL, CCSAS, CENAERO, Univ Lux, GEANT

Abstract: PRACE, the Partnership for Advanced Computing is the permanent pan-European High Performance Computing service providing world-class systems for world-class science. Systems at the highest performance level (Tier-0) are deployed by Germany, France, Italy, Spain and Switzerland, providing researchers with more than 17 billion core hours of compute time. HPC experts from 25 member states enabled users from academia and industry to ascertain leadership and remain competitive in the Global Race. Currently PRACE is finalizing the transition to PRACE 2, the successor of the initial five year period. The objectives of PRACE-6IP are to build on and seamlessly continue the successes of PRACE and start new innovative and collaborative activities proposed by the consortium. These include: assisting the development of PRACE 2; strengthening the internationally recognised PRACE brand; continuing and extend advanced training which so far provided more than 36 400 person·training days; preparing strategies and best practices towards Exascale computing, work on forward-looking SW solutions; coordinating and enhancing the operation of the multi-tier HPC systems and services; and supporting users to exploit massively parallel systems and novel architectures. A high level Service Catalogue is provided. The proven project structure will be used to achieve each of the objectives in 7 dedicated work packages. The activities are designed to increase Europe's research and innovation potential especially through: seamless and efficient Tier-0 services and a pan-European HPC ecosystem including national capabilities; promoting take-up by industry and new communities and special offers to SMEs; assistance to PRACE 2 development; proposing strategies for deployment of leadership systems; collaborating with the ETP4HPC, CoEs and other European and international organisations on future architectures, training, application support and policies. This will be monitored through a set of KPIs.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. Joint Laboratory for Extreme Scale Computing (JLESC) (2014-2023)

Participants: Thierry Gautier, Christian Perez.

Partners: NCSA (US), ANL (US), Inria (FR), Jülich Supercomputing Centre (DE), BSC (SP), Riken (JP).

The purpose of the Joint Laboratory for Extreme Scale Computing (JLESC) is to be an international, virtual organization whose goal is to enhance the ability of member organizations and investigators to make the bridge between Petascale and Extreme computing. The founding partners of the JLESC are Inria and UIUC. Further members are ANL, BSC, JSC and RIKEN-AICS.

JLESC involves computer scientists, engineers and scientists from other disciplines as well as from industry, to ensure that the research facilitated by the Laboratory addresses science and engineering's most critical needs and takes advantage of the continuing evolution of computing technologies.

Inria@EastCoast
Associate Team involved in the International Lab:

8.4.1.2. SUSTAM

Title: Sustainable Ultra Scale compuTing, dAta and energy Management

International Partner (Institution - Laboratory - Researcher):

Start year: 2017

See also: http://avalon.ens-lyon.fr/sustam

The SUSTAM associate team will focus on the joint design of a multi-criteria orchestration framework dealing with resources, data and energy management in an sustainable way. The SUSTAM associated team will enable a long-term collaboration between the Inria Avalon team and the Rutgers Discovery Informatics Institute (RDI2) from Rutgers University (USA).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Carlos Henrique Cardonha, IBM Research Brazil, from Jun 2019 until Jul 2019.

Jean-Philippe Aboumou, SAHAM Life Insurance, from Oct 2019.

8.5.1.1. Internships

Ibrahim Jouwad, M2, *Optimisation de la migration d'un ensemble de machines virtuelles dans un datacentre à l'aide d'un graphe d'états*

Laurent Turpin, M2, *Formalisation de paramètres, evaluation de performance et auto-configuration d'une application HPC en mémoire partagée : application au simulateur Aevol*

Josee Alvine Kouamen, M2, *Prise en main d'une infrastructure cloud et Big data pour l'analyse des fraudes a la simbox*

Zakaria Fraoui, *Distributed Stream Processing in the Edge: The Internet of Things Usecase*

Mohamed Hamnache, PFE, *Optimisation d'un environnement de calculs distribués pour la bio-informatique*

Alice Andres, M1, *Cloud vs Edge: fighting for energy !*

Adrien Berthelot, M1, *Revisiting low tech IT protocols*

Pierre Jacquot, L3, *Analysis of DDFacet/KillMS pipeline*

Marouane Azzouz, IUT, *Mode clients/serveur pour le projet CartomENSia*

BEAGLE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- CPER LECO++: Parallel HPC architectures evolve and the calculation codes are naturally bound to vary over time. Indeed, the architectures change every 2-3 years while the lifespan of a scientific code is much longer (at least 10 years). Knowing how to control the impacts of these changes in order to automatically adapt the digital simulation codes to maintain a high level of performance is a necessity to guarantee a certain sustainability of the developed code. Currently, these variations are manually managed by programmers which require a high level of expertise as well as time.

  A collaboration between the AVALON teams from LIP and BEAGLE from LIRIS on this subject involved one master trainees this year (funding from Federation Informatique de Lyon – PMSISEE project). More specifically, BEAGLE is interested in designing AEVOL a high performance parallel code for simulating the evolution of a population of bacteria. The different parts of the code have been adapted to the hardware characteristics of current architectures (multicore, vector computing, etc.) for which certain operations have several implementations (CPU or vector) or several parallel variants. Designing the assembly of the right versions and choosing the right parameters remains a difficult problem. In this issue, the AVALON team brings its expertise in the development and exploitation of component models, in parallel programming models and in the expertise of executive supports for HPC.

  A PhD thesis between Avalon and Beagle (Laurent Turpin) linked to the CPER LECO++ project (coordinator: T. Gautier, AVALON) has started with the aim of studying the robustness of computer codes on modern parallel architectures and their evolution. Thus, the targeted hardware is that being acquired through the LECO++ project (ARM machine, massively multi-GPU (10)).

  The work of this thesis aims to study the methods and approaches allowing to contribute to a solution to the problems of composition, choice of parameters and efficient execution on a parallel architecture in HPC. The problem addressed in the thesis concerns the portability of the performance of a parallel application for managing code variants and variations at runtime. The solutions that will be studied will be those at the interface between a programming model and its exploitation by executive support. In order to exploit the performance of a class of machines in a portable manner, the candidate will propose the necessary adaptations, whether to the existing component-based programming model (typically Comet) and to executive support (OpenMP type or an executive engine with task base). A major constraint of this work is the performance at execution: the evaluation will be based on an experimental methodology with AEVol as target application. The target hardware is that of an HPC computing node of tomorrow: a multi-core server coupled with a large number of hardware accelerators - GPUs - allowing to have a significant computing density (approximately from 30 to 128 TFlops double precision for 4 to 16 GPUs).

8.2. National Initiatives

8.2.1. ANR

- Evoluthon (2019-2022): Artificial Life as a benchmark for evolutionary studies, a 4-year project leaded by E Tannier with 2 partners, Beale Inria and Le Cocon, LBBE.
- Dopaciumcity (2014-2018): Dopamine modulation of calcium influx underlying synaptic plasticity, a 4-year project funded by a grant from the ANR-NSF-NIH Call for French-US Projects in Computational Neuroscience. With L. Venance, College de France, CIRB, CNRS/UMR 7241 - INSERM U1050, Paris, France and K Blackwell, Krasnow Institute of Advanced Studies, George Mason University, Fairfax, VA, USA. Supervisor: L Venance (for France) and K.L. Blackwell (for US). Participants: H Berry, I Prokin, A Foncelle

- Dallish (2016-2020): Data Assimilation and Lattice LIght SHeet imaging for endocytosis/exocytosis pathway modeling in the whole cell, Call AAPG ANR 2016. With C. Kervrann (Inria Rennes), J. Salamero (Institute Curie, Paris), B. Laroche (INRA, Jouy-en-Josas). Participants: H. Berry.
- Storiz (2018-2020): Horizontal transfers as documents from extinct or unknown species. Call ANR JCJC 2018. Leaded by Damien de Vienne (LBBE, Lyon) Participant: Eric Tannier
- LncEvoSys (2017-2019): An evolutionary systems approach to understand long non-coding RNA functionality, Call ANR JCJC 2017. Leaded by Anamaria Necsulea (LBBE, Lyon). Participant: Eric Tannier

8.2.2. Inria

- Naviscope (Inria Project Lab, 2018-2022): image-guided Navigation and VIsualization of large data sets in live cell imaging and microSCOPy. Nowadays, the detection and visualization of important localized events and process in multidimensional and multi-valued images, especially in cell and tissue imaging, is tedious and inefficient. Specialized scientists can miss key events due to complexity of the data and the lack of computer guidance. In Naviscope we develop original and cutting-edge visualization and navigation methods to assist scientists, enabling semi-automatic analysis, manipulation, and investigation of temporal series of multi-valued volumetric images, with a strong focus on live cell imaging and microscopy application domains. We build Naviscope upon the strength of scientific visualization and machine learning methods in order to provide systems capable to assist the scientist to obtain a better understanding of massive amounts of information. Such systems will be able to recognize and highlight the most informative regions of the dataset by reducing the amount of information displayed and guiding the observer attention. Head: C. Kervrann (Serpico), other EPIs: Aviz, Beagle, Hybrid, Morpheme, Mosaic, Parietal, and MaIage (INRA unit).
- Action Exploratoire "Community Garden Book": IPBES's recent report on declining biodiversity calls for generalization of agroecological, productive, biodiversity and environmental friendly methods, oriented towards participatory action research. This exploratory action is a proposal to develop tools from open science, evolution science and algorithmics for the co-construction and use of an agroecological network of interactions between groups, species, varieties found in fields and gardens.
- Action Exploratoire ExODE: In biology, the vast majority of systems can be modeled as ordinary differential equations (ODEs). Modeling more finely biological objects leads to increase the number of equations. Simulating ever larger systems also leads to increasing the number of equations. Therefore, we observe a large increase in the size of the ODE systems to be solved. A major lock is the limitation of ODE numerical resolution so ware (ODE solver) to a few thousand equations due to prohibitive calculation time. The AEx ExODE tackles this lock via 1) the introduction of new numerical methods that will take advantage of the mixed precision that mixes several floating number precisions within numerical methods, 2) the adaptation of these new methods for next generation highly hierarchical and heterogeneous computers composed of a large number of CPUs and GPUs. For the past year, a new approach to Deep Learning has been proposed to replace the Recurrent Neural Network (RNN) with ODE systems. The numerical and parallel methods of ExODE will be evaluated and adapted in this framework in order to improve the performance and accuracy of these new approaches.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

- Beagle is a member of the CNRS Laboratoire International Associé "EvoAct" (Evolution in Action). Other members of EvoAct are the TIMC-IMAG (Grenoble) and the Beacon Center (Michigan State University, USA).

8.3.1.2. Informal International Partners

- Collaboration with Alexander Fleischmann at Brown University (USA) on neuro-evo-devo.
- Collaboration with Cedric Chauve, SFU, Vancouver (Canada) on phylogeny and rearrangements.
- Collaboration with Tom Williams, Bristol (UK) on phylogeny.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- We welcomed Leonardo Trujillo (Venezuela) as a visiting professor from January 2019 to July 2019. Leonardo Trujillo worked on the innovation dynamics in evolution using NK Fitness-Landscapes.
- Corrado Cali, BESE Division, KAUST University, Saudi Arabia, 1 week in november

8.4.1.1. Internships

- Barbara Genocchi (PhD candidate, Tampere University of Technology, Tampere, Finland) visited us for 16 days (Sept 9 - Sept 24).

CASH Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- Laure Gonnord's "Jeune Chercheur" ANR, CODAS, has started in January 2018 (42 months).

8.1.2. Scientific Advising

- Christophe Alias is scientific advisor (concours scientifique, 20%) for the XTREMLOGIC start-up.

8.2. International Initiatives

8.2.1. Informal International Partners

- Laure Gonnord has regular collaborations with Fernando Pereira from UFMG, Brasil (5 publications in total, last in 2017). End of 2019 they have restarted discussions with Gabriel Radanne about proving termination properties of linux kernel BPF programs. These programs must be always terminating, and we hope to be able to prove these properties in a scalable way with the termite analyser.
- In 2018 Laure Gonnord has began a collaboration with Tobias Grösser, from ETH Zurich, and in end of 2019 this collaboration has been extended to involved more people of Verimag (David Monniaux) and CASH, in the contexte of a europeean project proposal around certified polyhedral optimisation.
- In 2019, Laure Gonnord has pursued her collaboration with Sebastien Mosser, who moved from univ Nice to UQAM (Quebec, Canada). This collaboration has led to shared interns and a "inria associate team" proposal late in october 2019, which got accepted in January 2019.
- Ludovic Henrio has regular collaborations with: University of Oslo and University of Bergen in Norway (Cristal C. Din, Einar B. Johnsen, and Silvia Lizeth. Tapia Tarifa, Violet K.I. Pun); Reiner Hähnle (TU Darmstadt), Wolfgang Ahrendt (Chalmers); Kiko Fernandez-Reyes, Dave Clarke, and Tobiaas Wrigstad (Univ Uppsala); Christoph Kessler and Ahmed Rezine (Univ of Linköping).

8.3. International Research Visitors

8.3.1. Visits of International Scientists

8.3.1.1. Internships

- Amaury Maillé, M2: from Dec 2018 to Aug 2019 (6 months in total), "Dataflow explicit futures: Formalisation and/or experimentation".
- Julien Rudeau, INSA 4A, from to Apr 2019 to Aug 2019, "Ordonnancement sous contrainte de pipeline", supervised by Christophe Alias.
- Julien Philippon, EPITECH 1A, from to Jul 2019 to Dec 2019, "Compiling dataflow models to circuits", supervised by Christophe Alias and Matthieu Moy.
- Mohamed Hadjoudj, ENS Paris-Saclay 1A, from Jun 2019 to Jul 2019, "Parallélisation sous contrainte de ressources", supervised by Christophe Alias.
- Julian Bruyat, Lyon 1 M1, part-time from January 2019 to May 2019, "Outillage pour l'étude de l'impact de l'ordre des passes de LLVM", supervised by Laure Gonnord and Matthieu Moy.
- Sebastien Michelland, ENS de Lyon M1, abroad co-supervision by Laure Gonnord and Matthieu Moy with main supervision Sebastien Mosser at UQAM (Canada), from May 2019 to July 2019 "Exploration et cartographie des passes de LLVM".

CHROMA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Inria ADT 'CORDES' (2017-19) & 'COLOC' (2019-20)

Participants: Olivier Simonin, Vincent Le Doze, Jilles Dibangoye, Alessandro Renzaglia.

The COLOC ADT, which follows the CORDES ADT, aims to coordinate a team of UAVs using both SLAM techniques and communication-based localization, considering outdoor urban environments. These ADT are coordinated by Olivier Simonin. They fund an Inria expert engineer position in Chroma (Vincent Le Doze, 10/17-11/20) focusing on UAVs control and localization. The project provides both a 3D simulator of UAV fleets (SimuDronesGR) and a new experimental platform exploiting IntelAero UAVs.

9.1.2. COMODYS project, FIL (Federation d'Informatique de Lyon), 2017-19

Participants: Laetitia Matignon, Olivier Simonin.

Project between two teams of two laboratories from Lyon : CHROMA (CITI) and SMA (LIRIS), entitled "COoperative Multi-robot Observation of DYnamic human poSes", 2017-2019. Leader : L. Matignon & O. Simonin.

This project funds materials, missions and internships and its objectives are the on-line adaptation of a team of robots that observe and must recognize human activities.

9.1.3. WIFI-Drones project, FIL (Federation d'Informatique de Lyon), 2019-21

Participants: Remy Grunblatt, Isabelle Guerin-Lassous [Inria/Lyon1 Dante team], Olivier Simonin.

Project between two teams of two laboratories from Lyon : DANTE (LIP) and CHROMA (CITI), entitled "*Performances des communications Wi-Fi dans les réseaux de drones : une approche expérimentale*", 2019-2021. Leader : I. Guerin-Lassous & O. Simonin.

The project aims to experimentally evaluate the Wireless communication in UAVs fleet scenarios. We consider the recent version of Wi-Fi based on 802.11n and 802.11 ac. Experimental measures will be used to build propagation models in order to be integrated in UAVs fleet simulations (in particular with Gazebo and NS3 simulators).

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR JCJC "Plasma" (2019-2023)

The ANR JCJC Plasma, led by Jilles S. Dibangoye, aims at developing a general theory and algorithms with provable guarantees to treat planning and (deep) RL problems arising from the study of multi-agent sequential decision-making, which may be described as Partially Observable Stochastic Games (POSG), see Figure 1. We shall contribute to the development of theoretical foundations of the fields of intelligent agents and MASs by characterizing the underlying structure of the multi-agent decision-making problems and designing scalable and error-bounded algorithms. The research group is made of four senior researchers, O. Simonin, C. Wolf (INSA Lyon), F. Charpillet (Inria Nancy) and O. Buffet (Inria Nancy), and two junior researchers Jilles S. Dibangoye and A. Saffidine (Univeristy of New South Whales). We plan to hire one PhD and one post-doc for two years as well as internships. We received a support for 42-months starting in March 2020 with a financial support of about 254 269,80 euros.

9.2.1.2. ANR "Delicio" (2019-2023)

The ANR Delicio, led by C. Wolf (INSA Lyon, LIRIS), proposes fundamental and applied research in the areas of Machine Learning and Control with applications to drone (UAV) fleet control. The consortium is made of 3 academic partners: INSA-Lyon/LIRIS (C. Wolf and L. Matignon), INSA-Lyon/CICI (J. Dibangoye, O. Simonin, and I. Redko), University Lyon 1/LAGEPP (M. Nadri, V. Andrieu, D. Astolfi, L. bako, and G. Casadei), and ONERA (S. Bertrand, J. Marzat, H. Piet-Lahanier). We plan to hire two Ph.D and two post-doc for one year as well as interships. We received a support for 48-months starting in October 2019 with a financial support of about 540 000 euros.

9.2.1.3. ANR "Valet" (2016-19)

The ANR VALET, led by A. Spalanzani, proposes a novel approach for solving the 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 Irccyn Ecole Centrale de Nantes and the AKKA company. The PhD student (Pavan Vashista) recruited in this project focuses on integrating models of human behaviors to evaluate and communicate a risk to pedestrians that may encounter the trajectory of the VALET vehicle. His PhD thesis, codirected by D. Vaufreydaz (Inria/PervasiveInteraction), has been defended in June 2019.

9.2.1.4. ANR "HIANIC" (2017-21)

The HIANIC project, led by A. Spalanzani, proposes to endow autonomous vehicles with smart behaviors (cooperation, negotiation, socially acceptable movements) that better suit complex SharedSpace situations. It will integrate models of human behaviors (pedestrian, crowds and passengers), social rules, as well as smart navigation strategies that will manage interdependent behaviors of road users and of cybercars. The consortium is made of 3 academic partners: Inria (RITS, Chroma, Pervasive Interaction teams), LIG Laboratory (Hawai team) and LS2N laboratory (ARMEN and PACCE teams).

9.2.1.5. PIA Ademe "CAMPUS" (2017-20)

The CAMPUS project aims to identify, develop and deploy new functions for the autonomous cars in urban environments. In this project, Chroma will focus on finding solutions to navigate in complex situations such as crowded environments or dense traffic. The consortium is made of 1 academic partner: Inria (Rits and Chroma teams) and 3 companies: Safran electronics, Gemalto and Valeo.

9.2.2. FUI Projects

9.2.2.1. FUI Tornado (2017 – 2020)

Participants: Rabbia Asghar, Anne Spalanzani, Christian Laugier, Olivier Simonin.

The project Tornado is coordinated by Renault. The academic partners of the project are Inria Grenoble-Rhône Alpes, UTC, Institut Pascal, University of Pau, IFSTTAR. The industrial and application partners are Renault, Easymile, Neavia, Exoskills, 4D-Virtualiz, MBPC and Rambouillet Territoires. The objective of the project is to demonstrate the feasibility of a mobility service systems operating in the commercial zone of Rambouillet and on some public roads located in its vicinity, with several autonomous cars (Autonomous Renault Zoe). The *IRT Nanoelec* is also involved in the project as a subcontractor, for testing the perception, decision-making, navigation and controls components developed in the project.

9.2.2.2. FUI STAR (2018 – 2021)

Participants: Andres Gomez Hernandez, Olivier Simonin, Christian Laugier.

The Project STAR is coordinated by IVECO. The academic partners of the project are Inria Grenoble-Rhône-Alpes, IFSTTAR, ISAE-Supaéro. The industrial and application partners are IVECO, Easymile, Transpolis, Transdev and Sector Groupe. The goal of the project is to build an autonomous bus that will operate on a safe lane Inria is involved in helping design situation awareness perception, especialy in special case like docking at the bus stop and handling dynamicity of any obstacle. The *IRT Nanoelec* is also involved in the project as a subcontractor, for testing the perception, decision-making, navigation and controls components developed in the project.

9.2.3. DGA/Inria AI projects

9.2.3.1. "DYNAFLOCK" (2019-2023)

The DYNAFLOCK project, led by O. Simonin, aims to extend flocking-based decentralized control of swarm of UAVs by considering the link quality between communicating entities. The consortium is made of 2 Inria teams from Lyon : Chroma and Dante (involving Prof. I. Guerin-Lassous). The PhD student (Alexandre Bonnefond) recruited in this project aims at defining dynamic flocking models based on the link quality. In 2020, an engineer will be recruited to conduct experiments with a quadrotors platform.
Funding of Dynaflock : $\sim$ 250 K€.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ICT Robotics project "BugWright2" (2020-23)

Success for European H2020 ICT Robotics project application 'BugWright2' (9M€), led by C. Pradalier (CNRS, GeorgiaTech Metz). Chroma is partner and responsible of WP6.

Title : Autonomous Robotic Inspection and Maintenance on Ship Hulls and Storage Tanks

1/01/2020 - 31/12/2023

O. Simonin leads the Multi-Robot Systems work-package (WP6). Chroma will work on multi-robot planning and experiment under environmental constraints. The Agora team is also involved (H. Rivano, O. Iova) to work on robot localization based on the Ultra-WideBand technology.

Funding for Chroma & Agora teams : 600K€

http://dream.georgiatech-metz.fr/research-projects/bugwright2/

9.3.2. Collaborations with Major European Organizations

- ETHZ, Zurich, Autonomous System laboratory, (Switzerland)
- University of Zurich, Robotics and Perception Group (Switzerland) Vision and IMU data Fusion for 3D navigation in GPS denied environment.
- Karlsruhe Institut fur Technologie (KIT, Germany) Autonomous Driving.
- University of Babes-Bolyai, Cluj-Napoca (Romania). Multi-robot patrolling and Machine Learning (PHC "DRONEM" 2017-18).
- Vislab Parma (Italy) Embedded Perception & Autonomous Driving (visits, projects submissions, and book chapter in the new edition of the Handbook of Robotics).

CONVECS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. ARC6 Programme

Participants: Lina Marsso, Radu Mateescu [correspondent], Wendelin Serwe.

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

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

9.2. National Initiatives

9.2.1. PIA (Programme d'Investissements d'Avenir)

9.2.1.1. CAPHCA

Participants: Frédéric Lang, Radu Mateescu [correspondent], Wendelin Serwe.

CAPHCA (*Critical Applications on Predictable High-Performance Computing Architectures*) is a project funded by the PIA. The project, led by IRT Saint-Exupéry (Toulouse), involves a dozen of industrial partners (among which Airbus, CS Systèmes d'Information, Synopsis, and Thalès Avionics), the University Paul Sabatier (Toulouse), and Inria Grenoble – Rhône-Alpes (CONVECS and SPADES project-teams). CAPHCA addresses the dual problem of achieving performance and determinism when using new, high performance, multicore System-on-Chip (SoC) platforms for the deployment of real-time, safety-critical applications. The methodology adopted by CAPHCA consists in building a pragmatic combination of methods, tools, design constraints and patterns deployable at a short-term horizon in the industrial domains targeted in the project.

CAPHCA started in December 2017 for four years. The main contributions of CONVECS to CAPHCA are the detection of concurrency errors in parallel applications by means of formal methods and verification techniques.

9.2.2. Competitivity Clusters

9.2.2.1. SECURIOT-2

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

SECURIOT-2 is a project funded by the FUI (*Fonds Unique Interministériel*) within the *Pôle de Compétitivité* Minalogic. The project, led by Tiempo Secure (Grenoble), involves the SMEs (*Small and Medium Enterprises*) Alpwise, Archos, Sensing Labs, and Trusted Objects, the Institut Fourier and the VERIMAG laboratories of Université Grenoble Alpes, and CONVECS. SECURIOT-2 aims at developing a secure micro-controller unit (SMCU) that will bring to the IoT a high level of security, based on the techniques used for smart cards or electronic passports. The SMCU will also include an original power management scheme adequate with the low power consumption constraints of the IoT.

SECURIOT-2 started in September 2017 for three years. The main contributions of CONVECS to SECURIOT-2 are the formal modeling and verification of the asynchronous hardware implementing the secure elements developed by the project partners.

9.2.3. Other National Collaborations

We had sustained scientific relations with the following researchers:

- Xavier Etchevers (Orange Labs, Meylan),
- Fabrice Kordon and Lom Messan Hillah (LIP6, Paris),
- Eric Jenn and Viet Anh Nguyen (IRT Saint-Exupéry, Toulouse),
- Michel Le Pallec (Nokia Bell Labs, Nozay),
- Chu-Min Li (University of Picardie Jules Verne),
- Ioannis Parissis and Oum-El-Kheir Aktouf (LCIS, Valence),
- Pascal Poizat (LIP6, Paris).

9.3. European Initiatives

9.3.1. 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.

9.4. International Initiatives

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

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Saarland University (Germany): we collaborate on a regular basis with the DEPEND (*Dependable Systems and Software*) research group headed by Holger Hermanns, who received an ERC Advanced Grant ("POWVER") in 2016.

9.4.2. Other International Collaborations

In 2019, we had scientific relations with several universities and institutes abroad, including:

- University of Málaga, Spain (Francisco Durán),
- University of Cali, Colombia (Camilo Rocha),
- University of Zaragoza, Spain (José Ignacio Requeno),
- ISTI/CNR, Pisa, Italy (Franco Mazzanti),
- FBK, Trento, Italy (Enrico Magnano),
- Aalto University, Finland and Northeastern University, Boston, Massachusetts (Stavros Tripakis),
- Saarland University, Germany (Holger Hermanns),
- Eindhoven University of Technology, The Netherlands (Anton Wijs and Sander de Putter),
- University of Zielona Gora, Poland (Remigiusz Wisniewski).

[0] http://fmics.inria.fr

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- H. Garavel is an invited professor at Saarland University (Germany) as a holder of the Gay-Lussac Humboldt Prize.
- Hernan Ponce de Leon (Fortiss, Munich, Germany) visited us on June 25–26, 2019. He gave a lecture entitled "*BMC with Weak Memory Models*".
- Hugues Evrard (Google, London, UK) visited us on October 21, 2019. He gave a lecture entitled "*GPU Schedulers: How Fair is Fair Enough?*".
- Karoliina Lehtinen (University of Liverpool, UK) visited us on October 23, 2019. She gave a lecture entitled "*Quasi-Polynomial Techniques for Parity Games and Other Problems*".
- Peter Csaba Ölveczky (University of Oslo, Norway) visited us on November 25, 2019. He gave a lecture entitled "*Formal Specification and Analysis of Real-Time Systems in Real-Time Maude*".

The annual CONVECS seminar was held in Villard-de-Lans (France) on July 1-3, 2019. The following invited scientists attended the seminar:

- Loïc Letondeur (Orange Labs) gave on July 2, 2019 a talk entitled "*Artificial Intelligence and Edge Computing*".
- Eric Jenn (IRT Saint-Exupéry / Thales Avionics) gave on July 3, 2019 a talk entitled "*Recent Achievements of the CAPHCA Project*".
- Viet Anh Nguyen (IRT Saint-Exupéry) gave on July 3, 2019 a talk entitled "*Using Model Checking to Identify Timing Interferences on Multicore Processors*".

CORSE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. HEAVEN Persyval Project

- Title: HEterogenous Architectures: Versatile Exploitation and programmiNg
- HEAVEN leaders: François Broquedis, Olivier Muller [TIMA lab]
- CORSE participants: François Broquedis, Frédéric Desprez, Georgios Christodoulis, Manuel Selva
- Duration: September 2015 - December 2019
- Abstract: The main objective of this project was to improve the accessibility of heterogeneous architectures comprising FPGA accelerators with portability and real experimentation in mind. The portability criterion allows application programmers to benefit from FPGA devices with only small modifications to their applications. It was achieved by extending a standard parallel programming environment already targeting heterogeneous architectures comprising CPUs and GPUs. During the project, we developed an operational prototype targeting Xilinx FPGAs. Experiments have been conducted using both matrix multiplication and Cholesky decomposition kernels. These experiments have shown the usability of the framework and its very low overhead. This framework opens the path for challenging questions regarding the scheduling of heterogeneous applications targeting FPGAs.

8.2. National Initiatives

8.2.1. IPL ZEP

- Title: Zero-Power computing systems
- Coordinator: Kevin Marquet (INRIA Socrate)
- CORSE participants: Fabrice Rastello
- Other INRIA Partners: Cairn, Pacap
- Duration: from Apr. 2017 to Sept. 2019
- Abstract: The ZEP project addresses the issue of designing tiny computing objects with no battery by combining non-volatile memory (NVRAM), energy harvesting, micro-architecture innovations, compiler optimizations, and static analysis. The main application target is Internet of Things (IoT) where small communicating objects will be composed of this computing part associated to a low-power wake-up radio system. The ZEP project gathers four Inria teams that have a scientific background in architecture, compilation, operating system and low power together with the CEA Lialp and Lisan laboratories of CEA LETI & LIST. The major outcomes of the project will be a prototype harvesting board including NVRAM and the design of a new microprocessor associated with its optimizing compiler and operating system.

8.3. International Initiatives

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

8.3.1.1. IOComplexity

Title: Automatic characterization of data movement complexity

International Partner (Institution - Laboratory - Researcher):

Ohio State University (United States). P. Sadayappan

Colorado State University (United States). Louis-Noël Pouchet

Start year: 2018

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

The goal of this project is to extend techniques for automatic characterization of data movement of an application to the design of performance estimation.

The EA as three main objectives: 1. broader applicability of IO complexity analysis; 2. Hardware characterization; 3. Performance model.

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

- Fabrice Rastello visited the University of Utah to work with P. Sadayappan during the month of November. He worked on abstract simulation, and optimization of pattern specific programs.
- Nicolas Derumigny visited the University of Utah to work with P. Sadayappan during the month of November. He worked on abstract simulation.
- Nicolas Tollenaere visited the University of Utah to work with P. Sadayappan during the month of November. He worked on abstract simulation, and optimization of convolutions
- Theo Barollet visited the Colorado State University to work with Steve Kommrusch during the month of October. He worked on graph neural networks.
- Nicolas Tollenaere visited the university of Utah to work with P. Sadayappan during the month of August. He worked on optimizing packing and transposition of tensors.

CTRL-A Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Grenoble Alpes Cybersecurity Institute Cross-Disciplinary Project of the Idex

The Grenoble Alpes Cybersecurity Institute aims at undertaking ground-breaking interdisciplinary research in order to address cybersecurity and privacy challenges. Our main technical focus is on low-cost secure elements, critical infrastructures, vulnerability analysis and validation of large systems, including practical resilience across the industry and the society.

In Ctrl-A, it is currently funding two “alternance” student positions and a PhD position might be provided in September 2020 and supervised by Stephane Mocanu.

9.2. National Initiatives

9.2.1. ANR HPeC

HPeC is an ANR project on Self-Adaptive, Energy Efficient High Performance Embedded Computing, with a UAV case study (http://hpec.fr/). The Coordinator is Lab-STICC / MOCS (Lorient / Brest), and the duration: 42 month from october 2015. Others Partners are: UBO, U. Clermont-Ferrand, InPixal.

In Ctrl-A, it has been funding a post-doc position, hired in Grenoble and co-advised with Lorient : Soguy Gueye. The work will be continued with a post-doc hired in Lorient : Erwan Moreac. A PhD based in Brest, Chabha Hireche, is co-advised by Stéphane Mocanu.

9.2.2. ANR Sacade

The ANR ASTRID Sacade project is funded by DGA. Stéphane Mocanu is in charge of several workpackages including a demonstrator. An expert engineer position is funded for the implementation of attack/defense scenarios in SCADA.

9.2.3. IRT Nanoelec Pulse program

The Pulse program aims the development for SCADA cybersecurity demonstrators. It has funded a Master grant in 2019 and two master grants in 2020. A PhD position was also approved for September 2020 and it will be co-supervised by Stéphane Mocanu

9.2.4. 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 (Ch. Perez, L. Lefevre, E. Caron), 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).

9.2.5. 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, I. Saffiedine), ST Microelectronics (V. Bertin), Schneider Electric (C. El-Kaed, P. Nappey, M. Pitel).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: ECSEL

Project acronym: CPS4EU

Project title: Cyber Physical Systems for Europe

Duration: july 2019 - june 2022

Coordinator: VALEO

Other partners: 38 participants

Abstract: CPS4EU proposes to address technical issues and organizational issues in an integrated way. Hence, CPS4EU promotes a high level of sharing, so that an operational ecosystem, with adequate skills and expertise all along the value chain can enable, at the end of the project, the European industry to lead strategic markets based on CPS technologies.

In this project, the Ctrl-A team is involved in WP4 and WP9 mainly, on topics of Software Architectures for Self-Adaptive systems in CPS, and our main industrial collaboration is with RTE.

9.4. International Initiatives

9.4.1. Inria International Labs

We participate in the jLESC, Joint Laboratory for Extreme Scale Computing, with partners Inria, the University of Illinois, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and RIKEN AICS.

We participated to the 9th Workshop of the JLESC at Knoxville, TE, USA, in April 2019, and visited ANL in Chicago.

We started a cooperation with Argonne National Labs, on Improving the performance and energy efficiency of HPC applications using autonomic computing techniques.

https://jlesc.github.io/projects/energy_autonomic/

We are also exploring possibilities on the topic of integrating FPGAs in HPC grids, with a participation in a workshop at FPT 18.

https://collab.cels.anl.gov/display/HPCFPGA/HPC-FPGA

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

We have ongoing relations with international colleagues in the emerging community on our topic of control for computing e.g., in Sweden at Lund (K.E. Arzen, M. Maggio), Mälardalen (A. Papadopoulos) and Linnaeus Universities (D. Weyns, N. Khakpour), in the Netherlands at CWI/leiden University (F. Arbab), in the U.K. at Liverpool U. (N. Berthier), 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).

DANTE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Idex Lyon ACADEMICS

Participants: Paulo Gonçalves, Rémi Gribonval, Marion Foare, Amélie Barbe, Gaetan Frusque.

The project brings together a **consortium of 4 teams from Laboratories of Université de Lyon** (UdL) and will form a working group with complementary expertise in machine learning (deep learning, statistical learning, data mining), in data science (complex data analysis, adaptive and/or data-driven methods, network science) and in the studies of climate modeling and of computational social science. It comprises:

- Laboratoire Informatique du Parallélisme (LIP): P. Gonçalves (PI), M. Karsai (PI for Comp. Social Sc.)
- Laboratoire de Physique (LP): P. Borgnat (Coordinator), F. Bouchet (PI for Climate)
- Laboratoire Hubert Curien (LabHC), Université Jean Monnet: M. Sebban (PI)
- Laboratoire d'InfoRmatique en Images et Systèmes d'information (LIRIS): C. Robardet (PI)

The **impacts** of the project will stem from the efficiency of our proposed methods to learn from complex and dynamic data, and if so, **future applications** will naturally follow in many areas: social science and study of social interactions, climate and environmental science but also in technological networks, neuroscience with the study of brain networks and more generally in any domain where effective dynamical models of complex situations are to be learned from data. All these situations go beyond the current classical applicative frameworks of ML (time measurements, 2D images, or texts) and compel us to work out a major scientific breakthrough.

9.1.2. ISI Torino / Dante

Participant: Márton Karsai [correspondant].

Duration of the project: **October 2016 - October 2020**.

This project involves M. Karsai and L. Gauvin (ISI Torino) and funded by the IXXI Complex System Institute. The purpose of this project is to investigate the presence and the importance of higher-order correlations in dynamical networks. As the first attempt to address this problem we applied autoencoder, a recent representation using deep neural networks, on modelled and small-scale real temporal networks. However, since the results were trivial on the modelled network and not convincing on the real one we decided to take a different approach during the second phase of the project. We involved an ISI PhD student Maddalena Toricelli, to work out a method for temporal network embedding. Our idea is to extend the node2vec representation of static networks for time-varying structures, by using a local random walk to explore the structural-temporal neighbourhood of a node. Based on such local information we can effectively propose an embedding, which captures the temporal and structural properties of nodes in a temporal network.

9.1.3. FIL PerfWiFi

Participants: Guérin-Lassous Isabelle [correspondant], Grünblatt Rémy.

Duration of the project: **January 2019 - December 2020**.

The goal of the project **PerfWiFi** is to set up a Wi-Fi experimental platform that will be, in the future, open to interested researchers. This platform consists in devices (cards, routers) implementing the last versions of Wi-Fi (Wi-Fi 5 and Wi-Fi 6) and with different chipsets from different manufacturers. This platform will also be interconnected to a fleet of UAVs equipped with Wi-Fi interfaces. The Wi-Fi devices are chosen to be as open as possible in order to have a large set of possibilities in terms of parameterization of the Wi-Fi parameters.

In 2019, a first version of the platform has been set up along with a set of software tools to automatically launch Wi-Fi experiments. The first experiments can monitor, during a long period, all the possible Wi-Fi channels and their medium use ratio. We intend to provide these data via an open website.

9.1.4. FIL ALIENOR

Participant: Begin Thomas [correspondant].

Duration of the project: **January 2019 - December 2020**.

The goal of ALIENOR (ArtificiaL IntElligence-assisted NetwORks) is to develop an approach to dynamically select adequate values for the IEEE 802.11 parameters related to the Rate Adaptation (RA) mechanism to the WLAN context. The search for an adequate setting for the RA parameters is made complex due to the vast number of parameters (e.g., the used amendment of 802.11, the channel transmission rate, the number of competing nodes, the Frame Error Rate (FER), the offered load, and the transport protocol to name a few) that may affect a WLAN behavior.

In ALIENOR, we propose to explore a new approach to determine an adequate setting of the RA parameters using a data-driven approach based on techniques of Machine Learning (ML) in Artificial Intelligence (AI). Our approach consists of three stages. First, we will build a large dataset of measurements that will serve as the training set. Second, we will use ML techniques to discover a function that fits the mapping between the dataset output and the inputs. Lastly, WLAN devices will embed and use this learned function to predict (approximately) what will be their attained throughput under various possible settings of their RA, and then select their best option.

9.1.5. ENS Lyon project Vehicular project

Participants: Begin Thomas [correspondant], Guérin Lassous Isabelle, Busson Anthony.

Duration of the project: **January 2017 - December 2020**.

The goal of this project is to design new performance tools to improve the sharing of communication resources in vehicular networks. In particular, we focus on the use case of delivering a Video on Demand service to vehicles traveling along a highway. Through the development of a simple and yet accurate performance modeling approach, we were able to demonstrate the feasibility of using IEEE 802.11p to deliver video content to vehicles. Our work also underlines the benefit of blocking the lowest transmission rates for the sake of a collective gain in terms of attained throughput and interruption time in the video playback. This somehow surprising property derives from the well-established performance anomaly of 802.11-based networks.

9.2. National Initiatives

9.2.1. ANR DataRedux

Participants: Paulo Gonçalves [correspondant], Rémi Gribonval, Marion Foare.

Duration of the project: **February 2020 - January 2024**.
DataRedux puts forward an innovative framework to reduce networked data complexity while preserving its richness, by working at intermediate scales (“mesoscales”). Our objective is to reach a fundamental breakthrough in the theoretical understanding and representation of rich and complex networked datasets for use in predictive data-driven models. Our main novelty is to define network reduction techniques in relation with the dynamical processes occurring on the networks. To this aim, we will develop methods to go from data to information and knowledge at different scales in a human-accessible way by extracting structures from high-resolution, diverse and heterogeneous data. Our methodology will involve the identification of the most relevant subparts of time-resolved datasets while remapping the remaining parts of the system, the simultaneous structural-temporal representations of time-varying networks, the development of parsimonious data representations extracting meaningful structures at mesoscales (“mesostructures”), and the building of models of interactions that include mesostructures of various types. Our aim is to identify data aggregation methods at intermediate scales and new types of data representations in relation with dynamical processes, that carry the richness of information of the original data, while keeping their most relevant patterns for their manageable integration in data-driven numerical models for decision making and actionable insights.

9.2.2. ANR Darling

Participants: Paulo Gonçalves [correspondant], Rémi Gribonval, Marion Foare.

Duration of the project: **February 2020 - January 2024**.
This project meets the compelling demand of developing a unified framework for distributed knowledge extraction and learning from graph data streaming using in-network adaptive processing, and adjoining powerful recent mathematical tools to analyze and improve performances. The project draws on three major parallel directions of research: network diffusion, signal processing on graphs, and random matrix theory which DARLING aims at unifying into a holistic dynamic network processing framework. Signal processing on graphs has recently provided a comprehensive set of basic instruments allowing for signal on graph filtering or sampling, but it is limited to static signal models. Network diffusion on the opposite inherently assumes models of time varying graphs and signals, and has pursued the path of proposing and understanding the performance of distributed dynamic inference on graphs. Both areas are however limited by their assuming either deterministic graph or signal models, thereby entailing often inflexible and difficult-to-grasp theoretical results. Random matrix theory for random graph inference has taken a parallel road in explicitly studying the performance, thereby drawing limitations and providing directions of improvement, of graph-based algorithms (e.g., spectral clustering methods). The ambition of DARLING lies in the development of network diffusion-type algorithms anchored in the graph signal processing lore, rather than heuristics, which shall systematically be analyzed and improved through random matrix analysis on elementary graph models. We believe that this original communion of as yet remote areas has the potential to path the pave to the emergence of the critically needed future field of dynamical network signal processing.

9.2.3. Equipex FIT (Futur Internet of Things)

Participant: Éric Fleury [correspondant].

Duration of the project: **February 2011 - December 2019**.
FIT was 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 5.8 million euro grant from the French government. 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.

9.2.4. ANR SoSweet

Participant: Márton Karsai [correspondant].

Duration of the project: **November 2015 - November 2019**.

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 linguistic behaviours. In particular, social medias such as Twitter provide channels of communication through which speakers/writers use their language in ways that differ from standard written and oral forms. The result is the emergence of new varieties of languages. The main goal of SoSweet is to provide a detailed account of the links between linguistic variation and social structure in Twitter, both synchronically and diachronically. Through this specific example, and aware of its bias, we aim at providing a more detailed understanding of the dynamic links between individuals, social structure and language variation and change.

9.2.5. ANR DylNet

Participant: Márton Karsai [correspondant].

Duration of the project: **September 2016 - September 2020**.

The DylNet project aims to observe and to characterise the relationships between childhood sociability and oral-language learning at kindergarten. With a view to this, it takes an multidisciplinary approach combining work on language acquisition, sociolinguistics, and network science. It will be implemented by following all the children (≈ 220) and teaching staff in one kindergarten over a 3-year period. The use of wireless proximity sensors will enable collection of social contacts throughout the study. The data on sociability will be linked to the results of language tests and recordings of verbal interactions used to follow the children's progress on both a psycholinguistic level (lexicon, syntax, pragmatics) and a sociolinguistic level (features showing belonging to a social group). The aim is to better understand the mechanisms of adaptation and integration at work when young children first come into contact with the school context.

9.2.6. Inria PRE LIAISON

Participant: Márton Karsai [correspondant].

Duration of the project: **November 2017 - December 2019**.

This project implements unsupervised deep learning approaches to infer correlations/patterns that exist between dynamic linguistic variables, the mesoscopic and dynamic structure of the social network, and their socio-economic attributes. This interdisciplinary project is positioned at the crossroads of Natural Language Processing (NLP), Network Science, Data Science and Machine Learning.

More precisely, we develop a joint feature-network embedding, named AN2VEC (Attributed Network to Vector), which ultimately aims at disentangling the information shared by the structure of a network and the features of its nodes. Building on the recent developments of Graph Convolutional Networks (GCN), we use a multitask GCN Variational Autoencoder where different dimensions of the generated embeddings can be dedicated to encoding feature information, network structure, or shared feature-network information separately. This method thus defines a range of models whose performance in embedding a given data set varies depending with the allocation of dimensions. By exploring the behaviour of these models on synthetic data sets having different levels of feature-network correlation, we show (i) that embeddings relying on shared information perform better than the corresponding reference with unshared information, and (ii) that this performance gap increases with the correlation between network and feature structure, thus confirming that our embedding is able to capture joint information of structure and features.

9.2.7. HOTNET - IXXI

Participant: Márton Karsai [correspondant].

Duration of the project: **January 2019 - December 2021**.

The purpose of the HOTNet (Higher-order representation of temporal networks) project is to develop a pipeline for the embedding of temporal networks that captures higher order correlations relevant for dynamical processes. We propose to detach from the straightforward representations of networks — as successions of static networks — by focusing on representations that better reflects the higher-order neighbourhood and temporal paths. To project plans to develop a framework that learns from this representation an embedding sufficient to estimate the outcome of spreading processes that might take place on top of the original network.

This is a small-scale collaborative project funded by the IXXI Complex System Institute to foster collaborations between MK and Laetitia Gauvin (ISI Torino) for the period of 2019-2021.

9.2.8. Inria & HCERES

Participant: Éric Guichard [correspondant].

Bilateral project on the evolution of the Multi/inter-disciplinary of SHS.

An increasing number of researchers in SHS has the desire to develop new researches with computer scientists or mathematicians because they want to apply new methodologies (according to various or numerous data) or to develop older ones, which can now be easily implemented online. Some also develop a reflexion on their discipline, with the idea that epistemological questions are revitalized by the internet. This reality invite them to discuss with philosophers or with other SHS scientists who have the same intuition (eg: cartography, visualisation).

The project is hence to measure these new forms or inter-multi-disciplinarity. The main source will be the publications of all academics of French SHS laboratories, to find out who writes a paper with somebody of a different discipline and/or laboratories. All data are anonymized,

9.2.9. Inria IPL BetterNet

Participant: Éric Guichard.

An Observatory to Measure and Improve Internet Service Access from User Experience.

BetterNet aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks with a particular focus on geography and cartography.

9.3. International Initiatives

9.3.1. Participation in Other International Programs

9.3.1.1. International Initiatives

MOTif

Title: Mobile phone sensing of human dynamics in techno-social environment

International Partners (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (Argentina) - Instituto de Cálculo - Alejo Salles

Universidade Federal de Minas Gerais (Brazil) - Jussara M. Almeida

Duration: 2018 - 2019

Start year: 2018

Information and Communication Technology (ICT) is becoming increasingly social, as demonstrated by the multitude of emerging technologies and technology platforms that facilitate social interactions, taking place as communication via telephone, text message, email, online social networks etc. At the same time, our social activities are increasingly embedded in the ICT environments that enable and enhance our ability to transact, share experiences, and maintain social relationships. One of the best ways to explore these developments is through the mining and analysis of data, which are collected through mobile phones and allow us to investigate how individuals act when embedded in a technology-enabled environment. Unlimited access to a wide range of mobile applications and services may change our way to gain information, to communicate, or even to behave in different contextual places like home, work, or anywhere else. Thus understanding individual activity patterns and the source of decisions behind them is moreover important for the design of future services and to estimate the demand on the infrastructure. The MOTIf project builds on the analysis and modeling of geo-localized temporally detailed but fully anonymised mobile phone call networks. These datasets allow us to address the two scientific objectives about spatiotemporal patterns of service usage of anonymised individuals to learn when, where, and what people are doing; and about the fine-grained sociodemographic structure of society and its effect on the the individual social behaviour. In other words our goal in general is to understand how individuals behave in a dynamic techno-social environment.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Jaqueline Faria has been a long term visitor in the DANTE team as a visiting PhD student from the PUC Minas University of Belo Horizonte (Brazil). Her stay between May-December was supported by the CAPES.

- Alexandre Brandwajn from University of California, Santa Cruz (USA) has been a visiting Professor in the DANTE team between Feb and Mar 2019.
- Dorsaf Ghozlani, PhD student at Ecole Nationale d'Ingénieurs de Tunis, has been a visitor in the Dante team from April to July 2019.

9.4.1.1. Internships

- Maxime De Freitas, Télécom Physique Strasbourg, from Jun 2019 until Aug 2019.
- Julien Alamelle, Université Claude Bernard Lyon 1, from Oct 2019 until Dec 2019.
- Juan Pablo Astudillo, Universitat Politècnica de Catalunya, PhD, from Apr 2019 until Jul 2019.
- Simon Fernandez, Master 2 student, ENS Lyon, from February 2019 until June 2019.
- Paul Grangette, Master 2 student, Université Claude from November 2019 to July 2020 (work-study contract).

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Christophe Crespelle is on leave with a Marie Sklodowska-Curie Grant from EU. He is currently at the University of Bergen (Norway) until February 1st, 2020.

DATAMOVE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **ANR grant GRECO (2017-2020).** Resource manager for cloud of things. Coordinator: Quarnot Computing. Partners: Quarnot Computing, Grenoble-INP, Inria.
- **ANR grant Energumen (2018-2022).** Resource management: malleable jobs for a better use of the resources along with energy optimization. Coordinator: Denis Trystram. Partners: Grenoble-INP, IRIT, Sorbonne Université.

9.1.2. Competitivity Clusters

- **FUI IDIOM (2018-2020)**. Monitoring and optimization of I/Os. Coordinator DDN Storage. Partners: DDN Storage, Criteo, Quarnot, QuasarDB, CEA, Université de Bretagne Occidentale, Telecom SudParis, Inria (DataMove).

9.1.3. Inria

- Inria PRE COSMIC (exploratory research project), 2017-2019. Photovoltaic Energy Management for Distributed Cloud Platforms. Myriads, DataMove.
- Inria IPL HPC-BigData (2018-2021). Convergence between HPC, Big Data and AI. Coordinator: Bruno Raffin. Partners: the Inria teams Zenith, Kerdata, Datamove, Tadaam, SequeL, Parietal, Tau, and the external partners ATOS, ANL, IBPC, ESI-Group. See https://project.inria.fr/hpcbigdata/

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- **H2020 EoCoE-II (2019-2021)**
  - Energy oriented Center of Excellence on HPC.
  - H2020 RIA european project, call H2020-INFRAEDI-2018-1.
  - PI: CEA.
  - Partners: CEA, FZL, ENEA, BSC, CNRS, Inria, CERFACS, Max-Planck-Gesellschaft, FRAUNHOFER, FAU, CNR, UNITN, PSNC, ULB, UBAH, CIEMAT, IFPEN, DDN. Datamove is leading the WP5 (Ensemble Runs)
  - Summary: The EoCoE-II project will build on its unique, established role at the crossroads of HPC and renewable energy to accelerate the adoption of production, storage and distribution of clean electricity. How will we achieve this? In its proof-of-principle phase, the EoCoE consortium developed a comprehensive, structured support pathway for enhancing the HPC capability of energy-oriented numerical models, from simple entry-level parallelism to fully-fledged exascale readiness. At the top end of this scale, promising applications from each energy domain have been selected to form the basis of 5 new Energy Science Challenges:
    * Wind turbine modelling, from detailed understanding single turbine dynamics to flow across entire wind farms in complex terrain;
    * Energy Meteorology, where probabilistic forecasting is needed to predict the production efficiency of solar and wind parks and their impact on energy trading across the grid;

* Design and study of new energy materials for photovoltaic cells, batteries and super-capacitors;
* Water for energy to manage geothermal and hydro-power including the influence of climate change on these resources;
* And fusion for energy, where the mandatory kinetic modelling of plasma turbulence and transport from the core to the edge of complex tokamak magnetic geometries requires exascale resources.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

- Program: SKŁODOWSKA-CURIE ACTIONS - Individual Fellowship
- Project acronym: DAMA
- Project title: Extreme-Scale Data Management
- Duration: November 2018 - October 2020
- Coordinator: Bruno Raffin
- Followship Recipient: Francieli Zanon Boito.
- Abstract: This project is concerned with the I/O challenges that arise from the convergence between these two different paradigms. It is clear data analytics tools cannot simply replace their typical storage solutions for the HPC I/O stack, centered on the abstraction of files and powered by a parallel file system, because their workload is not well suited for that and would observe poor performance. Moreover, the separated storage infrastructure breaks the data affinity idea in which they are built upon. Finally, even among traditional HPC applications there is a need to minimize data movement, as it imposes high latency and increases energy consumption.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. JLESC

- Title: Joint Laboratory for Extreme-Scale-Computing.
- International Partners:
  - University of Illinois at Urbana Champaign (USA)
  - Argonne National Laboratory (USA),
  - Barcelona Supercomputing Center (Spain),
  - Jülich Supercomputing Centre (Germany)
  - Riken Advanced Institute for Computational Science (Japan)
- Start year: 2009
- See also: https://jlesc.github.io/
- The purpose of the Joint Laboratory for Extreme Scale Computing is to be an international, virtual organization whose goal is to enhance the ability of member organizations and investigators to make the bridge between Petascale and Extreme computing. The JLESC organizes a workshop every 6 months DataMove participates to. DataMove developed several collaborations related to in situ processing with Tom Peterka group (ANL) , the Argo exascale operating system with Swann Perarnau (ANL).

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

9.3.2.1. UNIFY

- Title: Intelligent Unified Data Services for Hybrid Workflows Combining Compute-Intensive Simulations and Data-Intensive Analytics at Extreme Scales

- Partners:
  - Inria teams: KerData, DataMove
  - Argonne National Lab (Tom PETERKA)
- Duration: 2019-2021

9.3.3. Participation in Other International Programs

9.3.3.1. STIC AmSud SAQED

- Title: Scalable Approximate Query Evaluation on Document Inverted Files for GPU based Big-Data Applications
- International Partner:
  - Universidad Nacional de San Luis - UNSL, Argentina
  - Universidad de Santiago de Chile - USACH, Chile
  - Universidade Federal de São Carlos - UFSCAR, Brazil
- Duration: 2019-2021
- Develop efficient and scalable approximate search and document similarity evaluation on large datasets based on document inverted files using high performance computing and GPUs.

9.3.3.2. LICIA

- Title: International Laboratory in High Performance and Ubiquitous Computing
- International Partner (Institution - Laboratory - Researcher):
  - UFRGS (Brazil)
- Duration: Funded by CNRS in 2011-2018, by Univ Grenoble Alpes for 2019-2020.
- 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). DataMove is deeply involved in the animation of LICIA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Professor visit: Alfredo Goldman, Professor at Universidade de São Paulo, visited Datamove from June to July 2019.

DATASPHERE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The team is hosted by IXXI, the Complex System Institute, at ENS Lyon, and strongly involved in the interdisciplinary cooperation promoted by IXXI. Stéphane Grumbach is vice-director of IXXI. Kavé Salamatian is in the Executive committee of the Data Institute of Grenoble Alps Institute, and of the Cyber@Alps Institute of cybersecurity.

8.2. National Initiatives

- Chaire Castex, Ecole Militaire, Paris.
- AMNECYS (Alpine Multidisciplinary NEtwork on CYber-security Studies), University of Grenoble-Alpes.
- GEODE Research team on Geopolitics.
- Kavé Salamatian in co-leading the chair "AI and society" of the MIAI institute of University of Grenoble Alps.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- RIHN, Research Institute on Humanity and Nature, Kyoto.
- Information School, UC Berkeley.
- ICT, Institute of Computing Technologies, Chinese Academy of Sciences, Beijing.
- CSIRO, Sydney.
- Center for CyberSecurity, University Macquarie, Sydney.
- Center for Internet Human Rights (CIHR), Berlin.
- Nippon Institute of Computing Technology, Tokyo, Japan
- Cyber Civilisation Research Center at Keio University, Tokyo, Japan

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

Stéphane Grumbach has been visiting scientist at the Research Institute on Humanity and Nature, RIHN, in Kyoto for a semester in 2018/2019.

DRACULA Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

- The Région ARA project INGERENCE dedicated to “INferring GEne REgulatory NEtworks from single CEll Data to improve vaccine design", 2018-2021.
  Participants: Olivier Gandrillon, Fabien Crauste [Coordinator].

6.2. National Initiatives

6.2.1. ANR

- ANR SinCity “Single cell transcriptomics on genealogically identified differentiating cells” (https://anr.fr/Projet-ANR-17-CE12-0031), 2017-2020.
  Participant: Olivier Gandrillon [Coordinator].
- Olivier Gandrillon participates in the ANR MEMOIRE (head Jacqueline Marvel) dedicated to “MultiscalE MOdeling of CD8 T cell Immune REsponses”, 2018-2021.

6.2.2. Other projects

- Thomas Lepoutre is a member of the ERC MESOPROBIO (head Vincent Calvez) dedicated to "Mesoscopic models for propagation in biology", 2015-2020: (http://vcalvez.perso.math.cnrs.fr/mesoprobio.html).

6.3. European Initiatives

6.3.1. FP7 & H2020 Projects

- Olivier Gandrillon and Alexey Koshkin participate in the EU RTN network COSMIC (head Antpoine van Kampen) dedicated to “Combatting disorders of adaptive immunity with systems medicine”, 2018-2021, https://cosmic-h2020.eu

6.4. International Initiatives

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

6.4.1.1. MathModelingHematopoiesis

Title: Mathematical modeling of hematopoietic stem cell dynamics in normal and pathological hematopoiesis with optimal control for drug therapy

International Partner (Institution - Laboratory - Researcher):

Presidency University, Kolkata (India) - Subhas Khajanchi

Start year: 2019

The project proposes to develop and analyse new mathematical models of Hematopoietic Stem Cell population dynamics in normal and pathological hematopoiesis. Two important questions will be explored in this project: i) the biological data concerning the hematopoiesis process evolves constantly, and new understanding modifies the established mathematical models, ii) modeling constraints us to simplify the complicated biological scenarios, which moving away from the reality, but enabling us to reach a certain comprehension of the hematopoiesis process.

The project will shed new light on the different physiological mechanisms that converge toward the continuous regeneration of blood cells, for example: the behavior of hematopoietic stem cells under stress conditions, the understanding of deregulation of erythropoiesis under drug treatments (this can lead to lack of red blood cells (anemia), or a surplus of red blood cells (erythrocytoses)), the appearance of oscillations in patients with Chronic Myeloid Leukemia (CML); Or, the overproduction of blasts in patients with Acute Myeloid Leukemia (AML)). The effect of the immune system and drug therapy in the presence of CML or AML will be included in the model and optimal control method will also be used.

6.4.2. Participation in Other International Programs

6.4.2.1. Indo-French Center of Applied Mathematics

Title: Mathematical modeling of hematopoiesis process in application to chronic and acute myelogenous leukemia

International Partner (Institution - Laboratory - Researcher):

Department of Mathematics - Presidency University, Kolkata (India) - Subhas Khajanchi

Duration: 2018 - 2021

Start year: 2018

6.5. International Research Visitors

6.5.1. Visits of International Scientists

Jairo Gomes da Silva, PhD student at Institute of Biosciences, São Paulo State University (UNESP), Botucatu, Brazil, visiting the team for 6 months (from September 2019 to February 2020).

6.5.2. Visits to International Teams

Paul Lemarre is visiting University of California, Merced, USA, in 2019-2020.

ELAN Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. National Collaborations

- Long-term collaboration with Christophe Prud'homme and Vincent Chabannes (Université de Strasbourg and Centre de modélisation et de simulation de Strasbourg).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. GEM

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

Programm: H2020

Type: ERC

Duration: September 2015 - August 2021

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. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

- Long-term partnership with Rahul Narain (University of Minnesota, USA, and IIT Delhi, INDIA) and Rahul Narain's PhD student Jie Li (University of Minnesota, USA).
- Long-term partnership with Alexandre-Derouet-Jourdan (OLM Digital, JAPAN).

ERABLE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Muse

- Title: Multi-Omics and Metabolic models iNtegration to study growth Transition in *Escherichia coli*
- Coordinators: Delphine Ropers (EPI Ibis) and Marie-France Sagot
- ERABLE participants: Marie-France Sagot and Arnaud Mary.
- Type: IXXI Project (2018-2020).
- Web page: none for now.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. Aster

- Title: Algorithms and Software for Third gEneration Rna sequencing
- Coordinator: Hélène Touzet, University of Lille and CNRS.
- ERABLE participants: Vincent Lacroix (ERABLE coordinator), Audric Cologne, Eric Cumunel, Alex di Genova, Leandro I. S. de Lima, Arnaud Mary, Marie-France Sagot, Camille Sessegolo, Blerina Sinaimeri.
- Type: ANR (2016-2020).
- Web page: http://bioinfo.cristal.univ-lille.fr/aster/.

8.2.1.2. GraphEn

- Title: Enumération dans les graphes et les hypergraphes : Algorithmes et complexité
- Coordinator: D. Kratsch
- ERABLE participant(s): A. Mary
- Type: ANR (2015-2019)
- Web page: http://graphen.isima.fr/

8.2.1.3. GrR

- Title: Graph Reconfiguration
- Coordinator: N. Bousquet
- ERABLE participant(s): A. Mary
- Type: ANR JCJC (2019-2021)
- Web page: Not available

8.2.1.4. Green

- Title: Deciphering host immune gene regulation and function to target symbiosis disturbance and endosymbiont control in insect pests
- Coordinator: A. Heddi
- ERABLE participant(s): M.-F. Sagot, C. Vieira
- Type: ANR (2018-2021)
- Web page: Not yet available

8.2.1.5. Hmicmac

- Title: Host-microbiota co-adaptations: mechanisms and consequences
- Coordinator: F. Vavre
- ERABLE participant(s): F. Vavre
- Type: ANR PRC (2017-2020)
- Web page: Not available

8.2.1.6. Networks

- Title: Networks
- Coordinator: Michel Mandjes, University of Amsterdam
- ERABLE participant(s): S. Pissis, L. Stougie
- Type: NWO Gravity Program (2014-2024)
- Web page: https://www.thenetworkcenter.nl/

8.2.1.7. Resist

- Title: Rapid Evolution of Symbiotic Interactions in response to STress: processes and mechanisms
- Coordinator: N. Kremer
- ERABLE participant(s): F. Vavre
- Type: ANR JCJC (2017-2020)
- Web page: Not available

8.2.1.8. Swing

- Title: Worldwide invasion of the Spotted WING Drosophila: Genetics, plasticity and evolutionary potential
- Coordinator: P. Gibert
- ERABLE participant(s): C. Vieira
- Type: ANR PCR (2016-2020)
- Web page: Not available

8.2.1.9. U4atac-brain

- Title: Rôle de l'épissage mineur dans le développement cérébral
- Coordinator: Patrick Edery, Centre de Recherche en Neurosciences de Lyon.
- ERABLE participants: Vincent Lacroix (ERABLE coordinator), Audric Cologne.
- Type: ANR (2018-2021).
- Web page: Not available.

8.2.2. Idex

8.2.2.1. Micro-be-have

- Title: Microbial Impact on insect behaviour: from niche and partner selection to the development of new control methods for pests and disease vectors
- Coordinator: F. Vavre
- ERABLE participant(s): F. Vavre
- Type: AO Scientific Breakthrough (2018-2021)
- Web page: Not available

8.2.3. Others

Notice that were included here national projects of our members from Italy and the Netherlands when these have no other partners than researchers from the same country.

8.2.3.1. AHeAD

- Title: efficient Algorithms for HArnessing networked Data
- Coordinator: G. Italiano
- ERABLE participant(s): R. Grossi, G. Italiano
- Type: MUIR PRIN, Italian Ministry of Education, University and Research (2019-2022)
- Web page: https://sites.google.com/view/aheadproject

8.2.3.2. CMACBioSeq

- Title: Combinatorial Methods for analysis and compression of biological sequences
- Coordinator: G. Rosone
- ERABLE participant(s): N. Pisanti
- Type: SIR, MIUR PRIN, Italian Ministry of Research National Projects (2015-2019)
- Web page: http://pages.di.unipi.it/rosone/CMACBioSeq.html

8.2.3.3. MyOwnResearch

- Title: MyOwnResearch: Homogeneous subgroup identification in fatigue management across chronic immune diseases through single subject research design
- Coordinator: A. Schönhuth
- ERABLE participant(s): A. Schönhuth
- Type: Health Holland project (2018-2021)
- Web page: Not available

8.2.3.4. Open Innovation: Digital Innovation for Driving

- Title: Open Innovation: Digital Innovation for Driving
- Coordinator: G. Italiano
- ERABLE participant(s): G. Italiano
- Type: Bridgestone (2018-2019)
- Web page: Not available

8.3. European Initiatives

8.3.1. Collaborations in European Programs, Except FP7 & H2020

8.3.1.1. Pangaia

- Title: Pan-genome Graph Algorithms and Data Integration
- Coordinator: Paola Bonizzoni, University of Milan, Italy
- ERABLE participant(s): S. Pissis, A. Schönhuth, L. Stougie
- Type: H2020 MSCA-RISE (2020-2022)
- Web page: Not available

8.3.2. Collaborations with Major European Organizations

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 then became a European Inria Team.

8.4. International Initiatives

8.4.1. Inria Associate Teams Not Involved in an Inria International Lab

Compasso

- Title: COMmunity Perspective in the health sciences: Algorithms and Statistical approacheS for explOring it
- Duration: 2018, renewable from 2 to 5 years more
- Coordinator: On the Portuguese side, Susana Vinga, IST, Lisbon, Portugal; on the French side, Marie-France Sagot
- ERABLE participant(s): R. Andrade, M. Ferrarini, G. Italiano, A. Marchetti-Spaccamela, A. Mary, H. T. Pusa, M.-F. Sagot, B. Sinaimeri, L. Stougie, A. Viari, I. Ziska
- Web page: http://team.inria.fr/erable/en/projects/inria-associated-team-compasso/

8.4.2. Participation in Other International Programs

ERABLE is coordinator of a CNRS-UCBL-Inria Laboratoire International Associé (LIA) with the Laboratório Nacional de Computação Científica (LNCC), Petrópolis, Brazil. The LIA has for acronym LIRIO ("Laboratoire International de Recherche en bIOinformatique") and is coordinated by Ana Tereza Vasconcelos from the LNCC and Marie-France Sagot from BAOBAB-ERABLE. The LIA was created in January 2012 for 4 years, renewable once for 4 more years. This year (2019) is the final one. A web page for the LIA LIRIO is available at this address: http://team.inria.fr/erable/en/cnrs-lia-laboratoire-international-associe-lirio/.

Erable also participates in Network for Organismal Interactions Research (NOIR), a project funded by Conicyt in Chile within the call Internation Networking between Research Centers. The project started in 2019 and will last until the end of 2020. The coordinator on the Chilean side is Elena Vida from the Universidad Mayor, Santiago, Chile, and the Erable participants are Carol Moraga Quinteros, Mariana Ferrarini and Marie-France Sagot.

Finally, Marie-France Sagot participates in a Portuguese FCT project, Perseids for "Personalizing cancer therapy through integrated modeling and decision" (2016-2019), with Susana Vinga and a number of other Portuguese researchers. The budget of Perseids is managed exclusively by the Portuguese partner. Perseids ended in December 2019.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

In 2019, ERABLE greeted the following International scientists:

- In France: Alexandra Carvalho and Susana Vinga, Assistant and Associate professors resp., Instituto Superior Técnico, Lisbon, Portugal; Helisson Faoro, researcher, Instituto Carlos Chagas, Fiocruz, Paraná, Brazil; Ariel Silber, professor, Universidade de São Paulo, Brazil; Arnaldo Zaha, professor at Universidade Federal do Rio Grande do Sul, Brazil.
- In Italy: Travis Gaggie, Associate professor, Dalhousie University; Nicola Prezza, postdoc, University of Pisa; Elena Arseneva, Assistant professor, St Petersburg State University, Blerina Sinaimeri, Junior Researcher, Inria (see below); Marie-France Sagot, Senior researcher, Inria (see below).
- In the Netherlands: Wiktor Zuba, PhD student, University of Warsaw; Lorraine Ayad, Lecturer, King's College London; Grigorios Loukides, Lecturer, King's College London; Martin Farach-Colton, Professor, Rutgers University; Grigorios Loukides, Lecturer, King's College London; Martin Dyer, Professor, University of Leeds.

8.5.1.1. Internships

In 2019, ERABLE in France greeted the following Internships:

- Phablo Moura, postdoc, University of Campinas, Brazil.
- Diego Pérez and Evelyn Sanchéz, PhD students of Elena Vidal, Universidad Mayor, Santiago, Chile.

In the Netherlands, ERABLE greeted the following Internships: Luca Denti, University Bicocca of Milano, Italy, from October 2018 to January 2019, Mick van Dijk, TU Delft, from May 2018 to January 2019, Giulia Barnardini, University Bicocca of Milano, Italy, from September 2018 to November 2019.

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

From July 2019 to June 2020, Blerina Sinaimeri was on Sabbatical at Luiss University to work with Giuseppe Italiano, member of Erable.

8.5.2.2. Research Stays Abroad

In 2019, Marie-France Sagot visited Luiss University for 11 days as Visiting Professor from LUISS University to work with Blerina Sinaimeri who is on Sabbatical at Luiss University from July 2019 to June 2020, and with Giuseppe Italiano, member of Erable. While there, M.-F. Sagot also worked with Alberto Marchetti-Spaccamela from Sapienza University of Rome and from Erable.

IBIS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Project name	MuSE: MUlti-Omics and Metabolic models integration to study growth transition in Escherichia coli
Coordinator IBIS participants Type Web page	D. Ropers D. Ropers, T. Etienne IXXI/BioSyl project (2018-2020) http://www.biosyl.org/news/muse-2013-multi-omics-and-metabolic-models-integration-to-study-growth-transition-in-escherichia-coli

Project name	RNAfluo: Quantification d'ARN régulateurs *in vivo*
Coordinator IBIS participants Type	S. Lacour S. Lacour AGIR project Univ Grenoble Alpes (2016-2019)

7.2. National Initiatives

Project name	MEMIP – Modèles à effets mixtes de processus intracellulaires : méthodes, outils et applications
Coordinator IBIS participants Type	G. Batt E. Cinquemani, A. Marguet, D. Ropers ANR project (2016-2020)

Project name	ENZINVIVO – Détermination in vivo des paramètres enzymatiques dans une voie métabolique synthétique
Coordinator IBIS participants Type	G. Truan J. Geiselmann, H. de Jong ANR project (2016-2020)

Project name	MAXIMIC: Optimal control of microbial cells by natural and synthetic strategies
Coordinator IBIS participants Type Web page	H. de Jong C. Boyat, E. Cinquemani, J. Geiselmann, H. de Jong, A. Pavlou, C. Pinel, D. Ropers ANR project (2017-2021) https://project.inria.fr/maximic

Project name	RIBECO (RIBonucleotide ECOnomy): Engineering RNA life cycle to optimize economy of microbial energy
Coordinator	M. Cocaign-Bousquet
IBIS participants	E. Cinquemani, T. Etienne, D. Ropers
Type	ANR project (2018-2022)
Web page	https://project.inria.fr/ribeco/

Project name	COSY: real-time COntrol of SYnthetic microbial communities
Coordinator	E. Cinquemani
IBIS participants	E. Cinquemani, H. de Jong, J. Geiselmann, M. Mauri, T. Muszbek, C. Pinel, D. Ropers, M. Sangster
Type	Inria Project Lab (2017-2021)
Web page	https://project.inria.fr/iplcosy/

Project name	OPTICO : OPTImal COntrol software for microbial communities in a system of minibioreactors
Coordinator	E. Cinquemani
IBIS participants	E. Cinquemani, H. de Jong, J. Geiselmann, T. Muszbek
Type	Inria ADT (2019-2021)

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
Type	Inria Project Lab (2015-2019)
Web page	https://project.inria.fr/iplalgaeinsilico/

Project name	Analyse intégrative de la coordination entre stabilité des ARNm et physiologie cellulaire chez Escherichia coli
Coordinators	D. Ropers, M. Cocaign-Bousquet (Inra, LISBP)
IBIS participants	T. Etienne, D. Ropers
Type	Contrat Jeune Scientifique Inra-Inria (2016-2019)

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Tomas Gedeon, professor in Mathematics at Montana State University (USA), visited the IBIS project-team during two months (May-July 2019) to work on modeling and analysis of resource allocation in microorganisms. His stay at Inria was funded by the Visiting researcher program of the research center Grenoble - Rhône-Alpes.

7.3.1.1. Internships

Emmanouil Sideris, enrolled in the MSc program in Computer Science at the University of Patras (Greece), did a Master internship with Eugenio Cinquemani.

IMAGINE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Performance Lab (January 2018 - June 2021)

Participants: Rémi Ronfard, Qianqian Fu, Mélina Skouras, Maxime Garcia, Pierre Casati, Vaishnavi Ameya Murukutla, Rémi Colin de Verdière.

Performance Lab is a cross-disciplinary project (CDP) by IDEX Univ. Grenoble Alpes, started in January 2018, which is funding the Phd thesis of Qianqian Fu.

Conceived as an international platform, the Performance Lab brings together a community of researchers who are exploring contemporary issues that link embodiment, society and technology. The ambition of the project is to renew the ways in which research is conceived and practiced at Univ. Grenoble Alpes by developing new methods inspired by Anglo-Saxon notions of Performance as Research (PAR), research creation, practice-led and based research.

As part of the Performance Lab, IMAGINE is actively involved in the research group on "digital dramaturgies" co-led by Remi Ronfard and Julie Valero.

9.2. National Initiatives

9.2.1. InriaHub ADT Kino Ai (October 2018-September 2020)

Participants: Rémi Ronfard, Rémi Colin de Verdière, Qianqian Fu.

This two-year contract is a follow up to the one-year InriaHub ULTRAHD project which was successfully completed in December 2017. Kino Ai is a joint research project of the IMAGINE team at Inria Grenoble Alpes, and the Performance Lab at Univ. Grenoble Alpes. Following our previous work in “multiclip video editing” and “Split Screen Video Generation”, we are working to provide a user-friendly environment for editing and watching ultra-high definition movies online, with an emphasis on recordings of live performances.

The code from Vineet Gandhi’s PhD thesis was entirely re-designed for supporting ultra high definition video. The software was extensively tested in 2017 on a large dataset of 4K video recordings of theatre rehearsals, in collaboration with the Litt&Arts team at Univ. Grenoble Alpes, theatre director Jean-Francois Peyret in Paris, Theatre de l’Hexagone in Meylan and Theatre de Vidy in Lausanne. The goal of the Kino AI ADT is to allow the Kino Ai python code to run in a web server, and to provide a redesigned user interface (in javascript) running on a web client. The user interface was also designed, tested and evaluated with the Litt&Arts team at Univ. Grenoble Alpes, as part of CDP project Performance Lab.

9.2.2. FUI Collodi 2 (December 2016 - April 2019)

Participants: Rémi Ronfard, Maguelonne Beaud de Brive, Julien Daval.

This 2-year contract with two industrial partners: TeamTo and Mercenaries Engineering (software for production rendering), was a follow-up and a generalization of Dynam’it and Collodi 1. The goal was to propose an integrated software for the animation and final rendering of high-quality movies, as an alternative to the ever-ageing Maya. The project was funding 2 engineers for 2 years.

The project was extended for four additional months from January to April 2019 to allow extended expert evaluation of our sketch-based animation toolkit. Three short animations were created for this purpose by a professional animator from film examples of dancers (Gene Kelly in "Singing in the rain", Fred Astaire and Cyd Charisse in "The band wagon"). Those examples demonstrate that sketch-based animation can be used to create complex character animation even in very challenging situations. Those results were presented during the two final reviews of the COLLODI2 project in Valence and Paris in December 2019 and published as a research report.

9.2.3. FUI 3D-Oncochip (October 2018 - September 2021)

Participants: Jean-Claude Léon, Musaab Khalid Osman Mohammed.

3D-Oncochip project is a collaboration with Microlight 3D, with the objective of fabricating nanoscale 3D microtumors, which are human biological models of real tumors. This 3-year contract is funding the postdoc position of Musaab Khalid Osman Mohammed.

9.2.4. ANR E-ROMA (November 2017 - October 2020)

Participants: Rémi Ronfard, Stefanie Hahmann, Pierre Casati.

The eRoma project aims at revisiting the digitization and virtual restoration of archaeological and fine arts artefacts by taking advantage of the sites from which they were retrieved and the eras they belong to. To do so, e-Roma will develop a new virtual representation both versatile and unified enough to be used for both restoration and animation of digitized artworks. Traditional cardboard models with a fixed and rigid representation will therefore be replaced by interactive dynamic virtual prototypes, to help restore statues and illustrate changes over time.

This 3-year contract is a joint project with GeoMod team at LIRIS and the musée gallo-romain in Lyon. The contract started in November 2017 and is funding the PhD thesis of Pierre Casati.

9.2.5. ANR FOLD-DYN (November 2017 - October 2020)

Participant: Thomas Buffet.

The FOLDDyn project (Field-Oriented Layered Dynamics animating 3D characters) proposes the study of new theoretical approaches for the effective generation of virtual characters deformations, when they are animated. These deformations are twofolds: character skin deformations (skinning) and garment simulations. We propose to explore the possibilities offered by a novel theoretical way of addressing character deformations: the implicit skinning. This method jointly uses meshes (the standard representation for 3D animations) and volumetric scalar functions (an unusual representation in this community).

This 3-year contract is a joint project with the University of Toulouse.The contract started in November 2017 and is funding the PhD thesis of Thomas Buffet.

9.2.6. ANR ANATOMY2020 (November 2017 - October 2020)

Participants: Olivier Palombi, Rémi Ronfard, Vaishnavi Ameya Murukutla.

Anatomy2020 aims at developing an innovative educational platform to facilitate learning of functional anatomy. This platform will integrate recent advances in computer graphics, human-computer interaction together with recent insights in educational and cognitive sciences to design and test optimal scenarios for anatomy learning. The approach is based on evidences that body movements could improve learning of different knowledge by “augmenting” or “enriching” traces in long-term memory. This “embodied” perspective is particularly relevant for learning of functional anatomy as the knowledge to acquire could be specifically related to the learner’s body in motion.

This 3-year contract is a joint project with TIMC (Computer-Assisted Medical Intervention team), Anatoscope, Gipsa-Lab (speech and cognition dept.), LIBM and LIG (Engineering Human-Computer Interaction team). The contract started in November 2017 and is funding the PhD thesis of Ameya Murukutla.

MARACAS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- QAMUT *Quantum Algorithms for Multi Users wireless Transmissions* (2019-2021, leader : MARACAS, partners LIP and Institut Camille Jourdan). This project aims to propose new multi-user detection algorithms for wireless transmission systems, based on a quantum architecture.
- *Statistical Hypothesis Testing with Persistent Homology* 2019-2021, leader: MARACAS, partners CRAL. This project aims to develop statistical signal processing methods exploiting persistent homology.

9.2. National Initiatives

9.2.1. ANR

- ANR EPHYL *Enhanced PHY for Cellular Low Power Communication IoT* (2016-2019, 183 keuros, leader : Sequans). This project aims to investigate coming and future LPWA technologies with the aim to improve coverage, data rate and connectivity while keeping similar level of complexity and power consumption at the node for the access. New waveforms enablers will be investigated and trialled in order to increase the efficiency of future systems and to provide efficient and fair access to the radio resource. The proposed new waveforms should comply with system constraints and with the coexistence of multiple communications.
- ANR ARBURST *Acheivable region of bursty wireless networks* (2016-2020, 195 KEuros, leader : MARACAS). In this project, we propose an original approach complementary to other existing projects, devoted to the study of IoT networks fundamental limits. Instead of proposing one specific technical solution, our objective is to define a unified theoretical framework. We aim at establishing the fundamental limits for a decentralized system in a bursty regime which includes short packets of information and impulsive interference regime. We are targeting the fundamental limits, their mathematical expression (according to the usual information theory framework capturing the capacity region by establishing a converse and achievability theorems). We will use the recent results relative to finite block-length information theory and we will evaluate the margin for improvement between existing approaches and these limits and we will identify the scientific breakthrough that may bring significant improvements for IoT/M2M communications. This project will contribute to draw the roadmap for the development of IoT/M2M networks and will constitute a unified framework to compare existing techniques, and to identify the breakthrough concepts that may afford the industry the leverage to deploy IoT/M2M technical solutions.
- ANR EquipEx FIT/CorteXlab (2009-2020, 1M€, leader : UPMC). The FIT projet is a national equipex headed by the Lip6 laboratory. As a member of Inria, Maracas is in charge of the development of the Experimental Cognitive Radio platform (CorteXlab) that is used as a testbed for SDR terminals and cognitive radio experiments. This has been operational since 2014 and is maintained for a duration of 7 years. To give a quick view, the user will have a way to configure and program through Internet several SDR platforms (MIMO , SISO , and baseband processing nodes).

9.2.2. Autres sections...

1. SILECS is a research infrastructure being built to gather the efforts of several testbeds, relying on the success of Grid'5000 and FIT https://www.silecs.net/.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

1. COM-MED, *COMMunication systems with renewable Energy micro-griD*
   - Programm: H2020
   - Duration: October 2016 - October 2019
   - Coordinator: Inria
   - Inria contact: Samir M. Perlaza
   - Summary : A smart micro-grid is a small-scale power-grid system consisting of a number of distributed energy sources and loads which is responsible to ensure power sufficiency in a small area. The effectiveness of a smart micro-grid depends on the proper implementation of a communications and networking system which monitors, controls and manages the grid's operations. Due to the ever growing worldwide energy consumption, the need of an efficient framework for managing the way power is distributed and utilized has increased. The main objective of the project COM-MED is to study the fundamental interplay between communications and power networks in the context of smart micro-grids and renewable energy sources. On one hand, we study advanced signal processing techniques and communications methods to optimize the operation of smart micro-grid systems. On the other hand, we focus on mobile communications networks with renewable energy base-stations (BSs) and we investigate communications and networking techniques that take into account both data traffic and energy profiles to support high quality-of-service (QoS). The objectives of each technical WP have been assigned in such a way as to ensure that the project's target is realized during the project's time period. The theoretical results derived from the WPs 3, 4 and 5 will be tested using the telecommunication network of MTN in Cyprus but also the state-of-the-art equipment of the CITI/Inria research lab in France. The outcome of this project will provide a theoretical framework for the optimal cooperation between communications networks and power networks in the context of smart micro-grids and renewable energy sources. This is in line with the objectives of the call's theme "Renewable Energy" and is of paramount importance for the Mediterranean area. The consortium of the project has the expertise and the infrastructure to implement the objectives set and to bring the project to a successful end.
2. WindMill, *Machine Learning for Wireless Communications*
   - Programm: H2020; European Training Network (ETN).
   - Duration: January 2019 - December 2022.
   - Coordinator: Aalborg University, DK
   - Inria contact: Jean-Marie Gorce
   - Summary : With their evolution towards 5G and beyond, wireless communication networks are entering an era of massive connectivity, massive data, and extreme service demands. A promising approach to successfully handle such a magnitude of complexity and data volume is to develop new network management and optimization tools based on machine learning. This is a major shift in the way wireless networks are designed and operated, posing demands for a new type of expertise that requires the combination of engineering, mathematics and computer science disciplines. The ITN project WindMill addresses this need by providing Early Stage Researchers (ESRs) with an expertise integrating wireless communications and machine learning. The project will train 15 ESRs within a consortium of leading international research institutes and companies comprising experts in wireless communications and machine learning. This a very timely project, providing relevant inter-disciplinary training in an area where machine learning represents a meaningful extension of the current methodology used in wireless communication systems. Accordingly, the project will produce a new generation of experts, extremely competitive on the job market, considering the scale by which machine learning will impact the future and empower the individuals that are versed in it. The project will also nurture the sense of responsibility of the ESRs and the other participants through personal engagement in the training program and by promoting teamwork through collaborative joint projects.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

- Program: PHC Amadeus 2020
- Title: Towards Rigorous Design of Molecular Communication Systems
- Duration: 1/2020 - 12/2021
- Coordinator: Malcolm Egan (MARACAS)
- Other Partners: Institute of Mathematics and Scientific Computing, University of Graz, Austria; CNRS.
- Abstract: The main aim of this project is to bring together experts in molecular communication (Univ. Lyon, Inria, CNRS) and in chemical reaction-diffusion systems (Univ. Graz) to (i) develop novel design of molecular communication systems using up-to-date mathematical results in chemical reaction-diffusion systems, and (ii) strengthen the mathematical theory about chemical reaction networks arising from designation of communication systems.
- Program: COST
- Title: COST Action CA15104, IRACON Inclusive Radio Communications
- Duration: 3/2016 - 3/2020
- Coordinator: Prof. Claude Oestges, University Catholique de Louvain, Belgium.
- Other Partners: many, see website.
- Abstract: This COST Action aims at scientific breakthroughs by introducing novel design and analysis methods for the 5th-generation (5G) and beyond-5G radio communication networks. Challenges include i) modelling the variety of radio channels that can be envisioned for future inclusive radio, ii) capacity, energy, mobility, latency, scalability at the physical layer and iii) network automation, moving nodes, cloud and virtualisation architectures at the network layer, as well as iv) experimental research addressing Over-the-Air testing, Internet of Things, localization and tracking and new radio access technologies. The group of experts supporting this proposal comes from both academia and industry, from a wide spread of countries all over Europe, with the support of some non-COST institutions and R&D associations and standardisation bodies worldwide. The proposers have also long experience on COST Actions in the Radiocommunications field.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- Princeton University, School of Applied Science, Department of Electrical Engineering, NJ. USA. This cooperation with Prof. H. Vincent Poor is on topics related to decentralized wireless networks. Samir M. Perlaza has been appointed as Visiting Research Collaborator at the EE Department for the academic period 2016-2017. Scientific-Leaders at Inria: Samir M. Perlaza and Jean-Marie Gorce.
- Technical University of Berlin, Dept. of Electrical Engineering and Computer Science, Germany. This cooperation with Prof. Rafael Schaffer is on secrecy and covert communications. Scientific-Leaders at Inria: Samir M. Perlaza.
- National University Singapore (NUS), Department of Electrical and Computer Engineering, Singapore. This collaboration with Prof. Vincent Y. F. Tan is on the study of finite block-length transmissions in multi-user channels and the derivation of asymptotic capacity results with non-vanishing error probabilities. Scientific-Leaders at Inria: Samir M. Perlaza
- University of Sheffield, Department of Automatic Control and Systems Engineering, Sheffield, UK. This cooperation with Prof. Inaki Esnaola is on topics related to information-driven energy systems and multi-user information theory. Scientific-in-charge at Inria: Samir M. Perlaza.

- University of Arizona, Department of Electrical and Computer Engineering, Tucson, AZ, USA. This cooperation with Prof. Ravi Tandon is on topics related to channel-output feedback in wireless networks. Scientific-Leader at Inria: Samir M. Perlaza.
- University of Cyprus, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus. This cooperation with Prof. Ioannis Krikidis is on topics related to energy-harvesting and wireless communications systems. Scientific-Leaders at Inria: Guillaume Villemaud and Samir M. Perlaza.
- Queen's University Belfast, UK. This collaboration is on molecular communication and massive MIMO with Prof. Trung Q. Duong. Scientific-in-charge at Inria: Malcolm Egan
- Czech Technical University in Prague, Czech Republic. This collaboration is on optimisation methods related to machine learning with Dr. Vyacheslav Kungurtsev. Scientific-in-charge at Inria: Malcolm Egan
- TUMCREATE, Singapore. This collaboration is on signal processing in communications with Dr. Ido Nevat. Scientific-in-charge at Inria: Malcolm Egan.
- UMNG (Universidad Militar de Nueva Granada), Telecommunications Department, Bogota, Colombia. Ongoing collaboration on security for GSM networks using deep learning. Scientific-in-charge at Inria: Leonardo S. Cardoso.
- Department of Power, Electronic and Communication Engineering, University of Novi Sad, Serbia. This collaboration is on GNU radio and signal processing around FIT/CorteXlab with Prof. Dejan Vukobratovic. Scientific-in-charge at Inria: Jean-Marie Gorce.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

1. Huy Duy Do, February-July 2019, Master Thesis MONABIPHOT, ENS Cachan, "Biological Circuits for Detection in Molecular Communication".
2. Antoine Dejonghe, September 2018-July 2020, Telecommunication Department's Research Track, INSA-Lyon, "Techniques for Massive Access in Dense IoT Networks" (Provisional Title)
3. Nuria Vinyes, September 2019-January 2020, Master Thesis, UPC Barcelona, "Simultaneous Information and Energy Transmission: Towards Feasible Systems"
4. Charlotte Hoefler-Hoerle – Undergraduate Student at INSA de Lyon (programme "parcours recherche" de l'INSA de Lyon), Leonardo S. Cardoso and Samir M. Perlaza.
5. INSA de Lyon, D´epartement des T´el´ecommunications. I have advised the following students during their final projects for obtaining the title of Engineer of INSA of Lyon: Samia Bouchareb (2015) and Naslaty Ali Kari (2016), L´elio Chetot (2016), Matias Dwek (2016), and Mamy Niang (2016), Charlotte Hoefler-Hoerle (2019), Adam Ben-Ltaifa (2019), Carl Hatoum (2019).
6. ENS de Lyon, D´epartement d'Informatique. I have advised the following students during their M2-level projects: Lucas Venturini (2019) and Tran Xuan Thang (2019).
7. Matei Catalin Moldoveanu – Master Student at University of Sheffield (Research Intern, Summer 2019).

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Léonardo Cardoso visited Carles Anton, CTTC (Barcelona, Spain), June 2019.

MAVERICK Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

We have frequent exchanges and on-going collaborations with Cyril Crassin from nVIDIA-Research, and Eric Heitz, Laurent Belcour, Jonathan Dupuy and Kenneth Vanhoey from Unity-Research.

7.2. National Initiatives

7.2.1. 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. This project is in cooperation with Océ Print Logic technologies, the Museum of Ethnography at the University of Bordeaux and the Manao team at Inria Bordeaux. The grant started in October 2015, for 48 months.

7.2.2. CDP: Patrimalp 2.0

Participants: Nicolas Holzschuch [contact], Romain Vergne.

The main objective and challenge of Patrimalp 2.0 is to develop a cross-disciplinary approach in order to get a better knowledge of the material cultural heritage in order to ensure its sustainability, valorization and diffusion in society. Carried out by members of UGA laboratories, combining skills in human sciences, geosciences, digital engineering, material sciences, in close connection with stakeholders of heritage and cultural life, curators and restorers, Patrimalp 2.0 intends to develop of a new interdisciplinary science: Cultural Heritage Science. The grant starts in January 2018, for a period of 48 months.

7.2.3. ANR: CaLiTrOp

Participant: Cyril Soler [contact].

Computing photorealistic images relies on the simulation of light transfer in a 3D scene, typically modeled using geometric primitives and a collection of reflectance properties that represent the way objects interact with light. Estimating the color of a pixel traditionally consists in integrating contributions from light paths connecting the light sources to the camera sensor at that pixel.

In this ANR we explore a transversal view of examining light transport operators from the point of view of infinite dimensional function spaces of light fields (imagine, e.g., reflectance as an operator that transforms a distribution of incident light into a distribution of reflected light). Not only are these operators all linear in these spaces but they are also very sparse. As a side effect, the sub-spaces of light distributions that are actually relevant during the computation of a solution always boil down to a low dimensional manifold embedded in the full space of light distributions.

Studying the structure of high dimensional objects from a low dimensional set of observables is a problem that becomes ubiquitous nowadays: Compressive sensing, Gaussian processes, harmonic analysis and differential analysis, are typical examples of mathematical tools which will be of great relevance to study the light transport operators.

Expected results of the fundamental-research project CALiTrOp, are a theoretical understanding of the dimensionality and structure of light transport operators, bringing new efficient lighting simulation methods, and efficient approximations of light transport with applications to real time global illumination for video games.

7.3. European Initiatives

Together with Stefanie Hahmann and Melina Skouras from project-team IMAGINE, Georges-Pierre Bonneau is part of the H2020 FET-Open Challenging Current Thinking project $ADAM^2$, grant ID 862025, accepted in June 2019 and starting officially January 1st 2020. The Imagine and Maverick teams at Inria are in charge of modelling of micro-structured geometries and design of meta-metarials. More information is available at www.adam2.eu.

7.4. International Initiatives

7.4.1. ASICIAO: Erasmus+ capacity building project

Joëlle Thollot is an active member of the ASICIAO Erasmus+ project. In this project four European higher education institutions support six schools from Senegal and Togo in their pursuit of autonomy by helping them to develop their own method of improving quality in order to obtain the CTI accreditation and the EUR-ACE label and, by doing so, to reach international standards.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

7.5.1.1. Internships

Anmol Hanagodimath spent 6 months of internship in our team as part of his master thesis of Delft university. He was supervised by Romain Vergne and Joëlle Thollot in Grenoble and Elman Eisemann in Delft.

MISTIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

MISTIS is involved in the 4-year ANR project ExtremReg (2019-2023) hosted by Toulouse University. This research project aims to provide new adapted tools for nonparametric and semiparametric modeling from the perspective of extreme values. Our research program concentrates around three central themes. First, we contribute to the expanding literature on non-regular boundary regression where smoothness and shape constraints are imposed on the regression function and the regression errors are not assumed to be centred, but one-sided. Our second aim is to further investigate the study of the modern extreme value theory built on the use of asymmetric least squares instead of traditional quantiles and order statistics. Finally, we explore the less-discussed problem of estimating high-dimensional, conditional and joint extremes

The financial support for MISTIS is about 15.000 euros.

9.1.2. Grenoble Idex projects

MISTIS is involved in a transdisciplinary project **NeuroCoG** and in a newly accepted cross-disciplinary project (CDP) **Risk@UGA**. F. Forbes is also a member of the executive committee and responsible for the *Data Science for life sciences* work package in another project entitled **Grenoble Alpes Data Institute**.

- The main objective of the RISK@UGA project is to provide some innovative tools both for the management of risk and crises in areas that are made vulnerable because of strong interdependencies between human, natural or technological hazards, in synergy with the conclusions of Sendai conference. The project federates a hundred researchers from Human and Social Sciences, Information & System Sciences, Geosciences and Engineering Sciences, already strongly involved in the problems of risk assessment and management, in particular natural risks. The PhD thesis of Meryem Bousebata is one of the eleven PhDs funded by this project.
- The NeuroCoG project aims at understanding the biological, neurophysiological and functional bases of behavioral and cognitive processes in normal and pathological conditions, from cells to networks and from individual to social cognition. No decisive progress can be achieved in this area without an aspiring interdisciplinary approach. The interdisciplinary ambition of NeuroCoG is particularly strong, bringing together the best scientists, engineers and clinicians at the crossroads of experimental and life sciences, human and social sciences and information and communication sciences, to answer major questions on the workings of the brain and of cognition. One of the work package entitled InnobioPark is dedicated to Parkinson's Disease. The PhD thesis of Veronica Munoz Ramirez is one of the three PhDs in this work package.
- The Grenoble Alpes Data Institute aims at undertaking groundbreaking interdisciplinary research focusing on how data change science and society. It combines three fields of data-related research in a unique way: data science applied to spatial and environmental sciences, biology, and health sciences; data-driven research as a major tool in Social Sciences and Humanities; and studies about data governance, security and the protection of data and privacy. In this context, a 2-year multi-disciplinary projects has been granted in November 2018 to Mistis in collaboration with the Grenoble Institute of Neuroscience. The objective of this project is to develop a statistical learning technique that is able to solve a problem of tracking and analyzing a large population of single molecules. The main difficulties are: 1) the large number of observations to analyse, 2) the noisy nature of the signals, 3) the definition of a quality index to allow the elimination of poor-quality data and false positive signals. We also aim at providing a powerful, well-documented and open-source software, that will be user-friendly for non-specialists.

Also in the context of the Idex associated with the Université Grenoble Alpes, Alexandre Constantin was awarded half a PhD funding from IRS (Initiatives de Recherche Stratégique), 50 keuros.

9.1.3. Competitivity Clusters

The MINALOGIC VISION 4.0 project: MISTIS is involved in a three-year (2016-19) project. The project is led by VI-Technology, a world leader in Automated Optical Inspection (AOI) of a broad range of electronic components. The other partners are the G-Scop Lab in Grenoble and ACTIA company based in Toulouse. Vision 4.0 (in short Vi4.2) is one of the 8 projects labeled by Minalogic, the digital technology competitiveness cluster in Auvergne-Rhône-Alpes, that has been selected for the Industry 4.0 topic in 2016, as part of the 22nd call for projects of the FUI-Régions, for a total budget of the project of 3,4 Meuros.

Today, in the printed circuits boards (PCB) assembly industry, the assembly of electronic cards is a succession of ultra automated steps. Manufacturers, in constant quest for productivity, face sensitive and complex adjustments to reach ever higher levels of quality. Project VI4.2 proposes to build an innovative software solution to facilitate these adjustments, from images and measures obtained in automatic optical inspection (AOI). The idea is - from a centralized station for all the assembly line devices - to analyze and model the defects finely, to adjust each automatic machine, and to configure the interconnection logic between them to improve the quality. Transmitted information is essentially of statistical nature and the role of sc mistis is to identify which statistical methods might be useful to exploit at best the large amount of data registered by AOI machines. Preliminary experiments and results on the Solder Paste Inspection (SPI) step, at the beginning of the assembly line, helped determining candidate variables and measurements to identify future defects and to discriminate between them. More generally, the idea is to analyze two databases at both ends (SPI and Component Inspection) of the assembly process so as to improve our understanding of interactions in the assembly process, find out correlations between defects and physical measures and generate accordingly proactive alarms so as to detect as early as possible departures from normality.

9.1.4. Networks

MSTGA and AIGM INRA (French National Institute for Agricultural Research) networks: F. Forbes and J.B Durand are members 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. MISTIS co-organized and hosted 2 of the network meetings in 2008 and 2015 in Grenoble.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

VHIA ERC project (2015-19).

MISTIS is involved in R. Horaud's ERC advanced Grant entitled Vision and Hearing In Action. VHIA studies the fundamentals of audio-visual perception for human-robot interaction.

9.3. International Initiatives

9.3.1. Inria International Labs

International Laboratory for Research in Computer Science and Applied Mathematics
Associate Team involved in the International Lab:

9.3.1.1. SIMERG2E

Title: Statistical Inference for the Management of Extreme Risks, Genetics and Global Epidemiology

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) Abdou Kâ Diongue

Start year: 2018

See also: http://mistis.inrialpes.fr/simerge

SIMERG2E is built on the same two research themes as SIMERGE, with some adaptations to new applications: 1) Spatial extremes, application to management of extreme risks. We address the definition of new risk measures, the study of their properties in case of extreme events and their estimation from data and covariate information. Our goal is to obtain estimators accounting for possible variability, both in terms of space and time, which is of prime importance in many hydrological, agricultural and energy contexts. 2) Classification, application to genetics and global epidemiology. We address the challenge to build statistical models in order to test association between diseases and human host genetics in a context of genome-wide screening. Adequate models should allow to handle complexity in genomic data (correlation between genetic markers, high dimensionality) and additional statistical issues present in data collected from a family-based longitudinal survey (non-independence between individuals due to familial relationship and non-independence within individuals due to repeated measurements on a same person over time).

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

9.3.2.1. LANDER

Title: Latent Analysis, Adversarial Networks, and DimEnsionality Reduction

International Partner (Institution - Laboratory - Researcher):

La Trobe university, Melbourne (Australia) - Department of Mathematics - Hien Nguyen

Start year: 2019

See also: https://team.inria.fr/mistis/projects/lander/

The collaboration is based on three main points, in statistics, machine learning and applications: 1) clustering and classification (mixture models), 2) regression and dimensionality reduction (mixture of regression models and non parametric techniques) and 3) high impact applications (neuroimaging and MRI). Our overall goal is to collectively combine our resources and data in order to develop tools that are more ubiquitous and universal than we could have previously produced, each on our own. A wide class of problems from medical imaging can be formulated as inverse problems. Solving an inverse problem means recovering an object from indirect noisy observations. Inverse problems are therefore often compounded by the presence of errors (noise) in the data but also by other complexity sources such as the high dimensionality of the observations and objects to recover, their complex dependence structure and the issue of possibly missing data. Another challenge is to design numerical implementations that are computationally efficient. Among probabilistic models, generative models have appealing properties to meet all the above constraints. They have been studied in various forms and rather independently both in the statistical and machine learning literature with different depths and insights, from the well established probabilistic graphical models to the more recent (deep) generative adversarial networks (GAN). The advantages of the latter being primarily computational and their disadvantages being the lack of theoretical statements, in contrast to the former. The overall goal of the collaboration is to build connections between statistical and machine learning tools used to construct and estimate generative models with the resolution of real life inverse problems as a target. This induces in particular the need to help the models scale to high dimensional data while maintaining our ability to assess their correctness, typically the uncertainty associated to the provided solutions.

9.3.3. Inria International Partners

9.3.3.1. 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 Michigan, in Ann Arbor, USA, the statistics department of McGill University in Montreal, Canada, Université Gaston Berger in Senegal and Universities of Melbourne and Brisbane in Australia.

The main other active international collaborations in 2019 are with:

- E. Deme and A. Diop from Gaston Berger University in Senegal.
- N. Wang and C-C. Tu from University of Michigan, Ann Arbor, USA.
- Guillaume Kon Kam King, Stefano Favaro, Pierpaolo De Blasi, Collegio Carlo Alberto, Turin, Italy.
- Igor Prünster, Antonio Lijoi, and Riccardo Corradin Bocconi University, Milan, Italy.
- Bernardo Nipoti, Trinity College Dublin, Ireland.
- Yeh Whye Teh, Oxford University and DeepMind, UK.
- Stephen Walker, University of Texas at Austin, USA.
- Alex Petersen, University of California Santa Barbara, USA.
- Dimitri van de Ville, EPFL, University of Geneva, Switzerland.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Bernardo Nipoti, assistant professor at Milano Bicocca University, Italy, visited for a month in 2019 (three visits in February, April and September).
- Natalie Karavarsamis, assistant professor at La Trobe University in Melbourne, Australia, visited for a week in November 2019.
- Hien Nguyen, researcher at La Trobe University in Melbourne, Australia, visited for a month in November 2019.
- Darren Wraith, assistant professor at QUT, Brisbane, Australia, visited for 2 weeks in December 2019 and January 2020.
- Aboubacrène Ag Ahmad, PhD student at Univ. Gaston Berger, Senegal visited from September 2019 until November 2019.

9.4.1.1. Internships

Sharan Yalburgi did an internship of three months with Julyan Arbel on *Bayesian deep learning for model selection and approximate inference*.

9.4.1.2. Research Stays Abroad

Mariia Vladimirova visited David Dunson at Duke University for three months (Nov 2019 - Jan 2020).

MOEX Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Elker

Program: ANR-PRC

Project acronym: ELKER

Project title: Extending link keys: extraction and reasoning

Web site: https://project.inria.fr/elker/

Duration: October 2017 - September 2021

Coordinator: LIG/Manuel Atencia

Participants: Manuel Atencia Arcas, Jérôme David, Jérôme Euzenat

Other partners: Inria Lorraine, Université de Vincennes+Université Paris 13

Abstract: The goal of ELKER is to extend the foundations and algorithms of link keys (see §3.2) in two complementary ways: extracting link keys automatically from datasets and reasoning with link keys.

7.1.2. PEPS RegleX-LD

Program: Projets Exploratoires Premier Soutien (CNRS, INS2I)

Project acronym: REGLEX-LD

Project title: Découverte de règles expressives de correspondances complexes et de liage de données

Duration: January 2019 – December 2019

Coordinator: IRIT/Cássia Trojahn

Participants: Manuel Atencia Arcas, Jérôme David, Jérôme Euzenat

Other partners: IRIT Toulouse, INRA Paris, LRI Orsay

Abstract: RegleX-LD aims at discovering expressive ontology correspondences and data interlinking patterns using unsupervised or weakly supervised methods.

7.2. International Research Visitors

7.2.1. Visits of International Scientists

7.2.1.1. Internships

- Nacira Abbas (U. Lorraine) visited mOeX between 2019-02-04 and 2019-02-15 in the framework of the Elker project, working on link keys extraction with formal concept analysis.
- Hiba Belhadi, PhD student at Université des Sciences et de la Technologie Houari Boumediene (UTHB), Algiers, visited mOeX between 2019-10-15 and 2019-11-15 to work on selecting and matching properties for data interlinking.

MORPHEO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Data Driven 3D Vision

Edmond Boyer obtained a chair in the new Multidisciplinary Institute in Artificial Intelligence (MIAI) of Grenoble Alpes University. The chair entitled Data Driven 3D Vision is for 4 years and aims at investigating deep learning for 3D artificial vision in order to break some of the limitations in this domain. Applications are especially related to humans and to the ability to capture and analyze their shapes, appearances and motions, for upcoming new media devices, sport and medical applications.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR PRCE CaMoPi – Capture and Modelling of the Shod Foot in Motion

The main objective of the CaMoPi project is to capture and model dynamic aspects of the human foot with and without shoes. To this purpose, video and X-ray imagery will be combined to generate novel types of data from which major breakthroughs in foot motion modelling are expected. Given the complexity of the internal foot structure, little is known about the exact motion of its inner structure and the relationship with the shoe. Hence the current state-of-the art shoe conception process still relies largely on ad-hoc know-how. This project aims at better understanding the inner mechanisms of the shod foot in motion in order to rationalise and therefore speed up and improve shoe design in terms of comfort, performance, and cost. This requires the development of capture technologies that do not yet exist in order to provide full dense models of the foot in motion. To reach its goals, the CaMoPi consortium comprises complementary expertise from academic partners : Inria (combined video and X-ray capture and modeling) and Mines St Etienne (finite element modeling), as well as industrial : CTC Lyon (shoe conception and manufacturing, dissemination). The project has effectively started in October 2017 and is currently handled by Tomas Svaton, recruited as an engineer in April 2018.

9.2.1.2. ANR JCJC SEMBA – Shape, Motion and Body composition to Anatomy

Existing medical imaging techniques, such as Computed Tomography (CT), Dual Energy X-Ray Absorption (DEXA) and Magnetic Resonance Imaging (MRI), allow to observe internal tissues (such as adipose, muscle, and bone tissues) of in-vivo patients. However, these imaging modalities involve heavy and expensive equipment as well as time consuming procedures. External dynamic measurements can be acquired with optical scanning equipment, e.g. cameras or depth sensors. These allow high spatial and temporal resolution acquisitions of the surface of living moving bodies. The main research question of SEMBA is: "can the internal observations be inferred from the dynamic external ones only?". SEMBA's first hypothesis is that the quantity and distribution of adipose, muscle and bone tissues determine the shape of the surface of a person. However, two subjects with a similar shape may have different quantities and distributions of these tissues. Quantifying adipose, bone and muscle tissue from only a static observation of the surface of the human might be ambiguous. SEMBA's second hypothesis is that the shape deformations observed while the body performs highly dynamic motions will help disambiguating the amount and distribution of the different tissues. The dynamics contain key information that is not present in the static shape. SEMBA's first objective is to learn statistical anatomic models with accurate distributions of adipose, muscle, and bone tissue. These models are going to be learned by leveraging medical dataset containing MRI and DEXA images. SEMBA's second objective will be to develop computational models to obtain a subject-specific anatomic model with an accurate distribution of adipose, muscle, and bone tissue from external dynamic measurements only.

9.2.1.3. ANR JCJC 3DMOVE - Learning to synthesize 3D dynamic human motion

It is now possible to capture time-varying 3D point clouds at high spatial and temporal resolution. This allows for high-quality acquisitions of human bodies and faces in motion. However, tools to process and analyze these data robustly and automatically are missing. Such tools are critical to learning generative models of human motion, which can be leveraged to create plausible synthetic human motion sequences. This has the potential to influence virtual reality applications such as virtual change rooms or crowd simulations. Developing such tools is challenging due to the high variability in human shape and motion and due to significant geometric and topological acquisition noise present in state-of-the-art acquisitions. The main objective of 3DMOVE is to automatically compute high-quality generative models from a database of raw dense 3D motion sequences for human bodies and faces. To achieve this objective, 3DMOVE will leverage recently developed deep learning techniques. The project also involves developing tools to assess the quality of the generated motions using perceptual studies. This project currently involves one Ph.D. student who was hired in November 2019.

9.2.2. Competitivity Clusters

9.2.2.1. FUI24 SPINE-PDCA

The goal of the SPINE-PDCA project is to develop a unique medical platform that will streamline the medical procedure and achieve all the steps of a minimally invasive surgery intervention with great precision through a complete integration of two complementary systems for pre-operative planning (EOS platform from EOS IMAGING) and imaging/intra-operative navigation (SGV3D system from SURGIVISIO). Innovative low-dose tracking and reconstruction algorithms will be developed by Inria, and collaboration with two hospitals (APHP Trousseau and CHU Grenoble) will ensure clinical feasibility. The medical need is particularly strong in the field of spinal deformity surgery which can, in case of incorrect positioning of the implants, result in serious musculoskeletal injury, a high repeat rate (10 to 40% of implants are poorly positioned in spine surgery) and important care costs. In paediatric surgery (e. g. idiopathic scoliosis), the rate of exposure to X-rays is an additional major consideration in choosing the surgical approach to engage. For these interventions, advanced linkage between planning, navigation and postoperative verification is essential to ensure accurate patient assessment, appropriate surgical procedure and outcome consistent with clinical objectives. The project has effectively started in October 2018 with Di Meng's recruitment as a PhD candidate.

9.3. International Research Visitors

The Morpheo team is hosting Professor Stephane Durocher during his sabbatical from July 2019 to June 2020. He is involved in the team research activities, in particular on the development of efficient algorithms to cluster a set of moving objects based on their trajectories, as obtained using the Kinovis platform. This will allow to perform motion analysis tasks, such as clustering objects into components that follow similar motions, which can help in analyzing the relative motion of body parts.

9.3.1. Visits to International Teams

9.3.1.1. Research Stays Abroad

1. Victoria Fernández Abrevaya did an internship with a British company in London, from July 2019 until September 2019.
2. Nitika Verma did an intership with Google at New York, from May 2019 until September 2019.

MOSAIC Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. ENS de Lyon projets Emergents - Phyllo (2018 - 2019)

Participants: Christophe Godin, Bruno Leggio, Teva Vernoux [External Collaborator].

The aim in this project is to develop a model of phyllotaxis that would be compatible with the recent detailed and quantitative observations made by our group of the distribution of auxin in space and time at the SAM. In particular the work will seek at using the new quantitative data to estimate the parameters of the stochastic model previously developed of organ patterning.

7.1.2. IDEX Lyon Impulsion - MecaField (2019 - 2020)

Participants: Christophe Godin, Bruno Leggio, Teva Vernoux [External Collaborator].

In a previous work, we have shown that the coupling of mechanical and hydraulical descriptions in a 2D model of multicellular tissue growth induces the emergence of remarkable phenomena at tissue level. In particular, we have shown that the growth of an organ may induce a lateral inhibition surrounding the organ that prevents other organs to grow in its vicinity. The goal of this project is to estimate the hydraulic and mechanical parameters of such a model from confocal images of a growing SAM and to compare observations with the order of magnitude of the predicted inhibitory zones and of their amplitude at cellular resolution.

7.2. National Initiatives

7.2.1. Inria ADT - Gnomon

Participants: Olivier Ali, Romain Azaïs, Guillaume Cerutti, Florian Gacon, Christophe Godin, Jonathan Legrand, Grégoire Malandain [External Collaborator], Teva Vernoux [External Collaborator].

Gnomon is a user-friendly computer platform developed by the Mosaic team for seamless simulation of form development in silico. It is intended to be a major tool for the team members to develop, integrate and share their models, algorithms and tools. Flexible components (plugins) make it possible to up-load or to create such data-structures, to program their development, to analyze, visualize them and interact with them in 3D+time.

Based on the past experience of the team with the OpenAlea platform, the goal of this ADT is to develop a more scalable software engineering solution based on the dtk kernel developed by the group of software engineers (SED) from the Sophia-Antipolis Inria Center.

Partners:

- SED Sophia Antipolis Inria Research Centre
- Morpheme Inria projec-team, Sophia Antipolis, France

7.2.2. Inria IPL - Naviscope

Participants: Guillaume Cerutti, Emmanuel Faure [External Collaborator], Christophe Godin, Jonathan Legrand, Grégoire Malandain [External Collaborator].

In this project, we plan to develop original and cutting-edge visualization and navigation methods to assist scientists, enabling semi-automatic analysis, manipulation, and investigation of temporal series of multi-valued volumetric images, with a strong focus on live cell imaging and microscopy application domains. We will build Naviscope upon the strength of scientific visualization and machine learning methods in order to provide systems capable to assist the scientist to obtain a better understanding of massive amounts of information. Such systems will be able to recognize and highlight the most informative regions of the dataset by reducing the amount of information displayed and guiding the observer attention. Finally, we will overcome the technological challenge of gathering up the software developed in each team to provide a unique original tool for users in biological imaging, and potentially in medical imaging.

7.2.3. ANR - Imago (2016 - 2019)

Participants: Guillaume Cerutti, Christophe Godin, Jonathan Legrand.

The goal of this project is to investigate the role of ovule growth constraints on germ cell fate establishment. This project is motivated by recent findings from the partners' groups suggesting that disturbances in cell divisions and expansion in early (pre-meiotic) ovules are sufficient to induce ectopic germ cells. These observations suggest novel routes to engineer apomixis in plants but remains poorly understood. Recent developments in high-resolution 3D imaging, image processing, and modeling offer a powerful combination of approaches to investigate this question. IMAGO proposes to elucidate patterning rules governing ovule growth, and their contribution to female germ cell fate acquisition. We use a combination of high-resolution static and real-time 3D imaging, quantitative image processing, cell-based growth models and functional approaches to (1) define cellular growth patterns in the ovule primordium using quantitative imaging (2) test patterning rules in silico by cell-based growth models (3) validate patterning rules in vivo using genetic, pharmacological and mechanical perturbations.

Partners:

- UMR DIADE, IRD, Montpellier, France
- Department of Plant and Microbial Biology, Zurich, Swisszerland
- RDP, ENS de Lyon, France

7.2.4. ANR DigEM (2015 - 2019)

Participants: Christophe Godin, Bruno Leggio, Patrick Lemaire [External Collaborator], Grégoire Malandain [External Collaborator].

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.

Partners:

- UMR CRBM, CNRS Montpellier, France
- Morpheme Inria projec-team, Sophia Antipolis, France

7.2.5. ERA-CAPS Genes2shape (2018 - 2021)

Participants: Olivier Ali, Guillaume Cerutti, Christophe Godin, Bruno Leggio, Jan Traas [External Collaborator].

This project is aimed at understanding how molecular regulation integrates with mechanics to control overall plant shape, an unresolved problem with wide implications for both fundamental and applied biology. We will address this issue in the Arabidopsis flower, which, besides their obvious importance as reproductive structures, are amongst the best characterised systems in plant developmental biology. From a mechanistic point of view, it is widely accepted that regulatory molecular networks interfere with the properties of the structural cellular elements (cell wall, cytoskeleton) to induce particular growth patterns. How this occurs and how this is coordinated in space is not known. To obtain a mechanistic understanding of such a complex process, information from multiple scales, from molecular networks to physical properties and geometry have to be combined into a single picture. An integrated tool to do so is currently not available. Building on our complementary experience in interdisciplinary research on plant development, we will therefore develop a tool, called the "Computable Flower" that permits (i) integration of data on geometry, gene expression and biomechanics and (ii) the user to explore, interpret and generate hypotheses based on data supported by mechanistic modelling approaches. The tool therefore provides an integrated description in the form of a 3D dynamic template of the growing flower bud.

Partners:

- University of Cambridge (Sainsbury Lab.)
- California Institute of Technology
- MaxPlanck Institutes of Molecular Plant Physiology

7.2.6. MITI - MISGIVING (2019)

Participant: Romain Azaïs.

The diving performance of lung-breathing vertebrates, such as seabirds, can be quantified using measurement devices equipped on animals that allow us to reconstruct their activity at sea. During a classic dive, diving animals are faced with a dilemma: on the one hand, they want to optimize the time spent in contact with prey and therefore increase the time spent in diving; but, on the other hand, they are forced to return to the surface to breathe and will want to minimize this duration which remains however constrained by physiological rules. In addition, the dives are gathered in sequences because the prey are generally grouped in patches. In this project, we propose to use specific mathematical models to understand the complexity of the multi-scale decision processes that condition not only the optimal duration of the dive but also dives within a bout and therefore the total duration of the bout.

Partners:

- Centre d'Etudes Biologiques de Chizé
- Inria team CQFD in Bordeaux

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

Program: H2020

Project acronym: ROMI

Project title: RObotics for MIcrofarms

Duration: November 2017 - October 2021

Coordinator: Sony

Other partners: Iaac, (Spain), FEI (France), Inria (France), CNRS (France), UBER (Germany), Chatelain (France)

Abstract: All over Europe, young farmers are starting small market farms and direct sales businesses. These farms can be found both in rural, peri-urban and urban areas. They grow a large variety of crops (up to 100 different varieties of vegetables per year) on small surfaces (0.01 to 5 ha) using organic farming practices. These farms have proven to be highly productive, sustainable and economically viable. However, a lot of work is done manually, resulting in physically challenging work conditions. ROMI will develop an open and lightweight robotics platform for these microfarms. We will assist these farms in weed reduction and crop monitoring. This will reduce manual labour and increase the productivity through advanced planning tools. Thanks to ROMI's weeding robot, farmers will save 25 percents of their time. This land robot will also acquire detailed information on sample plants and will be coupled with a drone that acquires more global information at crop level. Together, they will produce an integrated, multi-scale picture of the crop development that will help the farmer monitor the crops to increase efficient harvesting. For this, ROMI will have to adapt and extend state-of-the-art land-based and air-borne monitoring tools to handle small fields with complex layouts and mixed crops. To achieve this, we will: (i) develop and bring to the market an affordable, multi-purpose, land-based robot, (ii) develop a weeding app for this robot that is adapted for organic microfarms, (iii) apply advanced 3D plant analysis and modelling techniques to in-field data acquisition, (iv) integrate these analysis techniques in the robot for detailed plant monitoring, (iv) integrate these techniques also in the aerial drone N-E-R-O for multi-scale crop monitoring, (v) extend the robot with novel, adaptive learning techniques to improve sensorimotor control of the plant monitoring app, and (vii) test the effectiveness of our solution in real-world field conditions.

7.3.2. Collaborations with Major European Organizations

Laboratoire International Associé (LIA): Computing Plant Morphogenesis

The focus of this LIA headed by Teva Vernoux (RDP) and Ottoline Leyser (SLCU) is on plant morphogenesis i.e. the mechanisms allowing the generation of plant shapes at different scales. Both the RDP and SLCU Laboratories are leaders of this field. The scenario for morphogenesis that has recently emerged is that chemical signals controlling cell identities lead to changes in mechanical properties of cells, triggering changes in shapes feeding back on the gene regulatory network. This in turn affects the distribution of chemical signals and mechanical forces, thus channeling morphogenesis. However, our understanding of the molecular and physical basis of morphogenesis in plants or in any other eukaryotic system is still in its infancy due to the complexity and non-linearity of processes involved in morphogenesis dynamics (or Morphodynamics). Understanding morphodynamics requires a modeling environment for the explicit representation of forms at multiple scales and for incorporating complex data from different origins and nature (chemical, mechanical, geometrical). In addition to creating a unique scientific environment, this LIA will gather the critical mass and interdisciplinary expertise required to create such a computational platform and to generate the data to produce an integrated vision of how chemical and mechanical signals interaction drive morphogenesis.

Partners: Sainsbury Lab. University of Cambridge (SLCU)

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Farah Ben Naoum, associate professor in computer science at the University of Sidi Bel Abbes, Algeria, visited the team in March 2019 for 3 weeks and worked with Romain Azais and Christophe Godin on the definition of a strategy to make efficient random walks in spaces of trees.
- Gabriela Mosca was a visiting researcher from Celia Baroux's Lab (U. Zurich, Switzerland) in the context of the ANR project IMAGO. She spent 3 weeks in the team working with Guillaume Cerutti, Jonathan Legrand, Olivier Ali and Christophe Godin to set up a protocol to reconstruct ovule development from confocal imaging.

7.4.1.1. Internships

- Salah Eddine Habibeche is a PhD student supervised by Farah Ben Naoum from the University of Sidi Bel Abbes. The PhD subject of Salah consists of developing compressing schemes for semi-ordered trees. During his visit, he will study methods of compression of trees with loss of information.
- Caro Chavez Hernandez is a PhD student from Elena Alvarez-Buylla, UNAM University, Mexico. Caro visited the MOSAIC group to work with Christophe Godin to integrate the extensive gene regulatory network she assembled of key molecular processes involved at different phases of plant development into a model of plant architecture development written in LPy.

NANO-D Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- An IDEX UGA grant is covering post-doc of Didier Devaurs, starting from December.
- Inria CORDI-S post-doctoral fellowship was obtained for Agnieszka Karczynska.

7.2. National Initiatives

7.2.1. ANR

In 2019, NANO-D had funding from one ANR program:

- **ANR PRCI**: covered the end of the PhD thesis of Guillaume Pages.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

The European Bioinformatics Institute (EMBL-EBI), Protein Data Bank in Europe (PDBe) team, Hinxton (UK)

We are collaborating on the integration of methods developed in the team into the PDBe web resource.

The Institute Laue-Langevin (ILL), the bioSANS team, Grenoble (France)

We are collaborating on the development of neutron small-angle scattering software

7.4. International Initiatives

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

7.4.1.1. FlexMol

Title: Algorithms for Multiscale Macromolecular Flexibility

International Partner (Institution - Laboratory - Researcher):

Rocasolano Institute of Physical Chemistry (IQFR-CSIC), Madrid, Spain (Spain) - Pablo Chacon

Start year: 2019

See also: https://team.inria.fr/nano-d/research/flexmol/

Molecular flexibility is essential to link structure and function of many biological macromolecules. Changes in protein conformation play a vital role in biochemical processes, from biopolymer synthesis to membrane transport. Many proteins can drastically alter their architecture and display considerable interdomain flexibility, as found in their 3D structures. For example, proteins rely on flexibility to respond to environmental changes, ligand binding and chemical modifications. Also, protein flexibility is tightly bound to their stability and is fundamental for drugs to exert biological effects.

Thus, one of the main challenges in the field of computational structural biology is to predict and explain molecular flexibility and corresponding conformational changes. For example, currently there are no methods that can reliably predict structural changes in proteins upon their binding. However, these are crucial to predict the structure of protein complexes with large conformational changes upon binding. To give another example, flexibility of the protein binding pocket is the

major hurdle in reliable prediction of protein-ligand interactions for computer-aided drug design. Finally, intrinsic flexibility of macromolecules is nowadays the limiting factor for high-resolution experimental structure determination.

The partners of this associate team proposal comprise world-leading teams working with sound mathematical representations and techniques in the field of structural bioinformatics. These include spherical harmonics, normal modes analysis, high-order fast Fourier transforms, and more. The partners have very similar interests, but complimentary expertise. The goal of this collaboration is to mutually explore novel computational techniques for emerging problems in structural biology and bioinformatics related to molecular flexibility. This problem can be tackled at different scales. Large-scale flexibility of macromolecules can be efficiently described using collective coordinates. We will try to represent these in polynomial spaces, such that a practical flexible docking method can be based on this representation. Other applications include 3D shape reconstruction and scattering problems. Local molecular flexibility can be modelled using various techniques, including robotics-inspired methods, fragment libraries, etc. Here, our goal will be to rapidly sample the conformational space, and to construct a potential energy function applicable to flexible molecules. The ultimate goal of the project is to combine multiple levels of representation of molecular flexibility together. The project outcome will be built around innovative computer-aided drug-design algorithm with applications to prediction and computational design of important pharmaceutical targets such as antibodies.

7.4.2. Inria International Partners

7.4.2.1. Declared Inria International Partners : BIOTOOLS

Title: Novel Computational Tools for Structural Bioinformatics

International Partner (Institution - Laboratory - Researcher):

MIPT (Russia (Russian Federation)) - Department of Control and Applied Mathematics - Vadim Strijov

Duration: 2016 - 2020

Start year: 2016

Abstract : The general scientific objectives of the forthcoming collaboration are the new developments of computational tools for structural bioinformatics. In particular, we plan to collaborate on several subjects: 1. Development of tractable approximations for intractable combinatorial problems in structural biology. 2. Development of new computational tools for scattering experiments. 3. Machine learning for structural bioinformatics.

7.4.2.2. Informal International Partners

- University of Stony Brook, lab of Dima Kozakov (USA). We have been collaborating on the development of novel protein docking methods.
- University of Vilnius, department of Bioinformatics (Lithuania). We have been collaborating on the development of novel protein docking methods.
- KU Copenhagen (Denmark), department of Chemistry. We collaborated on the integrative structural biology approaches.
- Francis Crick Institute, London (UK), Biomolecular Modelling Laboratory. We collaborate on the development of flexible protein docking methods.
- University of Oslo. Ongoing collaboration on modeling protein systems guided by small-angle Xray and neutron small-angle scattering.
- University of Bergen, Norway. Ongoing collaboration on novel methods for normal mode analysis of protein structures.
- Nagoya University and RIKEN Center for Computational Science, Kobe, Japan. We collaborated on novel algorithms for scattering methods.

- University of Kansas, bioinformatics unit, USA. We have been collaborating on modeling protein-protein interactions.

7.4.3. Participation in Other International Programs

Our team has obtained the PHC Gilibert grant for a 2-year collaboration with the Vilnius University (Lithuania). Our partner is the Department of Bioinformatics, http://www.bti.vu.lt/en/departments/department-of-bioinformatics.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Karina Dos Santos Machado, lecturer at the Federal University of Rio Grande (FURG, Brazil), Oct 2018 - Oct 2019.
- Vadim Strijov, professor at the department of Intelligent Systems, MIPT Moscow MIPT Moscow, July-August 2019.

7.5.1.1. Internships

- Khalid Mustafin (MIPT Moscow, Russia), Sep 2018 - Feb 2019.
- Ilia Igashov (MIPT Moscow, Russia), Nov 2018 - Apr 2020.
- Dmitrii Zhemchuzhnikov (UGA Grenoble), May 2019 - Sep 2019.

7.5.2. Visits to International Teams

- Sergei Grudinin visited the team of Ilia Vakser at Kansas University, Oct 15-31, 2019.

7.5.2.1. Explorer programme

- Sergei Grudinin visited Florence Tama and Osamu Miyashita, Nagoya University and RIKEN Center for Computational Science, Kobe, Japan. This was supported by the Exploration Japon 2019 program.
- Sergei Grudinin visited the team of Reidar Lund at University of Oslo, and the team of Nathalie Reuter at University of Bergen, Norway. Supported by the ÅSGARD 2019 program.

NECS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

DATASAFE (Understanding data accidents for traffic safety). PI: M.L. Delle Monache (2018-2019)
DATASAFE is a two years project funded by Grenoble Data Institute, with the aim to understand from real traffic data the behavior of traffic in the moments preceding an accident. The general approach is to use novel statistical techniques in order to learn traffic characteristics that can be used to develop new traffic models. Bayesian approaches are used to (supervised) classification and (unsupervised) clustering in order to respectively predict collision occurrences and discover traffic patterns.

MAVIT (Modeling autonomous vehicles in traffic flow). PI: M.L. Delle Monache (2018-2019)
MAVIT is a two year project funded by the University Grenoble Alpes, MSTIC department. The goal of this project is to develop a unified micro-macro approach for traffic management, involving human and autonomous vehicles drivers by providing analytical and numerical tools for traffic modeling, estimation and control. We will work towards field operational tests, by using instrumented cars to collect data on AVs trajectory and their interaction with the traffic flow with human drivers. The proposed research provides new mathematical models, computational/software tools, and engineering solutions for the control of human controlled vehicles via intelligently controlled AVs in the traffic stream. Moreover, the control of traffic via moving actuators provides a new alternative to contemporary control technologies, such as ramp metering and variable speed limits; even when AVs comprise a tiny fraction of the total fleet, these techniques may be viable, and rapidly configurable. This research considers new types of traffic models, new control algorithms for traffic flow regulation, and new sensing and control paradigms that are enabled by a small number of controllable systems anticipated in a flow. Specifically, the research focuses on new (1) micro-macro models to model few AVs in a flow; (2) estimation techniques for AV interactions with the traffic flow; (3) developing and assessing dynamical controllers to mitigate traffic events

SPACE (NanoSatellite Project: Advanced modelling and Control of attitude dynamics for quantum communication). PI: H. Fourati (2018-2019)
SPACE is a two-year project funded by the IDEX University Grenoble Alpes. It aims to launch an exploratory study to find the required minimal data we need to collect and combine for software design of Nanosatellite Attitude Determination and Control System (ADCS).

CAPTIMOVE (CAPture et analyse d'acTivités humaInes par MOdules inertiels : vers une solution adaptée à la naVigation multimodalE urbaine intelligente). PI: H. Fourati (2018-2019)
Mobility is currently evolving in urban scenarios and multimodality today is the key tomore efficient transportation. It is important to analyze the ecological impact of the varioustransportation modes, to be able to detect the mode used by the commuter and the rule usedto switch from one mode to another. The ultimate goal is to suggest smarter itineraries tocommuters. To this purpose, detection and classification of activities in human mobility fromhis principal residence to his destination (for example, place of work, place of entertainment,etc.) is an important study to carry out. We aim to identify, with high precision, the natureof the transportation modes used during the day (walking, cycling, public transportation, car,etc.) as well as transitions from one mode to another. To reach this goal, we will use inertial and attitude modules, embedded in most inertial units, connected watches and smartphones.These technological tools constitute truly innovative and promising instrumentation for bothnon-invasive automatic capture information in situ, over extended periods, only for accurateand reliable analysis of activities of a person during his/her trip. In terms of research, we willexploit techniques from Machine Learning and state estimation to address this issue. A studyshall be conducted to determine the type, number and location of sensors to be used., Issuesrelated to the quality of data to be provided to algorithms and how to detect and discarderroneous ones from our computation process, will be also addressed. This research finds itsmajor future interest later in the development of a multimodal

intelligent navigation systemfor indoor and outdoor environments. These results, once obtained, can also be used to studyand analyze the behavior (choice) of users regarding pedestrian navigation (walking) or theuse of modes of transport (convenience, cost, speed, safety and more and more frequentlyeffects on the environment) or respect for the privacy of individuals (dynamic anonymizationof data while retaining their usefulness).

9.2. National Initiatives

DOOM (Systems-theory for the Disorders Of Online Media). 80 PRIME from CNRS MITI (2019–2022). PI: P. Frasca
Online social media have a key role in contemporary society and the debates that take place on them are known to shape political and societal trends. For this reason, pathological phenomena like the formation of "filter bubbles" and the viral propagation of "fake news" are observed with concern. The scientific assumption of this proposal is that these information disorders are direct consequences of the inherent nature of these communication media, and more specifically of the collective dynamics of attention thereby. In order to capture these dynamics, this proposal advocates the mathematical modelling of the interplay between the medium (algorithmic component) and the users (human component). The resulting dynamics shall be explored by a system-theoretic approach, using notions such as feedback and stability. This quantitative and rigorous approach will not only unlock fundamental insights but also deliver suggestions on suitable policies to manage the media.

HANDY (Hybrid and Networked Dynamical Systems). ANR PRC (2019-2022). Co-PI: P. Frasca
Networked dynamical systems are ubiquitous in current and emerging technologies. From energy grids, fleets of connected autonomous vehicles to online social networks, the same scenario arises in each case: dynamical units interact locally to achieve a global behavior. When considering a networked system as a whole, very often continuous-time dynamics are affected by instantaneous changes, called jumps, leading to so-called hybrid dynamical systems. Hybrid phenomena thus play an essential role in these control applications, and call upon the development of novel adapted tools for stability and performance analysis and control design. In this context, the aim of HANDY project is to provide methodological control-oriented tools for realistic networked models, which account for hybrid phenomena. The project brings together researchers from LAAS in Toulouse, CRAN in Nancy, GIPSA in Grenoble and LSS in Gif-sur-Yvette, with expertise in various domains of automatic control, ranging from geometric control and optimization, switched systems, hybrid dynamics, nonlinear control, and multi-agent systems. See also: http://projects.laas.fr/handy

AgileWorld-MRSEI. PI: A. Kibangou AgileWorld is an ANR-MRSEI project (2018-2020), which aims at building an European network for an innovative training on road transportation systems in a connected world. The funding will help to prepare and then submit a proposal for the MSCA-ITN 2019 call. For this purpose a workshop was organized in November 2019 with the partners of the project in Grenoble.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

COST (Mathematical models for interacting dynamics on networks). Action no. 18232, 2019-2023, Management committee substitute member. PI: M.L. Delle Monache
Many physical, biological, chemical, financial or even social phenomena can be described by dynamical systems. It is quite common that the dynamics arises as a compound effect of the interaction between sub-systems in which case we speak about coupled systems. This Action shall study such interactions in particular cases from three points of view: 1. the abstract approach to the theory behind these systems, 2. applications of the abstract theory to coupled structures like networks, neighbouring domains divided by permeable membranes, possibly non-homogeneous simplicial complexes, etc., 3. modelling real-life situations within this framework. The purpose of this Action is to bring together leading groups in Europe working on a range of issues connected with modelling and analysing mathematical models for dynamical systems on networks. It aims to develop a semigroup approach to various (non-)linear dynamical systems on networks as well as numerical methods based on modern variational methods and applying them to road traffic, biological systems,

and further real-life models. The Action also explores the possibility of estimating solutions and long time behaviour of these systems by collecting basic combinatorial information about underlying networks

9.4. International Initiatives

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

MEMENTO (ModEling autonoMous vEhicles iN Traffic flOw). International Partner: Vanderbilt University, Nashville (United States) - Dan Work, Start year: 2018. See also: http://necs.inrialpes.fr/memento/index.html
PI: M.L. Delle Monache
In recent years, the strategic priorities of automotive and transportation systems focus on research, development and adoption of automation-related technologies as they emerge. As these technology developments are introduced in the traffic stream, an open question is how the mathematical models that are at the heart of transportation planning and operations will need to be advanced to accommodate these changes. The goal of the NeCS-Vanderbilt, MEMENTO, associate team is to create a multidisciplinary environment to model autonomous vehicles (AV) in human traffic flow. Specifically, our goal is to develop a unified micro-macro approach for traffic management, involving human drivers and autonomous vehicles by providing analytical and numerical tools for traffic modeling, estimation and control. We will work towards field operational tests, by using instrumented cars to collect data on AVs trajectories and their interaction with the traffic flow with human drivers.

9.4.2. Participation in Other International Programs

(Mean field game models for traffic application). Rutgers Global Grant - International collaborative research grant: International partner : Rutgers University - Camden (USA). PI: M.L. Delle Monache
This project focuses on the theoretical tools for traffic systems to mitigate traffic events that adversely affect. Specifically, the project will build algorithms to mitigate "phantom" traffic jams, which are instabilities caused by human driving behavior, lane changes, and other disturbances. This project is premised on the concept that connected and autonomous vehicles (CAVs) can act as instability pacifiers and enable a new era of freeway traffic management in which CAVs themselves are part of the traffic control system. The stabilizing Lagrangian (i.e., mobile) control signal will be fed directly to the vehicles, which will adjust their speed and lanes to match the requirements of the control.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Raphael Stern (University of Minnesota (USA)) visited the team in March 2019 to work with Maria Laura Delle Monache and Thibault Liard, in the framework of the associated team MEMENTO.

9.5.2. Visits to International Teams

- P. Frasca is a Visiting Scientist at the IEIIT-CNR Institute, National Research Council CNR, Turin, Italy. By this collaboration, he performs research on distributed estimation in sensor networks and distributed control of social networks. He visited Turin three times in 2019. He is also a Visiting Faculty at the Department of Applied Mathematics, University of Twente, Enschede, The Netherlands. By this collaboration, he performs research on vehicle platooning and on the dynamics of social media.
- Maria Laura Delle Monache visited Rutgers University – Camden in March and in November 2019 to work with Prof. Piccoli in the framework of the Rutgers collaborative grant.
- Maria Laura Delle Monache visited Vanderbilt University in November 2019 in the framework of the of the associated team MEMENTO.
- Stephane Mollier visited Temple University in January 2019 to discuss with Prof. Seibold concerning 2D traffic models.

- A. Kibangou visited the University of Johannesburg (South Africa) in March and November 2019. During his stay, he gave a lecture to students of Department of Town and Regional Planning of Univ. of Johannesburg on Mobility and traffic management. He also attended the first French-South African Science and Innovation days (December 2-3, 2019).

NUMED Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

INSERM / Plan Cancer 2019 - 2022: Evolutionary Mechanisms of Metabolic Adaptation and Scheduling of Therapy in ONcology (250 kE).

Project: This project combines mathematical models integrating heterogeneous phenotypic and genetic data with multiple in vitro models of cancer evolution. Triple Negative Breast Cancers (TNBC) are unsuited to targeted therapy and display high diversity and resistance. We will thus use 3 existing TNBC models, of common origin but subjected to different tumor initiating oncogenic insults, treated over several generations with two drugs targeting antagonist receptors involved in metabolism. By following phenotypic and genetic properties over time, we aim to uncover and quantify how distinct tumor initiation contexts shape evolutionary trajectories and the emergence of resistance. Using mathematical models and simulations, we will investigate how to optimise therapeutic regimens based on the intrinsic evolutionary properties of each model, before validating our predictions in vivo via murine xenografts. Results: The results of this project will help better characterize the influence of the initiating genetic alterations on the ensuing dynamics of development and resistance in TNBC. It will also pave the way to optimise novel therapeutic strategies aiming to leverage cell metabolism to control tumor evolution in the clinic.

5.2. International Research Visitors

5.2.1. Visits to International Teams

5.2.1.1. Research Stays Abroad

Paul Vigneaux spend one year at UCB (University British Columbia)

PERCEPTION Project-Team

7. Partnerships and Cooperations

7.1. European Initiatives

7.1.1. Collaborations with Major European Organizations

Universitat Politècnica de Catalunya (UPC), Spain

Physical complex Interactions and Multi-person Pose Estimation (PIMPE) is three year project financed by IDEX. The scientific challenges of PIMPE are the followings: (i) Modeling multi-person interactions in full-body pose estimation, (ii) Estimating human poses in complex multi-person physical interactions, and (iii) Generating controlled and realistic multi-person complex pose images.

7.2. International Research Visitors

7.2.1. Research Stays Abroad

Xavier Alameda-Pineda spent three months at the University of Verona, Italy.

Yihong Xu (Ph.D. student) spent three months at the Technical University Munich, Germany.

PERVASIVE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. LabEx Persyval, Project RHUM, Robots in Human Environments

Participants: Thierry Fraichard, Patrick Reignier.

Partners: GIPSA, Inria, LIG, LJK and TIMC.
Dates:*[Sep. 15-Dec. 19].*

The RHUM project from the LabEx Persyval (ANR-11-LABX-0025-01) brings together ten teams from different labs from the Grenoble academic scene: GIPSA, Inria, LIG, LJK and TIMC. Its goal is to tackle scientific problems related to active perception, navigation in human environments, learning and adaptation of robots behaviors for social interaction. PERVASIVE contributes to the navigation in human environments aspects.

8.1.2. ExpeSigno

Participants: Patrick Reignier, Amr Al-Zouhri Al-Yafi, Amine Awada.

Projet Région Pack Ambition Recherche EXPESIGNO : Expérimentation de la réactivité des ménages aux signaux des opérateurs de systèmes énergétiques
Other Partners : Laboratoire Gaël, Laboratoire G2ELAb, laboratoire G-Scop
Dates : 2018 - 2022

Buildings represent 66% of electricity consumption and they can act as nodes in a network of consumption, storage and energy production. In this case, it can be understood that buildings and their inhabitants will change from a passive consumer to an active consumer (the so called “pro-sumer”) who can respond quickly to price changes on the network and / or signals from operators, or even other pro-sumers offering energy production and storage solutions using solar panels or electric cars. To achieve this goal, energy systems must send consumers the right signal to induce appropriate local and global behavior. The introduction of equipment such as Smart Meters or interactive consumption management devices is decisive because they are considered as the solution to turn residential consumers into active users of their electricity or energy consumption. Nudges are an interesting way to induce lasting changes in consumer behavior. The idea of nudges is to set up environments of choice that help people make the choices that are best for them. During this project, we are going to deploy sensors within 4 volunteer families in order to study the impact of nudges on electricity consumption through a detailed analysis of the practices carried out. The objective is to establish the links between the sensor data and the activities declared by each household and to measure how nudges influence their activities.

8.1.3. ANR Project CEEGE: Chess Expertise from Eye Gaze and Emotion

Participants: Thomas Guntz, James Crowley, Dominique Vaufreydaz, Raffaella Balzarini.

Other Partners : Dept of NeuroCognition, CITEN, Bielefeld University
Dates : Jan 2016 to Dec 2019

The ANR CEEGE project is a multidisciplinary scientific research project conducted by the Inria PRIMA team in cooperation with the Dept of Cognitive Neuroscience at the University of Bielefeld. The primary impacts will be improved scientific understanding in the disciplines of Computer Science and Cognitive NeuroScience. The aim of this project is to experimentally evaluate and compare current theories for mental modelling for problem solving and attention, as well as to refine and evaluate techniques for observing the physiological reactions of humans to situation that inspire pleasure, displeasure, arousal, dominance and fear.

In this project, we have observed 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 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 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 has been used to determine and model the degree to which a player understands the game situation in terms of abstract configurations of chess pieces. This provides a structured environment that use for experimental evaluation of current theories of mental modeling and emotional response during problem solving and social interaction.

The project have been organized in two phases. During the first phase, we will observed individual players of different levels of chess expertise solving known chess problems. We correlated scan-path from eye tracking and other information about visual attention to established configurations of pieces and known solutions to chess problems. We constructed 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 have observed the attention and face expressions of pairs of players of different levels of chess ability solving problems followed by verbal self reports. We have used these recordings to evaluate the effectiveness of competing techniques for mental modeling and observation of emotions in terms of their abilities to predict the chess abilities of players, game outcomes and individual moves and player self reports.

8.1.4. CDP EcoSesa - Cross Disciplinary Project of the ComUE UGA

Participants: Patrick Reignier, James Crowley, Raffaella Balzarini, Amr Al-Zouhri Al-Yafi.

Funding : UGA Idex Cross disciplinary project
Dates : Jan 2017 to Dec 2020

Cities and their energy systems are undergoing profound transformations. Electric Power networks are being transformed from centralized, high capacity, generating plants, dimensioned to meet peak loads to decentralized, local, production based on intermittent renewable sources. This transformation is made possible by integration of information and energy technologies, new energy materials and components, and the rapid spread of pervasive computing. The result is a change in the socio-economics of energy distribution, and a change in the role of users from passive consumers to active participants in a dynamically fluctuating energy market. Many cities worldwide have initiated research projects and experiments to accelerate the spread of clean technologies. However, these initiatives generally focus on a specific issue that depends on the priorities and preferences of the local decision makers and stakeholders. At the same time, academic research has generally been confined to specialized silos in energy materials and management systems, in Social Sciences as well as in Information and Communication Technologies (ICT), resulting in piecemeal knowledge.

The vision of Eco-SESA is to address the problems resulting from the transition to clean decentralized energy production based on renewable sources with a holistic integrated humansystem approach. The project will address the development of Safe, Efficient, Sustainable and Accessible energy systems, from the individual end-user to dynamic communities of stakeholders at the district and grid levels.

Pervasive is involved in two research front of the project :

- Interactive systems to involve occupants of buildings
- Emerging behaviors from individual to communities

8.1.5. ANR VALET

Participant: Dominique Vaufreydaz.

Partners: Inria (Pervasive and Chroma teams for Inria Rhône-Alpes, RITS in Paris), Ircyyn (Nantes), AKKA (Paris)
Dates: 2016-2018

The ANR VALET project investigates two aspects of car sharing. In the first one, a novel approach for solving vehicle redistribution problem is proposed by managing an autonomous platoons guided by professional drivers. The second aspect concerns autonomous parking of shared cars when they arrived at their destination parking lot. In this project, our researches address the prediction of pedestrians' behaviors during urban fleet movements and during parking phases. The PhD student (Pavan Vashista) recruited in this project focus on integrating models of human behaviors to evaluate the risk that surrounding pedestrians encounter the trajectory of the VALET vehicles. His PhD thesis started in February 2016 is co-supervised by Anne Spalanzani (Chroma team) and Dominique Vaufreydaz.

8.1.6. ANR HIANIC

Participant: Dominique Vaufreydaz.

Partners: ARMEN and PACCE teams from LS2N laboratory (Nantes), Inria (Pervasive and Chroma teams for Inria Rhône-Alpes, RITS in Paris), MAGMA from LIG laboratory (Grenoble).
Dates: 2018-2021

The HIANIC project proposes to endow autonomous vehicles with smart behaviors (cooperation, negotiation, socially acceptable movements) to address problems that arise when autonomous cars are mixed with pedestrians in urban shared environment. It aims at developing new technologies in term of autonomous navigation in dense and human populated traffic. In order to contribute to urban safety and intelligent mobility, the HIANIC project also explores the complex problem of sociable interactions between pedestrians and cars while sharing the same urban environment.

In this project, Dominique Vaufreydaz works jointly with the Chroma team on perceiving pedestrians and their behaviors around autonomous cars and on interaction between autonomous vehicles and pedestrians.

8.1.7. LabEx Persyval - Project MicroBayes: Probabilistic Machines for Low-level Sensor Interpretation

Participants: Emmanuel Mazer, Raphael Frisch.

Partners: Laurent Girin (GIPSA Lab), Didier Piau (L'Institut Fourier)
Dates: Nov 2016 to Nov 2019

The project MicroBayes builds on results of the recently completed EC FET Open project BAMBI to explore a new technique for Blind source separation and acoustic signal location using a new form of Bayesian Computer. The techniques have recently been demonstrated using a software simulation. Current plans are to implement and demonstrate the Bayesian computer using an FPGA. By the end of the project we expect to produce a hardware implementation suitable for use in low-cost low-power applications.

8.1.8. Competitivity Clusters

James Crowley is on the scientific committee for the Minalogic Competitivity Cluster. Minalogic is the global innovation cluster for digital technologies serving France's Auvergne-Rhône-Alpes region. The Scientific Committee advises the pole of strategy, advises local industry in proposal preparation, reviews FUI project proposals, and makes recommendations about labelling and support of project proposals.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. AI4EU - A European AI On-Demand Platform and Ecosystem

Call: H2020 ICT-26-2018-2020
Coordinateur: Thales Systems
Partners: 79 European institutions
Dates: Jan 2019 through Dec 2021

AI4EU will build a comprehensive European AI-on-demand Platform that provides innovators in all areas of society with access to expertise, knowledge, algorithms and tools for developing, deploying and funding innovations based on Artificial Intelligence.

The aim is to empower actors across a broad spectrum of commercial, industrial and societal sectors in Europe with tools for innovation through AI Technologies. By bringing together a whole ecosystem of researchers, innovators, SMEs, large corporations, students and many others, around a single access point to AI resources, we will lower the barriers to education, research and innovation. Moreover, the AI4EU Platform will embrace on European values, respect European laws and support a human-centric approach providing a competitive advantage for European players.

8.2.1.2. H2020 FET Human AI

Call: H2020 FETFLAG-01-2018
Coordinateur: DFKI
Partners: 49 European institutions
Dates:1 March 2019 to 31 May 2020.

Humane AI has been funded to create a European network of centers of excellence for Artificial Intelligence technologies that synergistically work with humans, seamlessly fit in with our complex social settings and dynamically adapt to changes in our environment. The project seeks to develop world-leading insights and AI technologies, from fundamental algorithms, through methods specific to concrete applied AI domains such as Computer Vision, Robotics, IoT, Language Technologies and multi Agent Systems all the way up to disruptive AI applications and broadly usable platforms. Core innovations include (1) tools for enhancing human cognitive capabilities, channeling human creativity, inventiveness and intuition and empowering humans to make important decisions in a more informed way, (2) AI systems that can intelligently interact with and within complex social settings and seamlessly adapt to changing, open-ended environments, (3) explainable, transparent, validated and thus trustworthy AI systems that will help us more effectively deal with the complexity of a networked globalized world and (4) ways to embed values, ethics, privacy and security as core design considerations in all AI systems and applications.

To ensure broad and lasting socio-economic impact in areas which are important to Europe and its citizens on top of the basic research we will implemented dedicated impact-oriented work packages in domains such as Society and Policy, Industry 4.0, Sustainability and Energy, Finance, Science and Education, Health and Mobility/Automotive. To realize the Humane AI vision the consortium has lined up key European players and brought the relevant community on board to mobilize the critical mass needed for success. Many of the partners have strong interdisciplinary research track records, and several PIs on this project hold ERC grants, documenting scientific excellence. With their capability, networks and experience, we have a solid plan to bring the remaining players into the flagship activity during the preparatory action phase.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

8.3.1.1. Sethserey Sam, Vice-Président NIPTICT, Phnom Penh

Position: Vice-Président en charge de la recherche et des relations internationales du NIPTICT, Phnom Penh, Cambodge (et son assistante)
Date: Du 14 au 17 Avril 2019

8.3.1.2. Dr. Dao Trung Kien

Position: Directeur adjoint de l'Institut MICA, HUST, Hanoi, Vietnam
Date: novembre et décembre 2019
Travail sur la thématique de la localisation indoor de personnes grâce aux technologies sans fil et à la fusion intelligente de données hétérogènes.

POLARIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. IDEX UGA

- Nicolas Gast received a grant from the IDEX UGA that funds a two-years post-doctoral researcher (Takai Kennouche) for two years (2018 and 2019) to work on the smart-grid project that focus on distributed optimization in electrical distribution networks.
- Patrick Loiseau and Panayotis Mertikopoulos received a grant from the IDEX UGA that partly funds a PhD student (Benjamin Roussillon) to work on game theoretic models for adversarial classification.

9.2. National Initiatives

9.2.1. Inria Project Labs

Arnaud Legrand is the leader of the HAC SPECIS project. The goal of the HAC SPECIS (High-performance Application and Computers: Studying PErformance and Correctness In Simulation) project is to answer methodological needs of HPC application and runtime developers and to allow to study real HPC systems both from the correctness and performance point of view. To this end, we gather experts from the HPC, formal verification and performance evaluation community. Inria Teams: AVALON, POLARIS, MYRIADS, SUMO, HIEPACS, STORM, MEXICO, VERIDIS.

9.2.2. Grenoble INP grant

Patrick Loiseau and Bary Pradelski received a grant from the Presidence of Grenoble INP that covers half of the funding of PhD student Dimitrios Moustakas to work on dynamic matching. This PhD is done in collaboration with Univ. Zurich (Heinrich Nax), which covers the rest.

9.2.3. DGA Grants

Patrick Loiseau and Panayotis Mertikopoulos received a grant from DGA that complements the funding of PhD student (Benjamin Roussillon) to work on game theoretic models for adversarial classification.

9.2.4. PGMO Projects

PGMO projects are supported by the Jacques Hadamard Mathematical Foundation (FMJH). Our project (HEAVY.NET) is focused on congested networks and their asymptotic properties.

9.2.5. PEPS

Panayotis Mertikopoulos is co-PI of a PEPS I3A project: MixedGAN ("Mixed-strategy generative adversarial networks") (PI: R. Laraki, U. Dauphine).

9.2.6. Fondation Blaise Pascal

Project IAM (Informatique à la Main) funded by fondation Blaise Pascal (Jean-Marc Vincent).

9.2.7. MIAI @ Grenoble Alpes

MIAI @ Grenoble Alpes (Multidisciplinary Institute in Artificial Intelligence) is the 3IA institute of Grenoble that was selected by the government in 2019. With the MIAI institute, Patrick Loiseau is the co-holder of a chair on “Explainable and Responsible AI” of which Nicolas Gast and Bary Pradelski are also members; and Panayotis Mertikopoulos is a member of the “Optimization and Learning” chair.

9.2.8. ANR

- Nicolas Gast obtained funding from the ANR JCJC for the project REFINO. 250k euros. Duration: 4 years
- Bary Pradelski (PI), P. Mertikopoulos and P. Loiseau obtained funding from the ANR for the project ALIAS (Adaptive Learning for Interactive Agents and Systems). This is a bilateral PRCI (collaboration internationale) project joint with Singapore University of Technology and Design (SUTD). The Singapore team consists of G. Piliouras and G. Panageas.
- *ORACLESS (2016–2021)*
  ORACLESS is an ANR starting grant (JCJC) coordinated by Panayotis Mertikopoulos. The goal of the project is to develop highly adaptive resource allocation methods for wireless communication networks that are provably capable of adapting to unpredictable changes in the network. In particular, the project will focus on the application of online optimization and online learning methodologies to multi-antenna systems and cognitive radio networks.
- *CONNECTED (2016–2019)*
  CONNECTED is an ANR Tremplin-ERC (T-ERC) grant coordinated by Patrick Loiseau. The goal of the project is to work on several game-theoretic models involving learning agents and data revealed by strategic agents in response to the learning algorithms, so as to derive better learning algorithms for such special data.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. ReDaS

Title: Reproducible Data Science

International Partner (Institution - Laboratory - Researcher):

Universidade Federal do Rio Grande do Sul (Brazil) - Industrial Engineering and Operations Research Departments - Lucas Mello Schnorr

Start year: 2019

See also: https://associatedteam.gitlabpages.inria.fr/redas

Data science builds on a variety of technique and tools that makes analysis often difficult to follow and reproduce. The goal of this project is to develop interactive, reproducible and scalable analysis workflows that provide uncertainty and quality estimators about the analysis.

9.3.1.2. International Initiatives

GENE

Title: Stochastic dynamics of large games and networks

International Partners (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (Argentina) - Matthieu Jonckheere

Universidad de la Republica Uruguay (Uruguay) - Federico La Rocca

CNRS (France) - Balakrishna Prabhu

Universidad ORT Uruguay (Uruguay) - Andrés Ferragut

Duration: 2018 - 2019

Start year: 2018

Through the creation and consolidation of strong research and formation exchanges between Argentina, France and Uruguay, the GENE project will contribute to the fields of performance evaluation and control of communication networks, using tools of game theory, probability theory and control theory. Some of the challenges this project will address are: - Mean-field games and their application to load balancing and resource allocations, - Scaling limits for centralized and decentralized load balancing strategies and implementation of practical policies for web servers farms, - Information diffusion and communication protocols in large and distributed wireless networks.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

We have hosted multiple international scientists for short (typically one-week) visits: Jonathan Newton, Paul Duetting, Jason Marden, Bruno Ziliotto

9.4.2. Visits to International Teams

- V. Danjean spent one week at Porto Allegre (Brasil) at UFRGS, hosted by Lucas M. Schnorr to work on the research subject: Tracing of multi-tasked OpenMP Application.
- A. Legrand spent 10 days at Porto Allegre (Brasil) at UFRGS, hosted by Lucas M. Schnorr to teach scientific methodology and Performance Evaluation and to work on the visual performance analysis of dynamic task-based applications.
- G. Huard visited UFRGS (Porto Alegre, Brasil) in the context of the ReDaS Inria associated team from Nov. 27th to Dec 16th along with Alexis Janon. During this visit we worked with Lucas Schnorr on several application trace analysis cases using our own custom analysis framework and leveraging UFRGS expertise on the design and conduct of practical data analysis.
- B. Pradelski was invited for seminars at several places: IHP Game Theory Seminar, Bar-Ilan University Economic Theory seminar, University of Oxford Game Theory seminar. He is also an associate member of the Oxford Man Institute.

9.4.2.1. Research Stays Abroad

P. Mertikopoulos was invited to spend a three-month research visit at the Ecole Polytechnique Fédérale de Lausanne (EPFL). He was hosted by the LIONS lab (headed by V. Cevher).

PRIVATICS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. 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).

7.1.2. Data Institute

- Title: Data Institute UGA
- Duration: 2017 - .
- Coordinator: TIMC-IMAG.
- Others partners: AGEIS, BIG, CESICE, GIN, GIPSA-lab, IAB, IGE, IPAG, LAPP, LARHRA, LIDILEM, LIG, LISTIC, LITT&ArTS, LJK, LUHCIE, LECA, OSUG, PACTE, TIMC-IMAG
- Abstract: Privatics is leading the WP5 (Data Governance, Data Protection and Privacy). This action (WP5) aims to analyze, in a multi-disciplinary perspective, why and how specific forms of data governance emerge as well as the consequences on the interaction between the state, the market and society. The focus will be on the challenges raised by the collection and use of data for privacy, on the data subjects' rights and on the obligations of data controllers and processors. A Privacy Impact/Risk assessments methodology and software will be proposed. A case study will focus on medical and health data and make recommendations on how they should be collected and processed.

7.1.3. CyberAlps

- Title: CyberAlps
- Duration: 2018 - .
- Coordinator: IF.
- Others partners: CEA LETI, CERAG, CESICE, CREg, G2E lab, GIPSA-lab, GSCOP, IF, LCIS, LIG, LISTIC, LJK, PACTE, TIMC-IMAG, VERIMAG.
- Abstract: The Grenoble Alpes Cybersecurity Institute aims at undertaking ground-breaking interdisciplinary research in order to address cybersecurity and privacy challenges. Our main technical focus is on low-cost secure elements, critical infrastructures, vulnerability analysis and validation of large systems, including practical resilience across the industry and the society. Our approach to cybersecurity is holistic, encompassing technical, legal, law-enforcement, economic, social, diplomatic, military and intelligence-related aspects with strong partnerships with the private sector and robust national and international cooperation with leading institutions in France and abroad.

7.1.4. Antidot

- Title: Antidot
- Type: Fédération Informatique de Lyon (inter laboratories project)
- Duration: September 2018 - 2020.
- Coordinator: Inria.
- Others partners: LIRIS.
- Abstract: The ANTIDOT project is interested in the privacy issues raised by the increasingly ubiquitous collection of mobility data and their exploitation by third-party applications. The objective of this project is to propose solutions and tools to increase the user awareness about the risks of violation of their privacy in the context of the mobile Internet. In order to achieve this objective, ANTIDOT will jointly address the study of information gathering mechanisms, the study of mobility data vulnerabilities and the protection of this personal data.

7.1.5. DARC

- Title: DARC - the Data Anonymization and Re-identification Competition
- Type: Innovation Pédagogique - IDEX LYON
- Duration: September 2019 - 2020.
- Coordinator: INSA.
- Abstract: In order to increase awareness and empower future digital engineers in a fun way on privacy issues, the DARC project offers learning through play through a challenge carried out jointly by three different training courses of INSA students in Bourges and in Lyon. This challenge consists first of all in anonymizing a dataset from an online sales site, then secondly in trying to re-identify the anonymized data of the other groups.

7.2. National Initiatives

7.2.1. ADT PRESERVE

- Title: PRESERVE: Plate-foRme wEb de SEnsibilisation aux pRoblèmes de Vie privéE
- Duration: 2019 - 2020
- Coordinator: INSA.
- Abstract: The goal of this project is to develop a web platform to increase the user awareness on privacy issues. This platform will gather multiple works investigated in the team and will be used to conduct demonstration and stimulate new collaborations and dissemination actions to end users and media.

7.2.2. ANR

7.2.2.1. CISC

Title: Certification of IoT Secure Compilation.

Type: ANR.

Duration: April 2018 - March 2022.

Coordinator: Inria INDES project-team (France)

Others partners: Inria CELTIC project-team (France), College de France (France) (France).

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

Abstract: The objective of the ANR CISC project is to investigate multitier languages and compilers to build secure IoT applications with private communication. A first goal is to extend multitier platforms by a new orchestration language that we call Hiphop.js to synchronize internal and external activities of IoT applications as a whole. CISC will define the language, semantics, attacker models, and policies for the IoT and investigate automatic implementation of privacy and security policies by multitier compilation of IoT applications. To guarantee such applications are correct, and in particular that the required security and privacy properties are achieved, the project will certify them using the Coq proof assistant.

7.2.2.2. SIDES 3.0

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

Type: ANR.

Duration: August 2017 - August 2020.

Coordinator: Uness (France).

Others partners: Inria, UGA, ENS, Theia, Viseo.

Abstract: Since 2013, faculties of medicine have used a shared national platform that enables them to carry out all of their validating exams on tablets with automatic correction. This web platform entitled SIDES allowed the preparation of the medical students to the Computerized National Classing Events (ECN) which were successfully launched in June 2016 (8000 candidates simultaneously throughout France). SIDES 3.0 proposes to upgrade the existing platform. Privatics goals in this project is to ensure that privacy is respected and correctly assessed .

7.2.2.3. DAPCODS/IOTics

Title: DAPCODS/IOTics.

Type: ANR 2016.

Duration: May 2017 - Dec. 2020.

Coordinator: Inria PRIVATICS.

Others partners: Inria DIANA, EURECOM, Univ. Paris Sud, CNIL.

Abstract:

Thanks to the exponential growth of Internet, citizens have become more and more exposed to personal information leakage in their digital lives. This trend began with web tracking when surfing the Internet with our computers. The advent of smartphones, our personal assistants always connected and equipped with many sensors, further reinforced this tendency. And today the craze for "quantified self" wearable devices, for smart home appliances or for other connected devices enable the collection of potentially highly sensitive personal information in domains that were so far out of reach. However, little is known about the actual practices in terms of security, confidentiality, or data exchanges. The enduser is therefore prisoner of a highly asymmetric system. This has important consequences in terms of regulation, sovereignty, and leads to the hegemony of the GAFAs (Google, Amazon, Facebook and Apple). Security, transparency and user control are three key properties that should be followed by all the stakeholders of the smartphone and connected devices ecosystem. Recent scandals show that the reality is sometimes at the opposite.

The DAPCODS project gathers four renowned research teams, experts in security, privacy and digital economy. They are seconded by CNIL, the French data protection agency. The project aims at contributing along several axes:

- by analyzing the inner working of a significant set of connected devices in terms of personal information leaks. This will be made possible by analyzing their data flows (and associated smartphone application if applicable) from outside (smartphone and/or Wifi network) or inside, through ondevice static and dynamic analyses. New analysis methods and tools will be needed, some of them leveraging on previous works when applicable;

- by studying the device manufacturers' privacy policies along several criteria (e.g., accessibility, precision, focus, privacy risks). In a second step, their claims will be compared to the actual device behavior, as observed during the test campaigns. This will enable an accurate and unique ranking of connected devices;
- by understanding the underlying ecosystem, from the economical viewpoint. Data collected will make it possible to define the blurred boundaries of personal information market, a key aspect to set up an efficient regulation;
- and finally, by proposing a public website that will rank those connected devices and will inform citizens. We will then test the impact of this information on the potential change of behavior of stakeholders.

By giving transparent information of hidden behaviors, by highlighting good and bad practices, this project will contribute to reduce the information asymmetry of the system, to give back some control to the endusers, and hopefully to encourage certain stakeholders to change practices.

7.2.3. Inria-CNIL collaboration

Privatics is in charged of the Cnil-Inria collaboration. This collaboration was at the origin of the Mobilitics project and it is now at the source of many discussions and collaborations on data anoymisation, risk analysis, consent or IoT Privacy. Privatics and Cnil are both actively involved on the IoTics project, that is the follow-up of the Mobilitics projects. The goal of the Mobilitics project was to study information leakage in mobile phones. The goal of IoTics is to extend this work to IoT and connected devices.

Privatics is also in charged of the organization of the Cnil-Inria prize that is awarded every year to an outstanding publication in the field of data privacy.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, Except FP7 & H2020

7.3.1.1. UPRISE-IoT

Title: User-centric PRIvacy & Security in IoT

Programm: CHISTERA

Duration: December 2016 - December 2019

Coordinator: SUPSI (Suisse)

Inria contact: Claude Castelluccia

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

7.3.1.2. SPARTA

Title: Strategic Programs for Advanced Research and Technology in Europe (SPARTA)

Programm: H2020-SU-ICT-03-2018

Duration: February 2019 - January 2022

Coordinator: CEA

Inria contact: Thomas Jensen (Inria), Vincent Roca (for PRIVATICS)

SPARTA Cybersecurity European Competence Network. The consortium consists of 44 partners from 14 different countries, with the goal to demonstrate the setup and assessment of a European SPARTA Cybersecurity Competence Network.

7.4. International Initiatives

7.4.1. DATA

Title: Data and Algorithmic Transparency and Accountability

International Partner (Institution - Laboratory - Researcher):

Université du Québec à Montréal (UQAM) (Canada) - Département d'informatique - Sébastien Gambs

Start year: 2018

See also: http://planete.inrialpes.fr/data-associated-team/

The accelerated growth of the Internet has outpaced our abilities as individuals to maintain control of our personal data. The recent advent of personalized services has lead to the massive collection of personal data and the construction of detailed profiles about users. However, users have no information about the data which constitute its profile and how they are exploited by the different entities (Internet companies, telecom operators, ...). This lack of transparency gives rise to ethical issues such as discrimination or unfair processing.

In this associate team, we propose to strengthen the complementary nature and the current collaborations between the Inria Privatics group and UQAM to advance research and understanding on data and the algorithmic transparency and accountability.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Jeremy Decouchant (University of Luxembourg) visited Privatics from 14/10/2019 to 25/10/2019 through the Erasmus Staff Mobility For Teaching program. During the visit, Jeremie Decouchant participated in network programming lectures and practical sessions at the INSA Lyon engineering school at the M1 level. In addition, the existing scientific collaborations with the team have been also extended around the usage of Intel Software Guard Extensions (SGX) to implement a privacy-preserving recommendation systems and genome studies.
- Gergely Acs, assistant professor at Budapest University (Hungary), visited our team in June. He worked together with Claude Castelluccia on the security and privacy of Federated machine learning.
- Rosin Claude Ngueveu (UQAM) visited the team in Lyon in July 2019 for two weeks to increase the DATA collaboration. During the visit, Rosin Claude Ngueveu presented joint work at APVP 2019 and advanced existing collaboration to include fairness in our work on protection of motion sensor data.

ROMA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

ANR Project SOLHARIS (2019-2013), 4 years. The ANR Project SOLHAR was launched in November 2019, for a duration of 48 months. It gathers five academic partners (the HiePACS, ROMA, RealOpt, STORM and TADAAM) Inria project-teams, and CNRS-IRIT) and two industrial partners (CEA/CESTA and Airbus CRT). This project aims at producing scalable methods for direct methods for the solution of sparse linear systems on large scale and heterogeneous computing platforms, based on task-based runtime systems.

The proposed research is organized along three distinct research thrusts. The first objective deals with the development of scalable linear algebra solvers on task-based runtimes. The second one focuses on the deployement of runtime systems on large-scale heterogeneous platforms. The last one is concerned with scheduling these particular applications on a heterogeneous and large-scale environment.

9.2. International Initiatives

9.2.1. Inria International Labs

9.2.1.1. JLESC — Joint Laboratory on Extreme Scale Computing

The University of Illinois at Urbana-Champaign, Inria, the French national computer science institute, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and the Riken Advanced Institute for Computational Science formed the Joint Laboratory on Extreme Scale Computing, a follow-up of the Inria-Illinois Joint Laboratory for Petascale Computing. The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, BSC and JSC. It focuses on software challenges found in extreme scale high-performance computers.

Research areas include:

- Scientific applications (big compute and big data) that are the drivers of the research in the other topics of the joint-laboratory.
- Modeling and optimizing numerical libraries, which are at the heart of many scientific applications.
- Novel programming models and runtime systems, which allow scientific applications to be updated or reimagined to take full advantage of extreme-scale supercomputers.
- Resilience and Fault-tolerance research, which reduces the negative impact when processors, disk drives, or memory fail in supercomputers that have tens or hundreds of thousands of those components.
- I/O and visualization, which are important part of parallel execution for numerical silulations and data analytics
- HPC Clouds, that may execute a portion of the HPC workload in the near future.

Several members of the ROMA team are involved in the JLESC joint lab through their research on scheduling and resilience. Yves Robert is the Inria executive director of JLESC.

9.2.2. Inria International Partners

9.2.2.1. Declared Inria International Partners

- Anne Benoit, Frederic Vivien and Yves Robert have a regular collaboration with Henri Casanova from Hawaii University (USA). This is a follow-on of the Inria Associate team that ended in 2014.

9.2.3. 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 four 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. Anne Benoit and Mingsong Chen have lead a JORISS project on scheduling and resilience in cloud computing. Frédéric Vivien and Jing Liu (ECNU) are leading a JORISS project on resilience for real-time applications. In the context of this collaboration two students from ECNU, Li Han and Changjiang Gou, have joined Roma for their PhD.

9.3. International Research Visitors

9.3.1. Visits to International Teams

9.3.1.1. 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 since 2011. He collaborates with several ICL researchers on high-performance linear algebra and resilience methods at scale.

SOCRATE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Insa-Spie IoT Chair

The Insa-Spie IoT Chair http://www.citi-lab.fr/chairs/iot-chair/ relies on the expertise of the CITI Lab. The skills developed within the different teams of the lab integrate the study, modelling, conception and evaluation of technologies for communicating objects and dedicated network architectures. It deals with network, telecom and software matters as well as societal issues such as privacy. The chair will also lean on the skills developed at INSA Lyon or in IMU LabEx.

7.1.2. Inria Project Lab: ZEP

The ZEP project addresses the issue of designing tiny computing objects with no battery by combining non-volatile memory (NVRAM), energy harvesting, micro-architecture innovations, compiler optimizations, and static analysis. The main application target is Internet of Things (IoT) where small communicating objects will be composed of this computing part associated to a low-power wake-up radio system. The ZEP project gathers four Inria teams that have a scientific background in architecture, compilation, operating system and low power together with the CEA Lialp and Lisan laboratories of CEA LETI & LIST. The major outcomes of the project will be a prototype harvesting board including NVRAM and the design of a new microprocessor associated with its optimizing compiler and operating system.

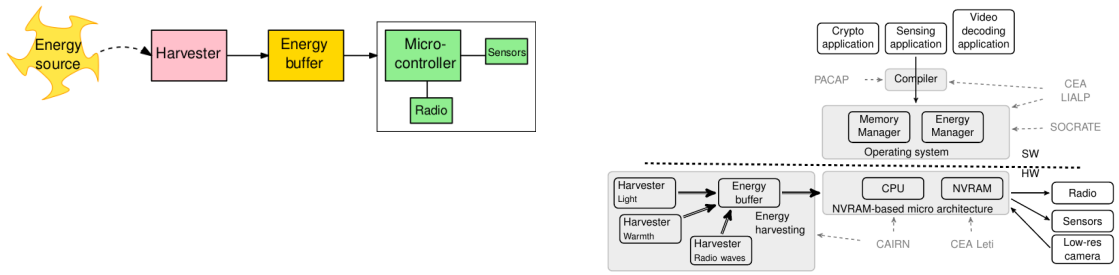

Figure 5. Example of system targeted by the ZEP project on the left, and on the right: the ZEP research program.

The scientific work (in progress) is organized around three fields :

- specific NVRAM-based architecture
- dedicated compiler pass that computes a worst-case energy consumption
- operating system managing NVRAM and energy, ensuring memory consistency across power outages

The project is illustrated by the figure 5 , where PACAP, SOCRATE, CORSE, and CAIRN are the teams involved in the project.

Another important goal of the project is to structure the research and innovation that should occur within Inria to prepare the important technological shift brought by NVRAM technologies.

7.1.3. ANR - Imprenum

The objective of this project (INSA-Lyon, École Normale Supérieure de Lyon, CEA LETI) is to promote **accuracy as a first class concern** in all the levels of a computing system:

- at the hardware level, with better support for lower-than-standard and higher-than-standard precisions;
- at the level of run-time support software, in particular answering the memory management challenges entailed by adaptive precision;
- at the lower level of mathematical libraries (kernel level), for instance BLAS for linear algebra, enhancing well established libraries with precision and accuracy control;
- at the higher level of mathematical libraries (solver level, including algebraic linear solvers such as LAPACK, ad hoc steppers for Ordinary Differential Equation, eigenvalues kernels, triangularization problems for computational geometry, etc.) Here, accuracy and precision control of the lower levels should enable higher-level properties such as convergence and stability;
- at the compiler level, enhancing optimising compilers with novel optimisations related to precision and accuracy;
- at the language level, embedding accuracy specification and control in existing languages, and possibly defining domain-specific languages with accuracy-aware semantics for some classes of applications.

7.1.4. ADT SytaRiot

The Riot system (https://www.riot-os.org/) is well known within Inria, it is a joint implementation of Inria and Freie Universität Berlin which is today one of the most widely used open-source OS on small embedded systems. The arrival of non-volatile memories promises a new generation of sensors on which the memory hierarchy will be more heterogeneous than today. The communicating system will be able to undergo a power cut em complete and resume its current activity when power returns.

Sytare (https://gitlab.inria.fr/citi-lab/sytare/), developed for three years by the Socrates team (with the support of an ADT), targets intermittent feeding which will arrive when the technologies of *harvesting* (recovery of ambient energy) are democratized.

The objective of this ADT is to make Riot compatible with NVRAM-based architecture, therefore to integrate Sytare with Riot and thus open Riot to ultra low power platforms containing NVRAM, *eg* Texas microcontrollers Instrument MSP430FR5969.

7.1.5. Digital Hardware AI Architectures

Florent de Dinechin participates to the chair *Digital Hardware AI Architectures* held by Prof. Frédéric Pétrot at the Multidisciplinary Institute in Artificial Intelligence (MIAI) of Grenoble. The other participants are François Duhem (Spintec/CEA) and Fabrice Rastello (LIG/Inria), with industrial partners Google France, Kalray, STMicroelectronics, and Upmem.

This chair funds the PhD of Maxime Christ, which studies how very low-precision arithmetic formats may improve the efficiency of the learning phase of neural networks.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, Except FP7 & H2020

Socrate is very active in COST IRACON CA15104: Guillaume Villemaud is National Delegate (Alt.) and FIT/CorteXlab is identify as one of the COST platform.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

Socrate has collaborations with the following international partners.

- **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.
- **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.
- **Technical University "Gh. Asachi" of Iasi, Romania**, Department of Electronics, Telecommunications and Information Technology. This recent collaboration has started on topics related on the theoretical aspects of the ultra-low power radio communications. Scientific-in-charge at Inria: Florin Hutu
- **Technical University of Fulda, Germany**. This collaboration with the group of Martin Kumm covers many aspects of computer arithmetic, with several joint papers, collaboration on the FloPoCo project, and work in progress on a textbook to appear in 2020. Scientific-in-charge at Inria: Florent de Dinechin
- **Imperial College, London, UK**, departments of Computing and Electrical Engineering. This collaboration with the groups of David Thomas and George Constantinides covers several aspects of reconfigurable computing and reconfigurable arithmetic. Scientific-in-charge at Inria: Florent de Dinechin

SPADES Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CASERM (Persyval-Lab project)

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

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

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

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

The CASERM consortium gathers researchers from the LIG and VERIMAG laboratories who are reknowned specialists in these fields. The project started in November 2016 and was completed in November 2019.

8.1.2. SEC: Construction of Safe Explainable Cyber-physical systems

Participants: Gregor Goessler, Thomas Mari.

In cyber-physical systems (CPS), software interacts with physical processes so as achieve desired functionalities. CPS are usually subject to safety and reliability requirements. Depending on the application, their failure may have unacceptable consequences, it is therefore crucial to ensure their correctness at design time. In addition, explainability of increasingly autonomous CPS is becoming crucial in order for the CPS to be socially acceptable.

The goal of this project is twofold. First, we will investigate a contract-based design approach for safe CPS in which different aspects – such as functional requirements, real-time constraints, and continuous behaviors – are modeled and verified separately. Second, we will leverage the contracts in order to ensure explainability of the system behavior by construction. By explainability we understand, informally, that for any behavior of the system we can automatically construct, from a log generated by the execution, an excerpt that retains only the events that causally contributed to the outcome, and that is easy to understand by a human expert.

The SEC project is supported by the "Initiatives de Recherche Stratégiques (IRS)" program of the IDEX UGA. It funds the PhD thesis of Thomas Mari, who will be co-advised by Gregor Gössler and Thao Dang (VERIMAG).

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. RT-proofs

Participants: Pascal Fradet, Xiaojie Guo, Maxime Lesourd, Sophie Quinton.

RT-proofs is an ANR/DFG project between Inria, MPI-SWS, Onera, TU Braunschweig and Verimag, running from 2018 until 2022.

The overall objective of the RT-proofs project is to lay the foundations for computer-assisted formal verification of timing analysis results. More precisely, the goal is to provide:

1. a strong formal basis for schedulability, blocking, and response-time analysis supported by the Coq proof assistant, that is as generic, robust, and modular as possible;
2. correctness proofs for new and well-established generalized response-time analysis results, and a better, precise understanding of the role played by key assumptions and formal connections between competing analysis techniques;
3. an approach for the generation of proof certificates so that analysis results – in contrast to analysis tools – can be certified.

The results obtained in 2019 in connection with the RT-proofs project are described in Section 6.2.4 .

8.2.1.2. DCore

Participants: Gregor Goessler, Jean-Bernard Stefani.

DCORE is an ANR project between Inria project teams ANTIQUE, FOCUS and SPADES, and the IRIF lab, running from 2019 to 2023.

The overall objective of the project is to develop a semantically well-founded, novel form of concurrent debugging, which we call *causal debugging*, that aims to alleviate the deficiencies of current debugging techniques for large concurrent software systems. The causal debugging technology developed by DCORE will comprise and integrate two main novel engines:

1. *a reversible execution engine* that allows programmers to backtrack and replay a concurrent or distributed program execution, in a way that is both precise and efficient (only the exact threads involved by a return to a target anterior or posterior program state are impacted);
2. a *causal analysis engine* that allows programmers to analyze concurrent executions, by asking questions of the form "what caused the violation of this program property?", and that allows for the precise and efficient investigation of past and potential program executions.

8.2.2. Institute of Technology (IRT)

8.2.2.1. CAPHCA

Participants: Alain Girault, Nicolas Hili.

CAPHCA is a project within the Antoine de Saint Exupéry IRT in Toulouse. The general objective of the project is to provide methods and tools to achieve both performance and determinism on modern, high-performance, multi-core and FPGA-enabled SOCs. Our specific contribution lies withing work packages dedicated to the design of novel PRET architectures and programming languages (see Section 6.2.1). This contract has yielded two publications so far [17], [16].

8.3. European Initiatives

8.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: Celtic-Plus

Project acronym: SENDATE

Project title: Secure Networking for a Data center cloud in Europe

Duration: April 2016 - March 2019

Coordinator: Nokia France

Other partners: Nokia, Orange, IMT, Inria

Abstract: The SENDATE project aims to develop a clean-slate architecture for converged telecommunications networks and distributed data centers supporting 5G cellular networks and the needs from the Industrial Internet and the Internet of Things. It aims to provide scientific and technical solutions for intra and inter data centrers security, control, management and orchestration, placement and management of virtual network functions, as well as high-speed transport networks for data centers access and interconnection.

8.3.2. Collaborations with Major European Organizations

We have a strong collaboration with the Technische Universität Braunschweig in Germany and the MPI-SWS in Kaiserslautern (Germany) on formal proofs for the analysis real-time systems. This collaboration is formalized by the ANR-PRCI project called RT-proofs started in 2018, which involves MPI-SWS, TU Braunschweig, Inria, and Onera.

8.4. International Initiatives

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

8.4.1.1. Quasar

Title: Quantitative systems formal verification

International Partner (Institution - Laboratory - Researcher):

CAS (China) - Department of Informatics - Lijun Zhang

Start year: 2019

The general scientific objectives are to extend formal analysis and verification methods such as model checking, process algebra and interactive theorem proving (Coq) to quantitative systems, more specifically probabilistic and quantum computing systems. Application fields include compositional modeling for dynamic real-time probabilistic software architectures and risk analysis. The collaboration will involve active scientists on all these fields not only from Inria and Inst Soft. CAS, but also from CWI, Verimag Grenoble, ECNU Shanghai, and partners of CWI (VU Amsterdam and Twente).

STEEP Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. QAMECS / MOBIL'AIR : ATMOSPHERIC POLLUTION: Characterization of novel exposure markers, of biological, health, economic and societal impacts and evaluation of public policies

Project funded by ADEME, Grenoble metropolis, IDEX Université Grenoble Alpes
Duration: 2016–2022
Project coordinator: Remy Slama (INSERM) and Sandrine Mathy (GAEL, CNRS). Inria Coordinator: Emmanuel Prados
Other partners: Air Rhône-Alpes, CNRS, Sciences Po Grenoble, Inserm, IAB, Université Grenoble-Alpes
Abstract: Urban atmospheric pollution is one of the main threats to human health that can be to some extent controlled by public action. In Europe, many cities have implemented various types of low emission zones (LEZ, focused on traffic and heating emissions), France being a notable exception. Although fine particulate matter (PM2.5) is usually assessed through its mass concentration, other metrics, such as PM chemical speciation as well as the so far little considered oxidative potential (OP) of PM, are worth considering, both in terms of associations with human health and in the context of monitoring of the efficiency of LEZ. QAMECS covers all dimensions from atmospheric emissions, impact of meteorological conditions on air pollution human behaviours related to transportation, environmental levels, health, associated economic costs and societal awareness. The project relies on environmental measurements, modelling, repeated observational (representative) population studies, an existing mother-child cohort, a controlled human experiment, health impact and related economic assessment. It is conducted by a consortium of specialists of chemistry and physics of air pollution, economics, sociology, epidemiology, geography, in relation with local authorities. It will bring results important for urban planning, public health, and more fundamental research on the measurement of PM and assessment of their biological and health impact.

8.2. National Initiatives

8.2.1. AF Filières : Analyse des Flux des Filières biomasse pour des stratégies régionales de bioéconomie

Project funded by ADEME
Duration: 2017-2019
Coordinator: Jean-Yves COURTONNE (Equipe STEEP, Inria) [Emmanuel Prados (STEEP/Inria) for Inria partner]
Other partners: Equipe STEEP, Inria, Grenoble Rhônalpénergie-Environnement (RAEE), Lyon Laboratoire d'Economie Forestière (LEF), INRA / AgroParisTech Nancy.
Keywords: Environmental assessment, Ecological accounting, Material Flow Analysis, Sustainable supply chains, Multicriteria analysis.
Abstract: Flow analyses of biomass supply chains for regional bioeconomy policies. The goals of the project are the following:

- Improve knowledge on the material flows of the forest-wood and agri-food supply chains in France at national and regional levels,
- Provide a holistic vision of the situation by associating environmental and socio-economic indicators to material flows,
- Provide a more precise assessments (quantitatively and qualitatively) in the case of the Auvergne-Rhône-Alpes region.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

University of Lausanne (UNIL), Department of Ecology and Evolution (Jérôme Gippet): development of the MoRIS model of propagation of invasive species.

8.3.2. Participation in Other International Programs

Pierre-Yves Longaretti is involved in TARA (Transition adaptation research alliance); he animated the theme *Operationalizing reflexive sustainability* at the TARA Workshop in Bogor, Indonesia, November 2019.

THOTH Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MIAI chair - Towards more data efficiency in machine learning

Participants: Julien Mairal, Karteek Alahari, Jakob Verbeek.

Julien Mairal holds a chair of the 3IA MIAI institute. The goal is to improve the data efficiency of machine learning algorithms.

9.1.2. MIAI chair - Towards self-supervised visual learning

Participant: Cordelia Schmid.

Cordelia Schmid holds a chair of the 3IA MIAI institute. The goal is to develop new self-supervised learning methods for computer vision.

9.1.3. MIAI chair - Multiscale, multimodal and multitemporal remote sensing

Participant: Jocelyn Chanussot.

Jocelyn Chanussot holds a chair of the 3IA MIAI institute.

9.1.4. DeCore (Deep Convolutional and Recurrent networks for image, speech, and text)

Participants: Jakob Verbeek, Maha Elbayad.

DeCore is a project-team funded by the Persyval Lab for 3.5 years (september 2016 - February 2020), coordinated by Jakob Verbeek. It unites experts from Grenoble's applied-math and computer science labs LJK, GIPSA-LAB and LIG in the areas of computer vision, machine learning, speech, natural language processing, and information retrieval. The purpose of DeCore is to stimulate collaborative interdisciplinary research on deep learning in the Grenoble area, which is likely to underpin future advances in machine perception (vision, speech, text) over the next decade. It provides funding for two full PhD students. Maha Elbayad is one of them, supervised by Jakob Verbeek and Laurant Besacier (LIG, UGA).

9.1.5. PEPS AMIES AuMalis POLLEN

Participant: Karteek Alahari.

This is a collaborative project with POLLEN, a startup in the Grenoble area, which develops POLLEN Metrology, a software editor specialized in signal processing, hybrid metrology and machine learning for the automatic processing of heterogeneous data. This funding supports a postdoc to accelerate the introduction of artificial intelligence, and in particular computer vision, techniques, into the manufacture of new generation of microprocessors. Karteek Alahari and Valerie Perrier (LJK, UGA) jointly supervise a postdoc as part of this collaboration. This collaboration ended in 2019.

9.2. National Initiatives

9.2.1. ANR Project Macaron

Participants: Julien Mairal, Zaid Harchaoui [Univ. Washington], Laurent Jacob [CNRS, LBBE Laboratory], Michael Blum [CNRS, TIMC Laboratory], Joseph Salmon [Telecom ParisTech], Mikita Dvornik, Daan Wynen.

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 4 years and half project, funded by ANR under the program "Jeunes chercheurs, jeunes chercheuses", which started in October 2014 and ended in March 2019. The principal investigator is Julien Mairal.

9.2.2. ANR Project DeepInFrance

Participants: Jakob Verbeek, Adria Ruiz Ovejero.

DeepInFrance (Machine learning with deep neural networks) project also aims at bringing together complementary machine learning, computer vision and machine listening research groups working on deep learning with GPUs in order to provide the community with the knowledge, the visibility and the tools that brings France among the key players in deep learning. The long-term vision of Deep in France is to open new frontiers and foster research towards algorithms capable of discovering sense in data in an automatic manner, a stepping stone before the more ambitious far-end goal of machine reasoning. The project partners are: INSA Rouen, Univ. Caen, Inria, UPMC, Aix-Marseille Univ., Univ. Nice Sophia Antipolis.

9.2.3. ANR Project AVENUE

Participant: Karteek Alahari.

This ANR project (started in October 2018) aims to address the perception gap between human and artificial visual systems through a visual memory network for human-like interpretation of scenes. To this end, we address three scientific challenges. The first is to learn a network representation of image, video and text data collections, to leverage their inherent diverse cues. The second is to depart from supervised learning paradigms, without compromising on the performance. The third one is to perform inference with the learnt network, e.g., to estimate physical and functional properties of objects, or give cautionary advice for navigating a scene. The principal investigator is Karteek Alahari, and the project involves participants from CentraleSupelec and Ecole des Ponts in Paris.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERC Advanced grant Allegro

Participants: Cordelia Schmid, Konstantin Shmelkov, Vladyslav Sydorov, Daan Wynen, Nikita Dvornik, Xavier Martin.

The ERC advanced grant ALLEGRO started in April 2013 and will end in April 2019. The aim of ALLEGRO is to automatically learn from large quantities of data with weak labels. A massive and ever growing amount of digital image and video content is available today. It often comes with additional information, such as text, audio or other meta-data, that forms a rather sparse and noisy, yet rich and diverse source of annotation, ideally suited to emerging weakly supervised and active machine learning technology. The ALLEGRO project will take visual recognition to the next level by using this largely untapped source of data to automatically learn visual models. We will develop approaches capable of autonomously exploring evolving data collections, selecting the relevant information, and determining the visual models most appropriate for different object, scene, and activity categories. An emphasis will be put on learning visual models from video, a particularly rich source of information, and on the representation of human activities, one of today's most challenging problems in computer vision.

9.3.1.2. ERC Starting grant Solaris

Participants: Julien Mairal, Ghislain Durif, Andrei Kulunchakov, Alberto Bietti, Dexiong Chen, Gregoire Mialon.

The project SOLARIS started in March 2017 for a duration of five years. The goal of the project is to set up methodological and theoretical foundations of deep learning models, in the context of large-scale data processing. The main applications of the tools developed in this project are for processing visual data, such as videos, but also structured data produced in experimental sciences, such as biological sequences.

The main paradigm used in the project is that of kernel methods and consist of building functional spaces where deep learning models live. By doing so, we want to derive theoretical properties of deep learning models that may explain their success, and also obtain new tools with better stability properties. Another work package of the project is focused on large-scale optimization, which is a key to obtain fast learning algorithms.

9.4. International Initiatives

9.4.1. Inria International Labs

Inria@EastCoast

Associate Team involved in the International Lab:

9.4.1.1. GAYA

Title: Semantic and Geometric Models for Video Interpretation

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Machine Learning Department - Katerina Fragkiadaki

Start year: 2019

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

We propose to renew the associate team GAYA, with the primary goal of interpreting videos in terms of recognizing actions, understanding the human-human and human-object interactions. In the first three years, the team has started addressing the problem of learning an efficient and robust video representation to attack this challenge. GAYA will now focus on building semantic models, wherein we learn incremental, joint audio-visual models, with limited supervision, and also geometric models, where we study the geometric properties of object shapes to better recognize them. The team consists of researchers from two Inria project-teams (Thoth and WILLOW), a US university (Carnegie Mellon University [CMU]) as the main partner team, and another US university (UC Berkeley) as a secondary partner. It will allow the partners to effectively combine their respective strengths in areas such as inference and machine learning approaches for vision tasks, joint audio-visual models, large-scale learning, geometric reasoning. The main expected outcomes of this collaboration are: new machine learning algorithms for handling minimally annotated multi-modal data, large-scale public datasets for benchmarking, theoretical analysis of objects shapes and contours. This associate team originally started in 2016, and was extended in 2019 for another 3 years.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- **MPI Tübingen:** Cordelia Schmid collaborates with Michael Black, a research director at MPI, starting in 2013. End of 2015 she was award a Humbolt research award funding a long-term research project with colleagues at MPI. In 2019, the project resulted in the development of an approach for object interaction [20].

9.4.3. Participation in Other International Programs

- **Indo-French project EVEREST** with IIIT Hyderabad, India, funded by CEFIPRA (Centre Franco-Indien pour la Promotion de la Recherche Avancee). The aim of this project between Cordelia Schmid, Karteek Alahari and C. V. Jawahar (IIIT Hyderabad) is to enable the use of rich, complex models that are required to address the challenges of high-level computer vision. The work plan for the project will follow three directions. First, we will develop a learning framework that can handle weak annotations. Second, we will build formulations to solve the non-convex optimization problem resulting from the learning framework. Third, we will develop efficient and accurate energy minimization algorithms, in order to make the optimization computationally feasible.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

- Pia Bideau (PhD Student, Univ. Massachusetts Amherst) was an intern in the team until Jan 2019.
- Avijit Dasgupta (PhD Student, IIIT Hyderabad, India) was an intern in the team from Feb to May 2019.
- Gunnar Sigurdsson (PhD student, CMU) was an intern in the team from Jan to Mar 2019.

TRIPOP Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The SMART PROTECT project (2019–2022) is a R&D booster project granted by the Région Auvergne Rhône–Alpes. The project is coordinated by Géolithe Innov, a French company specialized in the innovation in Geotechnics. The partners are Géolithe, Irstea and Myotis. The aim of the project is to design and validate a new type of protection structures against rockfall and avalanches. The role of the TRIPOP team is to propose a numerical modeling of the structure and to improve the link between simulations and wireless sensors, which will equip the structure.

8.2. National Initiatives

8.2.1. ANR project Digitslid

B. Brogliato coordinates the ANR project Digitslid (PRC, ANR-18-CE40-0008-01), Differentiateurs et commandes homogenes par modes glissants en temps discret: l'approche implicite. Partners: LS2N (Ecole Centrale de Nantes), Inria Lille Nord Europe (team Non-A-Post), and Tripop. October 2018-September 2021. 12 participants overall (3 post-doc students recruited by the project, 3 Ph.D. students supported by other means). Total financial support by the ANR: 338 362 euros (100 762 for Tripop, 18 months of post-doc to be recruited in 2019).

8.2.2. FUI Modeliscale.

https://team.inria.fr/modeliscale/

The ModeliScale FUI focuses on the modeling, simulation and analysis of large cyber-physical systems. It federates the research activities of several teams, covering a broad spectrum of topics, namely hybrid systems modeling & verification, numerical analysis, programming language design and automatic control. Our research agenda includes the following tracks:

- New compilation techniques for Modelica modelers: structural analysis of multimode DAE (Differential Algebraic Equations) systems, modular compilation, combining state-machines and non-smooth dynamical systems (complementarity dynamical systems and Filippov differential inclusions), contract-based specification of cyber-physical systems requirements, requirements capture using under-/over-determined DAE systems.
- Simulation of large cyber-physical systems: distributed simulation, discretization methods for non-smooth dynamical systems, space-/time-adaptive discretization methods for multimode DAE systems, quantized state solvers (QSS).
- Guaranteed numerics: guaranteed simulation of non-smooth and hybrid dynamical systems, numerical methods preserving invariant properties of hybrid systems, contract-based reasoning methods.

8.2.3. Inria Project Lab (IPL): ModeliScale, Languages and Compilation for Cyber-Physical System Design

https://team.inria.fr/modeliscale/

The project gathers researchers from three Inria teams, and from three other research labs in Grenoble and Paris area.

Table 1. Member of IPL Modeliscale

Name	Team	Inria Center or Laboratory
Vincent Acary	Bipop	Inria Grenoble Rhône Alpes
Bernard Brogliato		
Albert Benveniste	Hycomes Inria Rennes	
Benoît Caillaud		Bretagne Atlantique
Khalil Ghorbal		
Marc Pouzet	Parkas	ENS
Tim Bourke		Inria Paris
Goran Frehse	Tempo	Verimag-univ. Grenoble Alpes
Antoine Girard		L2S-CNRS, Saclay
Eric Goubault	Cosynus	LIX, École Polytechnique,
Sylvie Putot		Saclay

The main objective of ModeliScale is to advance modeling technologies (languages, compile-time analyses, simulation techniques) for CPS combining physical interactions, communication layers and software components. We believe that mastering CPS comprising thousands to millions of components requires radical changes of paradigms. For instance, modeling techniques must be revised, especially when physics is involved. Modeling languages must be enhanced to cope with larger models. This can only be done by combining new compilation techniques (to master the structural complexity of models) with new mathematical tools (new numerical methods, in particular).

ModeliScale gathers a broad scope of experts in programming language design and compilation (reactive synchronous programming), numerical solvers (nonsmooth dynamical systems) and hybrid systems modeling and analysis (guaranteed simulation, verification). The research program is carried out in close cooperation with the Modelica community as well as industrial partners, namely, Dassault Systèmes as a Modelica/FMI tool vendor, and EDF and Engie as end users.

TYREX Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

BioQurate

Title: Querying and Curating Hierarchies of Biological Graphs

Funding: Fédération Informatique de Lyon (FIL)

Duration: 2018-2020

Coordinator: Angela Bonifati

Others partners: LIP/LIRIS. The project involves a bio-computing team and a database team on a common research problem

Abstract: This project aims at leveraging graph rewriting techniques of ReGraph and graph data management techniques in order to provide a persistent, robust and scalable substrate for the construction and manipulation of hierarchies of biological graphs. Moreover, we wish to investigate whether the involved graphs need further expressive graph constraints for enforcing consistency and performing data cleansing.

7.2. National Initiatives

7.2.1. ANR

CLEAR

Title: Compilation of intermediate Languages into Efficient big dAta Runtimes

Call: Appel à projets générique 2016 défi 'Société de l'information et de la communication' – JCJC

Duration: January 2017 – September 2021

Coordinator: Pierre Genevès

See also: http://tyrex.inria.fr/clear

Abstract: This project addresses one fundamental challenge of our time: the construction of effective programming models and compilation techniques for the correct and efficient exploitation of big and linked data. We study high-level specifications of pipelines of data transformations and extraction for producing valuable knowledge from rich and heterogeneous data. We investigate how to synthesize code which is correct and optimized for execution on distributed infrastructures.

DataCert

Title: Coq deep specification of security aware data integration

Call: Appel à projets Sciences et technologies pour la confiance et la sécurité numérique

Duration: January 2016 – January 2020

Participant: Angela Bonifati

Others partners: Université Paris Sud/Laboratoire de Recherche en Informatique, Université de Lille/Centre de Recherche en Informatique, Signal et Automatique de Lille, Université de Lyon/Laboratoire d'InfoRmatique en Image et Systèmes d'information.

See also: http://datacert.lri.fr/

Abstract: This project's aim is to develop a comprehensive framework handling the fundamental problems underlying security-aware data integration and sharing, resulting in a paradigm shift in the design and implementation of security-aware data integration systems. To fill the gap between both worlds, we strongly rely on deep specifications and proven-correct software, develop formal models yielding highly reliable technology while controlling the disclosure of private or confidential information.

QualiHealth

Title: Enhancing the Quality of Health Data

Call: Appel à projets Projets de Recherche Collaborative – Entreprise (PRCE)

Duration: 2018-2022

Coordinator: Angela Bonifati

Others partners: LIMOS, Université Clermont Auvergne. LIS, Université d'Aix-Marseille. HEGP, INSERM, Paris. Inst. Cochin, INSERM, Paris. Gnubila, Argonay. The University of British Columbia, Vancouver (Canada)

Abstract: This research project is geared towards a system capable of capturing and formalizing the knowledge of data quality from domain experts, enriching the available data with this knowledge and thus exploiting this knowledge in the subsequent quality-aware medical research studies. We expect a quality-certified collection of medical and biological datasets, on which quality-certified analytical queries can be formulated. We envision the conception and implementation of a quality-aware query engine with query enrichment and answering capabilities.

To reach this ambitious objectives, the following concrete scientific goals must be fulfilled : (1) An innovative research approach, that starts from concrete datasets and expert practices and knowledge to reach formal models and theoretical solutions, will be employed to elicit innovative quality dimensions and to identify, formalize, verify and finally construct quality indicators able to capture the variety and complexity of medical data; those indicators have to be composed, normalized and aggregated when queries involve data with different granularities (e.g., accuracy indications on pieces of information at the patient level have to be composed when one queries cohort) and of different quality dimensions (e.g., mixing incomplete and inaccurate data); and (2) In turn, those complex aggregated indicators have to be used to provide new quality-driven query answering, refinement, enrichment and data analytics techniques. A key novelty of this project is the handling of data which are not rectified on the original database but sanitized in a query-driven fashion: queries will be modified, rewritten and extended to integrate quality parameters in a flexible and automatic way.