



RESEARCH CENTER

FIELD

Activity Report 2017

Section Partnerships and Cooperations

Edition: 2018-02-19

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ABS Project-Team (section vide)

ACUMES Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Collaboration with Venturi group

In the context of UCA partnerships, a collaboration with Venturi group has been initiated by R. Duvigneau and A. Habbal, concerning the aerodynamic optimization of a Formula-E vehicle and the multi-disciplinary modeling of an electric polar vehicle. This collaboration funded two internships (N. Abettan and A. Guinestre).

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. TramOpt

Title: A Traffic Management Optimization platform for enhanced road network efficiency

Programm: H2020

Duration: Mai 2017 - Octobre 2018

Coordinator: Inria

Inria contact: Paola Goatin

Building on the advances of the ERC TRAM3 project, the TRAMOPT PoC project aims are twofold:

- developing a robust prototype to allow real-life testing and deployment of a novel traffic control Decision Support System (DSS) based on a software platform for road traffic management including variable speed limits, ramp-metering and re-routing policies. This DSS is intended for public and private traffic managers to increase freeway network performances (e.g. congestion and pollution reduction);
- assessing the exploitation perspectives through a dedicated market study evaluating the added value of TRAMOPT over existing solutions and identifying the best business approach to foster uptake and commercialization of our technology.

7.3. International Initiatives

7.3.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

7.3.1.1. ORESTE

Title: Optimal RERoute Strategies for Traffic managEment

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science (EECS) (EECS) - Alexandre M. Bayen

Start year: 2015

See also: <http://www-sop.inria.fr/members/Paola.Goatin/ORESTE/index.html>

This project focuses on traffic flow modeling and optimal management on road networks. Based on the results obtained during the first three years, we aim at further develop a unified macroscopic approach for traffic monitoring, prediction and control. In particular, we aim at investigating user equilibrium inference and Lagrangian controls actuations using macroscopic models consisting of conservation laws or Hamilton-Jacobi equations.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

- University of Brescia, Information Engineering (R.M. Colombo: <http://rinaldo.unibs.it/>)
- University of Mannheim, Scientific Computing Research Group (SCICOM) (S. Göttlich: <http://lpwima.math.uni-mannheim.de/de/team/prof-dr-simone-goettlich/>)
- University of Rutgers - Camden, Department of Mathematical Science (B. Piccoli: <https://piccoli.camden.rutgers.edu/>)

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- A. Borzi (August 2017, Univ. Wurzburg) : Existence of Nash equilibria for deterministic and stochastic differential games.
- S. Roy (September 2017, Univ. Wurzburg) : Fokker-Planck constrained Nash games and Infinite Dimensional Hamilton-Jacobi equations.
- T. Liard (September 2017, Rutgers University - Camden): well-posedness of traffic control problems by autonomous vehicles.
- A. Keimer (October 2017, UC Berkeley): modeling and well-posedness study for Dynamic Traffic Assignment.

7.4.1.1. Internships

- G. Piacentini (March-July 2017, University of Pavia): traffic control by autonomous vehicles..

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

- N. Laurent-BROUTY visited UC Berkeley for 1 month in May 2017

AGORA Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **Labex IMU UrPolSens 10/2015-10/2018**
Participants: Amjed Belkhiri, Ahmed Boubrima, Leo Le Taro, Walid Bechkit, Hervé Rivano
The partners in this project are Ifsttar, LMFA, EVS, TUBA, and Air Rhone-Alpes, with Inria Agora leading the project. UrPolSens deals with the monitoring of air pollution using low-cost sensors interconnected by a wireless networks. Although they are less accurate than the high-end sensors used today, low-cost autonomous air quality sensors allow to achieve a denser spatial granularity and, hopefully, a better monitoring of air pollution. The main objectives of this project are to improve the modeling of air pollution dispersion; propose efficient models to optimize the deployment the sensors while considering the pollution dispersion and the impact of urban environment on communications; deploy a small-scale network for pollution monitoring as a proof of concept; compare the measured and estimated levels of exposure; study the spatial disparities in exposure between urban areas.
- **ARC6 “Robot fleet mobility under communication constraints” 10/2016-09/2019**
Participants: Fabrice Valois
This work is a joint project with the Inria Chroma research group. Considering a fleet of drones moving in a 3D area, looking for a given target, we focus on how to maintain the wireless connectivity of the network of drones while the drones patrol autonomously. The other partners in this project are University of Grenoble and Viameca.
- **Labex IMU Veleval 10/2017-10/2019**
Participants: Hervé Rivano
This pluridisciplinary project is leaded by the LAET and gathers researchers from EVS, LIRIS, LLSETI and CITI. The goal 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 informations 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 ABCD 10/2013-04/2017.**
Participants: Razvan Stanica
The partners in the ANR ABCD project are: Orange Labs, Ucopia, Inria Agora, UPMC LIP6 PHARE, Telecom ParisTech. The objective of ABCD is to characterize large-scale user mobility and content consumption in urban areas via mobile data mining, so as to achieve efficient deployment and management of cloud resources via virtual machines. Our contribution in the project consists on the characterization of human mobility and service consumption at a city scale, and the design of appropriate resource allocation techniques at the cellular network level.
- **ANR IDEFIX 10/2013-04/2017.**
Participants: Soukaina Cherkaoui, Hervé Rivano, Fabrice Valois
The partners in the ANR IDEFIX project are: Orange Labs, Alcatel Lucent - Bell Labs, Telecom Paris Tech, Inria Agora, Socrate and Dyogene.

9.2.2. DGA

- **DGA CLOTHO 10/2016-03/2018.**
Participants: Junaid Khan, Romain Pujol, Razvan Stanica, Fabrice Valois
The partners in the DGA CLOTHO project are Traqueur and Sigfox. The objective of the project is to reduce the energy consumption of the device tracking functionality, by taking profit of short-range communications between the tracked objects.

9.2.3. PIA

- **PIA ADAGE 07/2016-06/2018.**
Participants: Elli Zavou, Razvan Stanica
The partners in the PIA ADAGE project are Orange, LAAS-CNRS and Inria Privatics. The objective of the ADAGE project is to design and evaluate anonymization algorithms for the specific case of mobile traffic data. Our role in the project is focused on evaluating whether the anonymized data is still usable for adaptive networking mechanisms.

9.2.4. Pôle ResCom

- Ongoing participation (since 2006)
Communication networks, working groups of GDR ASR/RSD, CNRS (<http://rescom.inrialpes.fr>).
Hervé Rivano is member of the scientific committee of ResCom.

9.2.5. EquipEx

- **SenseCity**
We have coordinated the participation of several Inria teams to the SenseCity EquipEx. Within the SenseCity project, several small reproduction of 1/3rd scale city surroundings will be built under a climatically controlled environment. Micro and nano sensors will be deployed to experiment on smart cities scenarios, with a particular focus on pollution detection and intelligent transport services. Agora will have the opportunity to tests some of its capillary networking solutions in a very realistic but controlled urban environment. A proof of concept test site has been built in 2015. We have deployed an experiment on low cost sensor network for vehicle detection and one on atmospheric pollution sensor calibration. The operational site is build, the information system is being finalized and the equipment will be inaugurated in April 2018.

9.2.6. Inria Project lab

- **CityLab**
Agora is involved in the CityLab Inria Project Lab lead by Valérie Issarny. Within this project, Hervé Rivano co-advises, with Nathalie Mitton (FUN team, Inria Lille-Nord-Europe), the PhD thesis of Abdoul Aziz Mbacke on “Data gathering in sensor and passive RFID with energy harvesting for urban infrastructure monitoring”.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- **University of Waterloo, ON, Canada.** Joint publications and visits to/from the group of Prof. Catherine Rosenberg.
- **CNR-IEIIT, Turin, Italy.** Joint publications and projects with Dr. Marco Fiore.
- **IMDEA Networks, Madrid, Spain.** Collaboration around the OpenVLC platform with the group of Dr. Domenico Giustiniano.

9.3.2. Participation in Other International Programs

9.3.2.1. PHC Campus France

- **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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Abdelmalik Bachir, Professor, Biskra University, Algeria: invited professor at INSA Lyon (Spring semester, 2017).
- Ramona Marfievici, Senior Researcher, Cork University of Technology, Ireland: visiting professor (one week, November 2017).

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Jad Oueis visited the group of Prof. Catherine Rosenberg, at University of Waterloo, ON, Canada (3 months, Sep-Dec 2017).
- Mihai Popescu visited the group of Prof. Gabriela Czibula, at University of Cluj-Napoca, Romania (3 periods of 1 month duration: April, July and November 2017).
- Razvan Stanica visited the group of Prof. Catherine Rosenberg, at University of Waterloo, ON, Canada (1 month, Sep-Oct 2017).

AIRSEA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

STAREX - Clémentine Prieur obtained a 8k€ two-years funding for a local project on risk by the Labex Persyval. Philippe Naveau (from LSCE, Paris) visited the team during one month in spring 2017 in this context.

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

9.2. National Initiatives

9.2.1. ANR

COCOA: COMprehensive Coupling approach for the Ocean and the Atmosphere. PI: E. Blayo. Duration: 4 years (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.

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.

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

9.2.2. Other Initiatives

A. Vidard leads a group of projects gathering multiple partners in France and UK on the topic "Variational Data Assimilation for the NEMO/OPA9 Ocean Model", see 6.6 .

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 strongly involved in this group (co-chair) <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. in collaboration with Mercator océan

A. Vidard leads a group of projects gathering multiple partners in France and UK on the topic "Variational Data Assimilation for the NEMO/OPA9 Ocean Model", see 6.6 .

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERA-CLIM2

Type: COOPERATION

Instrument: Specific Targeted Research Project

Program: Collaborative project FP7-SPACE-2013-1

Project acronym: ERA-CLIM2

Project title: European Reanalysis of the Global Climate System

Duration: 01/2014 - 12/2016

Coordinator: Dick Dee (ECMWF, Europe)

Other partners: Met Office (UK), EUMETSAT (Europe), Univ Bern (CH), Univ. Vienne (AT), FFCUL (PT), RIHMI-WDC (RU), Mercator-Océan (FR), Météo-France (FR), DWD (DE), CER-FACS (FR), CMCC (IT), FMI (FI), Univ. Pacifico (CL), Univ. Reading (UK), Univ. Versailles St Quentin en Yvelines (FR)

Inria contact: Arthur Vidard

9.3.2. Collaborations with Major European Organizations

Partner: European 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. Exeter (UK).

We do have a strong collaboration with their ocean initialization team through both our NEMO, NEMO-ASSIM and NEMOVAR activities. They also are our partner in the NEMOVAR consortium.

Partner: University of Reading, Department of Meteorology, Department of Mathematics

Subject: Data assimilation for geophysical systems.

9.4. International Initiatives

F. Lemarié is involved in the Inria associate team NEMOLOCO with Santiago University (Chile)

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

C. Prieur collaborates with Jose R. Leon (UCV, Central University of Caracas), who was funded by the international Inria chair program. He moved in June 2017 to Montevideo, Uruguay, and the collaboration goes on.

C. Prieur is collaborating with AC Favre (LTHE, Grenoble) in the framework of a two-years canadian funding from CFQCU (Conseil franco-québécois de coopération universitaire) 2015-2016.

F. Lemarié and L. Debreu collaborate with Hans Burchard from the Leibniz-Institut für Ost-seeforschung in Warnemünde (Germany).

F. Lemarié and L. Debreu collaborate with Knut Klingbeil from the Dept. of Mathematics of the University of Hamburg (Germany).

9.4.2. Participation in Other International Programs

9.4.2.1. International Initiatives

SIDRE

Title: Statistical inference for dependent stochastic processes and application in renewable energy

International Partners:

Universidad de Valparaíso (Chile) - CIMFAV - Facultad de Ingeniería - Karine Bertin

Universidad Central de Venezuela (Venezuela) - Departamento de Matemáticas - Jose León

Duration: 2016 - 2017

Start year: 2016

See also: <http://sidre.cimfav.cl/>

We want to develop, apply and study the properties of statistical tools in several non-parametric models, segmentation models, time series and random fields models, and to study some classes of long-range dependent processes, for their possible application in renewable energies and other domains. In particular non-parametric statistical procedure in Markov switching non-linear autoregressive models, finite mixture, non-parametric functional test and non-parametric estimators in stochastic damping Hamiltonian systems will be considered. Statistical tools for segmenting dependent multiples series, censoring processes in time series models and a new model interpolation scheme will be studied.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Werner Bauer (Imperial College, London) spent one week in the AIRSEA team from October 9th to October 13th to work on mimetic schemes for atmospheric models.

9.5.1.1. Internships

Gino Rivano from the university of Valparaiso (Chile) : « High-resolution numerical modeling of the oceanic circulation in central Chile: application to larvae dispersal » (advisor: F. Lemarié), 3 months in the framework of the Inria MERIC center of excellence.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

C. Prieur visited during two weeks Karine Bertin in Chile. CIMFAV – Facultad de Ingeniería Universidad de Valparaíso.

F.-X. Le Dimet visited Florida State University, Dpt of Mathematics during two weeks in May 2017

F.-X. Le Dimet visited Harbin Institute of Technology, Dpt of Mathematics during 10 days in July 2017

ALICE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CPER (2014-2020) 50 k

Sylvain Lefebvre coordinates a work package for the CPER 2014-2020. It involves several members of ALICE as well as laboratories within the Nancy area (Institut Jean Lamour, LRGP, ERPI). Our goal is to consider the interaction between software and material in the additive manufacturing process, with a focus on filament-based printers.

9.1.2. PIC (2015-2017) 150 k

The PIC project (Polymères Innovants Composites) is a collaboration between Inria, Institut Jean Lamour and Ateliers Cini, funded by Région Lorraine. The goal is to develop a new additive manufacturing process using filaments of composite materials with applications in mechanical engineering and the medical domain. Our goal in the project is to provide novel ways to deposit the filament that is better suited to the considered materials and improves the quality of the final parts.

9.2. National Initiatives

9.2.1. EXPLORAGRAM

Inria exploratory project EXPLORAGRAM (in cooperation with MOKAPLAN): We explored new algorithms for computational optimal transport. The project allowed us to hire a post-doc for 18 months (Erica Schwindt). She worked on the semi-discrete algorithm, and its application to the simulation of fluid-structure interactions. The project allowed to strengthen the cooperation with MOKAPLAN. It also allowed us to start exploring new cooperations, with Institut d'Astrophysique de Paris, on early universe reconstruction.

9.2.2. ANR MAGA (2016-2020)

We participate to the ANR MAGA (ANR-16-CE40-0014) on the Monge Ampere equation and computational geometry. In this ANR project, we cooperate with Quentin Merigot and other researchers of the MOKAPLAN Inria team on new computational methods for optimal transport.

9.2.3. ANR ROOT (2016-2020)

We participate to the Young Researcher ANR ROOT (ANR-16-CE23-0009) on Optimal Transport for computer graphics, with Nicolas Bonneel (CNRS Lyon) as Principal Investigator. In the context of this project, we develop a new symmetric algorithm for semi-discrete optimal transport that optimizes for both the location of the samples and their Lagrange multipliers. An ENS training period will start in Jan. 2018 (Agathe Herrou), hosted in Nancy.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. SHAPEFORGE

Title: ShapeForge: By-Example Synthesis for Fabrication

Program: FP7 (ERC Starting Grant)

Duration: December 2012 - November 2017

Coordinator: Inria

Inria contact: Sylvain Lefebvre

Despite the advances in fabrication technologies such as 3D printing, we still lack the software allowing for anyone to easily manipulate and create useful objects. Not many people possess the required skills and time to create elegant designs that conform to precise technical specifications. 'By-example' shape synthesis methods are promising to address this problem: New shapes are automatically synthesized by assembling parts cutout of examples. The underlying assumption is that if parts are stitched along similar areas, the result will be similar in terms of its low-level representation: Any small spatial neighborhood in the output matches a neighborhood in the input. However, these approaches offer little control over the global organization of the synthesized shapes, which is randomized. The ShapeForge challenge is to automatically produce new objects visually similar to a set of examples, while ensuring that the generated objects can enforce a specific purpose, such as supporting weight distributed in space, affording for seating space or allowing for light to go through. These properties are crucial for someone designing furniture, lamps, containers, stairs and many of the common objects surrounding us. The originality of our approach is to cast a new view on the problem of 'by-example' shape synthesis, formulating it as the joint optimization of 'by-example' objectives, semantic descriptions of the content, as well as structural and fabrication objectives. Throughout the project, we will consider the full creation pipeline, from modeling to the actual fabrication of objects on a 3D printer. We will test our results on printed parts, verifying that they can be fabricated and exhibit the requested structural properties in terms of stability and resistance.

9.3.1.2. ICEXL

Title: IceXL: Advanced modeling and slicing software for additive manufacturing

Program: FP7 (ERC Proof of Concept)

Duration: November 2016 - February 2018

Coordinator: Inria

Inria contact: Sylvain Lefebvre

The ICEXL Proof of Concept projects aims at further developing our software IceSL and its industrial potential. We have released several new major features than allowed the software to gain visibility (as shown by a strong increase in downloads towards the end of 2017, 1500+ downloads in November). We have teamed with a selected number of industrial partners to work towards industrial use, and have ongoing discussions regarding technology transfer and licensing.

9.4. International Initiatives

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

9.4.1.1. PREPRINT3D

Title: Model Preparation for 3D Printing

International Partner (Institution - Laboratory - Researcher):

HKU (Hong Kong, China) - Department of Computer Science (CS) - Wenping Wang

Start year: 2017

We seek to develop novel ways to prepare and model objects for 3D printing which better take into account limitations of the fabrication processes as well as real-world properties such as the mechanical strength of the printed object. This is especially important when targeting an audience which is not familiar with the intricacies of industrial design. We target complex, intricate shapes such as models of vegetation and highly detailed meshes, as well as models with thin walls such as architectural models.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Jean-Francois Remacle (University of Louvain, Belgium), we cooperate on hexahedral-dominant meshing (visits, students exchange). Our former Ph.D. student Jeanne Pellerin is doing a post-doc in his lab.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Li-Yi Wei visited us from 05/04/17 to 18/04/17 to work on the topic of element based topology optimization with Jérémie Dumas, Jonàs Martínez and Sylvain Lefebvre. This work was submitted to SIGGRAPH but not accepted, we plan to resubmit it early 2018.

9.5.1.1. Internships

Sylvain Lefebvre supervised Mélanie Siret for a 3 months internship, as well as Jimmy Etienne for a 6 months internship.

9.5.2. Visits to International Teams

B. Lévy and Nicolas Ray visited Jean-Francois Remacle (U. Louvain, Belgium). B. Lévy visited Jan Obloj (Oxford, U.K.).

ALMANACH Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **ANR SoSweet** (2015-2019, PI J.-P. Magué, resp. ALMAAnaCH: DS; Other partners: ICAR [ENS Lyon, CRNS], Dante [Inria]). Topic: studying sociolinguistic variability on Twitter, comparing linguistic and graph-based views on tweets
- **ANR ParSiTi** (2016-2021, PI Djamé Seddah, Other partners: LIMSI, LIPN). Topic: context-aware parsing and machine translation of user-generated content
- **ANR PARSE-ME** (2015-2020, PI. Matthieu Constant, resp. Marie Candito [ALPAGE, then LLF], ALMAAnaCH members are associated with Paris-Diderot's LLF for this project). Topic: multi-word expressions in parsing
- **ANR Profiterole** (2016-2020, PI Sophie Prévost [LATTICE], resp. Benoit Crabbé [ALPAGE, then LLF], ALMAAnaCH members are associated with Paris-Diderot's LLF for this project). Topic: modelling and analysis of Medieval French
- **ANR TIME-US** (2016-2019, PI Manuela Martini [LARHRA], ALMAAnaCH members are associated with Paris-Diderot's CEDREF for this project). Topic: Digital study of remuneration and time budget textile trades in XVIIIth and XIXth century France

9.1.2. Competitvity Clusters

- **LabEx EFL** (2010-2019, PI Christian Puech [HTL, Paris 3], Sorbonne Paris Cité). Topic: empirical foundations of linguistics, including computational linguistics and natural language processing. ALPAGE was one of the partner teams of this LabEx, which gathers a dozen of teams within and around Paris whose research interests include one aspects of linguistics or more. BS serves as deputy head (and former head) of one of the scientific strands of the LabEx, namely strand 6 dedicated to language resources. BS and DS are in charge of a number of scientific "operations" within strands 6, 5 ("computational semantic analysis") and 2 ("experimental grammar"). BS, EVdLC and DS are now individual members of the LabEx EFL since 1st January 2017, and BS still serves as the deputy head of strand 6. Main collaborations are on language resource development (strands 5 and 6), syntactic and semantic parsing (strand 5, especially with LIPN [CNRS and U.Paris 13]) and computational morphology (strands 2 and 6, especially with CRLAO [CNRS and Inalco]).
- **PSL project LAKME** (2015-2017, PI Thierry Poibeau [LATTICE]). Topic: language resource development for morphologically rich languages, especially Rabbinic Hebrew (syntactic level), Medieval French (morphological level) and some Finno-Ugric languages (to a lesser extent).
- **PSL Iris project SCRIPTA** This project emanates from the history and philology department of the EPHE (DSBE). It is directed by Andreas Stauder (EPHE) with Philip Huyse (EPHE) and Charlotte Schmid (EFEO). It unites the forces of a great number of researchers in PSL (EPHE, ENS, EHESS, ENC, Collège de France and in addition the IRHT) working on written texts in all its forms, on all kinds of material, from all periods and regions and has important digital and computational ambitions especially with regard to epigraphy, palaeography, digital editions and NLP.

9.1.3. Other National Initiatives

- **TGIR Huma-Num** ALPAGE was a member of the CORLI consortium on "corpora, languages and interactions" (BS is a member of the consortium's board), and ALMAAnaCH is in the process of joining this consortium. With a joint funding of Huma-Num and the H2020 project Parthenos (on which see below), ALMAAnaCH members have also co-organised a workshop on 3D techniques for Humanities in Bordeaux (December 2016).

- **Institut de Linguistique Française (ILF):** ALPAGE was a member of this CNRS “federation”. ALMANACH is in the process of joining this federation if possible, especially as BS is the scientific head of the “Corpus de Référence du Français” initiative, an ILF project whose other head is Franck Neveu and whose goal is to develop a French National Corpus, a resource that has been awaited for a long time.
- **Notary registers project (2017-2018):** An explorative study has been launched in collaboration with the National Archives in France, in the context of the framework agreement between Inria and the Ministry of Culture, to explore the possibility of extracting various components from digitized 19th Century notary registers.
- **Nénufar (DGLFLF - Délégation générale à la langue française et aux langues de France):** The project is intended to digitize and exploit the early editions (beginning of the 20th Century) of the Petit Larousse dictionary. ALMANACH is involved to contribute to the automatic extraction of the dictionary content by means of GROBID-dictionaries and define a TEI compliant interchange format for all results.
- **PIA Opaline:** The objective of the project is to provide a better access to published French literature and reference material for visually impaired persons. Financed by the Programme d’Investissement d’Avenir, it will integrate technologies related to document analysis and re-publishing, textual content enrichment and dedicated presentational interfaces. Inria participates to deploy the GROBID tool suite for the automatic structuring of content from books available as plain PDF files.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- **H2020 Parthenos (2015-2019, PI Franco Niccolucci [University of Florence]; LR is a work package coordinator)** Topic: strengthening the cohesion of research in the broad sector of Linguistic Studies, Humanities, Cultural Heritage, History, Archaeology and related fields through a thematic cluster of European Research Infrastructures, integrating initiatives, e-infrastructures and other world-class infrastructures, and building bridges between different, although tightly interrelated, fields.
- **H2020 EHRI “European Holocaust Research Infrastructure” (2015-2019, PI Conny Kristel [NIOD-KNAW, NL]; LR is task leader)** Topic: transform archival research on the Holocaust, by providing methods and tools to integrate and provide access to a wide variety of archival content.
- **H2020 Iperion CH (2015-2019, PI Luca Pezzati [CNR, IT], LR is task leader)** Topic: coordinating infrastructural activities in the cultural heritage domain.
- **H2020 HIRMEOS:** HIRMEOS objective is to improve five important publishing platforms for the open access monographs in the humanities and enhance their technical capacities and services and rendering technologies, while making their content interoperable. Inria is responsible for improving integrating the entity-finding component deployed as an infrastructural service for the five platforms.
- **H2020 DESIR:** The DESIR project aims at contributing to the sustainability of the DARIAH infrastructure along all its dimensions: dissemination, growth, technology, robustness, trust and education. Inria is responsible for providing of a portfolio of text analytics services based on GROBID and entity-finding.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

- **ERIC DARIAH “Digital Research Infrastructure for the Arts and Humanities”** (set up as a consortium of states, 2014-2034; LR is president of the board of director) Topic: coordinating Digital Humanities infrastructure activities in Europe (17 partners, 5 associated partners).
- **COST enCollect (2017-2020, PI Lionel Nicolas [European Academy of Bozen/Bolzano])** Topic: combining language learning and crowdsourcing for developing language teaching materials and more generic language resources for NLP

9.2.3. Collaborations with Major European Organizations

Informal collaborations with institutions not cited above (for the SPMRL initiative, see below):

- University of Ljubljana (Darja Fišer) [wordnet development]
- University of Zürich, Switzerland (Géraldine Walther) [computational morphology, lexicons]
- Academy of Sciences, Berlin, Germany (Karl-Heinz Moerth) [lexicology]
- University of Fribourg, Switzerland [historical document analysis]
- University of Valencia, Spain [historical document analysis]
- University of Groningen, Netherlands [historical document analysis]
- University of Innsbruck, Austria [historical document analysis]

9.3. International Initiatives

9.3.1. International Partners

- **ANR-NSF project MCM-NL** (2016-2020, PI John Hale [Cornell University, USA], resp. for Inria Paris / ALMANACH: EVdLC) Topic: exploring correlations between data from neuro-imagery (fMRI, EEG) and data from NLP tools (mostly parsers). The data will come from “Le Petit Prince” read in French and English, and parsed with different parsers. Other partners: Cornell Univ., Univ. Michigan, Paris Saclay/Neurospin, Univ. Paris 8. Informal collaborations:
- **The SPMRL initiative** (Statistical Parsing of Morphologically Rich Languages): a worldwide network of internationally renowned teams that was initiated during the IWPT’09 conference ALPAGE organised in Paris, DS playing a leading role since then. Other institutions involved include the University of Heidelberg (Germany), Bar Ilan University (Israel), Potsdam University (Germany) and Indiana University (USA). The outcomes of this initiative include the successful SPMRL Workshop and Shared Task series hosted successively by NAACL-HLT (2010), IWPT (2011), ACL (2012), EMNLP (2013), CoLing (2014) and IWPT (2015), in which DS as well as other ALPAGE/ALMANACH members played an active role. DS also served as a co-editor of a special issue of Computational Linguistics on this topic.
- **Sofer Mahir (“fast scribe”) project**. Joint work on the computational processing of Rabbinic Hebrew manuscripts involving DSBE: Nachum Dershowitz (Tel Aviv University, Israel), Moshe Koppel (DICTA, Bar Ilan University, Israel), Meni Adler (DICTA, Ben Gurion University, Israel), Michael Elhadad (Ben Gurion University, Israel) on the NLP side and Hayim Lapin (University of Maryland, USA), Tal Ilan (FU Berlin, Germany) Shamma Friedmann (Bar Ilan University, Israel) on morphological analysis of Rabbinic Hebrew, alignment of manuscript witnesses (textual criticism), finding parallels, aligning related but different texts (like the Gospels). This work is also connected to the LAKME project mentioned above.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Daniel Dakota (Indiana University, 4 months, until Jan 2017)
- Theresa Lynn (Dublin City University, 10 days in January 2017)
- Amir More (Open University of Israel, 10 days in April 2017)

9.4.1.1. Internships

- Basant Agarwal (ERCIM, Aug-Sep 2017)

ALPINES Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. B3DCMB

ANR Decembre 2017 - Novembre 2021 This project is in the area of data analysis of cosmological data sets as collected by contemporary and forthcoming observatories. This is one of the most dynamic areas of modern cosmology. Our special target are data sets of Cosmic Microwave Background (CMB) anisotropies, measurements of which have been one of the most fruitful of cosmological probes. CMB photons are remnants of the very early evolution of the Universe and carry information about its physical state at the time when the Universe was much younger, hotter and denser, and simpler to model mathematically. The CMB has been, and continue to be, a unique source of information for modern cosmology and fundamental physics. The main objective of this project is to empower the CMB data analysis with novel high performance tools and algorithms superior to those available today and which are capable of overcoming the existing performance gap. Partners: AstroParticules et Cosmologie Paris 7 (PI R. Stompor), ENSAE Paris Saclay.

9.1.1.2. Medimax

ANR-MN (Modèles Numériques) October 2013 - September 2017

The main goal is the methodological and numerical development of a new robust inversion tool, associated with the numerical solution of the electromagnetic forward problem, including the benchmarking of different other existing approaches (Time Reverse Absorbing Condition, Method of Small-Volume Expansions, Level Set Method). This project involves the development of a general parallel open source simulation code, based on the high-level integrated development environment of FreeFem++, for modeling an electromagnetic direct problem, the scattering of arbitrary electromagnetic waves in highly heterogeneous media, over a wide frequency range in the microwave domain. The first applications considered here will be medical applications: microwave tomographic images of brain stroke, brain injuries, from both synthetic and experimental data in collaboration with EMTensor GmbH, Vienna (Austria), an Electromagnetic Medical Imaging company.

9.1.1.3. ANR Cine-Para

October 2015 - September 2019, Laura Grigori is Principal Coordinator for Inria Paris. Funding for Inria Paris is 145 Keuros. The funding for Inria is to combine Krylov subspace methods with parallel in time methods. Partners: University Pierre and Marie Curie, J. L. Lions Laboratory (PI Y. Maday), CEA, Paris Dauphine University, Paris 13 University.

9.1.1.4. Non-local DD

ANR appel à projet générique October 2015 - September 2020

This project in scientific computing aims at developing new domain decomposition methods for massively parallel simulation of electromagnetic waves in harmonic regime. The specificity of the approach that we propose lies in the use of integral operators not only for solutions local to each subdomain, but for coupling subdomains as well. The novelty of this project consists, on the one hand, in exploiting multi-trace formalism for domain decomposition and, on the other hand, considering optimized Schwarz methods relying on Robin type transmission conditions involving quasi-local integral operators.

9.1.1.5. Soilμ-3D

ANR appel à projet générique October 2015 - September 2020

In spite of decades of work on the modeling of greenhouse gas emission such as CO₂ and N₂O and on the feedback effects of temperature and water content on soil carbon and nitrogen transformations, there is no agreement on how these processes should be described, and models are widely conflicting in their predictions. Models need improvements to obtain more accurate and robust predictions, especially in the context of climate change, which will affect soil moisture regime.

The goal of this new project is now to go further using the models developed in MEPSOM to upscale heterogeneities identified at the scale of microbial habitats and to produce macroscopic factors for biogeochemical models running at the field scale.

To achieve this aim, it will be necessary to work at different scales: the micro-scale of pores (μm) where the microbial habitats are localized, the meso-scale of cores at which laboratory measurements on CO₂ and N₂O fluxes can be performed, and the macro-scale of the soil profile at which outputs are expected to predict greenhouse gas emission. The aims of the project are to (i) develop new descriptors of the micro-scale 3D soil architecture that explain the fluxes measured at the macro-scale, (ii) Improve the performance of our 3D pore scale models to simulate both micro- and meso- scales at the same time. Upscaling methods like “homogenization” would help to simulate centimeter samples which cannot be achieved now. The reduction of the computational time used to solve the diffusion equations and increase the number of computational units, (iii) develop new macro-functions describing the soil micro-heterogeneity and integrate these features into the field scale models.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. NLAFET

Title: Parallel Numerical Linear Algebra for Future Extreme-Scale Systems

Programm: H2020

Duration: November 2015 - November 2018

Coordinator: UMEÅUniversitet

Partners:

Science and Technology Facilities Council (United Kingdom)

Computer Science Department, UmeåUniversitet (Sweden)

Mathematics Department, The University of Manchester (United Kingdom)

Inria contact: Laura Grigori

The NLAFET proposal is a direct response to the demands for new mathematical and algorithmic approaches for applications on extreme scale systems, as identified in the FETHPC work programme and call. This project will enable a radical improvement in the performance and scalability of a wide range of real-world applications relying on linear algebra software, by developing novel architecture-aware algorithms and software libraries, and the supporting runtime capabilities to achieve scalable performance and resilience on heterogeneous architectures. The focus is on a critical set of fundamental linear algebra operations including direct and iterative solvers for dense and sparse linear systems of equations and eigenvalue problems. Achieving this requires a co-design effort due to the characteristics and overwhelming complexity and immense scale of such systems. Recognized experts in algorithm design and theory, parallelism, and auto-tuning will work together to explore and negotiate the necessary tradeoffs. The main research objectives are: (i) development of novel algorithms that expose as much parallelism as possible, exploit heterogeneity, avoid communication bottlenecks, respond to escalating fault rates, and help meet emerging power constraints; (ii) exploration of advanced scheduling strategies and runtime systems focusing on the extreme scale and strong scalability in multi/many-core and hybrid environments; (iii) design and evaluation of novel strategies and software support for both offline and online auto-tuning. The

validation and dissemination of results will be done by integrating new software solutions into challenging scientific applications in materials science, power systems, study of energy solutions, and data analysis in astrophysics. The deliverables also include a sustainable set of methods and tools for cross-cutting issues such as scheduling, auto-tuning, and algorithm-based fault tolerance packaged into open-source library modules.

9.2.1.2. EXA2CT

Title: EXascale Algorithms and Advanced Computational Techniques

Programm: FP7

Duration: September 2013 - August 2016

Coordinator: IMEC

Partners:

Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

Interuniversitair Micro-Electronica Centrum Vzw (Belgium)

Intel Corporations (France)

Numerical Algorithms Group Ltd (United Kingdom)

T-Systems Solutions for Research (Germany)

Universiteit Antwerpen (Belgium)

Universita della Svizzera italiana (Switzerland)

Université de Versailles Saint-Quentin-En-Yvelines. (France)

Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)

Inria contact: Luc Giraud

Numerical simulation is a crucial part of science and industry in Europe. The advancement of simulation as a discipline relies on increasingly computing intensive models that require more computational resources to run. This is the driver for the evolution to exascale. Due to limits in the increase in single processor performance, exascale machines will rely on massive parallelism on and off chip, with a complex hierarchy of resources. The large number of components and the machine complexity introduce severe problems for reliability and programmability. The former of these will require novel fault-aware algorithms and support software. In addition, the scale of the numerical models exacerbates the difficulties by making the use of more complex simulation algorithms necessary, for numerical stability reasons. A key example of this is increased reliance on solvers. Such solvers require global communication, which impacts scalability, and are often used with preconditioners, increasing complexity again. Unless there is a major rethink of the design of solver algorithms, their components and software structure, a large class of important numerical simulations will not scale beyond petascale. This in turn will hold back the development of European science and industry which will fail to reap the benefits from exascale. The EXA2CT project brings together experts at the cutting edge of the development of solvers, related algorithmic techniques, and HPC software architects for programming models and communication. It will take a revolutionary approach to exascale solvers and programming models, rather than the incremental approach of other projects. We will produce modular open source proto-applications that demonstrate the algorithms and programming techniques developed in the project, to help boot-strap the creation of genuine exascale codes.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- J. Demmel, UC Berkeley, USA

- R. Hipmair, ETH Zurich
- M. Grote (Université de Bâle, Suisse)
- F. Assous (Israel)

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Ralf Hiptmair (ETH Zürich) came to visit Xavier Claeys for a sabbatical semester, from January to June 2017.
- Mahadevan Ganesh (Colorado School of Mines) came to visit Xavier Claeys from the 4th of July 2017 to 18th of July 2017.
- Carlos Jerez-Hanckes (Pontificia Universidad Catolica, Santiago, Chile) came to visit Xavier Claeys from the 3rd of December to the 16th of December 2017.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Laura Grigori has spent 3 weeks at UC Berkeley, from July 21, 2016 to August 13, 2016.
- Xavier Claeys visited Catalin Turc (New Jersey Institute of Technology) from the 5th of November to the 14th of November 2017.

AMIBIO Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. FRM

AMIBio is in charge of Bioinformatics developments in this project on structural prediction from RNA probing data (SHAPE). It involves Biochemists at Université Paris Descartes (France, PI B. Sargueil) and is funded by a "Fondation pour la Recherche Medicale" grant. It also involves partners in Paris-Sud (France) and McGill University (Canada).

Fondation pour la Recherche Medicale – *Analyse Bio-informatique pour la recherche en Biologie* program

- Approche comparatives haut-débit pour la modelisation de l'architecture 3D des ARN à partir de données experimentales
- 2015–2018
- Yann Ponty, A. Denise, M. Regnier, A. Saaidi (PhD funded by FRM)
- B. Sargueil (Paris V – Experimental partner), J. Waldispuhl (Univ. McGill)

6.2. European Initiatives

6.2.1. Collaborations in European Programs, Except FP7 & H2020

Yann Ponty is the French PI for the French/Austrian RNALANDS project, jointly funded by the French ANR and the Austrian FWF, in partnership with the Theoretical Biochemistry Institute (University of Vienna, Austria), LRI (Univ. Paris-Sud) and EPI BONSAI (Inria Lille-Nord Europe).

French/Austrian International Program

RNALANDS (ANR-14-CE34-0011)

Fast and efficient sampling of structures in RNA folding landscapes

01/10/2014–30/09/2018

Coordinated by AMIB (Inria Saclay) and TBI Vienna (University of Vienna)

EPI BONSAI/INRIA Lille - Nord Europe, Vienna University (Austria), LRI, Université Paris-Sud (France)

The main goal of the RNALands project is to provide efficient tools for studying the kinetics of RiboNucleic Acids, based on efficient sampling strategies.

6.3. International Initiatives

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

6.3.1.1. ALARNA

Title: Associated Laboratory for the Analysis of RiboNucleic Acids

International Partner (Institution - Laboratory - Researcher):

McGill University (Canada) - REUSSI Program - Jerome Waldispuhl

Start year: 2017

See also: <https://team.inria.fr/alarna/>

RiboNucleic Acids (RNAs) are ubiquitous biomolecules whose structure, adopted as the outcome of a complex folding process, often plays a crucial part in cellular processes. The ALARNA Associate Team (Laboratory for the Analysis of RiboNucleic Acids), which consist of the AMIBio project-team (Inria Saclay/Ecole Polytechnique, France) and the CSB (Computer Science and Biology) group at university McGill (Montreal, Canada), addresses key questions in RNA bioinformatics. More specifically, it dedicates much of its effort to the production and interpretation of chemical probing data generated by SHAPE, an experimental technology which allows to accurately predict, in a high-throughput, one or several secondary structure(s) adopted by an RNA. To that end, the teams contribute their unique combinations of expertise, ranging from combinatorial optimization to sequence algorithmics through structural bioinformatics.

6.3.1.2. Informal International Partners

AMIBio enjoys regular interactions with the following institutions:

- TBI, University of Vienna (Austria). Within the RNALands project funded by the Austrian FWF and the french ANR, we frequently interact with our partners at the TBI, on projects associated with the kinetics of RNAs. Over the course of 2017, we have visited our partners twice, once in Vienna and once in Bled (Slovenia) over the course of the 2017 Winter retreat of the TBI. Additionally, Andrea Tanzer has visited AMIBio for a month in Oct 2018, funded by a visiting scholar program of Ecole Polytechnique;
- Simon Fraser University (Vancouver, Canada). The Mathematics department at SFU has ongoing projects on RNA design, comparative genomics and RNA structure comparison with our team. M. Mishna (SFU) has visited Inria Saclay in January 2017 to push an ongoing collaboration on 2D walks;
- McGill University (Montréal, Canada). Following our productive collaboration with J. Waldispühl (Computer Science Dept, McGill), and the recent defense of V. Reinharz's PhD, whose thesis was co-supervised by AMIBio members, we have increased our interactions on SHAPE data analysis through the ALARNA associate team;
- King's college (London, UK). Our collaboration with L. Mouchard (AMIBio associate) and S. Pissis on string processing and data structures was at the core of Alice Héliou's PhD, defended in July 2017.

6.3.2. Participation in Other International Programs

Title: PHC GRO-algo – Combination of time-course GRO-seq assay, algorithmics and software development for measuring genome-wide transcription elongation rates

International Partner (Institution - Laboratory - Researcher):

Wuhan University (China), College of Life Science – Pr Yu Zhou

Start year: 2017

Participant in a French-Chinese Hubert Curien Partnerships (PHC), supported by CampusFrance and funding bilateral exploratory research exchanges in Bioinformatics. The program involves research scientists from Wuhan University, Ecole Polytechnique and Univ. Paris-Sud.

Title: Computational methods and databases to identify small RNA-binding molecules regulating gene expression

International Partner (Institution - Laboratory - Researcher):

University McGill (Canada), Computer Science & Biochemistry – J. Waldispühl, N. Moitessier; Univ. Strasbourg, IBMC - E. Westhof.

Start year: 2017

The project, headed by N. Moitessier and J. Waldispühl (McGill University, Canada) strives to develop tools to derive a mechanical understanding of riboswitches at the 2D and 3D levels, including chemoinformatics aspects.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

Andrea Tanzer

Date: Oct 2017 - Nov 2017

Institution: TBI Vienna, Austria

Mathieu Blanchette

Date: June 2017

Institution: Univ. McGill, Canada

6.4.1.1. Internships

Paul Arijit

Institution: IISc Bangalore (India)

Supervisor: Mireille Régnier

Chinmay Singhal

Date: May 2017 - July 2017

Institution: IIT Guwahati, India (India)

Supervisor: Yann Ponty

ANGE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR SEDIFLO (2015-2019)

Participants: Emmanuel Audusse, Martin Parisot.

Program: ANR Défi 1 “Gestion sobre des ressources et adaptation au changement climatique” (JCJC)

Project acronym: SEDIFLO

Project title: Modelling and simulation of solid transport in rivers

Coordinator: Sébastien Boyaval (LHSV/ENPC)

Based on recent theoretical and experimental results, this project is aimed at modelling transport of sediments within rivers. It will rely on innovations from the point of view of rheology as well as advanced mathematical tools (asymptotic model reduction, PDE discretisation).

9.1.2. ANR Hyflo-Eflu (2016-2020)

Participants: Jérémy Ledoux, Martin Parisot, Jacques Sainte-Marie, Julien Salomon.

ANR project call: Energies marines renouvelables

Project acronym: Hyflo-Eflu

Project title: Hydroliennes flottantes et énergie fluviale

Coordinator: Julien Salomon

The project is a collaboration between the Inria-team ANGE, specialist of free surface flow and optimisation, and the industrial developers of the turbine, HYDROTUBE ENERGIE. The objective of the project HyFlo-EFlu is to deliver a numerical software able to simulate the dynamic of a floating water turbine in real context. For the academic partner, the main challenge is in the simulation of the floating structure at the scale of the river, and the modelling of the vertical and horizontal axis turbine. For the industrial partner, the objective is the validation of the stability of the structure and the performance in term of energy production.

9.1.3. ANR MIMOSA (2014–2017)

Participants: Marie-Odile Bristeau, Anne Mangeney, Bernard Di Martino, Jacques Sainte-Marie.

Program: ANR Défi 1 “Gestion sobre des ressources et adaptation au changement climatique”

Project acronym: MIMOSA

Project title: MICOseism modelling and Seismic Applications

Coordinator: Eleonore Stutzmann (IPGP)

Seismic noise is recorded by broadband seismometers in the absence of earthquakes. It is generated by the atmosphere-ocean system with different mechanisms in the different frequency bands. Even though some mechanisms have been known for decades, an integrated understanding of the noise in the broadband period band 1-300sec is still missing. Using novel theoretical, numerical and signal processing methods, this project will provide a unified understanding of the noise sources and quantitative models for broadband noise. Conversely, we will be able to interpret seismic noise in terms of ocean wave properties. This first analysis step will lead to the identification and characterisation of source events, which we will use to improve noise tomography, and seismic monitoring.

9.1.4. ANR CHARMS (2016-2020)

Participant: Cindy Guichard.

ANR project call: Transformations et inter-conversions énergétiques

Project acronym: CHARMS

Project title: Modèles de réservoirs quantitatifs pour les systèmes hydrothermaux complexes

Coordinator: Simon Lopez (BRGM)

Funding: 73k euros for LJLL (in 767k euros for the whole project)

CHARMS ANR project is focused on the mathematical methods and software tools dedicated to the simulation of the physical models issued from geothermal engineering. The final objective is the achievement of a highly parallel code, validated on realistic cases.

9.1.5. CNRS Moset (2016-2017)

Participants: Emmanuel Audusse, Martin Parisot.

CNRS project call: INSU Tellus

Project acronym: Moset

Project title: Modélisation des suspensions concentrées naturelles

Coordinator: Emmanuel Audusse

In collaboration with G. Antoine (EDF), S. Boyaval (LHSV), C. Le Bouteiller (Irstea), M. Jodeau (EDF).

Gathering mathematicians (numerical analysis) and geophysicists, this project focuses on the quantitative prediction of solid transport. This issue raises several questions about rheology when the sediment concentration is high enough. It is crucial for modelling the dynamics of suspension. The collaboration aims at assessing models by means of experimental data and at providing preliminary numerical results to evaluate the order of magnitude of constraints.

9.1.6. CNRS Simulations of free-surface flows (2017)

Participants: Cindy Guichard, Martin Parisot, Yohan Penel, Jacques Sainte-Marie.

CNRS project call: PEPS JC

Project title: modélisation avancée et simulation d'écoulements à surface libre

Coordinator: Yohan Penel

Funding: 2.5k euros

In collaboration with E. Fernández-Nieto.

Free-surface flows are extensively studied in the literature by means of simplified models (like the Shallow Water equations) due to the theoretical and numerical issues related to the Euler system. Intermediate models have then been derived to improve the accuracy and the physical relevance (e.g. taking into account hydrodynamic pressure or multilayer approaches). This collaboration aims at designing a hierarchy of multilayer models with a non-hydrostatic pressure as a discretisation along the vertical axis of the Euler equations. The hierarchy relies on the degree of approximation of the variables discretised with a Discontinuous Galerkin method for the vertical direction. These innovative models will imply a theoretical study and the development of numerical tools in dimensions 1 and 2 before the modelling of other physical phenomena (viscosity effects, ...).

9.1.7. CNRS Mocha (2017-2018)

Participant: Martin Parisot.

CNRS project call: LEFE

Project acronym: MOCHA

Project title: Multi-dimensiOnal Coupling in Hydraulics and data Assimilation

Coordinator: Martin Parisot

Funding: 14k euros

In collaboration with S. Barthélémy, N. Goutal, S. Ricci, M. Hoang Le.

Multi-dimensionnal coupling in river hydrodynamics offers a convenient solution to properly model complex flow while limiting the computational cost and making the most of pre-existing models. The project aims to adapt the lateral interface coupling proposed in [39] to the implicit version and test it on real data for the Garonne River.

9.1.8. Inria Project Lab “Algae in Silico” (2015-2018)

Participants: Marie-Odile Bristeau, Yohan Penel, Jacques Sainte-Marie, Fabien Souillé.

In the aftermath of the ADT In@lgae (2013–2015), we developed a simulation tool for microalgae culture. An Inria Project Lab “Algae in Silico” has started in collaboration with Inria teams BIOCORE and DYLISS. It concerns microalgae culture for biofuel production and the aim is to provide an integrated platform for numerical simulation “from genes to industrial processes”.

9.1.9. Inria Project Lab “CityLab” (2015-2018)

Participants: Vivien Mallet, Raphaël Ventura.

CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability.

9.1.10. GdR EGRIN (2013–2017)

Participants: Emmanuel Audusse, Bernard Di Martino, Nicole Goutal, Cindy Guichard, Anne Mangeney, Martin Parisot, Jacques Sainte-Marie.

EGRIN stands for Gravity-driven flows and natural hazards. J. Sainte-Marie is the head of the scientific committee of this CNRS research group and A. Mangeney is a member of the committee. Other members of the team involved in the project are local correspondents. The scientific goals of this project are the modelling, analysis and simulation of complex fluids by means of reduced-complexity models in the framework of geophysical flows.

9.1.11. ANR ESTIMAIR (2013-2017)

Participant: Vivien Mallet.

ANR project call: Modèles numériques

Project acronym: ESTIMAIR

Project title: Estimation d’incertitudes en simulation de la qualité de l’air à l’échelle urbaine

Coordinator: Vivien Mallet

Funding: 415k euros

The project aims to propagate uncertainties in a complete air quality modelling chain at urban scale, from road traffic assignment to air pollutant dispersion.

9.1.12. ANR FireCaster (2017-2020)

Participants: Frédéric Allaire, Vivien Mallet.

ANR project call: DS0104

Project acronym: FireCaster

Project title: Plateforme de prévision incendie et de réponse d’urgence

Coordinator: Jean-Baptiste Filippi (Univ. Corse)

Funding: 442k euros

The goal of the FireCaster project is to prototype a fire decision support system at the national scale to estimate upcoming fire risk (H+24 to H+48) and in case of crisis, to predict fire front position and local pollution (H+1 to H+12).

9.1.13. ANR CENSE (2017-2020)

Participants: Antoine Lesieur, Vivien Mallet.

ANR project call: DS0601

Project acronym: CENSE

Project title: Caractérisation des environnements sonores urbains : vers une approche globale associant données libres, mesures et modélisations

Coordinator: Judicaël Picaut (IFSTTAR)

Funding: 856k euros

The CENSE project aims at proposing a new methodology for the production of more realistic noise maps, based on an assimilation of simulated and measured data through a dense network of low-cost sensors.

9.1.14. ANR RAVEX (2017-2020)

Participant: Anne Mangeney.

ANR project call: DS0106

Project acronym: RAVEX

Project title: Développement d'une approche intégrée pour la réduction des Risques Associés au Volcanisme EXplosif, de la recherche sur l'aléa aux outils de gestion de crise : le cas de la Martinique

Coordinator: Olivier Roche (IRD)

Funding: 619k euros

9.1.15. ANR CARIB (2014-2017)

Participant: Anne Mangeney.

ANR project call: Simi6

Project acronym: CARIB

Project title: Fréquence et processus de mise en place des avalanches de débris tsunamigènes de l'arc des Petites Antilles : apport des forages de l'Expédition IODP 340 et impact en termes de risque

Coordinator: Anne Le Friant (IPGP)

Funding: 274k euros

9.1.16. ANR CINE-PARA (2015-2019)

Participant: Julien Salomon.

ANR project call: DS0708

Project acronym: CINE-PARA

Project title: Méthodes de parallélisation pour cinétiques complexes

Coordinator: Yvon Maday (LJLL)

9.2. European Initiatives**9.2.1. FP7 & H2020 Projects****9.2.1.1. ERC Consolidator Grant (2013-2018)**

Participants: Anne Mangeney, Hugo Martin.

The project SLIDEQUAKES is about detection and understanding of landslides by observing and modelling gravitational flows and generated earthquakes and is funded by the European Research Council (2 million euros). More precisely, it deals with the mathematical, numerical and experimental modelling of gravitational flows and generated seismic waves coupled with field measurements to better understand and predict these natural hazards and their link with volcanic, seismic and climatic activities.

9.2.1.2. *EoCoE (2015-2018)*

Title: Energy oriented Centre of Excellence for computer applications

Program: H2020

Duration: October 2015 - October 2018

Coordinator: Édouard Audit (CEA)

Partners: CEA (Commissariat à l'Énergie Atomique et aux Énergies Alternatives, France), Forschungszentrum Julich (Germany), Max Planck Gesellschaft (Germany), ENEA (Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile, Italy), CER-FACS (European Centre for Research and Advanced Training in Scientific Computing, France), Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland), Università Degli Studi di Trento (Italy), Fraunhofer Gesellschaft (Germany), University of Bath (United Kingdom), CYL (The Cyprus Institute, Cyprus), CNR (National Research Council of Italy), Université Libre de Bruxelles (Belgium), BSC (Centro Nacional de Supercomputacion, Spain)

Inria contact: Michel Kern (Serena team)

Participants: Vivien Mallet

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

9.2.1.3. *Env&You (2017)*

Title: Env&You

Program: EIT Digital

Duration: January 2016 - December 2016

Coordinator: Inria (MiMove)

Partners: NUMTECH, Ambiciti, ForumVirium, TheCivicEngine

Inria contact: Valérie Issarny (Mimove project-team)

Participants: Vivien Mallet, Raphaël Ventura

Env&You aims at delivering the whole picture of urban pollution, from the individual exposure to neighborhood-by-neighborhood and day-to-day variation, to citizens and governments, informing their decisions for healthy urban living.

9.2.2. Collaborations with Major European Organisations

9.2.2.1. CNRS PICS NHML (2017-2019)

Program: CNRS PICS (projet international de collaboration scientifique)

Project acronym: NHML

Project title: non-hydrostatic multilayer models

Duration: 01/17-12/19

Coordinator: Yohan Penel (CEREMA)

Other partners: IMUS (Sevilla, Spain)

Participants: Martin Parisot (Inria), Jacques Sainte-Marie (CEREMA), Enrique Fernández-Nieto (Sevilla), Tomas Morales de Luna (Cordoba)

Funding: 12k euros

Abstract: This collaboration aims at designing a hierarchy of multilayer models with a non-hydrostatic pressure as a discretisation along the vertical axis of the Euler equations. The hierarchy relies on the degree of approximation of the variables discretised with a Discontinuous Galerkin method for the vertical direction. These innovative models will imply a theoretical study and the development of numerical tools in dimensions 1 and 2 before the modelling of other physical phenomena (viscosity effects, ...).

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

Two collaborations with foreign colleagues are to be mentioned:

- A collaboration with spanish researchers has been initiated in 2016 to derive accurate models and efficient algorithms for free surface flows including non-hydrostatic effects.
- A joint work with R. LeVeque (Univ. Seattle) and M. Berger (New York Univ.) consists in modelling the impact of asteroids on the generation of tsunamis.

9.3.2. Participation in Other International Programs

9.3.2.1. PROCORE Hong-Kong (2016-2017)

Program: Hubert Curien PROCORE

Project title: time-parallelisation methods for control

Duration: 01/16-12/17

Coordinator: Felix Kwok (Univ. Hong-Kong)

Other partners: HKBU (Hong-Kong)

Funding: 5k euros

9.4. International Research Visitors

9.4.1. Visits to International Teams

9.4.1.1. Research Stays Abroad

- Y. Penel spent one month and a half (Mar.-Apr.) at the university of Sevilla (Spain) to collaborate with E. Fernández-Nieto.
- M. Parisot spent a week to Sevilla in April.

We also mention that M. Parisot spent four separate weeks at the university of Toulouse (CERFACS).

ANTIQUÉ Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. AnaStaSec

Title: Static Analysis for Security Properties

Type: ANR générique 2014

Defi: Société de l'information et de la communication

Instrument: ANR grant

Duration: January 2015 - December 2018

Coordinator: Inria Paris-Rocquencourt (France)

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

Inria contact: Jerome Feret

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

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

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

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

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

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

9.1.2. *REPAS*

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

9.1.3. *VeriFault*

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

9.1.4. *TGFSYSBIO*

Title: Microenvironment and cancer: regulation of TGF- β signaling

Type: ANR générique 2014

Defi: Société de l'information et de la communication

Instrument: Plan Cancer 2014-2019

Duration: December 2015 - November 2018

Coordinator: INSERM U1085-IRSET

Others partners: Inria Paris (France), Inria Rennes-Bretagne Atlantique (France),

Inria contact: Jerome Feret

Abstract: Most cases of hepatocellular carcinoma (HCC) develop in cirrhosis resulting from chronic liver diseases and the Transforming Growth Factor β (TGF- β) is widely regarded as both the major pro-fibrogenic agent and a critical inducer of tumor progression and invasion. Targeting the deleterious effects of TGF- β without affecting its physiological role is the common goal of therapeutic strategies. However, identification of specific targets remains challenging because of the pleiotropic effects of TGF- β linked to the complex nature of its extracellular activation and signaling networks.

Our project proposes a systemic approach aiming at identifying the potential targets that regulate the shift from anti- to pro-oncogenic effects of TGF- β . To that purpose, we will combine a rule-based model (Kappa language) to describe extracellular TGF-beta activation and large-scale state-transition based (Cadbium formalism) model for TGF- β -dependent intracellular signaling pathways. The multi-scale integrated model will be enriched with a large-scale analysis of liver tissues using shotgun proteomics to characterize protein networks from tumor microenvironment whose remodeling is responsible for extracellular activation of TGF- β . The trajectories and upstream regulators of the final model will be analyzed with symbolic model checking techniques and abstract interpretation combined with causality analysis. Candidates will be classified with semantic-based approaches and symbolic bi-clustering techniques. All efforts must ultimately converge to experimental validations of hypotheses and we will use our hepatic cellular models (HCC cell lines and hepatic stellate cells) to screen inhibitors on the behaviors of TGF- β signal.

The expected results are the first model of extracellular and intracellular TGF- β system that might permit to analyze the behaviors of TGF- β activity during the course of liver tumor progression and to identify new biomarkers and potential therapeutic targets.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

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

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

9.2.2. MemCad

Type: IDEAS

Defi: Design Composite Memory Abstract Domains

Instrument: ERC Starting Grant

Objectif: Design Composite Memory Abstract Domains

Duration: October 2011 - September 2016

Coordinator: Inria (France)

Partner: None

Inria contact: Xavier Rival

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

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

9.3. International Initiatives

9.3.1. Participation in Other International Programs

9.3.1.1. EXExecutable Knowledge

Title: EXExecutable Knowledge

Type: DARPA

Instrument: DARPA Program

Program: Big Mechanism

Duration: July 2014 - December 2017

Coordinator: Harvard Medical School (Boston, USA)

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

Inria contact: Jerome Feret

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

- Bridge the gap between rich data and their formal representation as executable model elements. Specifically, we seek an intermediate, but already formal, knowledge representation (meta-language) to express granular data germane to interaction mechanisms; a protocol defining which and how data are to be expressed in that language; and a translation procedure from it into the executable format.
- Implement mathematically sound, fast, and scalable tools for analyzing and executing arbitrary collections of rules.
- Develop a theory of causality and attendant tools to extract and analyze the unfolding of causal lineages to observations in model simulations.

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

9.3.1.2. *Active Context*

Title: Active Context

Type: DARPA

Instrument: DARPA Program

Program: Communicating with Computers

Duration: July 2015 - December 2018

Coordinator: Harvard Medical School (Boston, USA)

Partner: University of California, (San Diego, USA), Inria Paris-Rocquencourt, École normale supérieure de Lyon Université Paris-Diderot,

Inria contact: Jerome Feret

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

The barrier is the complexity of studying systems of numerous heterogeneously interacting components in a rapidly evolving field of science. The complexity comes from two kinds of dynamically changing context: the internal dynamics of a biological system, which provide the context for assessing the meaning of a protein-protein interaction datum, and the external dynamics of the very fact base used to define the system in the first place. We propose the integration of dynamic modeling into the practice of bioinformatics to address these two dynamics by coupling them. The external dynamics is at first handled by a novel kind of two-layered knowledge representation (KR). One layer

contextualizes proteins and their interactions in a structure that incrementally constructs, in an open-ended dialogue with the user, its own semantics by piecing together fragments of knowledge from a variety of sources tapped by the Big Mechanism program. The other layer is a model representation (MR) that handles and prioritizes the many executable abstractions compatible with the KR. The internal dynamics is handled not only by execution but also by addressing the impedance mismatch between the unwieldy formal language(s) required for execution and the more heuristic, high-level concepts that structure the modeling discourse with which biologists reason about molecular signaling systems. To the extent that we are successful on both ends, users will be able to effectively deploy modeling for curating the very fact base it rests upon, hopefully achieving self-consistency.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

Xavier Rival supervised the internship of Guillaume Cluzel (L3, École Normale Supérieure de Lyon), on the implementation of array abstract domains.

Xavier Rival supervised the internship of Sixiao Zhu (M1, École Polytechnique), on the integration of a three valued abstraction in MemCAD.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Xavier Rival visited KAIST (Korean Advanced Institute for Science and Technology) as an Invited Professor in November/December 2017.

AOSTE2 Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. FUI

9.1.1.1. CEOS

Participants: Slim Ben-Amor, Liliana Cucu, Mehdi Mezouak, Yves Sorel, Walid Talaboulma.

This project was started on May 2017. Partners of the project are: ADCIS, ALERION, Aéroports de Lyon, EDF, ENEDIS, RTaW, EDF, Thales Communications and Security, ESIEE engineering school and Lorraine University. The CEOS project delivers a reliable and secure system of inspections of pieces of works using professional mini-drone for Operators of Vital Importance coupled with their Geographical Information System. These inspections are carried out automatically at a lower cost than current solutions employing helicopters or off-road vehicles. Several software applications proposed by the industrial partners, are developed and integrated in the drone, within an innovative mixed-criticality approach using multi-core platforms.

9.1.1.2. WARUNA

Participants: Antoine Bertout, Liliana Cucu, Adriana Gogonel, Tomasz Kloda, Yves Sorel, Walid Talaboulma.

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

9.1.2. PIA

9.1.2.1. CAPACITES

Participants: Liliana Cucu, Cristian Maxim, Dumitru Potop-Butucaru, Yves Sorel, Walid Talaboulma.

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

9.1.2.2. DEPARTS

Participants: Liliana Cucu, Adriana Gogonel, Walid Talaboulma.

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

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

9.2.1.1. ASSUME

Participants: Keryan Didier, Fatma Jebali, Dumitru Potop-Butucaru.

Program: ITEA

Project acronym: ASSUME

Project title: Affordable Safe and Secure Mobility Evolution

Duration: September 2015 - August 2018

Coordinator: Daimler

Other partners: among 38 partners Absint, Ansys, Airbus, Kalray, Safran, Thales, ENS, KTH, FZI, etc.

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

9.2.2. Collaborations with Major European Organizations

University of York: Real-Time System Group (UK)

Uncertainties in real-time systems: the utilization of extreme value theory has received increased efforts from our community and more rigorous principles are needed for its full understanding. Our two research teams have gathered these principles in a joint publication.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Professor George Lima (University of Baha, Brazil) visited us between May and June. His stay was dedicated the study of the utilization of extreme value theory on the problem of probabilistic estimation of worst case execution time bounds for a program on a processor.

APICS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Contract Provence Alpes Côte d’Azur (PACA) Region - Inria, BDO (no. 2014-05764) funding the research grant of C. Papageorgakis, see Sections 5.1.3 , 6.1.2 .
- The team participates in the project WIMAG (Wave IMAGing) funded by the IDEX UCA^{Jedi}. It aims at identifying and gathering the research and development by partners of UCA involved in wave imaging systems. Other partners are UNS and CNRS (GéoAzur, I3S, LEAT, LJAD), together with Orange Labs. We forecast to co-advise an internship together with members of the LEAT team ISA <http://leat.unice.fr/pages/activites/isa.html>.
- The team co-advise a PhD (G. Bose) with the CMA team of LEAT (<http://leat.unice.fr/pages/activites/cma.html>) funded by the Labex UCN@Sophia on the co-conception of Antennas and Filters.
- The team participates in the transverse action C4PO funded by the IDEX UCA^{Jedi}. This “Center for Planetary Origin” brings together scientists from various fields to advance and organize Planetary Science at the the University of Nice, and supports research and teaching initiatives within its framework.
- The team also participates in the project ToMaT, “Multiscale Tomography: imaging and modeling ancient materials, technical traditions and transfers”, funded by the IDEX UCA^{Jedi} (“programme structurant Matière, Lumière, Interactions”). This project brings together researchers in archaeological, physical, and mathematical sciences, with the purpose of modeling and detecting low level signals in 3D images of ancient potteries. They will co-advise together a post-doctoral researcher (starting March 2018). The concerned scientists are from CEPAM-CNRS, Nice <http://www.cepam.cnrs.fr/spip.php?article40>, the team Morpheme, CNRS-I3S-Inria <http://www.inria.fr/equipes/morpheme>, and IPANEMA, CNRS, Ministère de la Culture et de la Communication, Université Versailles Saint Quentin <http://ipanema.cnrs.fr/>.

7.2. National Initiatives

7.2.1. ANR Cocoram

The ANR (Astrid) project Cocoram (Co-design et co-intégration de réseaux d’antennes actives multi-bandes pour systèmes de radionavigation par satellite) started January 2014. We are associated with three other teams from XLIM (Limoges University), geared respectively towards filters, antennas and amplifiers design. The core idea of the project is to realize dual band reception and emission chains by co-conceiving the antenna, the filters, and the amplifier. We are specifically in charge of the theoretical design of the filters, matching the impedance of a bi-polarized dual band antenna. This is a perfect training ground to test, apply and adapt our work on matching problems (see Section 5.2).

7.2.2. ANR MagLune

The ANR project MagLune (Magnétisme de la Lune) has been approved July 2014. It involves the Cerege (Centre de Recherche et d’Enseignement de Géosciences de l’Environnement, joint laboratory between Université Aix-Marseille, CNRS and IRD), the IGP (Institut de Physique du Globe de Paris) and ISTERre (Institut des Sciences de la Terre). Associated with Cerege are Inria (Apics team) and Irphe (Institut de Recherche sur les Phénomènes Hors Équilibre, joint laboratory between Université Aix-Marseille, CNRS and École Centrale de Marseille). The goal of this project (led by geologists) is to understand the past magnetic activity of the Moon, especially to answer the question whether it had a dynamo in the past and which mechanisms were at work to generate it. Apics participates in the project by providing mathematical tools and algorithms to recover the remanent magnetization of rock samples from the moon on the basis of measurements of the magnetic field it generates. The techniques described in Section 5.1 are instrumental for this purpose.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Apics is part of the European Research Network on System Identification (ERNSI) since 1992. System identification deals with the derivation, estimation and validation of mathematical models of dynamical phenomena from experimental data.

7.4. International Initiatives

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

7.4.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

International Partner (Institution - Laboratory - Researcher):

Massachusetts Institute of Technology (United States) - Department of Earth, Atmospheric and Planetary Sciences - Benjamin P. Weiss

Start year: 2016

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

The associate team IMPINGE is concerned with the inverse problem of recovering a magnetization distribution from measurements of the magnetic field above rock slabs using a SQUID microscope (developed at MIT). The application domain is to Earth and planetary sciences. Indeed, the remanent magnetization of rocks provides valuable information on their history. This is a renewal of the previous Associate Team IMPINGE that ended 2015. The US team also involves a group of Mathematicians at Vanderbilt University (see Section 5.1.1).

7.4.2. Inria International Partners

7.4.2.1. Informal International Partners

MIT-France seed funding is a competitive collaborative research program ran by the Massachusetts Institute of Technology (Cambridge, Ma, USA). Together with E. Lima and B. Weiss from the Earth and Planetary Sciences dept. at MIT, Apics obtained two-years support from the above-mentioned program to run a project entitled: “Development of Ultra-high Sensitivity Magnetometry for Analyzing Ancient Rock Magnetism”

NSF Grant L. Baratchart, S. Chevillard and J. Leblond are external investigators in the NSF Grant 2015-2018, “Collaborative Research: Computational methods for ultra-high sensitivity magnetometry of geological samples” led by E.B. Saff (Vanderbilt Univ.) and B. Weiss (MIT).

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Cauê Borlina (MIT, Boston, Massachusetts, USA, Apr. 24-28).
- Nattapong Bosuwan (Mahidol University, Bangkok, Thailand, May-Aug.).
- Briceyda Delgado Lopez (PhD student, Cinvestav, Queretaro, Mexico, Jan.-Mar.).
- Bernard Hanzon (Univ. Cork, Ireland, Apr.-Jun.).
- Douglas Hardin (Vanderbilt University, Nashville, Tennessee, USA, Apr. 24-28).
- Eduardo Lima (MIT, Boston, Massachusetts, USA, Apr. 24-28).
- Mateusz Rusiniak (BESA GmbH, Gräfelfing, Germany, Dec. 15).
- Ioannis Stratis (National and Kapodistrian University of Athens, Greece, Dec. 14-15).
- Carsten Wolters (University of Münster, Germany, Dec. 14-15).

7.5.1.1. Internships

- Gautier Dervaux (IMT Atlantique, Brest, France, Jul.-Aug.).

7.5.2. Visits to International Teams

7.5.2.1. Research Stays Abroad

L. Baratchart spent the fall semester 2017 at Vanderbilt University, Nashville, Tennessee, teaching a course on inverse problems and pursuing research with D. Hardin, E.B. Saff and C. Villalobos, as well as E. Lima, all members of the Inria associate team IMPINGE

7.6. List of international and industrial partners

- Collaboration under contract with Thales Alenia Space (Toulouse, Cannes, and Paris), CNES (Toulouse), XLIM (Limoges), University of Bilbao (Universidad del País Vasco / Euskal Herriko Unibertsitatea, Spain), BESA company (Munich), Flextronics.
- Regular contacts with research groups at UST (Villeneuve d'Asq), Universities of Bordeaux-I (Talence), Orléans (MAPMO), Aix-Marseille (CMI-LATP), Nice Sophia Antipolis (Lab. JAD), Grenoble (IJF and LJK), Paris 6 (P. et M. Curie, Lab. JLL), Inria Saclay (Lab. Poems, ENSTA), IMT Atlantique (Institut Mines-Télécom., Brest), Cerege-CNRS (Aix-en-Provence), CWI (the Netherlands), MIT (Boston, USA), Vanderbilt University (Nashville USA), Steklov Institute (Moscow), Michigan State University (East-Lansing, USA), Texas A&M University (College Station USA), Indiana University-Purdue University at Indianapolis, St Louis University (St Louis, Missouri, USA), Cinvestav (Queretaro, Mexico), Politecnico di Milano (Milan, Italy), University of Trieste (Italy), RMC (Kingston, Canada), University of Leeds (UK), of Maastricht (the Netherlands), of Cork (Ireland), Vrije Universiteit Brussel (Belgium), TU-Wien and Universität Wien (Austria), TFH-Berlin (Germany), ENIT (Tunis), KTH (Stockholm), University of Cyprus (Nicosia, Cyprus), University of Macau (Macau, China), SIAE Microelettronica (Milano).
- The project is involved in the GDR-project AFHP (CNRS), in the ANR (Astrid program) project Cocoram (with XLIM, Limoges, and DGA), in the ANR (Défis de tous les savoirs program) project MagLune (with Cerege, IPGP, ISTerre, Irphe), in a MIT-France collaborative seed funding, in the Associate Inria Team IMPINGE (with MIT, Boston), and in a NSF grant (with Vanderbilt University and MIT).

ARAMIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR-NIH-NSF NETBCI

Participants: Fabrizio de Vico Fallani [Correspondant], Mario Chavez, Denis Schwartz.

Project acronym: NETBCI

Project title: Modeling and predicting brain-computer interface learning from dynamic networks

Duration: Avr 2016 - Avr 2020

Amount: 322k€

Coordinator: Fabrizio De Vico Fallani

Other partners: Complex system group, UPenn, USA

Abstract: This project will bring together expertise in computational and experimental neuroscience, signal processing and network science, statistics, modeling and simulation, to establish innovative methods to model and analyze temporally dynamic brain networks, and to apply these tools to develop predictive models of brain-computer interface (BCI) skill acquisition that can be used to improve performance. Leveraging experimental data and interdisciplinary theoretical techniques, this project will characterize brain networks at multiple temporal and spatial scales, and will develop models to predict the ability to control the BCI as well as methods to engineer BCI frameworks for adapting to neural plasticity. This project will enable a comprehensive understanding of the neural mechanisms of BCI learning, and will foster the design of viable BCI frameworks that improve usability and performance.

9.1.1.2. ANR-NIH-NSF HIPLAY7

Participants: Olivier Colliot [Correspondant], Marie Chupin, Stanley Durrleman, Anne Bertrand.

Project acronym: HIPLAY7

Project title: Hippocampal layers: advanced computational anatomy using very high resolution MRI at 7 Tesla in humans

Duration: Jan 2017 - Jan 2020

Amount: 770k€

Coordinator: Olivier Colliot and Pierre-François Van de Moortele

Other partners: University of Minnesota, Neurospin

Abstract: The overall goal of this proposal is to develop a coherent mathematical framework for computational anatomy of the internal structures of the hippocampus based on cutting edge MRI acquisition techniques at 7 Tesla. These mathematical and computational approaches are expected to significantly advance the field of computational anatomy of the human brain, breaking down the millimeter barrier of conventional brain morphometry and providing a coherent analysis framework for anatomical data at ultra-high spatial resolution.

9.1.1.3. ANR PREV-DEMALS

Participants: Olivier Colliot [Correspondant], Marie Chupin, Stanley Durrleman, Anne Bertrand.

Project acronym: PREV-DEMALS

Project title: Predict to prevent frontotemporal lobar degeneration (FTLD) and amyotrophic lateral sclerosis (ALS)

Duration: Avr 2015 - Avr 2019

Amount: 487k€

Coordinator: Isabelle Le Ber

Other partners: ICM, AP-HP, CHR de Lille, CHU Limoges, CHU Rouen, Laboratory of Biomedical Imaging

Abstract: The project focuses on C9ORF72, the most frequent genetic form of frontotemporal lobar degeneration (FTLD) and amyotrophic lateral sclerosis (ALS). Since 2006, major discoveries have helped elucidate the pathological bases and linked FTLD and ALS: 1) TDP-43 aggregates in neurons and 2) C9ORF72 mutations in both disorders. Two major pathological subtypes are now defined in FTLD, FTLD-TDP and FTLD-TAU. C9ORF72 mutations (associated to FTLD-TDP) are the most frequent genetic causes of FTLD (15%), FTLD-ALS (65%) and ALS (40%). No curative treatment actually exists, but therapeutics emerged against tau aggregation. The objectives of the project are to develop appropriate cognitive, brain imaging markers and peripheral biomarkers of the early phase of FTLD, to follow disease progression and to guide future targeted therapeutic trials. To address this questions, we will conduct a multimodal study (cognition, brain structural MRI, brain metabolism - FDG-PET) in C9ORF72 families. The cohort will be followed at 3-time points (M0, M18, M36). Longitudinal analyses will aim at characterizing the trajectory of decline across time. Brain structural changes will be evaluated by 1) morphometric analysis to assess global brain atrophy, cortical thickness and study of the cortical sulci; 2) functional connectivity analysis of resting-state MR data; 3) structural connectivity analysis of diffusion-weighted MRI. Brain metabolism will be evaluated with FDG-PET. We will use the most recent RNA sequencing technology to detect gene expression and RNA splicing alterations in lymphocytes of patients and presymptomatic carriers. The discovery of new markers involved in FTLD will have practical consequences for early and accurate diagnosis of FLD and ALS disease.

9.1.1.4. ANR IVMRS

Participants: Anne Bertrand [Correspondant], Alexandra Petiet, Mathieu Santin, Francesca Branzoli, Benoit Delatour, Marc Sanson.

Project acronym: IVMRS

Project title: Implantable miniaturized probe for In-vivo Magnetic Resonance Spectroscopy: Application to Murine models of Alzheimer's disease and Gliomas.

Duration: Oct 2016 - Oct 2020

Amount: 633k€

Coordinator: Luc Hebrard

Other partners: ICube - Unistra, Strasbourg; ISA Laboratory, Lyon; NYU School of Medicine, NY, USA.

Abstract: During the development of new therapeutics against brain diseases, the pre-clinical phase, i.e. the validation of treatment delivery, safety and efficacy in animal models of the disease, represents a crucial step. Magnetic Resonance Imaging (MRI) is a method of particular interest at this stage, as it provides non-invasive surrogate endpoints that can help selecting appropriate candidates during the process of drug development. Single Voxel Magnetic Resonance Spectroscopy (SVS) provides non-invasive, in-vivo quantitative measurements of brain metabolites, which reflects functional changes at the cellular and subcellular levels, and can be repeated longitudinally. As high-field MRI has become the benchmark in preclinical research on animal models, it appears possible

to investigate the cerebral metabolomics changes in animals, and to use it as a surrogate marker in preclinical therapeutic trials. However, the number of relevant metabolites is much higher than the low number of measurable metabolites with conventional in-vivo high-field SVS. Moreover, considering also the subtle changes of these metabolites at the early stage of the disease, the use of conventional high-field SVS in preclinical studies remains strongly limited. The high volume of the Voxel-of-Interest (VOI), ranging from 10 to 30mm³, which is required to have a usable signal in conventional SVS, and the inherent variability of longitudinal SVS measurement due to the variable position of the VOI in the successive experiments, remain the two major issues when looking during time for small changes in metabolic concentrations and metabolites ratios in a specific small region of the animal brain. The IvMRS project aims at filling this gap by developing the first chronic implantable MRS micro-probe (μ -probe), minimally invasive, exhibiting very high signal sensitivity, and sharp spectral peaks, from sub-millimetric VOI. Such a probe will allow detecting a much higher number of metabolites than conventional in-vivo SVS. The μ -probe will work at frequencies ranging from 300MHz to 500MHz in ultra-high field Magnetic Resonance Imaging scanners, 7T and 11.7T. It will embed a specific micro-coil antenna, a low-noise signal conditioning circuit designed in CMOS microelectronics technology, as well as an accurate on-chip positioning sensor. It will be dedicated to the study of changes in brain metabolite markers of two major diseases, Alzheimer's disease and cerebral gliomas, and to the assessment of effective therapeutic strategies.

9.1.2. Inria Project Labs

9.1.2.1. IPL Neuromarkers

Participants: Stanley Durrleman [Correspondant], Olivier Colliot [Correspondant], Fabrizio de Vico Fallani, Anne Bertrand, Stéphane Epelbaum.

Project acronym: Neuromarkers

Project title: Design of imaging biomarkers of neurodegenerative diseases for clinical trials and study of their genetic associations

Duration: 2017-2021

Amount: 633k€

Coordinators: Stanley Durrleman and Olivier Colliot

Other partners: Inria GENSCALE, Inria BONSAI, Inria DYLISS, Inria XPOP, ICM, IHU/ICM iConics

Abstract: The Inria Project Lab Neuromarkers to develop new statistical and computational approaches to integrate multimodal imaging and omics data and to demonstrate their potential to identify early alterations and predict progression of neurodegenerative diseases. To tackle this challenge, the project brings together multidisciplinary expertise from Inria and ICM (Brain and Spine Institute) in the fields of statistical learning, brain imaging, bioinformatics, knowledge modeling, genomics and neurodegenerative diseases.

9.1.3. IHU

9.1.3.1. General program

Participants: Olivier Colliot, Mario Chavez, Stanley Durrleman, Marie Chupin, Didier Dormont, Dominique Hasboun, Damien Galanaud, Fabrizio de Vico Fallani.

Project acronym: IHU-A-ICM

Project title: Institute of Translational Neuroscience

Founded in 2011

General Director: Bertrand Fontaine

The IHU-A-ICM program was selected, in 2011, in a highly competitive national call for projects. A 10-year, 55M€ program, has been implemented by a recently created foundation for scientific cooperation. Based on the clinical and scientific strenghts of the ICM and the hospital Department of Nervous System Diseases, it mainly supports neuroscience research, but is also invested in improving care and teaching. ARAMIS is strongly involved in the IHU-A-ICM project, in particular in WP6 (neuroimaging and electrophysiology), WP7 (biostatistics), WP2 (Alzheimer) and WP5 (epilepsy). We have started collaborations with the new bioinformatics/biostatistics platform (IHU WP7, head: Ivan Moszer), in particular through a joint project on the integration of imaging and genomics data.

9.1.3.2. *ICM-Internal Research projects*

Participants: Anne Bertrand [Correspondant], Takoua Kaaouana, Benoit Delatour, Alexandra Petiet.

Project title: The Histo-MRI project: targeting MR signature of tauopathy from micro- to macroscopy

Started in 2014

Coordinator: Anne Bertrand

Identifying morphological MR signatures of brain diseases usually follows a top-down process, which starts by describing a pattern of MR signal changes in patients, hypothesizes an underlying pathological mechanism, and confirms this mechanism by correlating the observed MR signal changes with histological lesions on post-mortem examination. This top-down process, relevant for large, centimetric brain lesions, becomes inappropriate when targeting the MR signal intensity changes associated with microscopic lesions. Our project aims at developing an MR biomarker of NFT using a new bottom-up approach. We will start by identifying the MR signal changes associated with the presence of NFT at the level of the histological slice, and utilize these findings to develop a method of NFT quantification on clinical, millimetric 3D MR images. To achieve this goal, we will develop and implement a 11.7T histological coil dedicated to the scanning of histological slices, which allows both ultra-high resolution MR imaging (up to 33 microns in-plane) and perfect co-registration with histological staining, performed subsequently on the same slice. This method has the potential to provide a novel biomarker of tauopathy that could not have been identified using the usual top-down approach. It also envisions the possibility to describe and understand new MRI contrasts in other neurodegenerative diseases associated with microscopic deposition of various proteins.

9.1.3.3. *ICM-Internal Research projects*

Participants: Mario Chavez [Correspondant], Fabrizio de Vico Fallani [Correspondant].

Project title: Non-invasive manipulation of brain synchrony to enhance brain function and rehabilitate faulty cognition in humans: A proof of concept

Started in 2014

Coordinator: Antoni Valero Cabre (ICM-team “Dynamiques Cérébrales, Plasticité et Rééducation”)

Other partners: Service des Urgences Cérébro-Vasculaires de l’Hôpital Pitié-Salpêtrière, Paris.

The long-term goal of this project is to develop the use of non-invasive manipulation of abnormal cerebral oscillations underlying cognitive activity to restore brain function in neurological patients. Cognitive functions emerge from large distributed networks organized in space and time. The short-term goal of this application is to study the causal role played by oscillatory activity in visual awareness and test whether their manipulation by non-invasive brain stimulation has the potential to restore its function in stroke patients.

9.1.3.4. ICM Big Brain Theory Program

Participants: Stanley Durrleman [Correspondant], Harald Hampel [Correspondant], Sabrina Fontanella, Simone Lista, Olivier Colliot, Stephanie Allassonniere, Jean-Baptiste Schiratti, Bruno Dubois, Hovagim Bakardjian, Remi Genthon, Enrica Cavedo, Katrine Rojkowa.

Project title: Dynamic models of disease progression across Alzheimer's disease stages informed by multimodal neuroimaging and biological data

Founded in 2016-2017

Coordinator: Stanley Durrleman and Harald Hampel

Other partners: Institut de la Mémoire et de la maladie d'Alzheimer

The estimation of data-driven models of disease progression for neurodegenerative diseases, including Alzheimer's disease (AD), is crucial to confirm, refine and extend the current hypothetical models. The estimation of such quantitative models from longitudinal data sets is notably difficult because of the lack of principled methodological frameworks for the analysis of spatiotemporal data.

The project builds on an innovative mathematical, statistical, and computational framework to automatically align the dynamics and the direction of individual trajectories of the evolving pathology, and then to infer a normative scenario of disease progression across different disease stages. The estimated scenario will combine spatiotemporal maps of lesion propagation, such as maps of amyloid deposition or cortical atrophy, and global measurements such as levels of CSF biomarkers. It will be possible to estimate not only a normative scenario but also the inter-individual variability in the values, dynamics and direction of both topographical and pathophysiological biomarkers changes during the course of the disease.

The application of this technology to publicly available and in-house longitudinal data sets of individuals from the asymptomatic at risk to the prodromal and dementia stages will yield new insights into the pathophysiology of AD from the preclinical to the AD dementia stages. This quantitative data-driven approach will be exploited to assess and refine the current qualitative hypothetical models of AD progression. Notably, it will complement these models with typical pathways of lesion propagation in the brain during disease progression. It will also highlight the effect of the known risk factors of AD such as apolipoprotein E genotype on the disease progression profile.

The project will open up the concrete possibility to derive a computer-aided diagnosis, staging, and prognosis tool for a better recruitment of patients in clinical studies and to assist clinicians in the diagnosis and the monitoring of both disease progression and treatment efficacy.

9.1.3.5. IFR49-Internal Research projects

Participants: Mario Chavez [Correspondant], Fabrizio de Vico Fallani [Correspondant].

Project title: Exploring the impact and time frequency signature of rhythmic patterns of Transcranial Magnetic Stimulation (TMS) on network activity by Magneto-Encephalography (MEG)

Founded in 2014

Coordinator: Antoni Valero Cabre (ICM-team "Dynamiques Cérébrales, Plasticité et Rééducation")

Other partners: TMS, EEG and MEG technical platforms of the ICM at the Hopital Pitié-Salpêtrière; and Service des Urgences Cérébro-Vasculaires de l'Hôpital Pitié-Salpêtrière, Paris.

The long-term goal of this project is to better understand the ability of non invasive neurostimulation to induce lasting local and distributed reorganization effects in the human brain to better plan and document therapies for patients. The short-term goal of this application is to develop a new mapping procedure to be able to capture and characterize in terms of oscillatory activity the lasting impact of repetitive Transcranial Magnetic Stimulation (TMS) on specific brain regions and associated networks.

9.1.4. National Networks

- GdR Statistics and Medicine - <http://gdr-stat-sante.math.cnrs.fr/spip/>
- GdR (MaDICS) Masses de Données, Informations et Connaissances en Sciences Big Data - Data Science Statistics and Medicine - <http://www.madics.fr/reseaux/>

9.1.5. Other National Programs

9.1.5.1. Programme Hospitalier de Recherche Clinique (PHRC)

Participants: Olivier Colliot, Marie Chupin, Stanley Durrleman, Didier Dormont, Damien Galanaud.

- PHRC PredictPGRN, co-funding by Alzheimer Plan, *Caractérisation multimodale prospective de la démence frontotemporale due à des mutations du gène PGRN à un stade symptomatique et présymptomatique*. (Coordinator : A. Brice)
- PHRC ImaBio3, co-funding by Roche (pharmaceutical industry), *Rôle des réactions cellulaires sanguines, inflammatoires et immunitaires anti-amyloïde centrales et périphériques dans la maladie d'Alzheimer débutante*. (Coordinator : M. Sarazin)
- PHRC CAPP, *Caractérisation linguistique, anatomique/métabolique et biologique des différentes formes d'aphasie primaire progressive : vers le rationnel pour des essais pharmacologiques et des rééducations du langage ciblées*. (Coordinator: M. Teichmann)

9.1.5.2. Institut Universitaire d'Ingénierie pour la Santé (IUIS)

Participants: Mario Chavez, Xavier Navarro.

Project acronym: DYSPEV

Project title: Dépistage de la dyspnée par potentiels évoqués visuels

Funded in 2014

Amount: 38K€

Coordinator: Thomas Similowski

Other partners: UPMC, Inserm UMR 1158

Abstract: Steady state visual evoked potentials (SSVEP) have been widely utilized in brain computer interfacing (BCI) in last years. In this project, we explore the possibilities of SSVEP to manage the communication between patients suffering from respiratory disorders and health care providers. By imposing different breathing constraints, we use a SSVEP-based brain computer interface to help those subjects to communicate their breathing sensations (breathing well/breathing bad).

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. H2020 - Project EuroPOND

Participants: Olivier Colliot, Stanley Durrleman, Manon Ansart, Igor Koval, Alexandre Bône.

Project acronym: EuroPOND

Project title: Data-driven models for Progression Of Neurological Disease

Duration: Jan 2016 - Dec 2019

Amount: 6M€

Coordinator: Daniel Alexander

Other partners: University College London (UK), EMC Rotterdam (The Netherlands), VUMC (The Netherlands), Fate Bene Fratelli (Italy), Carol Besta Institute (Italy), Université de Genève (Switzerland), Icometrix (Belgium)

Abstract: EuroPOND will develop a data-driven statistical and computational modeling framework for neurological disease progression. This will enable major advances in differential and personalized diagnosis, prognosis, monitoring, and treatment and care decisions, positioning Europe as world leaders in one of the biggest societal challenges of 21st century healthcare. The inherent complexity of neurological disease, the overlap of symptoms and pathologies, and the high comorbidity rate suggests a systems medicine approach, which matches the specific challenge of this call. We take a uniquely holistic approach that, in the spirit of systems medicine, integrates a variety of clinical and biomedical research data including risk factors, biomarkers, and interactions. Our consortium has a multidisciplinary balance of essential expertise in mathematical/statistical/computational modelling; clinical, biomedical and epidemiological expertise; and access to a diverse range of datasets for sporadic and well-phenotyped disease types. The project will devise and implement, as open-source software tools, advanced statistical and computational techniques for reconstructing long-term temporal evolution of disease markers from cross-sectional or short-term longitudinal data. We will apply the techniques to generate new and uniquely detailed pictures of a range of important diseases. This will support the development of new evidence-based treatments in Europe through deeper disease understanding, better patient stratification for clinical trials, and improved accuracy of diagnosis and prognosis. For example, Alzheimer's disease alone costs European citizens around €200B every year in care and loss of productivity. No disease modifying treatments are yet available. Clinical trials repeatedly fail because disease heterogeneity prevents bulk response. Our models enable fine stratification into phenotypes enabling more focussed analysis to identify subgroups that respond to putative treatments.

9.2.1.2. *FET Flagship - Human Brain Project*

Participants: Olivier Colliot, Stanley Durrleman.

Project acronym: HBP

Project title: Human Brain Project

Sub-project: SP8 - Medical Informatics Platform

Duration (for this phase): 2016-2018

Abstract: The Human Brain Project (HBP) is a European Commission Future and Emerging Technologies Flagship. The HBP aims to put in place a cutting-edge, ICT-based scientific Research Infrastructure for brain research, cognitive neuroscience and brain-inspired computing. The Project promotes collaboration across the globe, and is committed to driving forward European industry. Our team is involved in the Subproject SP8 (Medical Informatics Platform). The Medical Informatics Platform (MIP) is an innovative data management system that gives researchers the means to access and analyse large amounts of anonymized clinical neuroscience data. Within that framework, we will develop and implement a method to construct disease progression models from longitudinal biomarkers. The method will use statistical learning techniques to infer a long-term disease progression model from multiple short term data from a series of individuals. The model will account for variability in age at disease onset, pace of disease progression and trajectories of biomarkers changes across individuals in the observed population.

9.2.1.3. *ERC - LEASP*

Participants: Stanley Durrleman, Raphael Couronné.

Project acronym: LEASP

Project title: Learning Spatiotemporal Patterns in Longitudinal Image Data Sets of the Aging Brain

Duration: 2016-2021

Abstract: Time-series of multimodal medical images offer a unique opportunity to track anatomical and functional alterations of the brain in aging individuals. A collection of such time series for several individuals forms a longitudinal data set, each data being a rich iconic-geometric representation of the brain anatomy and function. These data are already extraordinary complex and variable across individuals. Taking the temporal component into account further adds difficulty, in that each individual follows a different trajectory of changes, and at a different pace. Furthermore, a disease is here a progressive departure from an otherwise normal scenario of aging, so that one could not think of normal and pathologic brain aging as distinct categories, as in the standard case-control paradigm.

Bio-statisticians lack a suitable methodological framework to exhibit from these data the typical trajectories and dynamics of brain alterations, and the effects of a disease on these trajectories, thus limiting the investigation of essential clinical questions. To change this situation, we propose to construct virtual dynamical models of brain aging by learning typical spatiotemporal patterns of alterations propagation from longitudinal iconic-geometric data sets.

By including concepts of the Riemannian geometry into Bayesian mixed effect models, the project will introduce general principles to average complex individual trajectories of iconic-geometric changes and align the pace at which these trajectories are followed. It will estimate a set of elementary spatiotemporal patterns, which combine to yield a personal aging scenario for each individual. Disease-specific patterns will be detected with an increasing likelihood.

This new generation of statistical and computational tools will unveil clusters of patients sharing similar lesion propagation profiles, paving the way to design more specific treatments, and care patients when treatments have the highest chance of success.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

F. De Vico Fallani has a collaboration with the University Penn, Philadelphia, US (Prof. Danielle Bassett).

M. Chavez has different collaborations with the Mathematics Departement of the Queen Mary University of London, UK (Prof. V. Latora); and the Physics Department of the Universitat de Barcelona, Spain (Prof. Albert Diaz-Guilera)

F. De Vico Fallani has an enduring collaboration with the University Sapienza, Rome, Italy (Profs. Fabio and Claudio Babiloni) and with the IRCCS Fondazione Santa Lucia, Rome, Italy (M. Molinari and D. Mattia).

S. Durrleman has an enduring collaboration with professor Guido Gerig, Tandon School of Engineering, NYU. He is consultant for NIH Grant "4D shape analysis for modeling spatiotemporal change trajectories in Huntington's Disease "predict-HD".

O. Colliot has an enduring collaboration with the Center for Magnetic Resonance Research, University of Minnesota, USA (P-F Van de Moortele, T. Henry, M. Marjanska, K. Ugurbil) a leading center in 7T MRI.

S. Durrleman and O. Colliot have a collaboration with the Center for Medical Image Computing (CMIC) at University College London (UCL), London, UK (S. Ourselin, D. Alexander, M. Modat).

S. Durrleman has a collaboration with the department of Computer Science at New York University (NYU) (G. Gerig and J. Fishbaugh)

A. Bertrand has an enduring collaboration with professor Youssef Z. Wadghiri, head of the Pre-clinical Imaging Core, Center for Biomedical Imaging, NYU School of Medicine, New York, NY, USA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Professor Tom Fletcher from the University of Utah visited ARAMIS from January 23 to January 27.

9.4.1.1. Internships

Kuldeep Kumar (Ecole de Technologie Supérieure, Montréal, Canada) is visiting ARAMIS from October 2016 to March 2017 under the MITACS programme.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Junhao Wen, PhD candidate, did a 3-month internship in the team of Hui Zhang, UCL, to develop pipelines of analysis for advanced diffusion MRI acquisitions (Neurite Orientation Dispersion and Density Imaging). This internship was funded by the ICM Carnot Program.

ARIC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The PhD grant of Valentina Popescu has been funded since September 2014 by Région Rhône-Alpes through the “ARC6” programme.

9.2. National Initiatives

9.2.1. ANR DYNA3S Project

Participants: Guillaume Hanrot, Gilles Villard.

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

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

9.2.2. ANR FastRelax Project

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

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

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

9.2.3. ANR MetaLibm Project

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

MetaLibm is a four-year project (started in October 2013 and recently extended till March 2018) focused on the design and implementation of code generators for mathematical functions and filters. The web page of the project is <http://www.metalibm.org/ANRMetaLibm/>. It is headed by Florent de Dinechin (INSA Lyon and Socrate team) and, besides Socrate and AriC, also involves teams from LIRMM (Perpignan), LIP6 (Paris), CERN (Geneva), and Kalray (Grenoble). The main goals of the project are to automate the development of mathematical libraries (libm), to extend it beyond standard functions, and to make it unified with similar approaches developed in or useful for signal processing (filter design). Within AriC, we are especially interested in studying the properties of fixed-point arithmetic and floating-point arithmetic that can help develop such a framework.

9.2.4. 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.

9.2.5. RISQ Project

Participants: Benoît Libert, Fabien Laguillaumie, Damien Stehlé, Chitchanok Chuengsatiansup.

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 products. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. LattAC ERC grant

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

9.3.1.2. PROMETHEUS Project

Participants: Benoît Libert, Fabien Laguillaumie, 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 will start in January 2018. It gathers 7 academic partners (ENS de Lyon and Université de Rennes 1; CWI, Pays-Bas; Royal Holloway University of London, United Kingdom; Universitat Politècnica de Catalunya, Spain; Ruhr-Universität Bochum, Germany; Weizmann Institute, Israel), 5 industrial partners (Orange, IBM, Thales, TNO, Scyt). 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.

9.4. International Initiatives

9.4.1. Participation in International Programs

Vincent Lefèvre participated in the standardization of interval arithmetic (simplified version of the standard, IEEE 1788.1). He actively participates in the revision of the IEEE 754 standard for 2018.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Lloyd Nicholas Trefethen, from Oxford University (UK), is an expert in numerical analysis and notably the systematic use of Chebyshev approximation. He is spending the academic year 2017-2018 with AriC.
- Warwick Tucker, from Uppsala University (Sweden), is an expert of certified computation for dynamical systems. He is spending the academic year 2017-2018 with AriC.
- Huaxiong Wang, from Nanyang Technological University (Singapore), is an expert in cryptographic protocols and multi-party computation. He visited us in March and April 2017.
- Jung Hee Cheon, from Seoul National University (South Korea), is an expert in algorithmic number theory and the mathematical foundations of cryptography. He is visiting us since October 2017, until January 2018.

9.5.2. Internships

Benjamin Graillot

Date: May 2017–July 2017

Institution: ENS de Cachan

Supervisor: Bruno Salvy

9.5.3. Visits to International Teams

9.5.3.1. Research Stays Abroad

Benoît Libert spent one month in the cryptography team of Nanyang Technological University (Singapore), to collaborate with Khoa Nguyen and Huaxiong Wang.

AROMATH Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Our team AROMATH participates to the VADER project for VIRTUAL MODELING of RESPIRATION, UCA Jedi, axis "Modélisation, Physique et Mathématique du vivant". <http://benjamin.mauroy.free.fr/VADER>.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Program: Marie Skłodowska-Curie ITN

Project acronym: ARCADES

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

Duration: January 2016 - December 2019

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

Scientist-in-charge at Inria: L. Busé

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

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

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

8.2.2. Collaborations in European Programs, Except FP7 & H2020

Program: Partnership Agreement for the Development Framework

Project acronym: RANWALK

Project title: Random walks for the computation of potential and capacitance of electronic circuits

Duration: December 2017 - May 2020

Coordinator: C. Bakolias (Helic S.A.)

Scientist-in-charge at Inria: I.Z. Emiris (NKUA, Athens, Greece, and ATHENA Research Innovation Center)

Other partners: ATHENA Research Innovation Center, Maroussi (Greece), School of Electrical Engineering, U. Patras (Greece).

Abstract: The Project aims at reducing the fabrication cost of new generation circuits and achieve significant progress in Electronic Design Automation (EDA) of Integrated Circuits with the development of innovative technology, which will radically upgrade Helic's existing products by giving them a unique lead in the global market. A key element of the modeling engine and the general approach is the method of random walks between a set of conductors, based on the solution of the Laplace equation and the calculation of the Green function in cubic-shaped areas. We target the geometric modeling of the physical design of the conductors, as well as the efficient and robust calculation of the above electrostatic parameters, with the ultimate goal of a rapid simulation of the circuit's accuracy. We focus on calculating the maximum cube gap between rectangular elements and, for this, we develop large-scale geometric software.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Vlada Pototskaia, University of Göttingen (Germany), visited from August 28th to September 15th. The collaboration with E. Hubert and B. Mourrain concerned AAK theory and its applications to approximate low rank sums of exponentials.

Ibrahim Nonkané, University of Ouagadougou, visited from September 25th to October 9th to work with L. Busé on the discriminant of complete intersections in a projective space.

Sotirios Choularias, University of Strathclyde (Scotland), visited us from August 5th to November 5th in the context of his secondment in the ITN network ARCADES, to work on boundary element methods and isogeometric analysis.

Yairon Cid Ruiz, University of Barcelona (Spain), visits us since October 1st, to work with L. Busé on the birationality of bi-graded rational maps in small dimensions.

Roser Homs Pons, University of Barcelona (Spain), visited us from October 9th to December 15th, to work with B. Mourrain on effective methods for the construction of Gorenstein algebra of low colength.

Simon Telen, University of Leuven (Belgium), visited us from August 24th to September 24th, to work with B. Mourrain on algebraic solvers and numerical linear algebra.

Meng Wu, University of Hefei (China), visited us from September 4th to September 29th, to work with B. Mourrain on isogeometric analysis and its applications.

Gang Xu, Hangzhou Dianzi University (China) visited us from September 7th to September 15th, to work with B. Mourrain on parameterization of computation domains for isogeometric analysis.

8.3.1.1. Internships

Antoine Deharveng, student at the engineer school of the University of Nice Sophia Antipolis, did his PFE (Projet de fin d'étude) with L. Busé until March 2017. He developed the interpolation of cylinders and cones passing through minimal point sets in the C++ library ASurfExt (<https://gitlab.inria.fr/lbuse/ASurfExt/wikis/home>).

Andrien Boudin did his internship with L. Busé from June 15th to September 15th. He developed and implemented a new method for the interpolation of torus through a minimal point set in the C++ library ASurfExt (<https://gitlab.inria.fr/lbuse/ASurfExt/wikis/home>).

Thomas Laporte, student at the engineer school of the University of Nice Sophia Antipolis, did his internship with A. Galligo from June 15th to September 15th. He studied "Hand modeling" and implemented in Axel a method inspired by the paper by P AULY .M, T AGLIASACCHI .A, T KACH .A. Sphere-Meshes for Real-Time Hand Modeling and Tracking. ACM Transactions on Graphics 2016. (Proc. of SIGGRAPH Asia).

Emmanouil Christoforou, Master student from NKUA, works from September 4th to December 31th on software development for the algebraic-geometric modeler Axel.

8.3.1.2. Research Stays Abroad

F. Yildirim was on secondment at Barcelona university (Spain), with Carlos D'Andrea, for 3 months (September 15-December 15).

A. Fuentes Suarez was on secondment at Athens university (Greece), with Ioannis Emiris, for 4 months (September-December).

A. Blidia was on secondment at Evolute, Vienna (Austria), with A. Schiftner (Evolute) and H. Pottmann (TUW), for 3 months (November-January).

E. Hubert received a grant from the London Mathematics Society to visit the University of Kent in Canterbury (UK) from February 21st to March 1st.

ASAP Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR project *SocioPlug*

Participants: Davide Frey, Anne-Marie Kermarrec, Pierre-Louis Roman, Francois Taiani.

SocioPlug is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, and LIRIS (INSA Lyon and Univ. Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more or less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

7.1.2. *DeSceNt CominLabs*

Participants: Resmi Ariyattu Chandrasekharannair, Davide Frey, Michel Raynal, Francois Taiani.

The DeSceNt project aims to ease the writing of distributed programs on a federation of plug computers. Plug computers are a new generation of low-cost computers, such as Raspberry pi (25\$), VIA- APC (49\$), and ZERO Devices Z802 (75\$), which offer a cheap and readily available infrastructure to deploy domestic on-line software. Plug computers open the opportunity for everyone to create cheap nano-clusters of domestic servers, host data and services and federate these resources with their friends, colleagues, and families based on social links. More particularly we will seek in this project to develop novel decentralized protocols than can encapsulate the notion of privacy-preserving federation in plug-based infrastructures. The vision is to use these protocols to provide a programming toolkit that can support the convergent data types being developed by our partner GDD (Gestion de Données Distribuées) at Univ. Nantes.

7.1.3. ANR *Blanc* project *Displexity*

Participants: George Giakkoupis, Anne-Marie Kermarrec, Michel Raynal.

The Displexity project started in 2011. The aim of this ANR project that also involves researchers from Paris and Bordeaux is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing. One difficulty to be faced by DISPLEXITY is to reconcile two non necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues on distributed algorithms.

7.1.4. ANR project *PAMELA*

Participants: Davide Frey, George Giakkoupis, Francois Taiani.

PAMELA is a collaborative ANR project involving ASAP, Inria Lille, UMPC, Mediego and Snips. The project aims at developing machine learning theories and algorithms in order to learn local and personalized models from data distributed over networked infrastructures. This project seeks to provide first answers to modern information systems built by interconnecting many personal devices holding private user data in the search of personalized suggestions and recommendations. More precisely, we will focus on learning in a collaborative way with the help of neighbors in a network. We aim to lay the first blocks of a scientific foundation for these new types of systems, in effect moving from graphs of data to graphs of data and learned models. We argue that this shift is necessary in order to address the new constraints arising from the decentralization of information that is inherent to the emergence of big data. We will in particular focus on the question of learning under communication and privacy constraints. A significant asset of the project is the quality of its industrial partners, SNIPS and MEDIEGO, who bring in their expertise in privacy protection and distributed computing as well as use cases and datasets. They will contribute to translate this fundamental research effort into concrete outcomes by developing personalized and privacy-aware assistants able to provide contextualized recommendations on small devices and smartphones.

7.1.5. ANR project *OBrowser*

Participants: David Bromberg, Davide Frey, Francois Taiani.

OBrowser is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, the Bretagne Sud. University, and Orange. The project emerges from the vision of designing and deploying distributed application on millions of machines using web-enabled technologies without relying on a cloud or a central authority. OBrowser proposes to build collaborative applications through a decentralized execution environment composed of users' browsers that autonomously manages issues such as communication, naming, heterogeneity, and scalability. The introduction of browser-to-browser communication with WebRTC's Datachannel has made these scenarios closer, but today only experts can afford to tackle the technical challenges associated with large-scale browser-based deployments such as decentralized instant-messaging (Firechat) and Infrastructure-less Mission Critical Push To Talk. O'Browser aims to solve these challenges by means of a novel programming framework.

7.1.6. ANR project *DESCARTES*

Participants: George Giakkoupis, Michel Raynal, Francois Taiani.

DESCARTES is a collaborative ANR project involving ASAP, Labri (U. Bordeaux), Lafia (U. Paris Diderot), Vérimag (Grenoble), LIF (Marseilles), and LINA (Nantes). Despite the practical interests of reusable frameworks for implementing specific distributed services, many of these frameworks still lack solid theoretical bases, and only provide partial solutions for a narrow range of services. In this project, we argue that this is mainly due to the lack of a generic framework that is able to unify the large body of fundamental knowledge on distributed computation that has been acquired over the last 40 years. The DESCARTES project aims at bridging this gap, by developing a systematic model of distributed computation that organizes the functionalities of a distributed computing system into reusable modular constructs assembled via well-defined mechanisms that maintain sound theoretical guarantees on the resulting system. DESCARTES arises from the strong belief that distributed computing is now mature enough to resolve the tension between the social needs for distributed computing systems, and the lack of a fundamentally sound and systematic way to realize these systems.

7.1.7. ANR-ERC *Tremplin* project *NDFUSION*

Participant: George Giakkoupis.

NDFUSION is an 18-month ANR project awarded to the PI to support his preparation for his upcoming ERC grant application. The idea of intervening in a network diffusion process to enhance or retard its spread has been studied in various contexts, e.g., to increase the spread or speed of diffusion by choosing an appropriate set of seed nodes (a standard goal in viral marketing by word-of-mouth), or achieve the opposite effect either by choosing a small set of nodes to remove (a goal in immunization against diseases), or by seeding a competing diffusion (e.g., to limit the spread of misinformation in a social network). The aim of this project is to consolidate existing work under a single, comprehensive framework, and using this framework to develop

new, efficient algorithms for optimizing (maximizing or minimizing) the spread of diffusion processes. Novel aspects of the project involve issues of scalability, multiple concurrent diffusions, and the use of multistage online strategies to optimize diffusions. Results from this project are likely to be relevant to many different disciplines, from network optimization in computing to disease containment in medicine.

7.2. International Initiatives

7.2.1. Inria International Labs

- Anne-Marie Kermarrec is the scientific co-chair (with Willy Zwaenepoel) of the EPFL/Inria International Lab

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

7.2.2.1. LiDiCo

Title: Aux limites du calcul réparti

International Partner (Institution - Laboratory - Researcher):

UNAM (Mexico) - Instituto de Matematicas - Sergio Rajsbaum

Start year: 2017

See also: <https://sites.google.com/site/lidicoequipeassociee/>

Today distributed applications are pervasive, some very successful (e.g., Internet, P2P, social networks, cloud computing), and benefit everyone, but the design and the implementation of many of them still rely on ad-hoc techniques instead of on a solid theory. The next generation of distributed applications and services will be more and more complex and demands research efforts in establishing sound theoretical foundations to be able to master their design, their properties and their implementation. This proposal is a step in this inescapable direction.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

- Peter Kling (U of Hamburg) visited ASAP (hosted by G Giakkoupis), Jan 19–25.
- Emanuele Natale (Max Planck, Saarbrücken) visited ASAP (hosted by G Giakkoupis), Apr 23–29.
- Thomas Sauerwald (U of Cambridge) visited ASAP (hosted by G Giakkoupis), Aug 21–24.
- Robert Elsässer (Salzburg U) visited ASAP (hosted by G Giakkoupis), Sep 25–29.

7.3.1.1. Internships

- Jodi Spacek from University of British Columbia, Research internship from May 2017 until Aug 2017, supervised by David Bromberg.
- Stewart Grant from University of British Columbia, Research internship from May 2017 until Aug 2017, supervised by David Bromberg.
- Hayk Saribekyan from MIT, research Internship from June 2017 to August 2017.

7.3.2. Visits to International Teams

7.3.2.1. Research Stays Abroad

- Michel Raynal was at the Hong Kong Polytechnic University from 15 September to 14 October 2017,
- David Bromberg did a visit at USP - Department of Computer Science University of São Paulo, Sao Paulo, Brazil from February 22, 2017 to March 24, 2017

ASCLEPIOS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Marco Lorenzi is principal investigator of the project Big Data for Brain Research, funded in 2017 by the Department des Alpes Maritimes (AAP Santé 2017). The project aims at creating a computing platform within the facility of Inria Sophia Antipolis dedicated to the analysis of large biomedical datasets. The realization of the data management system and computational platform will be achieved through the collaboration with the Maison de la Modélisation, de la Simulation et des Interactions (MSI) of the Université Côte d'Azur.
- N. Ayache and P. Robert are principal investigators of the project MNC3 (Médecine Numérique, Cerveau, Cognition, Comportement) financé par l'Idex Jedi du UCA (2017-2021, 450k€). M. Lorenzi (Inria) actively participates to the supervision of this project with the help of V. Manera (ICP).

8.2. National Initiatives

8.2.1. Consulting for Industry

Nicholas Ayache is a scientific consultant for the company Mauna Kea Technologies (Paris).

8.2.2. Collaboration with national hospitals

The Asclepios-project team collaborates with the following 3 French IHU (University Hospital Institute): the IHU-Strasbourg (Pr J. Marescaux and L. Soler) on image-guided surgery, the IHU-Bordeaux (Pr M. Haïssaguere and Pr P. Jaïs) on cardiac imaging and modeling and the IHU-Pitié Salpêtrière (Dr. O. Colliot and S. Durrleman) on neuroimaging.

We also have long term collaborations with the CHU Nice and Centre Antoine Lacassagne in Nice.

The Asclepios-project team is part of the EQUIPEX MUSIC consortium with Bordeaux University Hospital, which aim is to exploit an XMR interventional room equipped with a MUSIC workstation.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ECSTATIC

Title: Electrostructural Tomography – Towards Multiparametric Imaging of Cardiac Electrical Disorders

Programm: H2020

Type: ERC

Duration: 2017 - 2022

Coordinator: U. Bordeaux

Inria contact: Maxime Sermesant

Cardiac electrical diseases are directly responsible for sudden cardiac death, heart failure and stroke. They result from a complex interplay between myocardial electrical activation and structural heterogeneity. Current diagnostic strategy based on separate electrocardiographic and imaging assessment is unable to grasp both these aspects. Improvements in personalised diagnostics are urgently needed as existing curative or preventive therapies (catheter ablation, multisite pacing, and implantable defibrillators) cannot be offered until patients are correctly recognised.

ECSTATIC aims at achieving a major advance in the way cardiac electrical diseases are characterised and thus diagnosed and treated, through the development of a novel non-invasive modality (Electrostructural Tomography), combining magnetic resonance imaging (MRI) and non-invasive cardiac mapping (NIM) technologies.

The approach will consist of: (1) hybridising NIM and MRI technologies to enable the joint acquisition of magnetic resonance images of the heart and torso and of a large array of body surface potentials within a single environment; (2) personalising the inverse problem of electrocardiography based on MRI characteristics within the heart and torso, to enable accurate reconstruction of cardiac electrophysiological maps from body surface potentials within the 3D cardiac tissue; and (3) developing a novel disease characterisation framework based on registered non-invasive imaging and electrophysiological data, and propose novel diagnostic and prognostic markers.

This project will dramatically impact the tailored management of cardiac electrical disorders, with applications for diagnosis, risk stratification/patient selection and guidance of pacing and catheter ablation therapies. It will bridge two medical fields (cardiac electrophysiology and imaging), thereby creating a new research area and a novel semiology with the potential to modify the existing classification of cardiac electrical diseases.

8.3.1.2. MD PAEDIGREE

Title: Model-Driven European Paediatric Digital Repository

Programm: FP7

Duration: March 2013 - February 2017

Coordinator: Ospedale Pediatrico Bambini Gesù, Rome.

Partners:

Athena Research and Innovation Center in Information Communication & Knowledge Technologies (Greece)

Biomolecular Research Genomics (Italy)

Deutsches Herzzentrum Berlin (Germany)

Empirica Gesellschaft für Kommunikations- und Technologie Forschung MbH (Germany)

Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

Haute Ecole Spécialisée de Suisse Occidentale (Switzerland)

Istituto Giannina Gaslini (Italy)

Katholieke Universiteit Leuven (Belgium)

Lynkeus (Italy)

Motek Medical B.V. (Netherlands)

Ospedale Pediatrico Bambino Gesù (Italy)

Siemens Aktiengesellschaft (Germany)

Siemens Corporation (United States)

Technische Universiteit Delft (Netherlands)

University College London (United Kingdom)

Universitair Medisch Centrum Utrecht (Netherlands)

Universita Degli Studi di Roma Lapienza (Italy)
The University of Sheffield (United Kingdom)
Universitatea Transilvania Din Brasov (Romania)
Stichting Vu-Vumc (Netherlands)
Maat Francerl (France)

Inria contact: Xavier Pennec

MD-Paedigree is a clinically-led VPH project that addresses both the first and the second actions of part B of Objective ICT-2011.5.2:

1. it enhances existing disease models stemming from former EC-funded research (Health-e-Child and Sim-e-Child) and from industry and academia, by developing robust and reusable multi-scale models for more predictive, individualised, effective and safer health-care in several disease areas;
2. it builds on the eHealth platform already developed for Health-e-Child and Sim-e-Child to establish a worldwide advanced paediatric digital repository. Integrating the point of care through state-of-the-art and fast response interfaces, MD-Paedigree services a broad range of off-the-shelf models and simulations to support physicians and clinical researchers in their daily work. MD-Paedigree vertically integrates data, information and knowledge of incoming patients, in participating hospitals from across Europe and the USA, and provides innovative tools to define new workflows of models towards personalised predictive medicine. Conceived of as a part of the 'VPH Infostructure' described in the ARGOS, MD-Paedigree encompasses a set of services for storage, sharing, similarity search, outcome analysis, risk stratification, and personalised decision support in paediatrics within its innovative model-driven data and workflow-based digital repository. As a specific implementation of the VPH-Share project, MD-Paedigree fully interoperates with it. It has the ambition to be the dominant tool within its purview. MD-Paedigree integrates methodological approaches from the targeted specialties and consequently analyzes biomedical data derived from a multiplicity of heterogeneous sources (from clinical, genetic and metagenomic analysis, to MRI and US image analytics, to haemodynamics, to real-time processing of musculoskeletal parameters and fibres biomechanical data, and others), as well as specialised biomechanical and imaging VPH simulation models.

8.3.1.3. MedYMA

Title: Biophysical Modeling and Analysis of Dynamic Medical Images

Programme: FP7

Type: ERC

Period: April 2012 - March 2017

Coordinator: Inria

Inria contact: Nicholas Ayache

During the past decades, exceptional progress was made with in vivo medical imaging technologies to capture the anatomical, structural and physiological properties of tissues and organs in patients, with an ever increasing spatial and temporal resolution. Physicians are now faced with a formidable overflow of information, especially when a time dimension is added to the already hard to integrate 3-D spatial, multimodal and multiscale dimensions of modern medical images. This increasingly hampers the early detection and understanding of subtle image modifications, which can have a vital impact on the patient's health. To change this situation, a new generation of computational models for the simulation and analysis of dynamic medical images is introduced. Thanks to their generative nature, they will allow the construction of databases of synthetic and realistic medical image sequences simulating various evolving diseases, producing an invaluable new resource for

training and benchmarking. Leveraging on their principled biophysical and statistical foundations, these new models will bring an added clinical value once they have been personalized with innovative methods to fit the medical images of any specific patient. By explicitly revealing the underlying evolving biophysical processes observable in the images, this approach will yield new groundbreaking image processing tools to correctly interpret the patient's condition (computer aided diagnosis), to accurately predict the future evolution (computer aided prognosis), and to precisely simulate and monitor an optimal and personalized therapeutic strategy (computer aided therapy). First applications concern high impact diseases including brain tumors, Alzheimer's disease, heart failure and cardiac arrhythmia and will open new horizons in computational medical imaging.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. Inria Associate Team GeomStats (part of Inria@SiliconValley)

Title: Geometric Statistics in Computational Anatomy: Non-linear Subspace Learning Beyond the Riemannian Structure

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Statistics - Susan Holmes

Start year: 2015

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

The scientific goal of the associated team is to develop the field of geometric statistics with key applications in computational anatomy.

Computational anatomy is an emerging discipline at the interface of geometry, statistics, image analysis and medicine that aims at analyzing and modeling the biological variability of the organs shapes at the population level. An important application in neuroimaging is the spatial normalization of subjects which is necessary to compare anatomies and functions through images in populations with different clinical conditions.

The research directions have been broken into three axes, the first two being methodologically driven and the last one being application driven. The first axis aims at generalizing the statistical framework from Riemannian to more general geometric structures and even non-manifold spaces (e.g. stratified spaces). The goal is to understand what is gained or lost using each geometric structure. The second axis aims at developing subspace learning methods in non-linear manifolds. This objective contrasts with most manifold learning methods which assumes that subspaces are embedded in a large enough Euclidean space. The third scientific direction is application driven with cross-sectional and longitudinal brain neuroimaging studies. The goal will be to extract reduced models of the brain anatomy that best describe and discriminate the populations under study. One intend for instance to show where is impact of a treatment for traumatic brain injuries.

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

8.4.2.1. PERSOCARDIOLEARN

Title: Personalization of Cardiac Models using Experimental Data and Machine Learning

International Partner (Institution - Laboratory - Researcher):

University of Toronto (Canada) - Sunnybrook Research Institute - Mihaela Pop

Start year: 2017

See also: <https://team.inria.fr/asclepios/research/associated-team-persocardiolearn/>

Multi-scale computer modelling is a powerful tool that could be used to simulate in silico cardiac electrical activity and biomechanical function of individual heart. Imaging and 3D heart models built from images can help us understand the basis of structurally-diseased hearts at organ level and to predict in silico the changes in electro-mechanical function as a consequence of muscle remodelling in pathologic state (e.g. chronic infarction, a major cause of death). We hypothesize that MRI-based predictive models can help us identify new opportunities to intervene or to predict the outcome of ablation therapy, which currently has low clinical success. However, these predictive models need to be validated and thoroughly tested in preclinical experiments prior to their integration into the clinical stage. Hence, the next logical step for our joint Inria-SB efforts is to expand our experimental-theoretical framework and to personalize fast 3D heart models from in vivo MR-EP data. This translational step involves numerous challenging tasks from the modelling perspective since the in vivo imaging and physiological signals are rather noisy and obtained at a poor spatial resolution, potentially leading to erroneous customization of mathematical model parameters. However, this collaboration employs a rare combination of experiments and modelling specialists. Moreover, the originality of the proposed approach is to build upon machine-learning techniques rather than on data assimilation methods that are more explored in the literature but have inherent limitations (robustness to noise, local minima...).

8.4.3. Inria International Partners

8.4.3.1. Informal International Partners

8.4.3.1.1. St Thomas' Hospital, King's College London, United Kingdom

Maxime Sermesant is a visiting lecturer in the Division of Imaging Sciences and Biomedical Engineering, St Thomas' Hospital, King's College London lead by Pr Reza Razavi. The XMR facility within this hospital is a unique opportunity to validate and exploit the cardiovascular modelling work.

8.4.3.1.2. Massachusetts General Hospital, Boston

A collaboration with Dr Jan Unklebach, Assistant Professor of Radiation Oncology and Dr Jayashree Kalpathy-Cramer, radiology instructor was initiated in 2013 around the topics of tumor growth modeling, radiotherapy planning and edema characterization from MRI.

8.4.3.1.3. University College London (UCL), London, UK

Marco Lorenzi is collaborator of the Translational Imaging Group of UCL, led by Prof. Sebastien Ourselin. His collaboration is around the topic of spatio-temporal analysis of medical images, with special focus on brain imaging analysis and biomarker development in Alzheimer disease. He is also collaborating with the "Progression Over Neurodegenerative Disorders" (POND) group (Prof. Daniel Alexander) for developing new computational models and techniques for learning characteristic patterns of disease progression using large longitudinal clinical data sets, with special focus on dementias.

8.4.3.1.4. Imaging Genetics Center (IGC), University of Southern California (USC), CA, USA

Marco Lorenzi is currently collaborator with the IGC for the investigation of the complex relationship between brain atrophy and genetics in Alzheimer's disease, in particular for demonstrating the effectiveness of multivariate statistical models in providing a meaningful description of the relationship between genotype and brain phenotype.

8.4.3.1.5. Other International Hospitals

Collaborations with several other European hospitals have been established through the European projects VP2HF and MD PAEDIGREE.

ASCOLA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. RFI Atlanstic 2020

9.1.1.1. CoMe4ACloud

Participants: Thomas Ledoux [coordinator], Frederico Alvares de Oliveira Junior, Zakarea Al Shara.

The high-level objective of the 1-year CoMe4ACloud (Constraints and Model Engineering for Autonomic Clouds) project is to provide an end-to-end solution for autonomic Cloud services. To that end, we rely on techniques of Constraint Programming so as a decision-making tool and Model-driven Engineering to ease the automatic generation of the so-called autonomic managers as well as their synchronization with the managed system (i.e., the Cloud layers).

This year, we got the best paper award of CLOSER 2017 (the 7th International Conference on Cloud Computing and Services Science) [27]. We have also submitted two publications and provided two video-demonstrations of the early results.

CoMe4ACloud is an Atlanstic2020 funded project and supports a post-doc position. The project is led by Ascola research team and involves also AtlanModels and TASC, all of them from the LS2N and situated at IMT Atlantique. See <https://come4acloud.github.io> for more information.

9.1.1.2. SyMeTRIC

Participant: Jean-Marc Menaud [coordinator].

SyMeTRIC is a regional federated project in Systems Medicine funded by the Pays de la Loire french region. Systems Medicine approaches can be compared to Systems Biology. They aim at integrating several information sources to design and validate bio-models and biomarkers to anticipate and enhance patients follow-up (diagnosis, treatment response prediction, prognosis).

9.2. National Initiatives

9.2.1. CominLabs laboratory of excellence

9.2.1.1. EPOC

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

The project EPOC (Energy Proportional and Opportunistic Computing system) is a project running for 4 years. Four other partners collaborate within the project that is coordinated by ASCOLA: Myriads team, and the three institutions ENIB, ENSTB and University of Nantes. In this project, the partners focus on energy-aware task execution from the hardware to application components in the context of a *mono-site* data center (all resources are in the same physical location) which is connected to the *regular electric Grid and to renewable energy sources* (such as windmills or solar cells). Three major challenges are addressed in this context: optimize the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services; design a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed system; investigate energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

One of the strengths of the project is to provide a systematic approach, and use a single model for the system (from hard to soft) by mixing constraint programming and behavioral models to manage energy consumption in data centers.

9.2.1.2. *PrivGen*

Participants: Fatima-Zahra Boujdad, Mario Südholt [coordinator].

PrivGen (“Privacy-preserving sharing and processing of genetic data”) is a three-year project that has been started in Oct. 2016 and is conducted by three partners: a team of computer scientists from the LATIM Inserm institute in Brest mainly working on data watermarking techniques, a team of geneticists from an Inserm institute in Rennes working on the gathering and interpretation of genetic data, and the Ascola team. The project provides funding of 330 KEUR altogether with an Ascola share of 120 KEUR.

The project considers challenges related to the outsourcing of genetic data that is in the Cloud by different stakeholders (researchers, organizations, providers, etc.). It tackles several limitations of current security solutions in the cloud, notably the lack of support for different security and privacy properties at once and computations executed at different sites that are executed on behalf of multiple stakeholders.

The partners are working on three main challenges:

- Mechanisms for a continuous digital content protection
- Composition of security and privacy-protection mechanisms
- Distributed processing and sharing of genetic data

The Ascola team is mainly involved in providing solutions for the second and third challenges.

9.2.2. *ANR*

9.2.2.1. *GRECO (ANR)*

Participant: Adrien Lebre [Contact point].

The GRECO project (Resource manager for cloud of Things) is an ANR project (ANR-16-CE25-0016) running for 42 months (starting in January 2017 with an allocated budget of 522KEuros, 90KEuro for ASCOLA).

The consortium is composed of 4 partners: Qarnot Computing (coordinator) and 3 academic research group (DATAMOVE and AMA from the LIG in Grenoble and ASCOLA from Inria Rennes Bretagne Atlantique).

The goal of the GRECO project (<https://anr-greco.net>) is to design a manager for cloud of things. The manager should act at the IaaS, PaaS and SaaS layer of the cloud. One of the principal challenges will consist in handling the execution context of the environment in which the cloud of things operates. Indeed, unlike classical resource managers, connected devices imply to consider new types of networks, execution supports, sensors and new constraints like human interactions. The great mobility and variability of these contexts complexify the modelling of the quality of service. To face this challenge, we intend to innovate in designing scheduling and data management systems that will use machine learning techniques to automatically adapt their behaviour to the execution context. Adaptation here requires a modelling of the recurrent cloud of things usages, the modelling of the dynamics of physical cloud architecture.

9.2.2.2. *KerStream (ANR)*

Participant: Shadi Ibrahim [Coordinator].

The KerStream project (Big Data Processing: Beyond Hadoop!) is an ANR JCJC (Young Researcher) project (ANR-16-CE25-0014-1) running for 48 months (starting in January 2017 with an allocated budget of 238KEuros).

The goal of the KerStream project is to address the limitations of Hadoop when running Big Data stream applications on large-scale clouds and do a step beyond Hadoop by proposing a new approach, called KerStream, for scalable and resilient Big Data stream processing on clouds. The KerStream project can be seen as the first step towards developing the first French middleware that handles Stream Data processing at Scale.

9.2.3. *FSN*

9.2.3.1. *Hosanna (FSN)*

Participants: Jean-Marc Menaud [coordinator], Remy Pottier.

By deploying and using a Fog/Edge OS on backbones, our ultimate vision is to enable large parts of the Internet to be hosted and operated by its internal structure itself: a scalable set of resources delivered by any computing facilities forming the Internet, starting from the larger hubs operated by ISPs, governments and academic institutions, to any idle resources that may be provided by end users.

ASCOLA leads the DISCOVERY IPL and contributes mainly around two axes: VM life cycle management and security concerns.

9.2.6. InriaHub

9.2.6.1. MERCURY

Participants: Ronan-Alexandre Cherrueau, Adrien Lebre [coordinator].

ASCOLA, in particular within the framework of the DISCOVERY initiative has been working on the massively distributed use case since 2013. With the development of several proof-of-concepts around OpenStack, the team has had the opportunity to start an InriaHub action. Named MERCURY, the goal of this action is twofold: (i) support the research development made within the context of DISCOVERY and (ii) favor the transfer toward the OpenStack community.

Further information available at: <http://beyondtheClouds.github.io>.

9.2.7. Fond d'amorçage IMT Industrie du Futur 2017

9.2.7.1. aLIFE

Participants: Hélène Coullon [coordinator], Jacques Noyé.

The French engineering school IMT Atlantique is organizing the aLIFE workshop between industry and academia, in Nantes during two days on January, 30-31 2018. The objective of this workshop is to share various experiences and success stories, as well as open challenges related to the contribution of software-related research to Factories of the Future, in French apport de l'industrie du Logiciel à l'Industrie du Futur Européenne (aLIFE). To this end, big multinational companies, as well as SMEs and academics will exchange through plenary sessions and discussion panels.

9.2.8. Connect Talent

9.2.8.1. Apollo (Connect Talent)

Participant: Shadi Ibrahim [Coordinator].

The Apollo project (Fast, efficient and privacy-aware Workflow executions in massively distributed Data-centers) is an individual research project “Connect Talent” running for 36 months (starting in November 2017 with an allocated budget of 201KEuros).

The goal of the Apollo project is to investigate novel scheduling policies and mechanisms for fast, efficient and privacy-aware data-intensive workflow executions in massively distributed data-centers.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. CoqHoTT

Title: Coq for Homotopy Type Theory

Programm: H2020

Type: ERC

Duration: June 2015 - May 2020

Coordinator: Inria

Inria contact: Nicolas TABAREAU

Every year, software bugs cost hundreds of millions of euros to companies and administrations. Hence, software quality is a prevalent notion and interactive theorem provers based on type theory have shown their efficiency to prove correctness of important pieces of software like the C compiler of the CompCert project. One main interest of such theorem provers is the ability to extract directly the code from the proof. Unfortunately, their democratization suffers from a major drawback, the mismatch between equality in mathematics and in type theory. Thus, significant Coq developments have only been done by virtuosos playing with advanced concepts of computer science and mathematics. Recently, an extension of type theory with homotopical concepts such as univalence is gaining traction because it allows for the first time to marry together expected principles of equality. But the univalence principle has been treated so far as a new axiom which breaks one fundamental property of mechanized proofs: the ability to compute with programs that make use of this axiom. The main goal of the CoqHoTT project is to provide a new generation of proof assistants with a computational version of univalence and use them as a base to implement effective logical model transformation so that the power of the internal logic of the proof assistant needed to prove the correctness of a program can be decided and changed at compile time—according to a trade-off between efficiency and logical expressivity. Our approach is based on a radically new compilation phase technique into a core type theory to modularize the difficulty of finding a decidable type checking algorithm for homotopy type theory. The impact of the CoqHoTT project will be very strong. Even if Coq is already a success, this project will promote it as a major proof assistant, for both computer scientists and mathematicians. CoqHoTT will become an essential tool for program certification and formalization of mathematics.

9.3.1.2. *BigStorage*

Title: BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: Universidad politecnica de Madrid

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Ca Technologies Development Spain (Spain)

Commissariat A L Energie Atomique et Aux Energies Alternatives (France)

Deutsches Klimarechenzentrum (Germany)

Foundation for Research and Technology Hellas (Greece)

Fujitsu Technology Solutions (Germany)

Johannes Gutenberg Universitaet Mainz (Germany)

Universidad Politecnica de Madrid (Spain)

Seagate Systems Uk (United Kingdom)

Inria contact: G. Antoniu & A. Lebre

The consortium of this European Training Network (ETN) 'BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data' will train future data scientists in order to enable them and us to apply holistic and interdisciplinary approaches for taking advantage of a data-overwhelmed world, which requires HPC and Cloud infrastructures with a redefinition of storage architectures underpinning them - focusing on meeting highly ambitious performance and energy usage objectives. There has been an explosion of digital data, which is changing our knowledge about the world. This huge data collection, which cannot be managed by current data management systems, is known as Big Data. Techniques to address it are gradually combining with what has been traditionally known as High Performance Computing. Therefore, this ETN will focus on the convergence of Big Data, HPC, and Cloud data storage, its management and analysis. To gain value from Big Data it must be addressed from many different angles: (i) applications, which

can exploit this data, (ii) middleware, operating in the cloud and HPC environments, and (iii) infrastructure, which provides the Storage, and Computing capable of handling it. Big Data can only be effectively exploited if techniques and algorithms are available, which help to understand its content, so that it can be processed by decision-making models. This is the main goal of Data Science. We claim that this ETN project will be the ideal means to educate new researchers on the different facets of Data Science (across storage hardware and software architectures, large-scale distributed systems, data management services, data analysis, machine learning, decision making). Such a multifaceted expertise is mandatory to enable researchers to propose appropriate answers to applications requirements, while leveraging advanced data storage solutions unifying cloud and HPC storage facilities.'

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

National University of Singapore (NUS): We collaborate on resource management for workflows in the cloud and optimizing graph processing in geo-distributed data-centers.

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Research Stays Abroad

HUST and ShenZhen University, China: From October 28 to November 11, S. Ibrahim visited the Services Computing Technology and System Lab at Huazhong university of Science and Technology and the National High Performance Computing Center at Shenzhen University.

ASPI Team

7. Partnerships and Cooperations

7.1. Regional initiatives

7.1.1. *Stochastic Model-Data Coupled Representations for the Upper Ocean Dynamics (SEACS) — inter labex project*

Participants: François Le Gland, Valérie Monbet.

January 2015 to December 2017.

This is a joint research initiative supported by the three labex active in Brittany, **CominLabs (Communication and Information Sciences Laboratory)**, **Lebesgue (Centre de Mathématiques Henri Lebesgue)** and **LabexMER (Frontiers in Marine Research)**.

This project aims at exploring novel statistical and stochastic methods to address the emulation, reconstruction and forecast of fine-scale upper ocean dynamics. The key objective is to investigate new tools and methods for the calibration and implementation of novel sound and efficient oceanic dynamical models, combining

- recent advances in the theoretical understanding, modeling and simulation of upper ocean dynamics,
- and mass of data routinely available to observe the ocean evolution.

In this respect, the emphasis will be given to stochastic frameworks to encompass multi-scale/multi-source approaches and benefit from the available observation and simulation massive data. The addressed scientific questions constitute basic research issues at the frontiers of several disciplines. It crosses in particular advanced data analysis approaches, physical oceanography and stochastic representations. To develop such an interdisciplinary initiative, the project gathers a set of research groups associated with these different scientific domains, which have already proven for several years their capacities to interact and collaborate on topics related to oceanic data and models. This project will place Brittany with an innovative and leading expertise at the frontiers of computer science, statistics and oceanography. This transdisciplinary research initiative is expected to resort to significant advances challenging the current thinking in computational oceanography.

7.2. National initiatives

7.2.1. *Computational Statistics and Molecular Simulation (COSMOS) — ANR challenge Information and Communication Society*

Participant: Frédéric Cérou.

Inria contract ALLOC 9452 — January 2015 to December 2017.

The COSMOS project aims at developing numerical techniques dedicated to the sampling of high-dimensional probability measures describing a system of interest. There are two application fields of interest: computational statistical physics (a field also known as molecular simulation), and computational statistics. These two fields share some common history, but it seems that, in view of the quite recent specialization of the scientists and the techniques used in these respective fields, the communication between molecular simulation and computational statistics is not as intense as it should be.

We believe that there are therefore many opportunities in considering both fields at the same time: in particular, the adaption of a successful simulation technique from one field to the other requires first some abstraction process where the features specific to the original field of application are discarded and only the heart of the method is kept. Such a cross-fertilization is however only possible if the techniques developed in a specific field are sufficiently mature: this is why some fundamental studies specific to one of the application fields are still required. Our belief is that the embedding in a more general framework of specific developments in a given field will accelerate and facilitate the diffusion to the other field.

7.2.2. *Advanced Geophysical Reduced-Order Model Construction from Image Observations (GERONIMO) — ANR programme Jeunes Chercheuses et Jeunes Chercheurs*

Participant: Patrick Héas.

Inria contract ALLOC 8102 — March 2014 to February 2018.

The GERONIMO project aims at devising new efficient and effective techniques for the design of geophysical reduced-order models (ROMs) from image data. The project both arises from the crucial need of accurate low-order descriptions of highly-complex geophysical phenomena and the recent numerical revolution which has supplied the geophysical scientists with an unprecedented volume of image data. Our research activities are concerned by the exploitation of the huge amount of information contained in image data in order to reduce the uncertainty on the unknown parameters of the models and improve the reduced-model accuracy. In other words, the objective of our researches is to process the large amount of incomplete and noisy image data daily captured by satellites sensors to devise new advanced model reduction techniques. The construction of ROMs is placed into a probabilistic Bayesian inference context, allowing for the handling of uncertainties associated to image measurements and the characterization of parameters of the reduced dynamical system.

7.3. European initiatives

7.3.1. *Molecular Simulation: Modeling, Algorithms and Mathematical Analysis (MSMaths) — ERC Consolidator Grant*

Participant: Mathias Rousset.

January 2014 to December 2019.

PI: Tony Lelièvre, Civil Engineer in Chief, Ecole des Ponts Paris-Tech.

Note that 1/3 of Mathias Rousset research activities are held within the MSMATH ERC project.

With the development of large-scale computing facilities, simulations of materials at the molecular scale are now performed on a daily basis. The aim of these simulations is to understand the macroscopic properties of matter from a microscopic description, for example, its atomistic configuration.

In order to make these simulations efficient and precise, mathematics have a crucial role to play. Indeed, specific algorithms have to be used in order to bridge the time and space scales between the atomistic level and the macroscopic level. The objective of the **MSMath** ERC project is thus to develop and study efficient algorithms to simulate high-dimensional systems over very long times. These developments are done in collaboration with physicists, chemists and biologists who are using these numerical methods in an academic or industrial context.

In particular, we are developing mathematical tools at the interface between the analysis of partial differential equations and stochastic analysis in order to characterize and to quantify the metastability of stochastic processes. Metastability is a fundamental concept to understand the timescale separation between the microscopic model and the macroscopic world. Many algorithms which aim at bridging the timescales are built using this timescale separation.

7.3.2. *Design of Desalination Systems Based on Optimal Usage of Multiple Renewable Energy Sources (DESIRES) — ERANETMED NEXUS-14-049*

Participant: Valérie Monbet.

January 2016 to December 2018.

This project is funded by the ERA-NET Initiative ERANETMED (Euro-Mediterranean Cooperation through ERA-NET Joint Activities and Beyond). It is a collaboration with Greece, Tunisia and Morocco, coordinated by Technical University of Crete (TUC). The French staff includes: Pierre Ailliot (Université de Bretagne Occidentale, Brest), Denis Allard (INRA Avignon), Anne Cuzol (Université de Bretagne Sud, Vannes), Christophe Maisondieu (IFREMER Brest) and Valérie Monbet.

The aim of **DESIRES** is to develop an Internet-based, multi-parametric electronic platform for optimum design of desalination plants, supplied by renewable energy sources (RES). The platform will rely upon (i) a solar, wind and wave energy potential database, (ii) existing statistical algorithms for processing energy-related data, (iii) information regarding the inter-annual water needs, (iv) a database with the technical characteristics of desalination plant units and the RES components, and (v) existing algorithms for cost effective design, optimal sizing and location selection of desalination plants.

7.4. International initiatives

7.4.1. *Rare event simulation in epidemiology — PhD project at université de Ziguinchor*

Participants: Ramatoulaye Dabo, François Le Gland.

This is the subject of the PhD project of Ramatoulaye Dabo (université Assane Seck de Ziguinchor and université de Rennes 1).

The question here is to develop adaptive multilevel splitting algorithms for models that are commonly used in epidemiology, such as SIR (susceptible, infectious, recovered) models [26], or more complex compartmental models. A significant advantage of adaptive multilevel splitting is its robustness, since it does not require too much knowledge about the behavior of the system under study. An interesting challenge would be to understand how to couple the algorithm with numerically efficient simulation methods such as τ -leaping [35]. Complexity bounds and estimation error bounds could also be studied.

7.5. International research visitors

7.5.1. *Visits to international teams*

Patrick Héas has been invited to present his work on 3D wind field reconstruction by infrared sounding, at EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites) in Darmstadt in February 2017.

ATHENA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Inria SAM Action Transverse

Participants: Paul Görlach, Evelyne Hubert [Aromath Project-Team], Théodore Papadopoulo, Rachid Deriche.

Finding biomarkers of abnormalities of the white matter is one important problem in dMRI processing. As these biomarkers need to be independent of the orientation of the head, they are functions of the rotational invariants of the shapes that characterize the diffusion probabilities in the white matter. While the situation is well understood for second order tensors, these are not powerful enough to represent crossings in the white matter. Acquisitions made with the HARDI scheme allow for a richer description of probabilities, which have been modelled in the literature team as (positive) ternary quartics (tensors of order 4). But invariants of these quartics are not well known. For a long period, only six (out of 12 in theory) were known. Previous work in the ATHENA team developed some new strategies to compute more invariants. But these were ever non-polynomial and had some stability problems [95]. Another strategy [80] was leading to polynomial and stable invariants, but the approach was generating a number of invariants (more than 12) for which it was impossible to extract an irreducible family.

The goal of this "Transverse action" was to join forces with the project-team GALAAD/AROMATH and leverage the methods they developed [85], [86], [84] to have a better insight in this problem of rotational invariants of ternary quartics.

In collaboration with GALAAD/AROMATH, we developped a complete set of rational invariants for ternary quartics [44]. Being rational, they are very close to the polynomial invariants developed in [80] but they constitute a complete set of invariants. They also are good tools to understand better the algebraic invariants of [95] and some others based on spherical harmonics decomposition [61].

9.1.2. Inria SAM Action Transverse

Participants: Yann Thanwerdas [Asclepios Project-Team], Xavier Pennec [Asclepios Project-Team], Maureen Clerc, Nathalie Gayraud.

The goal of the proposed internship will be to study and implement the barycentric subspace analysis procedure on SPD matrices endowed with the affine invariant metric and to test it with BCI datasets. In the context of BCI, the problem is not trivial. The cross-session and cross-subject variability must be taken into account during the process of selecting the optimal lower dimensional subspace. In a first step, algorithms will be developed to project points into a barycentric subspace, and then to optimize the location of the reference points themselves. In order to avoid an intensive optimization, one will usefully restrict reference points to belong to the original data points. In a second step, the barycentric coordinates will be used to describe the data in the hierarchy of embedded barycentric subspaces and one will study the power of this signature to classify / predict the correct brain state

9.1.3. Inria SAM Action Marquante

Participants: Demian Wassermann, Maureen Clerc, Théodore Papadopoulo, Amandine Audino.

Duration: october 2016 to January 2018

Elucidating the structure-function relationship of the brain is one of the main open question in neuroscience. The capabilities of diffusion MRI-based techniques to quantify the connectivity strength between brain areas, namely structural connectivity (SC), in combination with modalities such as electro encephalography (EEG) to quantify brain function have enabled advances in this field. However, the actual relationship between these SC measures and measures of information transport between neuronal patches is still far from being determined.

In this project, we will address this problem by establishing a relationship between diffusion MRI (dMRI) SC measures and electrical conductivity on the human brain cortex. We will exploit the ATHENA's competences in dMRI (Deriche-Wassermann) and EEG (Clerc-Papadopoulo) and our collaboration with the neurosurgical service at CHU Nice (Fontaine-Almairac). In successfully addressing this problem, we will set the bases to solve the current open problem of non-invasively measuring cortico-cortical (CC) connectivity in the human brain. This will boost the understanding of cognitive function as well as neurosurgical planning for the treatment of pathologies such as drug-resistant epilepsy and resection of glioblastomas.

9.2. National Initiatives

9.2.1. Inria Project Lab

9.2.1.1. IPL BCI-LIFT

Participants: Maureen Clerc, Théodore Papadopoulo, Nathanaël Foy, Nathalie Gayraud, Federica Turi.

Duration: January 2015 to December 2018

The Inria Project-Lab BCI-LIFT is an Inria-funded research consortium to foster collaborative research on Brain-Computer Interfaces on the topic of Learning, Interaction, Feedback and Training. It is coordinated by Maureen Clerc. Its members are from 6 Inria teams: ATHENA, CAMIN, HYBRID, MJOLNIR, NEUROSYS, POTIOC, and from Dycog team from CRNL Lyon, and University of Rouen. The goal is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. For more information, refer to the [BCI-LIFT](#) website.

9.2.2. ANR

9.2.2.1. ANR MRSEI LEMONS

Participants: Maureen Clerc, Théodore Papadopoulo.

Duration: October 2015 to April 2017

Call: ANR MRSEI Montage de réseaux scientifiques européens ou internationaux 2015

LEMONS (Learning, Monitoring, Operating Neural Interface) aims to consolidate a European Network by organizing meetings and visits, in order to submit a proposal for a MSCA-ITN Training Network. The European consortium was led by ATHENA (coordinator Maureen Clerc). The European consortium was composed of 8 beneficiaries from 6 countries (Inria, EPFL, TU Graz, Fondazione Santa Lucia, Albert-Ludwigs Universität Freiburg, Universiteit Leiden, Université Lyon 1, eemagine GmbH) and 8 additional Partner Organizations from clinical and industrial sectors. The LEMONS project was submitted twice but was eventually not selected for EU funding.

9.2.2.2. ANR NeuroRef

Participants: Demian Wassermann, Antonia Machlouziredes, Guillermo Gallardo, Rachid Deriche.

Duration: October 2016 to September 2019

Call: NSF-ANR Program Collaborative Research in Computational Neuroscience 2015

This project is a collaboration with Pr.S.Bouix and his team at the Psychiatry NeuroImaging Lab, Dept of Radiology, Brigham and Women's Hospital, Harvard Medical School (USA) to build MRI reference atlases to analyze brain trauma and post-traumatic stress. The goal is to develop a robust framework to perform subject-specific neuroimaging analyses of Diffusion MRI (dMRI), as this modality has shown excellent sensitivity to brain injuries and can locate subtle brain abnormalities that are not detected using routine clinical neuroradiological readings.

9.2.2.3. ANR MOSIFAH

Participants: Rachid Deriche, Rutger Fick, Demian Wassermann, Maureen Clerc, Théodore Papadopoulo.

Duration: October 2013 to September 2017

Call: ANR Numerical Models 2013

This ANR project is about multimodal and multiscale modelling and simulation of the fiber architecture of the human heart. It started on October 2013 and involves three partners: Creatis Team, INSA, Lyon (I. Magnin, Y. Zhu); TIMC-IMAG, CNRS, Grenoble (Y. Uson) and the ATHENA project team.

It consists in modelling and simulating the ex vivo and in vivo 3D fiber architectures at various scales using multiphysical data from different imaging modalities working at different spatial resolutions. To this end, the myocardium of the human heart will be imaged using respectively Polarized Light Imaging (PLI) and dMRI.

9.2.2.4. ANR VIBRATIONS

Participants: Théodore Papadopoulo, Maureen Clerc, Rachid Deriche, Demian Wassermann.

Duration: February 2014 to January 2018

Call: ANR Programme de Recherche Translationnelle en Santé (PRTS) 2013

The VIBRATIONS project proposes to simulate in a biologically realistic way MEG and EEG fields produced by different configurations of brain sources, which will differ in terms of spatial and dynamic characteristics. The research hypothesis is that computational and biophysical models can bring crucial information to clinically interpret the signals measured by MEG and EEG. In particular, they can help to efficiently address some complementary questions faced by epileptologists when analyzing electrophysiological data.

9.2.3. ADT

9.2.3.1. AMDT BCI-Browser

Participants: Théodore Papadopoulo, Maureen Clerc.

Duration: 1 year

Most often, BCI techniques are demonstrated in simple toy applications made. The only "few" real BCI applications are specific developments and are not used much as they lack of functionality, maintenance, The goal of this development contract is to demonstrate a new approach to BCI, in which BCI interactions are integrated in existing applications. Ideally, the original software is not modified and not even recompiled. It is modified by providing either modified GUI libraries or providing extensions as plugins. As a proof of concept, we aim at modifying C++/Qt applications with a focus on web browsing, by redefining some of its basic interactions (mouse clicks, keyboard, ...) using some BCI components. In this manner, it might be possible to drive standard and state-of-the-art application using BCI and at a limited maintenance cost.

This contract is part of the AMDT initiative.

9.2.3.2. ADT BOLIS 2

Participants: Théodore Papadopoulo, Juliette Leblond [APICS project-team], Jean-Paul Marmorat [CMA Ecole des Mines Paritech].

Duration: 6 months.

This contract is a follow-up of ADT BOLIS which aimed at building a software platform dedicated to inverse source localisation, building upon the elements of software found in FindSources3D. The platform is modular, ergonomic, accessible and interactive and offers a detailed visualisation of the processing steps and the results. Its goal is to provide a convenient graphical interface and a tool that can be easily distributed and used by professionals (target audience: clinicians and researchers). BOLIS 2 aims at simplifying some maintenance aspects of the software.

This contract is part of the AMDT initiative.

9.2.4. Other Funding Programs

9.2.4.1. Big Brain Theory ICM Program: MAXIM'S

Participants: Demian Wassermann, Alexandra Petiet [ICM, CENIR, Paris], Stéphane Lehericy [ICM, CENIR, Paris], Julien Valette [Institut d'Imagerie Biomédicale, CEA, France], Virginie Callot [Center for Magnetic Resonance in Biology and Medicine - UMR 7339, Center for Magnetic Resonance in Biology and Medicine - UMR 7339].

Shedding light on the specificity of microstructural MRI biomarkers of axonal and myelin integrity using multi-modal imaging in rodents and quantitative histological correlations.

Magnetic Resonance Imaging (MRI) biomarkers (BMs) of axonal and myelin integrity suffer from lack of specificity at the microstructural level, which hinders our understanding of disease mechanisms. A better knowledge of the role of the white matter (WM) microstructure in normal and abnormal function relies on the development of MRI metrics that can provide (i) increased specificity to distinct attributes of WM such as local fiber architecture, axon morphology, myelin content, and (ii) specific markers of axonal vs. myelin pathologies. Advanced diffusion-weighted (DW) imaging techniques based on biophysical models of cerebral tissues and cellular compartments can extract for example mean axonal diameters or cellular geometry. In addition, diffusion-weighted spectroscopy (DWS) offers new insights into the diffusion properties of intracellular metabolites. More specifically, probing metabolite diffusion at different time scales allows assessing fiber diameter and length, and the specific compartmentalization of different metabolites in different cell types allows differentiating between astrocytic and neuronal microstructural parameters. Although very promising, these novel techniques still need extensive histological validation.

We propose to develop these two cutting-edge MRI techniques – DW-MRI and DWS, at 11.7T to investigate axonopathy and myelinopathy in well-established mouse models with a single lesion type, and to validate these new microstructural BMs with multivariate quantitative histological analyses.

Duration: March 2016 to March 2019

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERC AdG CoBCoM

Program: H2020-EU.1.1. (ERC-ADG-2015 - ERC Advanced Grant)

Project acronym: CoBCoM - **ID:** 694665

Project title: *Computational Brain Connectivity Mapping*

Start date: 2016-09-01, End date: 2021-08-31

P.I : R. Deriche

Partners: ATHENA project-team

Abstract:

One third of the burden of all the diseases in Europe is due to problems caused by diseases affecting brain. Although exceptional progress has been obtained for exploring it during the past decades, **the brain is still terra-incognita** and calls for specific research efforts to better understand its architecture and functioning.

CoBCoM is our response to this great challenge of modern science with the overall goal to **develop a joint Dynamical Structural-Functional Brain Connectivity Network** (DSF-BCN) solidly grounded on advanced and integrated methods for diffusion Magnetic Resonance Imaging (dMRI) and Electro & Magneto-Encephalography (EEG & MEG).

To take up this grand challenge and achieve new frontiers for brain connectivity mapping, we will develop a new generation of computational models and methods for identifying and characterizing the structural and functional connectivities that will be at the heart of the DSF-BCN. Our strategy is to break with the tradition to incrementally and separately contributing to structure or function and develop **a global approach involving strong interactions between structural and functional connectivities**. To solve the limited view of the brain provided just by one imaging modality, our models will be developed under a rigorous computational framework integrating complementary non invasive imaging modalities: dMRI, EEG and MEG.

COBCOM will push far forward the state-of-the-art in these modalities, developing **innovative models and ground-breaking processing tools** to provide in-fine a joint DSF-BCN solidly grounded on a detailed mapping of the brain connectivity, both in space and time.

Capitalizing on the strengths of dMRI, MEG & EEG methodologies and building on the **bio-physical and mathematical foundations** of our new generation of computational models, COBCOM will be applied to high-impact diseases, and its **ground-breaking computational nature and added clinical value** will open new perspectives in neuroimaging.

9.3.1.2. *ERC StG NeuroLang*

Program: H2020-EU.1.1. (ERC-StG-2016 - ERC Starting Grant)

Project acronym: NEUROLANG

Project title: Accelerating Neuroscience Research by Unifying Knowledge Representation and Analysis Through a Domain Specific Language

Start date: March 2018, End date: Fe. 2023

PI : D. Wassermann

Partners: ATHENA project-team (Till Oct. 2017). PARIETAL project-team (Since Nov. 2017)

Abstract: The grand challenge of NeuroLang is to unify neuroanatomical descriptions into a formal language embodied by a Domain Specific Language (DSL) which can be used to perform neuroimaging data analysis. NeuroLang will formalise neuroanatomical knowledge into a DSL, providing an individualized as well as a population-based methodology to represent the anatomy and function of the brain and facilitating the analysis of large neuroimaging datasets and ontologies. Besides formalizing and unifying neuroanatomy, there are four major challenges in NeuroLang: (i) Developing a Neuroanatomical DSL, (ii) Representation of Neuroanatomical Data, (iii) Enabling Large-Scale Inference in a Neuroanatomical DSL and (iv) Reproducible Research and Applicability in Clinical and Cognitive Research.

9.3.1.3. *ChildBrain ETN*

ATHENA is an Associated Partner in the ChildBrain European Training Network: the team participates in training workshops and receive PhD students in secondments.

Program: European Training Network

Project acronym: ChildBrain

Project title: Advancing brain research in children's developmental neurocognitive disorders

Duration: March 2015 to March 2019

Coordinator: Prof. Paavo Leppänen, University of Jyväskylä, Finland

Other partners: University of Leuven (Belgium), University of Münster (Germany), Rabboud University (The Netherlands), Aston University (United Kingdom), IcoMetrix (Belgium), Elekta (Finland), BESA (Germany)

Abstract: The purpose of the ChildBrain ETN is to train young scientists, i.e. Early Stage Researchers (ESRs), to utilise evidence-based neuroscientific knowledge for helping children, especially those at high risk for dropout due to neurocognitive disorders, to meet future educational and societal demands.

9.4. International Initiatives

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

9.4.1.1. LargeBrainNets

Title: Characterizing Large-scale Brain Networks Using Novel Computational Methods for dMRI and fMRI-based Connectivity

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Stanford Cognitive and Systems Neuroscience Laboratory -
Vinod Menon

Duration :Jan. 2016 – Dec. 2018

Partners: ATHENA project-team,

See also: <http://www-sop.inria.fr/members/Demian.Wassermann/large-brain-nets.html>

The first major goal of this project is to develop and validate appropriate sophisticated computational and mathematical tools for identifying functional nodes at the whole-brain level and measuring structural and functional connectivity between them, using state-of-the-art human brain imaging techniques and open-source HCP data. To this end, we will first develop and validate novel computational tools for (1) identifying stable functional nodes of the human brain using resting-state functional MRI and (2) measuring structural connectivity between functional nodes of the brain using multi-shell high-angular diffusion MRI. Due to the complementarity of the two imaging techniques fMRI and dMRI, our novel computational methods methods, the synergy between the two laboratories of this associate team will allow us to reveal in unprecedented detail the structural and functional connectivity of the human brain. The second major goal of this project is to use our newly developed computational tools to characterize normal structural and functional brain networks in neurotypical adults.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

- Sherbrooke University, CA (M. Descoteaux)
- Harvard Medical School, USA (S. Bouix)
- CMRR, University of Minnesota, USA (Christophe Lenglet)
- Verona University, It (Gloria Menegaz)
- Department of CISE, the University of Florida, Gainesville, USA (Baba C. Vemuri)
- Centre for Medical Image Computing (CMIC), Dept. Computer Science, UCL, UK (D. Alexander)
- SBIA, University of Pennsylvania Medical School, USA (R. Verma).
- BESA company on EEG/MEG modeling.

9.4.3. Participation in Other International Programs

- University Houari Boumedienne (USTHB, Algiers) (L. Boumghar) and University of Boumerdes, (D. Cherifi), Algeria.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Dr. Lang Chen, Research Fellow, Stanford Medical School, USA (October 2017)

9.5.1.1. Internships

- Gaston Zanitti, Computer Science Department, School of Sciences, University of Buenos Aires, Argentina (Mars-June 2017)

Participants: Laurent Lefèvre, Christian Perez, Jérôme Richard, Thierry Gautier.

Since January 2013, the team is participating to the C2S@Exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that proposes algorithms and contributes to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.1.3.2. DISCOVERY, DIStributed and COoperative management of Virtual EnviRonments autonomously, 4 years, 2015-2019

Participants: Jad Darrous, Gilles Fedak, Christian Perez.

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

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

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

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

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

Participants: Laurent 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.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

8.2.1.1. COST IC1305 : Nesus

Participants: Marcos Dias de Assunção, Laurent Lefèvre.

Program: COST

Project acronym: IC1305

Project title: Network for Sustainable Ultrascale Computing (NESUS)

Duration: 2014-2019

Coordinator: Jesus Carretero (Univ. Madrid)

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger than today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. In Nesus, Laurent Lefèvre is co-chairing the Working on Energy Efficiency (WG5).

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. Joint Laboratory for Extreme Scale Computing (JLESC) (2014-2018)

Participants: Gilles Fedak, Thierry Gautier, Christian Perez, Jérôme Richard.

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

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

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

8.3.1.2. Associate Team DALHIS – Data Analysis on Large-scale Heterogeneous Infrastructures for Science (2013-2018)

Participant: Frédéric Suter.

Partners: EPC Myriads (Rennes, Bretagne Atlantique), Avalon (Grenoble, Rhône-Alpes), Data Science and Technology Department (LBNL,USA).

The goal of the Inria-LBL collaboration is to create a collaborative distributed software ecosystem to manage data lifecycle and enable data analytics on distributed data sets and resources. Specifically, our goal is to build a dynamic software stack that is user-friendly, scalable, energy-efficient and fault tolerant. We plan to approach the problem from two dimensions: (i) Research to determine appropriate execution environments that allow users to seamlessly execute their end-to-end dynamic data analysis workflows in various resource environments and scales while meeting energy-efficiency, performance and fault tolerance goals; (ii) Engagement in deep partnerships with scientific teams and use a mix of user research with system software R&D to address specific challenges that these communities face, and inform future research directions from acquired experience.

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

8.3.2.1. Associate Team SUSTAM – Sustainable Ultra Scale compuTing, dAta and energy Management (2017-2020)

Participants: Eddy Caron, Hadrien Croubois, Marcos Dias de Assunção, Alexandre Da Silva Veith, Jean-Patrick Gelas, Olivier Glück, Laurent Lefèvre, Valentin Lorentz, Christian Perez, Issam Rais, Pedro de Souza Bento Da Silva.

International Partners: Rutgers University (United States) - RDI2 - Manish Parashar

The SUSTAM associate team will focus on the joint design of a multi-criteria orchestration framework dealing with resources, data and energy management in a 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). The SUSTAM associated team is led by Laurent Lefèvre.

8.3.3. Participation in Other International Programs

8.3.3.1. Joint Project CNRS/University of Melbourne – Algorithms for Placement and Reconfiguration of Data Stream Processing Applications (2017-2018)

Participants: Marcos Dias de Assunção, Alexandre Da Silva Veith, Laurent Lefèvre.

Partner: Clouds Lab (The University of Melbourne, Australia).

Much of the “big data” produced today is created as continuous data streams that are most valuable when processed quickly. Several data stream processing frameworks have been designed for running on clusters of homogeneous computers. Under most frameworks, an application is a Direct Acyclic Graph (DAG) whose vertices are operators that execute transformations over the incoming data and edges that define how the data flows between operators. While cloud computing is a key infrastructure for deploying such frameworks, more modern solutions leverage the edges of the Internet (e.g. edge computing) to offload some of the processing from the cloud and hence reduce the end-to-end latency. The placement and reconfiguration of stream processing DAGs onto highly distributed and heterogeneous infrastructure are, however, challenging endeavours. This project aims to investigate algorithms for the placement and dynamic reconfiguration of stream processing components considering multiple criteria.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Joao Ferreira Lima (visit from January 30th to March 2nd) from UFSM, Santa Maria, Brazil. Research collaboration funded by Labex Milyon. During the visit, he worked on energy consumption of OpenMP runtimes with Thierry Gautier.

Leila Helali (visit from June 5th to June 31th). Research collaboration with the University of Sousse (Tunisia). During the visit she worked with Eddy Caron on autonomic deployment and licenses management.

Manuel Dolz (from 25th September to 7th October 2017) from University Carlos III from Madrid, Spain. Research collaboration funded by the NESUS COST IC1305 european project. During the visit, he worked on operators placement for efficient data-streaming scenario with Marcos Dias de Assuncao, Laurent Lefevre and Alexandre Veith.

AVIZ Project-Team

7. Partnerships and Cooperations

7.1. European Initiatives

7.1.1. FP7 & H2020 Projects

7.1.1.1. CENDARI

Title: Collaborative European Digital/Archival Infrastructure

Programm: FP7

Duration: February 2012 - January 2016

Coordinator: Trinity College - Dublin

Partners:

Consortium of European Research Libraries (United Kingdom)

Koninklijke Bibliotheek (Netherlands)

Fondazione Ezio Franceschini Onlus (Italy)

Freie Universitaet Berlin (Germany)

King's College London (United Kingdom)

"matematicki Institutnu, Beograd" (Serbia)

Narodni Knihovna Ceske Republiky (Czech Republic)

Societa Internazionale Per Lo Studio Del Medioevo Latino-S.I.S.M.E.L.Associazione (Italy)

The Provost, Fellows, Foundation Scholars & The Other Members of Board of The College of The Holy & Undivided Trinity of Queen Elizabeth Near Dublin (Ireland)

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

The University of Birmingham (United Kingdom)

Universitaet Stuttgart (Germany)

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

Inria contact: L. Romary

'The Collaborative European Digital Archive Infrastructure (CENDARI) will provide and facilitate access to existing archives and resources in Europe for the study of medieval and modern European history through the development of an 'enquiry environment'. This environment will increase access to records of historic importance across the European Research Area, creating a powerful new platform for accessing and investigating historical data in a transnational fashion overcoming the national and institutional data silos that now exist. It will leverage the power of the European infrastructure for Digital Humanities (DARIAH) bringing these technical experts together with leading historians and existing research infrastructures (archives, libraries and individual digital projects) within a programme of technical research informed by cutting edge reflection on the impact of the digital age on scholarly practice. The enquiry environment that is at the heart of this proposal will create new ways to discover meaning, a methodology not just of scale but of kind. It will create tools and workspaces that allow researchers to engage with large data sets via federated multilingual searches across heterogeneous resources while defining workflows enabling the creation of personalized research environments, shared research and teaching spaces, and annotation trails, amongst other features. This will be facilitated by multilingual authority lists of named entities (people, places, events) that will harness user involvement to add intelligence to the system. Moreover, it will develop new visual paradigms for the exploration of patterns generated by the system, from knowledge transfer and dissemination, to language usage and shifts, to the advancement and diffusion of ideas.'

7.2. International Initiatives

7.2.1. *Informal International Partners*

- University of Calgary. Pierre Dragicevic and Petra Isenberg collaborate with Wesley Willett on situated data visualization.
- University of Washington, Chicago University and University of Zurich. Pierre Dragicevic collaborates with Matthew Kay, Steve Haroz and Chat Wacharamanatham on transparent statistical reporting and efficient statistical communication
- Stanford University. Pierre Dragicevic and Jean-Daniel Fekete collaborate with Sean Follmer on swarm user interfaces.
- Chicago University and University of Maryland, Evanthia Dimara and Pierre Dragicevic collaborate with Steven Franconeri and Catherine Plaisant on a taxonomy of cognitive biases.

7.3. International Research Visitors

7.3.1. *Visits of International Scientists*

- Catherine Plaisant (June–July): Invited professor from University of Maryland, USA. Invited through a DigiCosme grant, Catherine Plaisant has spent two months with Aviz. We have launched two research projects, one on hypergraph visualization and one on tracing users to understand their use of visualization. Catherine Plaisant has interacted with all of the Aviz students and post-doctoral fellows, as well as with the permanent researchers.
- Paolo Buono, from University of Bari, Italy. Paolo Buono has spent two months with Aviz working on the visualization of dynamic networks. He has collaborated with Paoa Valdivia, Catherine Plaisant, and Jean-Daniel Fekete for that project. He has also interacted with all the members of Aviz.

7.3.1.1. *Internships*

- Jaemin Jo (March–April): intern from Seoul National University, Korea. Worked on converting a KNN algorithm into a progressive form.
- Nicola Pezzotti (April–May): intern from University of Delft, The Netherlands. Worked on data structures and algorithms for managing very large (out of core) datasets in the context of progressive algorithms.

BEAGLE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

IntraCellXevo (2016-2018). Participants: E. Tannier, in collaboration with T Henry, Insem Lyon. This projects mixes an experimental evolution of *Franscicella tumarensis* in the cytosol and a bioinformatics analysis of the adaptive mutations. It has been funded by the Labex Ecofect up to 120keuros.

Lipuscale (2017-2019). Participants: C. Knibbe, in collaboration with S. Bernard (Inria Dracula) and M.-C. Michalski (CarMeN laboratory, INSERM U1060/ INRA U1397/ Université Lyon1/ INSA de Lyon). This project aims at reaching a quantitative understanding of the lipolysis and adsorption of dietary triglycerides, by using and adapting SimuScale (a multi-scale simulator developed by the Inria Dracula team) to model and simulate the processes, and by using wet experiments on in vitro systems and cellular cultures to calibrate the models parameters. It is funded by the Rhône-Alpes Institute for Complex Systems (IXXI, 5k€ for two years).

PMSISEE (2017-2019): The goal of the PMSISEE (Performance, Maintainability and Scalability of In-Silico Experimental Evolution Simulation) project is to improve the collaboration between the Inria Avalon team of the LIP laboratory and the Inria Beagle team of the LIRIS laboratory through research activities on programming model and tools for High Performance Computing applied to in-silico experimental evolution. One of the outcome is to improve the scalability and performance of the Aevol software. Moreover, we are formalizing a mini-application (mini-Aevol) representative of the resources usage of Aevol. The goal of this mini-application is to propose a simplify version of Aevol that could be used by the parallel computing community as use case to test new improvements. It is founded by the Lyon Computer Science Federation (FIL FR2000).

7.2. National Initiatives

7.2.1. ANR

Ancestrrome (2012-2017): phylogenetic reconstruction of ancestral "-omes", a five-year project, call "Bioinformatics" of the "Investissements d'avenir". Supervisor: V Daubin (CNRS, LBBE, Lyon) ; with Institut Pasteur, ENS Paris, ISEM (Univ Montpellier 2) Participant: E Tannier.

Aucomsi (2013-2016) (Models of the vocal tract to study auditory circuits): a 4-year project funded by a grant from the ANR-NSF-NIH Call for French-US Projects in Computational Neuroscience. With F. Theunissen, UC Berkeley, CA, USA. Supervisor: H. Soula (for France) and F. Theunissen (for US). Participants: H. Soula, M. Fernandez.

Dopaciumcity (2014-2017): Dopamine modulation of calcium influx underlying synaptic plasticity, a 4-year project funded by a grant from the ANR-NSF-NIH Call for French-US Projects in Computational Neuroscience. With L. Venance, College de France, CIRB, CNRS/UMR 7241 - INSERM U1050, Paris, France and K Blackwell, Krasnow Institute of Advanced Studies, George Mason University, Fairfax, VA, USA. Supervisor: L Venance (for France) and K.L. Blackwell (for US). Participants: H Berry, I Prokin, A Foncelle

Dallish (2016-2020): Data Assimilation and Lattice Light Sheet imaging for endocytosis/exocytosis pathway modeling in the whole cell, Call AAPG ANR 2016. With C. Kervrann (Inria Rennes), J. Salamero (Institute Curie, Paris), B. Laroche (INRA, Jouy-en-Josas). Participants: H. Berry.

7.2.2. Inria

ADT Phylophile. Participants: E Tannier, in collaboration with D Parsons, Inria, V Daubin, B Boussau, CNRS, Université de Lyon 1. This project aims at producing an easy to use software integrating modern algorithmic methods to build gene trees. It has been funded by Inria by a 24 month software engineer.

ADT Aevol. Participants: C Kinbbbe, G Beslon, V Liard, J Rouzaud-Cornabas, D Parsons. This project aims at speeding and scaling and maintaining the code for our most complex software, aevol. It has been funded by Inria by a 24 month software engineer.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. EvoEvo

Although the EvoEvo project was officially closed in December 2016, we let it in the 2017 report because (i) the scientific actions and the cooperations started in the project were still very active in 2017, (ii) the remaining of the project grant has served to fund many actions of the team in 2017 (including of course the continuation of the EvoEvo researches themselves).

Title: Evolution of Evolution

Programm: FP7

Duration: November 2013 - October 2016

Coordinator: Inria

Partners:

Agencia Estatal Consejo Superior de Investigaciones Cientificas (Spain)

Institut National des Sciences Appliquees de Lyon (France)

Universite Lyon 1 Claude Bernard (France)

Universite Joseph Fourier Grenoble 1 (France)

Universiteit Utrecht (Netherlands)

University of York (United Kingdom)

Inria contact: Guillaume Beslon

Evolution is the major source of complexity on Earth, at the origin of all the species we can observe, interact with or breed. On a smaller scale, evolution is at the heart of the adaptation process for many species, in particular micro-organisms (*e.g.* bacteria, viruses...). Microbial evolution results in the emergence of the species itself, and it also contributes to the organisms' adaptation to perturbations or environmental changes. These organisms are not only organised by evolution, they are also organised to evolve. The EvoEvo project will develop new evolutionary approaches in information science and will produce algorithms based on the latest understanding of molecular and evolutionary biology. Our ultimate goal is to address open-ended problems, where the specifications are either unknown or too complicated to express, and to produce software able to operate in unpredictable, varying conditions.

We will start from experimental observations of micro-organism evolution, and abstract this to reproduce EvoEvo, in biological models, in computational models, and in application software. Our aim is to observe EvoEvo in action, to model EvoEvo, to understand EvoEvo and, ultimately, to implement and exploit EvoEvo in software and computational systems. The EvoEvo project will have impact in ICT, through the development of new technologies. It will also have impact in biology and public health, by providing a better understanding of micro-organism adaptation (such as the emergence of new pathogens or the development of antibiotic resistances).

7.4. International Initiatives

7.4.1. Participation in International Programs

Beagle is a member of the CNRS "Laboratoire International Associé" (LIA) EvoAct together with Dominique Schneider's team at TIMC-IMAG (Université Grenoble Alpes) and the Beacon center at Michigan State University (Richard Lenski and Charles Ofria). EvoAct aims at studying "Evolution in Action" by *in vivo*, *in vitro* and *in silico* experiments. More specifically the Beagle team is in charge of the *in silico* experiments.

BIGS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- *Popart (2016-2017)* In the framework of collaboration with A. Deveau of Inra Nancy, A. Gégout-Petit and A. Muller-Gueudin are included in the Inra "Microbial Ecosystems & Metaomics, Call 2016" Project "Popart" for "Regulation of the Poplar microbiome by its host: is the immune system involved ? ". The aim is to develop methodology for the inference of regulation network between micro-organisms around Poplar. The specificity of the data is the inflation of zeros that has to be taken into account.
- GDR 3475 Analyse Multifractale, Funding organism: CNRS, Leader: S. Jaffard (Université Paris-Est), Céline Lacaux
- GDR 3477 Géométrie stochastique, Funding organism: CNRS, Leader: P. Calka (Université Rouen), Céline Lacaux
- FHU CARTAGE (Fédération Hospitalo Universitaire Cardial and ARterial AGEing ; leader : Pr Athanase BENETOS), Jean-Marie Monnez
- RHU Fight HF (Fighting Heart Failure ; leader : Pr Patrick ROSSIGNOL), located at the University Hospital of Nancy, Jean-Marie Monnez
- Project "Handle your heart", team responsible for the creation of a drug prescription support software for the treatment of heart failure, head: Jean-Marie Monnez
- "ITMO Physics, mathematics applied to Cancer" (2017-2019): "Modeling ctDNA dynamics for detecting targeted therapy", Funding organisms: ITMO Cancer, ITMO Technologies pour la santé de l'alliance nationale pour les sciences de la vie et de la santé (AVIESAN), INCa, Leader: N. Champagnat (Inria TOSCA), Participants: A. Gégout-Petit, A. Muller-Gueudin, P. Vallois
- Modular, multivalent and multiplexed tools for dual molecular imaging (2017-2020), Funding organism: ANR, Leader: B Kuhnast (CEA). Participant: T. Bastogne.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

- Photobrain project. AGuIX theranostic nanoparticles for vascular-targeted interstitial photodynamic therapy of brain tumors, project **EuroNanoMed II**, resp.: M. Barberi-Heyob, (2015-2017), participant: T. Bastogne.
- NanoBit Project. Nanoscintillator-Porphyrin Complexes for Bimodal RadioPhotoDynamic Therapy, project **EuroNanoMed II**, resp.: P. Juzenas, (2016-2018), participant: T. Bastogne.

BIOCORE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. National programmes

- **ANR-Purple Sun:** The objective of this project (ANR-13-BIME-004, 2013-2017) is to study and optimize a new concept consisting in coupling the production of microalgae with photovoltaic panels. The main idea is to derive the excess of light energy to PV electricity production, in order to reduce the phenomena of photoinhibition and overwarming both reducing microalgal productivity.
- **ANR-Facteur 4:** The objective of this project (2012-2017) is to produce non OGM strain of microalgae with enhanced performance. BIOCORE is involved in the directed selection of microalgae with interesting properties from an industrial point of view. The theory of competition is used to give a competitive advantage to some species. This competitive advantage can be provided by an online closed loop controller.
- **ANR-Phycover:** The overall objective of the PHYCOVER project (2014-2018) is to identify a modular wastewater treatment process for the production of biogas. The method combines three modules. First, a high-rate algal pond is dedicated to the treatment of municipal wastewater. Then, an anaerobic digester capable of co-digesting biomass products (and others organic matter resources) to significantly reduce biological and chemical contaminants while producing a sustainable energy as biogas is analysed. A final module transforms the residual carbon, nitrogen and phosphorus into high-value microalgae dedicated to aquaculture and green chemistry.
- **ITE-OPALE:** The goal of the Institut de la Transition Énergétique - OPALE project (2016-2019) is to increase the lipid content of microalgae by specific selection pressure. The project relies on the strain already selected during the Facteur 4 project, whose productivity was 4 times higher than the wild type. We expect to still increase strain performances up to 10 times the productivity of the wild type.
- **ANR-FunFit:** The objective of this project (2013-2018) is to develop a trait-based approach linking individual fitness of fungal plant pathogens to ecological strategies. The idea is to derive eco-epidemiological strategies from fitness optimization in colonized environments and during colonization, as well as understanding the coexistence of sibling species. This project is co-coordinated by F. Grogard.
- **ANR-TripTic:** The objective of this project (2014-2018) is to document the biological diversity in the genus of the minute wasps *Trichogramma*, and to study the behavioral and populational traits relevant to their use in biological control programs.
- **ANR-MIHMES:** “Multi-scale modeling, from animal Intra-Host to Metapopulation, of mechanisms of pathogen spread to Evaluate control Strategies”, ANR – Investissement d’avenir, action Bioinformatique (ANR-10-BINF-07) & Fond Européen de Développement Régional des Pays-de-la-Loire (FEDER), 2012–2017. This project aimed at producing scientific knowledge and methods for the management of endemic infectious animal diseases and veterinary public health risks. BIOCORE participated in this project via MaIAGE, INRA Jouy-en-Josas. This project supported Natacha Go’s postdoctoral position.
- **ANR-ICycle:** This project (2016-2020) aims at understanding the communication pathways between the cell division cycle and the circadian clock, using mathematical modeling and control theory to construct and implement two coupled synthetic biological oscillators. Project coordinated by M. Chaves.

- **ANR - Maximic:** The goal of the project (accepted in July 2017) is to design and implement control strategies in a bacterium from producing at maximal rate a high value product. It is coordinated by H. de Jong (IBIS Grenoble), and involves members of Biocore and McTao.
- **RESET:** The objective of this project (2012-2017) is to control the growth of *E. coli* cells in a precise way, by arresting and restarting the gene expression machinery of the bacteria in an efficient manner directed at improving product yield and productivity. RESET is an “Investissements d’Avenir” project in Bioinformatics (managed by ANR) and it is coordinated by H. de Jong (Ibis, Inria)
- **SIGNALIFE:** Biocore is part of this Labex (scientific cluster of excellence) whose objective is to build a network for innovation on Signal Transduction Pathways in life Sciences, and is hosted by the University of Nice Sophia Antipolis.
- **UMT FIORIMED:** FioriMed is a Mixed Technology Unit created in January 2015 to strengthen the production and dissemination of innovation to the benefit of ornamental horticulture. Horticultural greenhouses are seen as a “laboratory” for the actual implementation of agroecology concepts with the possibility of generic outcomes being transferred to other production systems. The main partners of UMT FioriMed are ASTREDHOR (National Institute of Horticulture) and the ISA Joint Research Unit of INRA-CNRS-Univ. Nice.
- **AMIES-PEPS Exactcure:** The goal of the project is to study pharmacokinetic models, in collaboration with the start-up Exactcure (Nice). This funded the M2 internship of L. Dragoni.

9.1.2. Inria funding

- **Inria Project Lab, Algae in silico:** (2014-2018) The Algae in silico Inria Project Lab, funded by Inria and coordinated by O. Bernard, focuses on the expertise and knowledge of biologists, applied mathematicians and computer scientists to propose an innovative numerical model of microalgal culturing devices. The latest developments in metabolic modeling, hydrodynamic modeling and process control are joined to propose a new generation of advanced simulators in a realistic outdoor environment. The project gathers 5 Inria project teams and 3 external teams.
- **Inria Project Lab, Cosy:** (2017-...) This proposal aims at exploiting the potential of state-of-art biological modeling, control techniques, synthetic biology and experimental equipment to achieve a paradigm shift in control of microbial communities. We will investigate, design, build and apply an automated computer-driven feedback system for control of synthetic microbial communities, not just accounting for but rather leveraging population heterogeneity in the optimal accomplishment of a population-level task. The development of methodologies of general applicability will be driven by and applied to two different applications closely connected with real-world problems in the biomedical and biotechnological industry. The consortium is composed of the four Inria project-teams IBIS, BIOCORE, COMMANDS, NON-A, the Inria Action Exploratoire INBIO, as well as the external partners BIOP (Université Grenoble Alpes, including members of IBIS), MaIAge (INRA), and YoukLAB (TU Delft). The project began in November.

9.1.3. INRA funding

- **MoGeR:** “From knowledge to modeling: towards a user-friendly simulation tool to test crop resistance management scenarios in the Phoma-oilseed rape case study”, INRA Metaprogramme SMaCH, 2017–2019. This is a follow-up of the K-Masstec project, which focused on sustainable strategies for the deployment of genetic resistance in the field, based on molecular knowledge on avirulence genes.
- **ABCD:** INRA SPE is funding the project ABCD “Augmentative Biological Control; optimizing natural enemies Deployment” (2017-2019) in which Biocore is a partner with INRA Sophia Antipolis.

9.1.4. Networks

- **GDR Invasions Biologiques:** The objectives of this GDR are to encourage multidisciplinary research approaches on invasion biology. It has five different thematic axes: 1) invasion biology scenarios, 2) biological invasions and ecosystem functioning, 3) environmental impact of invasive species, 4) modeling biological invasions, 5) socio-economics of invasion biology. L. Mailleret is a member of the scientific committee of the GDR .
- **ModStatSAP:** The objective of this INRA network is to federate researchers in applied mathematics and statistics and to promote mathematical and statistical modeling studies in crop and animal health. S. Touzeau is a member of the scientific committee.
- **Seminar:** BIOCORE organizes a regular seminar “Modeling and control of ecosystems” at the station zoologique of Villefranche-sur-Mer, at INRA-ISA or at Inria.

9.2. European Initiatives

9.2.1. Collaborations with Major European Organizations

Imperial college, Department of Chemical engineering (UK),
 Modeling and optimization of microalgal based processes; with B. Chachuat.
 Imperial College, Centre for Synthetic Biology and Innovation, Dept. of Bioengineering (UK):
 Study of metabolic/genetic models; with D.A. Oyarzún.
 University of Padova (Italy):
 Modelling and control of microalgal production at industrial scale; with F. Bezzo.
 University of Aveiro, Dept. of Mathematics (Portugal):
 Hybrid models and boolean networks; with M.A. Martins.

9.3. International Initiatives

9.3.1. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

9.3.1.1. GREENCORE

Title: Modeling and control for energy producing bioprocesses
 International Partners (Institution - Laboratory - Researcher):
 CIRIC (Chile) - Méline Gautier
 PUCV (Chile) - Escuela de Ingenieria Bioquimica (EIB) - David Jeison
 UTFSM (Chile) - Departamento de Matematica - Pedro Gajardo
 Univ. Chile (Chile) - Centro de modelacion matematica - Hector Ramirez

Inria coordinator: O. Bernard

Start year: 2017

See also: <https://team.inria.fr/eagreencore/>

The worldwide increasing energy needs together with the ongoing demand for CO₂ neutral fuels represent a renewed strong driving force for the production of energy derived from biological resources. In this scenario, the culture of oleaginous microalgae for biofuel and the anaerobic digestion to turn wastes into methane may offer an appealing solution. The main objective of our proposal is to join our expertise and tools, regarding these bioprocesses, in order to implement models and control strategies aiming to manage and finally optimize these key bioprocesses of industrial importance. By joining our expertise and experimental set-up, we want to demonstrate that closed loop control laws can significantly increase the productivity, ensure the bioprocess stability and decrease the environmental footprint of these systems. This project gathers experts in control theory and optimization (BIOCORE, UTFSM) together with experts in bioprocesses (PUCV and CMM) and software development (CIRIC).

LIRIMA

Associate Team involved in the International Lab:

9.3.1.2. EPITAG

Title: Epidemiological Modeling and Control for Tropical Agriculture

International Partner (Institution - Laboratory - Researcher):

Université de Douala (Cameroon) - Mathematics Department - Samuel Bowong

Inria coordinator: S. Touzeau

Start year: 2017

See also: <https://team.inria.fr/epitag/>

EPITAG gathers French and Cameroonian researchers, with a background in dynamical systems and control and with an interest in crop diseases. Crop pests and pathogens are responsible for considerable yield losses. Their control is hence a major issue, especially in Cameroon, where agriculture is an important sector in terms of revenues and employment. To help design efficient strategies for integrated pest management, mathematical models are particularly relevant. Our main objective is to study the epidemiology and management of tropical crop diseases, with a focus on Cameroon and Sub-Saharan Africa. Our approach consists in developing and analysing dynamical models describing plant-parasite interactions, in order to better understand, predict and control the evolution of damages in crops. To ensure the relevance of our models, “end users” will be closely associated. We will focus on three pathosystems: cocoa plant mirids, coffee berry borers and plantain plant-parasitic nematodes.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Univ. Ben Gurion : Microalgal Biotechnology Lab (IL), Member of the ESSEM COST Action ES1408 European network for algal-bioproductions (EUALGAE). Modeling of photosynthesis.

9.3.3. Participation in Other International Programs

Biocore is involved in the IFCAM project, with India, PULSPOP "PULses in Spatial POPulation dynamics" (2016-2017) whose partners are Institut Sophia Agrobiotech and National Institute of Technology, Meghalaya (India). This project financed the visit of Bapan Ghosh to ISA and BIOCORE, and the visit of Nicolas Bajoux to India.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Claude Aflalo (Ben Gurion University of the Negev, Israel), 6 months.
- Samuel Bowong (University of Douala, Cameroon), 5 days.
- Myriam Djoukwe Tapi (University of Douala, Cameroon), 1 week.
- Bapan Ghosh (National Institute of Technology Meghalaya, India), 1 month.
- Yves Fotso Fotso (University of Dschang, Cameroon), 4 months.
- Israël Tankam Chedjou (University of Yaoundé 1, Cameroon), 4 months.

9.5. Project-team seminar

BIOCORE organized a 4-day seminar in September in Porquerolles. On this occasion, every member of the project-team presented his/her recent results and brainstorming sessions were organized.

BIOVISION Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. VREAD: Making reading enjoyable again

Participants: Marco Benzi, Pierre Kornprobst, Stéphanie Baillif [Centre hospitalier Pasteur 2 (service d'ophtalmologie, Nice, France)], Annick Martin [”27Delvalle” (Centre d’Innovation Santé de la ville de Nice, France)], Eric Castet [Aix-Marseille Université (CNRS, Laboratoire de Psychologie Cognitive, Marseille, France)], Fabio Solari [University of Genoa (DIBRIS, Genoa, Italy)], Manuela Chessa [University of Genoa (DIBRIS, Genoa, Italy)]

Coordinator: Pierre Kornprobst

Duration: August 2017 to January 2019

Our goal is to develop a new platform to bring reading experience to a higher level of immersivity, making reading enjoyable again for low-vision people. This project received funding from Université Côte d’Azur (France), in the "Pré-maturation" call which finances actions that transform existing proof of concept into an operational laboratory prototype allowing either the realization of "robust" demonstrators or the complete experimental validation of concept. The perspective is industrialisation, through transfer or start-up creation.

9.1.2. *Modélisation Théorique et Computationnelle en Neurosciences et Sciences Cognitives*

The Biovision team is a member of this "Axe Interdisciplinaire de Recherche de l’Université de Nice – Sophia Antipolis". It has participated to the [Rencontre C@UCA 2017](#) in Fréjus (April 2017). This axe is partly funding our work on retinal waves.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. Trajectory

Title: Encoding and predicting motion trajectories in early visual networks

Programme: ANR

Duration: October 2015 - September 2020

Coordinator: Invibe Team, Institut des Neurosciences de la Timone, Frédéric Chavane,

Partners:

Institut de Neurosciences de la Timone (CNRS and Aix-Marseille Université, France)

Institut de la Vision (Paris, France)

Universidad Tecnico Federico Santa María (Electronics Engineering Department, Valparaíso, Chile)

Inria contact: Bruno Cessac

Global motion processing is a major computational task of biological visual systems. When an object moves across the visual field, the sequence of visited positions is strongly correlated in space and time, forming a trajectory. These correlated images generate a sequence of local activation of the feed-forward stream. Local properties such as position, direction and orientation can be extracted at each time step by a feed-forward cascade of linear filters and static non-linearities. However such local, piecewise, analysis ignores the recent history of motion and faces several difficulties, such as systematic delays, ambiguous information processing (e.g., aperture and correspondence problems) high sensitivity to noise and segmentation problems when several objects are present. Indeed, two main aspects of visual processing have been largely ignored by the dominant, classical feed-forward scheme. First, natural inputs are often ambiguous, dynamic and non-stationary as, e.g., objects moving along complex trajectories. To process them, the visual system must segment them from the scene, estimate their position and direction over time and predict their future location and velocity. Second, each of these processing steps, from the retina to the highest cortical areas, is implemented by an intricate interplay of feed-forward, feedback and horizontal interactions. Thus, at each stage, a moving object will not only be processed locally, but also generate a lateral propagation of information. Despite decades of motion processing research, it is still unclear how the early visual system processes motion trajectories. We, among others, have proposed that anisotropic diffusion of motion information in retinotopic maps can contribute resolving many of these difficulties. Under this perspective, motion integration, anticipation and prediction would be jointly achieved through the interactions between feed-forward, lateral and feedback propagations within a common spatial reference frame, the retinotopic maps. Addressing this question is particularly challenging, as it requires to probe these sequences of events at multiple scales (from individual cells to large networks) and multiple stages (retina, primary visual cortex (V1)). “TRAJECTORY” proposes such an integrated approach. Using state-of-the-art micro- and mesoscopic recording techniques combined with modeling approaches, we aim at dissecting, for the first time, the population responses at two key stages of visual motion encoding: the retina and V1. Preliminary experiments and previous computational studies demonstrate the feasibility of our work. We plan three coordinated physiology and modeling work-packages aimed to explore two crucial early visual stages in order to answer the following questions: How is a translating bar represented and encoded within a hierarchy of visual networks and for which condition does it elicit anticipatory responses? How is visual processing shaped by the recent history of motion along a more or less predictable trajectory? How much processing happens in V1 as opposed to simply reflecting transformations occurring already in the retina? The project is timely because partners master new tools such as multi-electrode arrays and voltage-sensitive dye imaging for investigating the dynamics of neuronal populations covering a large segment of the motion trajectory, both in retina and V1. Second, it is strategic: motion trajectories are a fundamental aspect of visual processing that is also a technological obstacle in computer vision and neuroprostheses design. Third, this project is unique by proposing to jointly investigate retinal and V1 levels within a single experimental and theoretical framework. Lastly, it is mature being grounded on (i) preliminary data paving the way of the three different aims and (ii) a history of strong interactions between the different groups that have decided to join their efforts.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

- Program: Leverhulme Trust
- Project acronym:
- Project title: A novel approach to functional classification of retinal ganglion cells
- Duration: 2017-2020
- Coordinator: Evelyne Sernagor, Institute of Neuroscience (ION, Newcastle, UK)

- Other partners:
 - Melissa Bateson Institute of Neuroscience (ION, Newcastle, UK)
 - Matthias Hennig Institute for Adaptive and Neural Computation (ANC, School of Informatics University of Edinburgh, UK)
- Abstract: Vision begins with photoreceptors converting light from different parts of the visual scene into electrical signals, compressing our visual world into a parsimonious code of impulses at the retinal output level, the retinal ganglion cells (RGCs). This information is sent to the brain via only $\approx 1\text{m}$ RGCs (45,000 in mouse). Amazingly, the brain can recreate images from interpreting these “barcodes” or trains of impulses. This ability is partly due to the astonishing functional diversity of RGCs, each interpreting a different feature of the visual scene. It is all these parallel streams of information that impart the complexity of visual scenes to our brain visual areas. At present, at least 30 RGC subtypes have been identified. Classification is typically based on common anatomical features, or on basic functions (e.g. whether cells respond to the onset or offset of the light, or whether they are sensitive to motion direction) and it has recently progressed to include molecular markers. Recent studies have successfully characterised common physiological properties between RGCs sharing gene expression, suggesting that their molecular signature may indeed be a good indicator of function. However, according to mouse genetics repositories (e.g., the Allen Brain Project) many genes are expressed in subpopulations of RGCs for which we have no phenotype yet. Genes that are expressed in most RGCs probably do not reflect specific functional populations, but some other genes are expressed only in sparse RGC groups. Each gene-specific class exhibits a distinct spatial mosaic pattern across the retina, suggesting that the cells belong to a common group. Many classes, even sparse, exhibit asymmetric distributions across the retina, e.g., with larger numbers on the ventral or dorsal side, suggesting specific roles in ecological vision, e.g., specialised in detecting moving objects in the sky (ventral) or on the ground (dorsal).

9.4. International Initiatives

9.4.1. International Research Network to Study Predictive Coding in the Retina

Program: CHILEAN SUPPORT OF INTERNATIONAL NETWORKING BETWEEN RESEARCH CENTRES

Project title: International Research Network to Study Predictive Coding in the Retina

Duration: 2018-2020

Coordinator: Maria-José Escobar, Advanced Center for Electrical and Electronic Engineering, Universidad Técnica Federico Santa María, Chile

Other partners:

Advanced Center for Electrical and Electronic Engineering (Valparaiso, Chili)

Centro Interdisciplinario de Neurociencia de Valparaíso (CINV, Valparaíso, Chile)

Abstract: The retina, a well-structured multilayer neural system, encodes the visual information of the environment from an input of photon flux to a series of electrical pulses that are ultimately readout by the brain to create perception and program motor actions. The retina, from an engineering point of view, can be seen as a series of circuits computing visual features from the visual world in parallel encoding only informative inputs that are then sent to the brain. Regarding all the visual features that can be detected from the outer world, motion processing represents a fundamental visual computation ruling many visuomotor behaviours. Motion sensitive neurons have been early reported in the retina, but recently additional features have been added to the pool of capabilities present in this organ: especially motion direction selectivity and predictive coding. Motion processing presents predictive coding characteristics, in the sense that there is an anticipatory response of the visual system when an object in motion follows a trajectory in the visual field. Motion anticipation is fundamental for survival. Interestingly, this mechanism, observed in the visual cortex, has been also

reported in the retina. Understanding how the visual system accumulates information along a certain trajectory raises fundamental questions about neural computation, its dynamics, and implementation. This understanding could be also extended to new algorithms to image/video processing, and also, autonomous navigation of robots.

In this project, we propose the formal establishment of a collaborative network between the AC3E Biomedical System group (AC3E-UTFSM), Centro Interdisciplinario de Neurociencia de Valparaíso (CINV -UV) and Biovision team (Inria Sophia-Antipolis Méditerranée), gathering together skills related with physiological recording in the retina, data analysis and theoretical tools to implement functional and biophysical models. This network aims to study the anticipatory response observed in the mammalian retina, characterizing its underlying mechanisms and the predictive coding capabilities present in this part of the nervous system.

9.4.2. Inria International Partners

Institute of Neuroscience (ION, Newcastle, UK)

Institute for Adaptive and Neural Computation (ANC, School of Informatics University of Edinburgh, UK)

Universidad Tecnico Federico Santa María (Electronics Engineering Department, Valparaíso, Chile)

Centro Interdisciplinario de Neurociencia de Valparaíso (CINV, Valparaíso, Chile)

University of Genoa (DIBRIS, Genoa, Italy)

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Harold E. Bedell (University of Houston College of Optometry, USA)
- Fabio Anselmi (University of Genoa, Italy)
- Jennifer Sarah Goldman (McGill University, Montreal Neurological Institute and Hospital, Canada)

9.5.1.1. Internships

- Jenny Kartsaki, Greek Msc student, March-August 2017. Now a PhD student supervised by Bruno Cessac.

BIPOP Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Christophe Prieur and Bernard Brogliato are coordinator and member (respectively) of the Labex Persyval project e-Baccuss (2016-2018).
- Pierre-Brice Wieber is co-coordinator of the Labex Persyval project RHUM (2015-2018).

9.2. National Initiatives

- Vincent Acary and Bernard Brogliato are members of the Inria IPL Modeliscale (coordinator: Benoit Caillaud, Inria Rennes).
- Vincent Acary and Bernard Brogliato are members of the FUI project Modeliscale (coordinator: Benoit Caillaud, Inria Rennes).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. GEM

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

Programm: H2020

Type: ERC

Duration: September 2015 - August 2020

Coordinator: Inria

Inria contact: Florence BERTAILS-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.

9.3.1.2. COMANOID

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: CNRS (Lirmm)

Partners:

Centre national de la recherche scientifique (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Airbus Groups (France)

Universita Degli Studi di Roma Lapienza (Italy)

Inria contact: Francois Chaumette

COMANOID investigates the deployment of robotic solutions in well-identified Airbus airliner assembly operations that are laborious or tedious for human workers and for which access is impossible for wheeled or rail-ported robotic platforms. As a solution to these constraints a humanoid robot is proposed to achieve the described tasks in real-use cases provided by Airbus Group. At a first glance, a humanoid robotic solution appears extremely risky, since the operations to be conducted are in highly constrained aircraft cavities with non-uniform (cargo) structures. Furthermore, these tight spaces are to be shared with human workers. Recent developments, however, in multi-contact planning and control suggest that this is a much more plausible solution than current alternatives such as a manipulator mounted on multi-legged base. Indeed, if humanoid robots can efficiently exploit their surroundings in order to support themselves during motion and manipulation, they can ensure balance and stability, move in non-gaited (acyclic) ways through narrow passages, and also increase operational forces by creating closed-kinematic chains. Bipedal robots are well suited to narrow environments specifically because they are able to perform manipulation using only small support areas. Moreover, the stability benefits of multi-legged robots that have larger support areas are largely lost when the manipulator must be brought close, or even beyond, the support borders. COMANOID aims at assessing clearly how far the state-of-the-art stands from such novel technologies. In particular the project focuses on implementing a real-world humanoid robotics solution using the best of research and innovation. The main challenge will be to integrate current scientific and technological advances including multi-contact planning and control; advanced visual-haptic servoing; perception and localization; human-robot safety and the operational efficiency of cobotics solutions in airliner manufacturing.

9.4. International Initiatives

9.4.1. Inria International Labs

- Inria-Chile: two engineers supervised by Vincent Acary (Stephen Sinclair and Salomé Candela)

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Jozsef Kovecses (McGill University, Mechanical Engineering).
- Alexandre Derouet-Jourdan (OLM Digital, Japan).

BONSAI Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- ANR ASTER: ASTER is a national project that aims at developing algorithms and software for analyzing third-generation sequencing data, and more specifically RNA sequencing. BONSAI is the principal investigator in this ANR. Other partners are Erable (LBBE in Lyon) and two sequencing and analysis platforms that have been very active in the MinION Access Program (Genoscope and Institut Pasteur de Lille).
- PIA France Génomique: National funding from “Investissements d’Avenir” (call *Infrastructures en Biologie-Santé*). France Génomique is a shared infrastructure, whose goal is to support sequencing, genotyping and associated computational analysis, and increases French capacities in genome and bioinformatics data analysis. It gathers 9 sequencing and 8 bioinformatics platforms. Within this consortium, we are responsible for the workpackage devoted to the computational analysis of sRNA-seq data, in coordination with the bioinformatics platform of Génomole Toulouse-Midi-Pyrénées.

8.1.2. ADT

- ADT Vidjil (2015–2017): The purpose of this ADT was to strengthen Vidjil development and to ensure a better diffusion of the software by easing its installation, administration and usability. This enabled the software to be well suited for a daily clinical use. Vidjil is now used in routine practice by seven European hospitals (France, Germany, Italy and Czech Republic). Hospitals from the United Kingdom and the Japan are currently assessing Vidjil and may do their clinical routine practice with the software in a near future.
- ADT SeedLib (2017–2019): The SeedLib ADT aims to consolidate existing software developments in Bonsai, into an existing and well-engineered framework. Bonsai has published several new results on spaced seeds and developed several tools that integrate custom implementations of spaced seeds. In parallel, the GATB project is a C++ software library that facilitates the development of next-generation sequencing analysis tools. It is currently maintained by a collaboration between the GenScale team at Inria Rennes and the Bonsai team. Many users from other institutions (including the Erable team at Inria Rhones-Alpes) actively develop tools using GATB. The core object in GATB is k -mers, which can be seen as the predecessor of spaced seeds. The goal of this ADT is to integrate existing space seeds formalisms into GATB, therefore further expanding the features offered by the library, and at the same time provide visibility for tools and results in the Bonsai team.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

- International ANR RNAlands (2014-2018): National funding from the French Agency Research (call *International call*). Our objective is the fast and efficient sampling of structures in RNA Folding Landscapes. The project gathers three partners: Amib from Inria Saclay, the Theoretical Biochemistry Group from Universität Wien and BONSAI.
- Interreg Va (France-Wallonie-Vlaanderen): Portfolio “SmartBioControl”, including 5 constitutive projects and 25 partners working together towards sustainable agriculture.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- *Astrid Lindgrens Hospital, Stockholm University*: Collaboration with Anna Nilsson and Shanie Saghalian-Hedengren on RNA sequencing of stromal cells (pilot study done in 2017).
- *Childhood Leukaemia Investigation Prague (CLIP), Department of Pediatric Hematology/Oncology, 2nd Faculty of Medicine, Charles University, Prague, Czech Republic*: Collaboration with Michaela Kotrová and Eva Fronkova on leukemia diagnosis and follow-up.
- *CWI Amsterdam*: Collaboration with Alexander Schoenhuth on data structures for genomic data.
- *Department of Statistics, North Carolina State University*: Collaboration with Donald E. K. Martin on spaced seeds coverage [21].
- *Département des Sciences de la Vie, Faculté des Sciences de Liège*: Collaboration with Denis Beaurain on nonribosomal peptides.
- *Gembloux Agro-Bio Tech, Université de Liège*: Collaboration with Philippe Jacques on nonribosomal peptides.
- *Institute of Biosciences and Bioresources, Bari*: Collaboration with Nunzia Scotti on the assembly of plant mitochondrial genomes.
- *Medvedev lab, The Pennsylvania State University*: Collaboration with Paul Medvedev on algorithms and data structures for genomic data, e.g. the Allsome Sequence Bloom Trees.
- *Novo Nordisk Foundation Center for Biosustainability, Technical University of Denmark*: Collaboration with Tilmann Weber on nonribosomal peptides.
- *Proteome Informatics Group, Swiss Institute of Bioinformatics*: Collaboration with Frédérique Lisacek on nonribosomal peptides.
- *School of Social and Community Medicine, University of Bristol*: Collaboration with John Moppett and Stephanie Wakeman on leukemia diagnosis follow-up.
- *Theoretical Biochemistry Group, Universität Wien*: Collaboration with Andrea Tanzer and Ronny Lorenz on RNA folding and RNA kinetics.

8.3.2. Participation in Other International Programs

- Participation in the EuroClonality-NGS consortium. This consortium aims at standardizing the study of immune repertoire, clonality and minimal residual disease in leukemia at the european level. We are part of the bioinformatics workgroup led by Nikos Darzentas (CEITEC, Brno, Czech Republic). Withing this consortium, we participated to a lead opinion paper on immunohematology [20].

CAGIRE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Predicting head losses in aeronautical fuel injectors

This is a 3-year programme, started mid-2015 and funded by Conseil Régional d'Aquitaine (2014 Call) and two small-size companies, AD Industrie (Gurmençon, France) and GDTECH (Bordes, France). The objective is to investigate the possibility of using advanced RANS or hybrid RANS-LES approaches to better predict the pressure losses in aeronautical fuel nozzles. [PB,RM]

9.1.2. SEIGLE

SEIGLE means "Simulation Expérimentation pour l'Interaction de Gouttes Liquides avec un Ecoulement fortement compressible". It is a 3-year program which has started since October 2017 and was funded by Régional Nouvelle-Aquitaine, ISAE-ENSMA, CESTA and Inria. The interest of understanding aerodynamic mechanisms and liquid drops atomization is explained by the field of applications where they play a key role, specially in the new propulsion technologies through detonation in the aerospace as well as in the securities field. The SEIGLE project was articulated around a triptych experimentation, modeling and simulation. An experimental database will be constituted. It will rely on a newly installed facility (Pprime), similar to a supersonic gust wind tunnel/ hypersonic from a gaseous detonation tube at high pressure. This will allow to test modeling approaches (Pprime / CEA) and numerical simulation (Inria / CEA) with high order schemes for multiphasic compressible flows, suitable for processing shock waves in two-phase media [VP, JJ].

9.2. National Initiatives

9.2.1. GIS Success

We are members of the CNRS GIS Success (Groupement d'Intérêt Scientifique) organised around two of the major CFD codes employed by the Safran group, namely AVBP and Yales 2. No scientific activity has been devoted around those codes during 2017 but Yales2 has been installed and tested on one of our workstation to prepare some planned scientific activity to come in 2018 in the field of low Mach flows and low Reynolds flows simulations [PB].

9.2.2. ANR MONACO_2025 [RM]

The ambition of the MONACO_2025 project, coordinated by Rémi Manceau, is to join the efforts made in *two different industrial sectors* in order to tackle the industrial simulation of transient, turbulent flows affected by buoyancy effects. It brings together two academic partners, the project-team Cagire hosted by the university of Pau, and the institute Pprime of the CNRS/ENSMA/university of Poitiers (PPRIME), and R&D departments of two industrial partners, the PSA group and the EDF group, who are major players of the automobile and energy production sectors, respectively.

- The main **scientific objective** of the project is to make a breakthrough in *the unresolved issue* of the modelling of turbulence/buoyancy interactions in transient situations, within the continuous hybrid RANS/LES paradigm, which consists in preserving a computational cost compatible with industrial needs by relying on statistical approaches where a fine-grained description of the turbulent dynamics is not necessary. The transient cavity flow experiments acquired during MONACO_2025 will provide the partners and the scientific community with *an unrivalled source of knowledge* of the physical mechanisms that must be accounted for in turbulence models.

- The main **industrial objective** is *to make available computational methodologies* to address dimensioning, reliability and security issues in buoyancy-affected transient flows. It is to be emphasized that such problems are *not tackled using CFD at present in the industry*. At the end of MONACO_2025, a panel of methodologies, ranging from simple URANS to sophisticated hybrid model based on improved RANS models, will be evaluated in transient situations, against the dedicated cavity flow experiments and a real car underhood configuration. This final benchmark exercise will form *a decision-making tool* for the industrial partners, and will thus pave the way towards high-performance design of low-emission vehicles and highly secure power plants. In particular, the project is in line with the *Full Digital 2025 ambition*, e.g., the declared ambition of the PSA group to migrate, within the next decade, to a design cycle of new vehicles nearly entirely based on CAE (computer aided engineering), without recourse to expensive full-scale experiments.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. SOPRANO

Participants: Rémi Manceau, Pascal Bruel, [Post doc starting in 2018].

Topic: MG-1.2-2015 - Enhancing resource efficiency of aviation

Project acronym: SOPRANO

Project title: Soot Processes and Radiation in Aeronautical inNOvative combustors

Duration: 01/09/2016 - 31/08/2020

Coordinator: SAFRAN

Other partners:

- France: CNRS, CERFACS, INSA Rouen, SAFRAN SA, Snecma SAS, Turbomeca SA.
- Germany: DLR, GE-DE GmbH, KIT, MTU, RRD,
- Italy: GE AVIO SRL, University of Florence
- United Kingdom: Rolls Royce PLC, Imperial College of Science, Technology and Medicine, Loughborough University.

Abstract: For decades, most of the aviation research activities have been focused on the reduction of noise and NO_x and CO₂ emissions. However, emissions from aircraft gas turbine engines of non-volatile PM, consisting primarily of soot particles, are of international concern today. Despite the lack of knowledge toward soot formation processes and characterization in terms of mass and size, engine manufacturers have now to deal with both gas and particles emissions. Furthermore, heat transfer understanding, that is also influenced by soot radiation, is an important matter for the improvement of the combustor's durability, as the key point when dealing with low-emissions combustor architectures is to adjust the air flow split between the injection system and the combustor's walls. The SOPRANO initiative consequently aims at providing new elements of knowledge, analysis and improved design tools, opening the way to: • Alternative designs of combustion systems for future aircrafts that will enter into service after 2025 capable of simultaneously reducing gaseous pollutants and particles, • Improved liner lifetime assessment methods. Therefore, the SOPRANO project will deliver more accurate experimental and numerical methodologies for predicting the soot emissions in academic or semi-technical combustion systems. This will contribute to enhance the comprehension of soot particles formation and their impact on heat transfer through radiation. In parallel, the durability of cooling liner materials, related to the walls air flow rate, will be addressed by heat transfer measurements and predictions. Finally, the expected contribution of SOPRANO is to apply these developments in order to determine the main promising concepts, in the framework of current low-NO_x technologies, able to control the emitted soot particles in terms of mass and size over a large range of operating conditions without compromising combustor's liner durability and performance toward NO_x emissions.

In the SOPRANO project, our objective is to complement the experimental (ONERA) and LES (CERFACS) work by RANS computations of the flow around a multiperforated plate, in order to build a database making possible a parametric study of mass, momentum and heat transfer through the plate and the development of multi-parameter-dependent equivalent boundary conditions. Our activity is due to start in September 2018.

9.4. International Initiatives

9.4.1. Informal International Partners

- Collaboration with Alireza Mazaheri, from NASA Langley Research Center on the first order formulation of the compressible Navier-Stokes system (2-month leave of V. Perrier at National Institute of Aerospace, Hampton, VA).
- Collaboration with E. Dick (University of Ghent, Belgium) and Y. Moguen (UPPA) on the determination of the best splitting of variables for handling low Mach flows with a pressure-energy based coupling. [PB]
- Collaboration with A. Beketaeva and A. Naïmanova (Institute of Mathematics, Almaty, Kazakhstan) related to the simulations of a supersonic jet in crossflow configuration. Contacts were also made with Axel Vincent from Onera Palaiseau in order to have access to recent experimental data on supersonic combustion. The low-Mach preconditioning of an in-house ENO based compressible flow solver was also addressed. [PB] (10-day stay in Almaty).
- Collaboration with P. Correia (University of Evora, Portugal) related to the development of enhanced boundary conditions for the simulations of Mach zero flows with the artificial compressibility method. [PB] (5-day stay in Evora).
- Collaboration with S. Lardeau (Siemens Industry Software Computational Dynamics, Nuremberg, Germany) on the EB-RSM model and hybrid RANS/LES model for industrial applications. [RM]

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Sergio Elaskar (Conicet and University National of Cordoba, Argentina) visited LMAP-Cagire for a 1-week stay from August 28 to September 1, 2017.
- Prof. Ezequiel Del Rio (Polytechnic University of Madrid) visited LMAP-Cagire for a 4-day stay from August 21 to August 31, 2017. The objective of these two simultaneous visits was to determine the possibility of generating data on the Maveric test facility to validate the intermittency model (mapping) jointly developed by S. Elaskar and E. Del Rio.

CAIRN Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

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

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

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

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

Participants: Emmanuel Casseau, Imran Wali.

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

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

Participants: Arnaud Tisserand, Gabriel Gallin, Audrey Lucas.

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

8.1.4. *Labex CominLabs - BBC (2016-2020)*

Participants: Olivier Sentieys, Cédric Killian, Joel Ortiz Sosa.

The aim of the BBC (on-chip wireless Broadcast-Based parallel Computing) project is to evaluate the use of wireless links between cores inside chips and to define new paradigms. Using wireless communications enables broadcast capabilities for Wireless Networks on Chip (WiNoC) and new management techniques for memory hierarchy and parallelism. The key objectives concern improvement of power consumption, estimation of achievable data rates, flexibility and reconfigurability, size reduction and memory hierarchy management. For more details see <http://www.bbc.cominlabs.ueb.eu>. In this project, CAIRN will address new low-power MAC (media access control) technique based on CDMA access as well as broadcast-based fast cooperation protocol designed for resource sharing (bandwidth, distributed memory, cache coherency) and parallel programming.

8.1.5. *Labex CominLabs - SHERPAM (2014-2018)*

Participant: Patrice Quinton.

Heart failure and peripheral artery disease patients require early detection of health problems in order to prevent major risk of morbidity and mortality. Evidence shows that people recover from illness or cope with a chronic condition better if they are in a familiar environment (i.e., at home) and if they are physically active (i.e., practice sports). The goal of the Sherpam project is to design, implement, and validate experimentally a monitoring system allowing biophysical data of mobile subjects to be gathered and exploited in a continuous flow. Transmission technologies available to mobile users have been improved a lot during the last two decades, and such technologies offer interesting prospects for monitoring the health of people anytime and anywhere. The originality of the Sherpam project is to rely simultaneously and in an agile way on several kinds of wireless networks in order to ensure the transmission of biometric data, while coping with network disruptions. Sherpam also develops new signal processing algorithms for activity quantification and recognition which represent now a major social and public health issue (monitoring of elderly patient, personalized quantification activity, etc.). Sherpam involves research teams from several scientific domains and from several laboratories of Brittany (IRISA/CASA, LTSI, M2S, CIC-IT 1414-CHU Rennes and LAUREPS). For more details see <http://www.sherpam.cominlabs.ueb.eu>

8.1.6. DGA RAPID - FLODAM (2017–2021)

Participants: Olivier Sentieys, Angeliki Kritikakou.

FLODAM is an industrial research project for methodologies and tools dedicated to the hardening of embedded multi-core processor architectures. The goal is to: 1) evaluate the impact of the natural or artificial environments on the resistance of the system components to faults based on models that reflect the reality of the system environment, 2) the exploration of architecture solutions to make the multi-core architectures fault tolerant to transient or permanent faults and 3) test and evaluate the proposed fault tolerant architecture solutions and compare the results under different scenarios provided by the fault models.

8.2. European Initiatives

8.2.1. H2020 ARGO

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

Program: H2020-ICT-04-2015

Project acronym: ARGO

Project title: WCET-Aware Parallelization of Model-Based Applications for Heterogeneous Parallel Systems

Duration: Feb. 2016 - Feb. 2019

Coordinator: KIT

Other partners: KIT (DE), UR1/Inria/CAIRN (FR), Recore Systems (NL), TEI-WG (GR), Scilab Ent. (FR), Absint (DE), DLR (DE), Fraunhofer (DE)

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

8.2.2. ANR International ARTEFaCT

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

Program: ANR International France-Switzerland

Project acronym: ARTEFaCT

Project title: AppRoximaTivE Flexible Circuits and Computing for IoT

Duration: Feb. 2016 - Dec. 2019

Coordinator: CEA

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

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

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. IoTA

Title: Ultra-Low Power Computing Platform for IoT leveraging Controlled Approximation

International Partner (Institution - Laboratory - Researcher):

Ecole Polytechnique Fédérale de Lausanne (Switzerland) - Christian Enz

Start year: 2017

See also: <https://team.inria.fr/cairn/IOTA>

Energy issues are central to the evolution of the Internet of Things (IoT), and more generally to the ICT industry. Current low-power design techniques cannot support the estimated growth in number of IoT objects and at the same time keep the energy consumption within sustainable bounds, both on the IoT node side and on cloud/edge-cloud side. This project aims to build on the preliminary results on inexact and exact sub/near-threshold circuit design to achieve major energy consumption reductions by enabling adaptive accuracy control of applications. Advanced ultra low-power hardware design methods utilize very low supply voltage, such as in near-threshold and sub-threshold designs. These emerging technologies are very promising avenues to decrease active and stand-by-power in electronic devices. To move another step forward, recently, approximate computing has become a major field of research in the past few years. IoTA proposes to address, in a consistent fashion, the entire design stack, from hardware design, up to software application analysis, compiler optimizations, and dynamic energy management. We do believe that combining sub-near-threshold with inexact circuits on the hardware side and, in addition, extending this with intelligent and adaptive power management on the software side will produce outstanding results in terms of energy reduction, i.e., at least one order of magnitude, in IoT. The main scientific challenge is twofold: (1) to add adaptive accuracy to hardware blocks built in near/sub threshold technology and (2) to provide the tools and methods to program and make efficient use of these hardware blocks for applications in the IoT domain. This entails developing approximate computing units, on one side, and methods and tools, on the other side, to rigorously explore trade-offs between accuracy and energy consumption in IoT systems. The expertise of the members of the two teams

is complementary and covers all required technical knowledge necessary to reach our objectives, i.e., ultra low power hardware design (EPFL), approximate operators and functions (Inria, EPFL), formal analysis of precision in algorithms (Inria), and static and dynamic energy management (Inria, EPFL). Finally, the proof of concept will consist of results on (1) an adaptive, inexact or exact, ultra-low power microprocessor in 28 nm process and (2) a real prototype implemented in an FPGA platform combining processors and hardware accelerators. Several software use-cases relevant for the IoT domain will be considered, e.g., embedded vision, IoT sensors data fusion, to practically demonstrate the benefits of our approach.

8.3.2. Inria International Partners

8.3.2.1. LRS

Title: Loop unRolling Stones: compiling in the polyhedral model

International Partner (Institution - Laboratory - Researcher):

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

8.3.2.2. HARAMCOP

Title: Hardware accelerators modeling using constraint-based programming

International Partner (Institution - Laboratory - Researcher):

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

8.3.2.3. SPINACH

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

International Partner (Institution - Laboratory - Researcher):

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

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

8.3.2.4. DARE

Title: Design space exploration Approaches for Reliable Embedded systems

International Partner (Institution - Laboratory - Researcher):

IMEC (Belgium) - Francky Catthoor

Methodologies to design low cost and efficient techniques for safety-critical embedded systems, Design Space Exploration (DSE), run-time dynamic control mechanisms.

8.3.2.5. Informal International Partners

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

Department of Electrical and Computer Engineering, University of Patras (Greece), Wireless Sensor Networks, Worst-Case Execution Time, Priority Scheduling.

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

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

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

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Mattia Cacciotti, Ecole Polytechnique Fédérale de Lausanne (Switzerland), from May 2017 until June 2017.

Emna Hammami, University of Tunis, from April 2017 until June 2017.

Prof. Stanislaw Piestrak, Univ de Lorraine, June 2017.

8.4.2. Visits to International Teams

P. Quinton was invited in Passau University (Passau, Germany) by Prof. Chris Lengauer during one week in June 2017, and gave an invited seminar on the synthesis of parallel architectures.

P. Quinton was invited by Prof. Daniel Massicotte of Université de Trois-Rivières (Québec) in October 2017 to cooperate on the design of FPGA hardware accelerators for electric simulation. His stay was supported by a grant of the RESMIQ (regroupement stratégique en microsystemes du Québec). He gave an invited seminar on the synthesis of data-flow parallel systems.

8.4.3. Sabbatical programme

Casseau Emmanuel

Date: Aug 2016 - Jul 2017

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

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

CAMIN Team

8. Partnerships and Cooperations

8.1. National Initiatives

- BCI-LIFT: an Inria Project-Lab Participants : Mitsuhiro Hayashibe, Saugat Bhattacharyya.
BCI-LIFT is a large-scale 4-year research initiative (2015-2018) which aim is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. We work on BCI-FES study for promoting motor learning.
- ADT PersoBalance2
Participants : Mitsuhiro Hayashibe, Philippe Fraisse.
A half-year engineer was funded by Inria ADT on "Personalized Balance Assessment in Home Rehabilitation, version2 (PersoBalance2)".

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Program: FP7

Project acronym: EPIONE

Project title: Natural sensory feedback for phantom limb pain modulation and therapy

Duration: 2013-2017

Coordinator: AAU (Aalborg, Denmark)

Other partners: Ecole polytechnique fédérale de Lausanne (EPFL), IUPUI (Indianapolis, USA), Lund University (LUNDS UNIVERSITET), MXM (Vallauris, France), Novosense AB (NS), IMTEK (Freiburg, Germany), UAB (Barcelona, Spain), Aalborg Hospital, Università Cattolica del Sacro Cuore (UCSC), Centre hospitalier Universitaire Vaudois (CHUV)

Abstract: <http://project-epione.eu/>. The aim of the project is to treat phantom limb pain. CAMIN is only involved in the invasive approach using intrafascicular electrodes. We developed certified software with EPFL and AAU, co-supervised animal tests and data processing with UAB, provide support to clinical trials with IMTEK and UCSC and developed a new stimulator with MXM.

8.3. International Initiatives

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

8.3.1.1. CACAO

Lower limb electrical stimulation for function restoration University of Brasilia, UNB (Brazil)

Núcleo de Tecnologia Assistiva, Acessibilidade e Inovação (NTAAI)

<https://team.inria.fr/cacao/>

Start year: 2016

Electrical stimulation (ES) can activate paralyzed muscles to support rehabilitation. ES applied to fully or partially paralyzed muscles artificially induces muscle contraction substituting or completing the normal volitional control. In CACAO team we will join our efforts and specific expertise to develop approaches of lower limb function restoration in spinal cord injured individuals. Two main applications will be addressed: 1) Functional Electrical Stimulation (FES) to assist SCI individuals to perform pivot transfers and 2) FES-assisted cycling. We aim at proposing solutions that can have an effect on patients' quality of life, thus our choices intend to be realistic from a practical point of view. We will take care in evaluating both functional and psychological effects of our solutions and to constrain technical choices to be acceptable by final user. CACAO project will be a good opportunity to combine "bioengineer" (DEMAR) and "physiology/rehabilitation" (NTAAI) visions and knowledges towards solutions for clinical applications.

8.3.2. Participation in Other International Programs

Programme Ciensia Sem Fronteiras CAPES, avec l'Univeristé Brasilia (chercheur invité).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Antonio Lanari Padilha Bo spent one month in CAMIN in July 2017 as invited reseracher (LIRMM funding).
 Adriana Mendes, M2 Univ Lisboa spent 9 months (funded by Erasmus) from october 2016 to june 2017
 Lucas Fonseca, PhD student in Brasilia University, spent 9 months in CAMIN.

8.4.2. Visits to International Teams

Thomas Guiho, Aurora program with Norway, short stays to initiate collaborations

8.4.2.1. Research Stays Abroad

Christine Azevedo spent 1 month in Brasilia University between october and december in the context of CACAO associate team with a grant from CAPES for invited researchers.

CAMUS Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Inria Large Scale Initiative on Multicore

Philippe Clauss, Jens Gustedt, Alain Ketterlin, Cédric Bastoul and Vincent Loechner are involved in the Inria Project Lab entitled “Large scale multicore virtualization for performance scaling and portability” and regrouping several French researchers in compilers, parallel computing and program optimization⁰. The project started officially in January 2013. In this context and since January 2013, Philippe Clauss is co-advising with Erven Rohou of the Inria team PACAP, Nabil Hallou’s PhD thesis focusing on dynamic optimization of binary code. The PhD defense was held December the 18th 2017.

Philippe Clauss, Jens Gustedt and Maxime Mogé are involved in the ADT Inria project ASNAP (*Accélération des Simulations Numériques pour l’Assistance Peropératoire*), in collaboration with the Inria team MIMESIS. The goal is to find opportunities in the SOFA simulation platform for applying automatic parallelization techniques developed by Camus. We are currently investigating two approaches. The first uses memory behavior memoization to generate a parallel code made of independent threads at runtime. The second uses ordered read-write locks (ORWL) to dynamically schedule a pipeline of parallel tasks.

9.1.2. ANR AJACS

Participant: Arthur Charguéraud [contact].

The AJACS research project is funded by the programme “Société de l’information et de la communication” of the ANR, from October 2014, until November 2018. <http://ajacs.inria.fr/>

The goal of the AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts implemented in JavaScript, the most widely used language for the Web. The proposal is to prove correct analyses for JavaScript programs, in particular information flow analyses that guarantee no secret information is leaked to malicious parties. The definition of sub-languages of JavaScript, with certified compilation techniques targeting them, will allow deriving more precise analyses. Another aspect of the proposal is the design and certification of security and privacy enforcement mechanisms for web applications, including the APIs used to program real-world applications. Arthur Charguéraud focuses on the description of a formal semantics for JavaScript, and the development of tools for interactively executing programs step-by-step according to the formal semantics.

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

9.1.3. ANR Vocal

Participant: Arthur Charguéraud [contact].

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

⁰<https://team.inria.fr/multicore>

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

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

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Project acronym: ERC Deepsea

Project title: Parallel dynamic computations

Duration: Jun. 2013 - May 2018

Coordinator: Umut A. Acar

Other partners: Carnegie Mellon University

Abstract:

The objective of this project is to develop abstractions, algorithms and languages for parallelism and dynamic parallelism with applications to problems on large data sets. Umut A. Acar (affiliated to Carnegie Mellon University and Inria Paris - Rocquencourt) is the principal investigator of this ERC-funded project. The other main researchers involved are Mike Rainey (Inria, Gallium team), who is full-time on the project, and Arthur Charguéraud (Inria, Toccata Camus), who works part time on this project. Project website: <http://deepsea.inria.fr/>.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

The CAMUS team maintains regular contacts with the following entities:

- Reservoir Labs, New York, NY, USA
- University of Batna, Algeria
- Ohio State University, Columbus, USA
- Louisiana State University, Baton Rouge, USA
- Colorado State University, Fort Collins, USA
- Carnegie Mellon University, Pittsburgh, USA
- Indian Institute of Science (IIS) Bangalore, India
- Barcelona Supercomputing Center, Barcelona, Spain

CAPSID Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CPER – IT2MP

Participants: Marie-Dominique Devignes [contact person], David Ritchie.

Project title: *Innovations Technologiques, Modélisation et Médecine Personnalisée*; PI: Faiez Zannad, Univ Lorraine (Inserm-CHU-UL). Value: 14.4 M€ (“SMEC” platform – Simulation, Modélisation, Extraction de Connaissances – coordinated by Capsid and Orpailleur teams for Inria Nancy – Grand Est, with IECL and CHRU Nancy: 860 k€, approx); Duration: 2015–2020. Description: The IT2MP project encompasses four interdisciplinary platforms that support several scientific pôles of the university whose research involves human health. The SMEC platform supports research projects ranging from molecular modeling and dynamical simulation to biological data mining and patient cohort studies.

8.1.2. LUE – CITRAM

Participants: Marie-Dominique Devignes [contact person], Isaure Chauvot de Beauchêne, Bernard Maigret, Philippe Noël, David Ritchie.

Project title: *Conception d’Inhibiteurs du Transfert de Résistances aux agents Anti-Microbiens: bio-ingénierie assistée par des approches virtuelles et numériques, et appliquée à une relaxase d’élément conjugatif intégratif*; PI: N. Leblond, Univ Lorraine (DynAMic, UMR 1128); Other partners: Chris Chipot, CNRS (SRSMSC, UMR 7565); Value: 200 k€ (Capsid: 80 k€); Duration: 2017–2018. Description: This project follows on from the 2016 PEPS project “MODEL-ICE”. The aim is to investigate protein-protein interactions required for initiating the transfer of an ICE (Integrated Conjugative Element) from one bacterial cell to another one, and to develop small-molecule inhibitors of these interactions.

8.1.3. PEPS – DynaCriGalT

Participants: Isaure Chauvot de Beauchêne [contact person], Bernard Maigret, David Ritchie.

Project title: *Criblage virtuel et dynamique moléculaire pour la recherche de bio-actifs ciblant la β 4GalT7, une enzyme de biosynthèse des glycosaminoglycanes*; PI: I. Chauvot de Beauchêne, Capsid (Inria Nancy – Grand Est); Partners: Sylvie Fournel-Gigleux, INSERM (IMoPA, UMR 7365); Value: 15 k€; Duration: 2017–2018. Description: The β 4GalT7 glycosyltransferase initiates the biosynthesis of glycosaminoglycans (GAGs), and is a therapeutic target for small molecules which might correct a defect in the synthesis and degradation of GAGs in rare genetic diseases. Classical approaches to propose active molecules have failed for this target. The DynaCriGalT project combines molecular dynamics modelling of the GAG active site with virtual screening in order to propose a diverse set of small molecules for *in vitro* compound testing.

8.1.4. PEPS – InterANRIL

Participant: Isaure Chauvot de Beauchêne [contact person].

Project title: *Identification et modélisation des interactions nécessaires à l’activité du long ARN non-codant ANRIL dans la régulation épigénétique des gènes*; PI: Sylvain Maenner, Univ Lorraine (IMoPA, UMR 7365); Value: 20 k€; Duration: 2017–2018. Description: ANRIL is a long non-coding RNA (lncRNA) which has been identified as an important factor in the susceptibility cardiovascular diseases. ANRIL is involved in the epigenetic regulation of the expression of a network of genes via mechanisms that are still largely unknown. This project aims to identify and model the protein-RNA and/or DNA-RNA interactions that ANRIL establishes within the eukaryotic genome.

8.2. National Initiatives

8.2.1. FEDER – SB-Server

Participants: David Ritchie [contact person], Bernard Maigret, Isaure Chauvot de Beauchêne, Sabeur Aridhi, Marie-Dominique Devignes.

Project title: *Structural bioinformatics server*; PI: David Ritchie, Capsid (Inria Nancy – Grand Est); Value: 24 k€; Duration: 2015–2020. Description: This funding provides a small high performance computing server for structural bioinformatics research at the Inria Nancy – Grand Est centre.

8.2.2. ANR

8.2.2.1. Fight-HF

Participants: Marie-Dominique Devignes [contact person], Bernard Maigret, Sabeur Aridhi, Claire Lacomblez, David Ritchie.

Project title: *Combattre l'insuffisance cardiaque*; PI: Patrick Rossignol, Univ Lorraine (FHU-Cartage); Partners: multiple; Value: 9 m€ (Capsid and Orpailleur: 450 k€, approx); Duration: 2015–2019. Description: This “Investissements d’Avenir” project aims to discover novel mechanisms for heart failure and to propose decision support for precision medicine. The project has been granted € 9M, and involves many participants from Nancy University Hospital’s Federation “CARTAGE” (<http://www.fhu-cartage.com/>). In collaboration with the Orpailleur Team, Marie-Dominique Devignes is coordinating a work-package on network-based science and drug discovery for this project.

8.2.2.2. IFB

Participants: Marie-Dominique Devignes [contact person], Sabeur Aridhi, Isaure Chauvot de Beauchêne, David Ritchie.

Project title: *Institut Français de Bioinformatique*; PI: Jean-François Gibrat (CNRS UMS 3601); Partners: multiple; Value: 20 M€ (Capsid: 126 k€); Duration: 2014–2021. Description: The Capsid team is a research node of the IFB (Institut Français de Bioinformatique), the French national network of bioinformatics platforms (<http://www.france-bioinformatique.fr>). The principal aim is to make bioinformatics skills and resources more accessible to French biology laboratories.

8.3. International Initiatives

8.3.1. Informal International Partners

Participant: David Ritchie; Project: *Integrative Modeling of 3D Protein Structures and Interactions*; Partner: Rocasolano Institute of Physical Chemistry, Spain. Funding: Inria Nancy – Grand Est (“Nancy Emerging Associate Team”).

Participant: Bernard Maigret; Project: *Characterization, expression and molecular modeling of TRR1 and ALS3 proteins of Candida spp., as a strategy to obtain new drugs with action on yeasts involved in nosocomial infections*; Partner: State University of Maringá, Brasil.

Participant: Bernard Maigret; Project: *Fusarium graminearum target selection*; Partner: Embrapa Recursos Geneticos e Biotecnologia, Brasil.

Participant: Bernard Maigret; Project: *The thermal shock HSP90 protein as a target for new drugs against paracoccidioidomycosis*; Partner: Brasília University, Brasil.

Participant: Bernard Maigret; Project: *Protein-protein interactions for the development of new drugs*; Partner: Federal University of Goiás, Brasil.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Isis Grenier Capoci from the State University of Maringá, Brasil visited the team (through the programme “Doutorado Sanduiche no Exterior”) to develop new inhibitors of *Candida albicans* TRR1 under the supervision of Bernard Maigret.

CARAMBA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PEPS CHARIoT

The PEPS CHARIoT (“CHiffrement Authentifié pour Renforcer l’IoT”) project is dedicated to the study of authenticated encryption schemes, especially the CAESAR candidates, and to the performance analysis of those schemes on dedicated embedded architectures such as micro-controllers (MSP430, ARM and AVR). It involves Marine Minier (CARAMBA), Franck Rousseau (IMAG - Grenoble) and Pascal Lafourcade (LIMOS-UCA - Clermont-Ferrand).

9.2. International Research Visitors

9.2.1. Visits of International Scientists

Thorsten Kleinjung from EPFL visited the team from 6 to 10 February to work on the Number Field Sieve algorithm.

CARDAMOM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR MAIDESC

Title: Maillages adaptatifs pour les interfaces instationnaires avec deformations, etirements, courbures.

Type: ANR

Duration: 48 months

Starting date : 1st Oct 2013

Coordinator: Dervieux Alain (Inria Sophia)

Abstract: Mesh adaptive numerical methods allow computations which are otherwise impossible due to the computational resources required. We address in the proposed research several well identified main obstacles in order to maintain a high-order convergence for unsteady Computational Mechanics involving moving interfaces separating and coupling continuous media. A priori and a posteriori error analysis of Partial Differential Equations on static and moving meshes will be developed from interpolation error, goal-oriented error, and norm-oriented error. From the minimization of the chosen error, an optimal unsteady metric is defined. The optimal metric is then converted into a sequence of anisotropic unstructured adapted meshes by means of mesh regeneration, deformation, high stretching, and curvature. A particular effort will be devoted to build an accurate representation of physical phenomena involving curved boundaries and interfaces. In association with curved boundaries, a part of studies will address third-order accurate mesh adaption. Mesh optimality produces a nonlinear system coupling the physical fields (velocities, etc.) and the geometrical ones (unsteady metric, including mesh motion). Parallel solution algorithms for the implicit coupling of these different fields will be developed. Addressing efficiently these issues is a compulsory condition for the simulation of a number of challenging physical phenomena related to industrial unsolved or insufficiently solved problems. Non-trivial benchmark tests will be shared by consortium partners and by external attendees to workshops organized by the consortium. The various advances will be used by SME partners and proposed in software market.

9.1.2. PIA TANDEM

Title: Tsunamis in the Atlantic and the English Channel: Definition of the Effects through numerical Modeling (TANDEM)

Type: PIA - RSNR (Investissement d'Avenir, "Recherches en matière de Sécurité Nucléaire et Radioprotection")

Duration: 48 months

Starting date : 1st Jan 2014

Coordinator: H. Hebert (CEA)

Abstract: TANDEM is a project dedicated to the appraisal of coastal effects due to tsunami waves on the French coastlines, with a special focus on the Atlantic and Channel coastlines, where French civil nuclear facilities have been operated since about 30 years. As identified in the call RSNR, this project aims at drawing conclusions from the 2011 catastrophic tsunami, in the sense that it will allow, together with a Japanese research partner, to design, adapt and check numerical methods of tsunami hazard assessment, against the outstanding observation database of the 2011 tsunami. Then these validated methods will be applied to define, as accurately as possible, the tsunami hazard for the French Atlantic and Channel coastlines, in order to provide guidance for risk assessment on the nuclear facilities.

9.1.3. FUI ICARUS

Title: Intensive Calculation for AeRo and automotive engines Unsteady Simulations.

Type: FUI

Duration: January 2017 - December 2019

Coordinator: Turbomeca, Safran group

9.1.4. APP Bordeaux 1

Title : Reactive fluid flows with interface : macroscopic models and application to self-healing materials

Type : Project Bordeaux 1

Duration : 36 months

Starting : September 2014

Coordinator : M. Colin

Abstract : Because of their high strength and low weight, ceramic-matrix composite materials (CMCs) are the focus of active research, for aerospace and energy applications involving high temperatures. Though based on brittle ceramic components, these composites are not brittle due to the use of a fiber/matrix interphase that manages to preserve the fibers from cracks appearing in the matrix. The lifetime-determining part of the material is the fibers, which are sensitive to oxidation; when the composite is in use, it contains cracks that provide a path for oxidation. The obtained lifetimes can be of the order of hundreds of thousands of hours. These time spans make most experimental investigations impractical. In this direction, the aim of this project is to furnish predictions based on computer models that have to take into account: 1. the multidimensional topology of the composite made up of a woven ceramic fabric; 2. the complex chemistry taking place in the material cracks; 3. the flow of the healing oxide in the material cracks.

9.1.5. APP University of Bordeaux

Title : Modélisation d'un système de dégivrage thermique

Type : Project University of Bordeaux

Duration : 36 months

Starting : October 2016

Coordinator : H. Beaugendre and M. Colin

Abstract : From the beginning of aeronautics, icing has been classified as a serious issue : ice accretion on airplanes is due to the presence of supercooled droplets inside clouds and can lead to major risks such as air crash for example. As a consequence, each airplane has its own protection system : the most important one is an anti-icing system which runs permanently. In order to reduce gas consumption, de-icing systems are developed by manufacturers. One alternative to real experiment consists in developing robust and reliable numerical models : this is the aim of this project. These new models have to take into account multi-physics and multi-scale environment : phase change, thermal transfer, aerodynamics flows, etc. We aim to use thin films equations coupled to level-set methods in order to describe the phase change of water. The overall objective is to provide a simulation platform, able to provide a complete design of these systems.

9.1.6. CRA - Region Aquitaine

Title : Virtual prototyping of EVE engines

Type : Co-funded from Region Aquitaine and Inria

Duration : 36 months

Starting : January 2017

Coordinator : P.M. Congedo

Abstract : The main objective of this thesis is the construction of a numerical platform, for permitting an efficient virtual prototyping of the EVE expander. This will provide EXOES with a numerical tool, that is much more predictive with respect to the tools currently available and used in EXOES, by respecting an optimal trade-off in terms of complexity/cost needed during an industrial design process. Two research axes will be mainly developed. First, the objective is to perform some high-predictive numerical simulation for reducing the amount of experiments, thanks to a specific development of RANS tools (Reynolds Averaged Navier-Stokes equations) for the fluids of interest for EXOES. These tools would rely on complex thermodynamic models and a turbulence model that should be modified. The second axis is focused on the integration of the solvers of different fidelity in a multi-fidelity platform for performing optimization under uncertainties. The idea is to evaluate the system performances by using massively the low-fidelity models, and by correcting these estimations via only few calculations with the high-fidelity code.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: Ocean ERANET

Project acronym: **MIDWEST**

Project title: Multi-fidelity decision making tools for wave energy systems

Duration: October 2015- October 2018

Coordinator: M. Ricchiuto

Other partners: Chalmers University (Sweden), IST Lisbon (Portugal), DTU Compute (Denmark)

MIDWEST is a project starting in 2016 (kick-off in December 2015) and funded by the EU-OceaneraNET program by the French ADEME, by the Swedish SWEA, and by the Portuguese FCT, aiming at proposing new tools for the wave energy industry. Wave energy converters (WECs) design currently relies on low-fidelity linear hydrodynamic models. While these models disregard fundamental nonlinear and viscous effects – which might lead provide sub-optimal designs – high-fidelity fully nonlinear Navier-Stokes models are prohibitively computational expensive for optimization. The MIDWEST project will provide an efficient asymptotic nonlinear finite element model of intermediate fidelity, investigate the required fidelity level to resolve a given engineering output, construct a multi-fidelity optimization platform using surrogate models blending different fidelity models. Combining know how in wave energy technology, finite element modelling, high performance computing, and robust optimization, the MIDWEST project will provide a new efficient decision making framework for the design of the next generation WECs which will benefit all industrial actors of the European wave energy sector.

Program: H2020 MSCA-ITN

Project acronym: **UTOPIAE**

Project title: Handling the unknown at the edge of tomorrow

Duration: January 2017- December 2020

Coordinator: M. Vasile (Strathclyde University)

Other partners: see <http://utopiae.eu/> for additional details

UTOPIAE is a European research and training network looking at cutting edge methods bridging optimisation and uncertainty quantification applied to aerospace systems. The network will run from 2017 to 2021, and is funded by the European Commission through the Marie Skłodowska-Curie Actions of H2020. The network is made up of 15 partners across 6 European countries, including the UK, and one international partner in the USA, collecting mathematicians, engineers and computer scientists from academia, industry, public and private sectors.

Mission statement : To train, by research and by example, 15 Early Stage Researchers in the field of uncertainty quantification and optimisation to become leading independent researchers and entrepreneurs that will increase the innovation capacity of the EU. To equip the researchers with the skills they will need for successful careers in academia and industry. To develop fundamental mathematical methods and algorithms to bridge the gap between Uncertainty Quantification and Optimisation and between Probability Theory and Imprecise Probability Theory for Uncertainty Quantification to efficiently solve high-dimensional, expensive and complex engineering problems.

9.3. International Initiatives

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

9.3.1.1. COMMUNES

Title: Computational Methods for Uncertainties in Fluids and Energy Systems

International Partner (Institution - Laboratory - Researcher):

CWI (Netherlands) - Scientific Computing Group - Daan Crommelin

Start year: 2017

This project aims to develop numerical methods capable to take into account efficiently unsteady experimental data, synthetic data coming from numerical simulation and the global amount of uncertainty associated to measurements, and physical-model parameters. We aim to propose novel algorithms combining data-inferred stochastic modeling, uncertainty propagation through computer codes and data assimilation techniques. The applications of interest are both related to the exploitation of renewable energy sources: wind farms and solar Organic Rankine Cycles (ORCs).

9.3.1.2. HAMster

Title: High order Adaptive moving MeSh finiTE elements in immeRsed computational mechanics

International Partner (Institution - Laboratory - Researcher):

Duke (United States) - Civil & Environmental Engineering and Mechanical Engineering
& Material Science - Guglielmo Scovazzi

Start year: 2017

See also: <https://team.inria.fr/athamster/>

This project focuses on adaptive unstructured mesh finite element-type methods for fluid flows with moving fronts. These fronts may be interfaces between different fluids, or fluid/solid, and modelling or physical fronts (e.g. shock waves) present in the flow. The two teams involved in the project have developed over the years complementary strategies, one focusing more on an Eulerian description aiming at capturing fronts on adaptive unstructured grids, the other working more on Lagrangian approaches aiming at following exactly some of these features. Unfortunately, classical Lagrangian methods are at a disadvantage in the presence of complex deformation patterns, especially for fronts undergoing large deformations, since the onset of vorticity quickly leads to mesh rotation and eventually tangling. On the other end, capturing approaches, as well as Immersed Boundary/Embedded (IB/EB) methods, while providing enormous flexibility when considering complex cases, require a careful use of mesh adaptivity to guarantee an accurate capturing of interface physics. The objective of this team is to study advanced hybrid methods combining high order, adaptive, monotone capturing techniques developed in an Eulerian or ALE setting, with fitting techniques and fully Lagrangian approaches.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

University of Zurich : R. Abgrall. Collaboration on penalisation on unstructured grids and high order adaptive methods for CFD and uncertainty quantification.

Politecnico di Milano, Aerospace Department (Italy) : Pr. A. Guardone. Collaboration on ALE for complex flows (compressible flows with complex equations of state, free surface flows with moving shorelines).

von Karman Institute for Fluid Dynamics (Belgium). With Pr. T. Magin we work on Uncertainty Quantification problems for the identification of inflow condition of hypersonic nozzle flows. With Pr. H. Deconinck we work on the design of high order methods, including goal oriented mesh adaptation strategies

NASA Langley: Dr. Alireza Mazaheri. Collaboration on high order schemes for PDEs with second and third order derivatives, with particular emphasis on high order approximations of solution derivatives.

Technical University of Crete, School of Production Engineering & Management : Pr. A.I. Delis. Collaboration on high order schemes for depth averaged free surface flow models, including robust code to code validation

Chalmers University (C. Eskilsson) and Technical University of Denmark (A.-P. Engsig-Karup) : our collaboration with Chalmers and with DTU compute in Denmark aims at developing high order non hydrostatic finite element Boussinesq type models for the simulation floating wave energy conversion devices such as floating point absorbers ;

University of Delaware: F. Veron. Collaboration on the modelling of rain effects on wave propagation.

CNRS-LIMSI: O. Le Maitre. Collaboration on Uncertainty Quantification methods.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- From 14/07/17 to 23/07/17 and from 18/12/2017 to 13/01/2018 Guglielmo SCOVAZZI, professor at Duke University, US has visited Mario Ricchiuto to work on...
- From 25/07/2017 to 28/07/2017, Anne EGGELS (PhD / CWI) has visited P.M. Congedo and F. Sanson for working around clustering in UQ methods.
- From 02/2017 to 07/2017, Luca Cirrottola (PhD/ Politecnico di Milano) has visited Cecile Dobrzynski to work on..
- From 2/10/17 to 20/10/2017, Loic GIRALDI , post doc at Ecole Centrale de Nantes has visited P.M. Congedo for working on UQ methods.
- From 13/11/17 to 17/11/2017 Ting SONG (PhD / Duke University) has visited Mario Ricchiuto to work on..
- From 15/12/17to 07/01/18 Leo NOUVEAU, post doc at Duke University, has visited Héloïse Beaugendre and Mario Ricchiuto to work on..
- From 19/03/17 to 25/03/17, Hossein GORJI, post-doc at the RWTH Aachen University (Germany), has visited Luc Mieussens to work on the modelling of collisions in gases by Fokker-Planck models
- From 06/09/17 to 13/09/17, Kazuo AOKI, professor at the National Cheng Kung University (Taiwan), has visited Luc Mieussens to work on kinetic modelling of rarefied gases.

9.4.1.1. Internships

- From June 2017 to Sep 2017 Alexandre Bourriaud (Inria, M. Sc. Student)
- From Apr 2017 to Aug 2017 Khawla Msheik (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Loic Hale (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Lola Bouet (Inria, M. Sc. Student)
- From Apr 2017 to Sep 2017 Remi Chassagne (Inria, M. Sc. Student)
- From Mar 2017 to Aug 2017 Saad Abouelfateh (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Stephane Capitaine-Vaillant (Inria, M. Sc. Student)
- From Mar 2017 to Aug 2017 Yamina Hamidi (Inria, M. Sc. Student)

CARMEN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CALM

The project “Cardiac Arrhythmia Localization Methods” has been granted by the Région Nouvelle-Aquitaine, with matching from funds held by our clinical collaborators Dr. Hubert Cochet and Dr. Pierre Jaïs, and from Inria. The purpose of this project is to develop a tool that can predict the exit site of an arrhythmia with moderate accuracy (1 cm) in an absolute sense, with respect to the anatomy of the heart in situ, and with a resolution of about 2 mm in a relative sense, with respect to a nearby pacing site. This tool must fulfill the following criteria:

- it uses only data that are already recorded in the cathlab by other systems: ECG data and electroanatomical mapping data;
- it must work in nearly real-time; catheter displacement advice must be available within 5 seconds after a paced beat;
- it must work automatically, requiring the operator only to indicate which ECG data correspond to the target arrhythmia; and
- it must be safe and easy to operate.

We will in the first place test a number of proposed methods using synthetic data, produced with our realistic models of cardiac electrophysiology and accurate geometric models of different patients. This in-silico testing phase will answer a number of important practical questions. Subsequently we will use offline clinical data, and within 2 years we aim to build a clinical prototype that can be tested (without interfering in the procedure) in the cathlab. In order to work real-time we will initially use very simple methods. However, the clinical prototype and the collection of synthetic data that we created will later serve also as a platform to test also more sophisticated inverse methods.

8.1.2. EXACARD

We started a collaboration with the STORM team at Inria Bordeaux Sud-Ouest to work on further scaling of the Propag code, to push the limit from about 10^4 to 10^6 parallel processors. A pre-proposal has been submitted to the ANR, and we are doing preparatory work.

8.2. National Initiatives

8.2.1. ANR HR-CEM

The project “High Resolution Cardiac Electrophysiology Models: HR-CEM” within the ANR call *Modèles Numériques* started in November 2013 and lasted until November 2017.

This international project involved three partners: Inria (coordinator), IHU LIRYC, and UMI-CRM in Montréal (Canada). The project has external collaborators in Univ. Bordeaux and Univ. Pau.

Based on these collaborations and new developments in structural and functional imaging of the heart available at LIRYC, we plan to reconsider the concepts behind the models in order to improve the accuracy and efficiency of simulations. Cardiac simulation software and high-resolution numerical models will be derived from experimental data from animal models. Validation will be performed by comparing of simulation output with experimentally recorded functional data. The validated numerical models will be made available to the community of researchers who take advantage of in-silico cardiac simulation and, hopefully, become references. In particular we shall provide the first exhaustive model of an animal heart including the four chambers coupled through the special conduction network, with highly detailed microstructure of both the atria and the ventricles. Such a model embedded in high-performance computational software will provide stronger medical foundations for in-silico experimentation, and elucidate mechanisms of cardiac arrhythmias.

8.2.2. ANR MITOCARD

The MITOCARD project (Electrophysiology of Cardiac Mitochondria), coordinated by S. Arbault (Université de Bordeaux, ISM), was granted by the ANR in July 2017. The objective of MITOCARD is to improve understanding of cardiac physiology by integrating the mitochondrial properties of cell signaling in the comprehensive view of cardiac energetics and rhythm pathologies. It was recently demonstrated that in the heart, in striking contrast with skeletal muscle, a parallel activation by calcium of mitochondria and myofibrils occurs during contraction, which indicates that mitochondria actively participate in Ca^{2+} signaling in the cardiomyocyte. We hypothesize that the mitochondrial permeability transition pore (mPTP), by rhythmically depolarizing inner mitochondrial membrane, plays a crucial role in mitochondrial Ca^{2+} regulation and, as a result, of cardiomyocyte Ca^{2+} homeostasis. Moreover, mitochondrial reactive oxygen species (ROS) may play a key role in the regulation of the mPTP by sensing mitochondrial energetics balance. Consequently, a deeper understanding of mitochondrial electrophysiology is mandatory to decipher their exact role in the heart's excitation-contraction coupling processes. However, this is currently prevented by the absence of adequate methodological tools (lack of sensitivity or selectivity, time resolution, averaged responses of numerous biological entities). The MITOCARD project will solve that issue by developing analytical tools and biophysical approaches to monitor kinetically and quantitatively the Ca^{2+} handling by isolated mitochondria in the cardiomyocyte.

MITOCARD is a multi-disciplinary project involving 4 partners of different scientific fields: the CARMEN team as well as

ISM, the largest chemistry laboratory of the Université de Bordeaux, where the necessary measurement methods will be developed;

Liryc, where mitochondria are studied at all levels of integration from the isolated mitochondrion to the intact heart; and

LAAS, the MiCrosystèmes d'Analyse (MICA) group at the Laboratory of Analysis and Architecture of Systems, which develops the biological microensors for this project.

The project will

- develop chips integrating 4 different electrochemical microensors to monitor in real-time key mitochondrial signaling parameters: Ca^{2+} , membrane potential, quinone reduction status, O_2 consumption, and ROS production;
- develop microwell arrays integrating ring nanoelectrodes to trap single mitochondria within micrometric chambers and measure locally by combined fluorescence microscopy and electrochemical techniques intra- (by fluorescence) and extra-mitochondrial (electrochemistry) metabolites; and
- develop a mathematical model of mitochondrial Ca^{2+} and ROS handling built on existing knowledge, new hypotheses, and the measured data.

The model may serve both to assess biological assumptions on the role of mitochondria in Ca^{2+} signaling and to integrate pathological data and provide clues for their global understanding.

8.2.3. GENCI

GENCI (*grand équipement national de calcul intensif*) is the agency that grants access to all national high-performance resources for scientific purposes in France. GENCI projects have to be renewed yearly. Our project renewal *Interaction between tissue structure and ion-channel function in cardiac arrhythmia*, submitted in September 2017, has been granted 9 million core-hours on the three major systems Curie, Occigen, and Turing. This compute time is primarily destined for our research into the interaction between ionic and structural heart disease in atrial fibrillation, Brugada syndrome, and early repolarisation syndrome [7] [61].

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

We participated in two H2020 Research and Innovation Action proposals.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

We coordinated a proposal with 5 European partners. The proposal could not be submitted due to administrative problems related to one of the partners, but we will benefit from the existing consortium to submit a new proposal in April 2018.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. EPICARD

Title: inversE Problems In CARDiac electrophysiology

International Partner (Institution - Laboratory - Researcher):

ENIT (Tunisia) – Department of Intelligence Science and Technology - Nabil Gmati

Start year: 2015

See also: <https://team.inria.fr/carmen/epicard/>

Improving the information that we can extract from electrical signals measured on patients with heart diseases is a major priority for the IHU LIRYC in Bordeaux headed by Professor Michel Haïssaguerre. We would like to non-invasively construct the electrical potential on the heart surface only from measurements of the electrical potential on the chest of the patient.

This helps the medical doctor to visualise an image of the electrical potential of the heart of the patient. It is known that have been used in the literature for solving this electrocardiography imaging (ECGI) problem, including those used in commercial medical devices have several limitations. This problem could be mathematically seen as a boundary data completion problem for elliptic equations.

Many works in the literature have been carried out in order to solve this Cauchy problem, but have never been used for solving the ECGI problem. Our goal from the associate team is to develop an experimental platform allowing to test various methods and compare their performance on real life experimental data.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Y. Coudière works with the group of Prof. Y. Bourgault from the Department of Mathematics and Statistics of the University of Ottawa (Canada). Some results on the numerical analysis of time-stepping methods from C. Douanla's PhD were carried out together, as well as some theoretical results on parameter identification in the PhD of A. Gérard.

M. Potse and O. Bernus (Liryc) work with the group of Prof. A. Panfilov in Ghent, Belgium, on simulation and analysis of complex reentrant arrhythmia.

M. Potse works with the group of Prof. U. Schotten at Maastricht University (The Netherlands) and the Center for Computational Medicine in Cardiology at the *Università della Svizzera italiana* (Lugano, Switzerland) on simulation studies of atrial fibrillation [51]. The Maastricht group was partially funded by the FP7 project EUTRAF and our simulations were supported by GENCI (section 8.2.3).

M. Potse set up a project and recruited a PhD student to co-direct with Dr. Esther Pueyo of the University of Zaragoza, within the context of the H2020 International Training Network "Personalised In-silico Cardiology" (PIC), coordinated by Dr. Pablo Lamata of King's College London.

N. Zemzemi works with Cesare Corrado at King's College London on the development of new eikonal models allowing conduction velocity adaptation [14].

N. Zemzemi collaborated with Jesús Requena-Carrión from the Queen Mary University of London to study the effects of the spatial resolution of electrode systems on the spectrum of cardiac signals in cardiac electrocardiography [12].

N. Zemzemi worked with R. Aboulaich group from Mohamed V university in Morocco on sensitivity of the electrocardiographic problem to multiple independent sources of uncertainty including noise in the measurements and the heterogeneity in the torso [34].

CARTE Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Simon Perdrix is PI of the PRCE ANR SoftQPro "Solutions logicielles pour l'optimisation des programmes et ressources quantiques". (2017- 2021) [Atos-Bull, LORIA, CEA, LRI].
- The team is partner of the ANR VanQuTe "Validation des technologies quantiques émergentes" (PRCI with Singapore) [LIP6, LORIA, SUTD, NUS, NTU] (2018-2022)
- The team is a partner in ANR Elica (2014-2019), "Elargir les idées logistiques pour l'analyse de complexité". The CARTE team is well known for its expertise in implicit computational complexity.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Mathieu Hoyrup participates in the Marie-Curie RISE project Computing with Infinite Data coordinated by Dieter Spreen (Univ. Siegen) that has started in April 2017. We organized a workshop CCC'17 in Nancy in June 2017, that was also the first meeting of the project.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

The team is partner of the ITEA3 Quantex project [LORIA, LRI, CEA/Leti, Atos-Bull, Siemens, TUDelft, KPN, EKUT] (2018-2020)

9.3. International Initiatives

Simon Perdrix is member of the STIC AmSud FoQCOSS with Argentina. He visited Quilmes University during 2 weeks in July 2017.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Ross Duncan (Assistant Prof. at Strathclyde U., Glasgow), spent one month (June 2017) in our team as an invited professor at Université de Lorraine.

9.4.2. Internships

Jordina Francès de Mas, Quentin Ladeveze were interns in our team ; they worked on cellular automata and produced two technical reports (see [34] and [38]).

CASCADE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives with Industry

7.1.1. *CryptoComp*

Program: FUI

Duration: October 2014 – November 2018

Coordinator: CryptoExperts

Partners: CEA, CNRS, Kalray, Inria, Dictao, Université de Limoges, VIACCESS, Bertin technologies, GEMALTO

Local coordinator: David Pointcheval

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

7.1.2. *RISQ*

Program: GDN

Duration: February 2017 – September 2020

Coordinator: Secure-IC

Partners: ANSSI, AIRBUS, C-S, CEA LIST, CryptoExperts, Inria/ENS/CASCADE, GEMALTO, Inria POLSYS, Inria AriC, IRISA, Orange Labs, THALES, UVSQ, PCQC

Local coordinator: Michel Abdalla

The main goal of RISQ is to help the French Industry and Academia become a significant international player in the transition to post-quantum cryptography.

7.2. National Collaborations within Academics

7.2.1. *EnBiD*

Title: Encryption for Big Data

Program: ANR JCJC

Duration: October 2014 – September 2018

PI: Hoeteck Wee

Partners: Université Paris 2, Université Limoges

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

7.2.2. *EfTrEC*

Title: Efficient Transferable E-Cash

Program: ANR JCJC

Duration: October 2016 – September 2020

PI: Georg Fuchsbauer

Partners: Université Paris 2

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

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

7.2.3. ALAMBIC

Title: AppLicAtions of MalleaBility in Cryptography

Program: ANR PRC

Duration: October 2016 – September 2020

PI: Damien Vergnaud

Partners: ENS Lyon, Université Limoges

The main objectives of the proposal are the following:

- Define theoretical models for “malleable” cryptographic primitives that capture strong practical attacks (in particular, in the settings of secure computation outsourcing, server-aided cryptography, cloud computing and cryptographic proof systems);
- Analyze the security and efficiency of primitives and constructions that rely on malleability;
- Conceive novel cryptographic primitives and constructions (for secure computation outsourcing, server-aided cryptography, multi-party computation, homomorphic encryption and their applications);
- Implement these new constructions in order to validate their efficiency and effective security.

7.3. European Initiatives

7.3.1. CryptoAction

Title: Cryptography for Secure Digital Interaction

Program: H2020 ICT COST

Duration: April 2014 – April 2018

Local coordinator: Michel Abdalla

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

7.3.2. CryptoCloud

Title: Cryptography for the Cloud

Program: FP7 ERC Advanced Grant

Duration: June 2014 – May 2019

PI: David Pointcheval

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

7.3.3. SAFEcrypto

Title: Secure Architectures of Future Emerging Cryptography

Program: H2020

Duration: January 2015 – January 2019

Coordinator: The Queen's University of Belfast

Partners: Inria/ENS (France), Emc Information Systems International (Ireland), Hw Communications (United Kingdom), The Queen's University of Belfast (United Kingdom), Ruhr-Universität Bochum (Germany), Thales UK (United Kingdom), Università della Svizzera italiana (Switzerland), IBM Research Zurich (Switzerland)

Local coordinator: Michel Abdalla

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

7.3.4. ECRYPT-NET

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

Program: H2020 ITN

Duration: March 2015 – February 2019

Coordinator: KU Leuven (Belgium)

Partners: KU Leuven (Belgium), Inria/ENS (France), Ruhr-Universität Bochum (Germany), Royal Holloway, University of London (UK), University of Bristol (UK), CryptoExperts (France), NXP Semiconductors (Belgium), Technische Universiteit Eindhoven (the Netherlands)

Local coordinator: Michel Abdalla

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

7.3.5. aSCEND

Title: Secure Computation on Encrypted Data

Program: H2020 ERC Starting Grant

Duration: June 2015 – May 2020

PI: Hoeteck Wee

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

7.3.6. FENTEC

Title: Functional Encryption Technologies

Program: H2020

Duration: January 2018 – December 2020

Coordinator: ATOS Spain SA

Scientific coordinator: Michel Abdalla

Partners: Inria/ENS (France), Flensburg University (Germany), KU Leuven (Belgium), University of Helsinki (Finland), Nagra (Switzerland), XLAB (Switzerland), University of Edinburgh (United Kingdom), WALLIX (France)

Local coordinator: Michel Abdalla

Functional encryption (FE) has recently been introduced as a new paradigm of encryption systems to overcome all-or-nothing limitations of classical encryption. In an FE system the decryptor deciphers a function over the message plaintext: such functional decryptability makes it feasible to process encrypted data (e.g. on the Internet) and obtain partial view of the message plaintext. This extra flexibility over classical encryption is a powerful enabler for many emerging security technologies (i.e. controlled access, searching and computing on encrypted data, program obfuscation...). FENTEC's mission is to make the functional encryption paradigm ready for wide-range applications, integrating it in ICT technologies as naturally as classical encryption. The primary objective is the efficient and application-oriented development of functional encryption systems. FENTEC's team of cryptographers, software and hardware experts and information technology industry partners will document functional encryption needs of specific applications and subsequently design, develop, implement and demonstrate applied use of functional cryptography. Ultimately, a functional encryption library for both SW and HW-oriented application will be documented and made public so that it may be used by European ICT entities. With it, the FENTEC team will build emerging security technologies that increase the trustworthiness of the European ICT services and products. Concretely, the FENTEC team will showcase the expressiveness and versatility of the functional encryption paradigm in 3 use cases:

- Privacy-preserving digital currency, enforcing flexible auditing models
- Anonymous data analytics enabling computation of statistics over encrypted data, protecting European Fundamental Rights of Data Protection and Privacy
- Key and content distribution with improved performance & efficiency as foundational technology for establishing secure communication among a vast amount of IOT devices.

7.4. International Initiatives with Industry

7.4.1. CryPrivBC

Title: Cryptography for Privacy on the Blockchain

Partners: MSR Redmond (USA), MSR Cambridge (UK), Inria

Duration: October 2017 – October 2021

PI: Georg Fuchsbauer

The goal of this Microsoft-Inria joint project on privacy and decentralization is to use cryptography to improve privacy on the blockchain. We will investigate means of privacy-preserving authentication, such as electronic currencies, and other applications of blockchain and distributed transparency mechanisms.

7.5. International Research Visitors

- Melissa Chase (MSR Redmond)
- Huijia Rachel Lin (UCSB)
- Yuval Ishai (Technion)
- Stefano Tessaro (UCSB)
- Vinod Vaikuntanathan (MIT)

CASTOR Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Inria Project Lab: FRATRES (*Fusion Reactors Research and Simulation*)

- Participants : Inria project-teams : CASTOR, IPSO, TONUS,
- Partners : IRFM-CEA, Max Planck Institute-IPP Garching, LJLL-Jussieu, IMT-Toulouse

Controlled nuclear fusion can be considered as an example of grand challenge in many fields of computational sciences from physical modelling, mathematical and numerical analysis to algorithmics and software development and several Inria teams and their partners are developing mathematical and numerical tools in these areas.

Since January 2015, H. Guillard is coordinating the Inria Project Lab FRATRES (<https://team.inria.fr/ipf-fratres/>) to organize these developments on a collaborative basis in order to overcome the current limitations of today numerical methodologies. The ambition is to prepare the next generation of numerical modelling methodologies able to use in an optimal way the processing capabilities of modern massively parallel architectures. This objective requires close collaboration between a) applied mathematicians and physicists that develop and study mathematical models of PDE; b) numerical analysts developing approximation schemes; c) specialists of algorithmic proposing solvers and libraries using the many levels of parallelism offered by the modern architecture and d) computer scientists. This Inria Project Lab will contribute in close connection with National and European initiatives devoted to nuclear Fusion to the improvement and design of numerical simulation technologies applied to plasma physics and in particular to the ITER project for magnetic confinement fusion.

Contact : Hervé Guillard

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. EuroFusion Consortium

CASTOR participates to the following EuroFusion consortium projects :

- CfP-WP14-ER-01/Swiss Confederation-01. École Polytechnique Fédérale de Lausanne (PI: Paolo Ricci) “Synergetic numerical-experimental approach to fundamental aspects of turbulent transport in the tokamak edge”
- CfP-WP14-ER-01/CEA-01. CEA (PI: Matthias Hoelzl IPP) “JOEKE, BOUT++ non-linear MHD modelling of MHD instabilities and their control in existing tokamaks and ITER”
- Enabling research contract 2014-2018. (B. Nkonga, H. Guillard, A. Sangam) CfP-WP15-ENR-01/IPP-05, Grant agreement No 633053. «Global non-linear MHD modeling in toroidal X-point geometry of disruptions, edge localized modes, and techniques for their mitigation and suppression»
- EUROfusion WPCD (Working Package Code Development)
 - ACT1: Extended equilibrium and stability chain (participation)
 - ACT2: Free boundary equilibrium and control (participation and coordination)

8.2.1.2. *EoCoE*

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Inria contact: Michel Kern

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

8.3. International Initiatives

8.3.1. *Inria International Partners*

The team collaborates with TUC (Technical University of Crete, Prof. Argyris Delis) on extension of the shallow water model to turbulent flows. These common works overlap with the collaboration with Taiwan in the framework of the former AMOSS associate team. [27]

8.3.2. *Participation in Other International Programs*

ITER Contracts (B. Nkonga):

- ITER IO/17/CT/4300001505 : 2017-2019, "Non-linear MHD simulations for ITER QH-mode plasma with & without 3D magnetic field perturbations from in-vessel ELM control coils". (150KE)
- ITER IO/15/PR/11410/MCI: 2015-2017, "Modeling of plasma instabilities in ITER" (120KE)

CEDAR Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- AIDE (“A New Database Service for Interactive Exploration on Big Data”) is an ANR “Young Researcher” project led by Y. Diao, started at the end of 2016.
- CBOD (“Cloud-Based Organizational Design”) is a 4-year ANR started in 2014, coordinated by prof. Ahmed Bounfour from UPS. Its goal is to study and model the ways in which cloud computing impacts the behavior and operation of companies and organizations, with a particular focus on the cloud-based management of data, a crucial asset in many companies.
- ContentCheck (2015-2018) is an ANR project in collaboration with U. Rennes 1 (F. Goasdoué), INSA Lyon (P. Lamarre), the LIMSI lab from U. Paris Sud, and the Le Monde newspaper, in particular their fact-checking team Les Décodeurs. Its aim is to investigate content management models and tools for journalistic fact-checking.

8.1.2. LabEx, IdEx

- CloudSelect is a three-years project started in October 2015. It is financed by the *Institut de la Société Numérique* (ISN) of the IDEX Paris-Saclay; it funds the PhD scholarship of S. Cebiric. The project is a collaboration with A. Bounfour from the economics department of Université Paris Sud. The project aims at exploring technical and business-oriented aspects of data mobility across cloud services, and from the cloud to outside the cloud.

8.1.3. Others

- ODIN is a four-year project started in 2014, funded by the Direction Générale de l’Armement, between the SemSoft company, IRISA Rennes and Cedar. The project aims to develop a complete framework for analytics on Web data, in particular taking into account uncertainty, based on Semantic Web technologies such as RDF.
- The goal of the iCODA project is to develop the scientific and technological foundations for knowledge-mediated user-in-the-loop collaborative data analytics on heterogeneous information sources, and to demonstrate the effectiveness of the approach in realistic, high-visibility use-cases. The project stands at the crossroad of multiple research fields—content analysis, data management, knowledge representation, visualization—that span multiple Inria themes, and counts on a club of major press partners to define usage scenarios, provide data and demonstrate achievements. This is a project funded directly by Inria (“Inria Project Lab”), and is in collaboration with GraphIK, ILDA, LINKMEDIA (coordinator), as well as the press partners AFP, Le Monde (Les Décodeurs) and Ouest-France.

8.2. International Initiatives

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

8.2.1.1. WebClaimExplain

Title: Mining for explanations to claims published on the Web

International Partner (Institution - Laboratory - Researcher):

AIST (Japan) - Julien Leblay

Start year: 2017

See also: <https://team.inria.fr/cedar/projects/webclaimexplain/>

The goal of this research is to create tools to find explanations for facts and verify claims made online. While this process cannot be fully automated, the main focus of our work will be explanation finding via trusted sources, based on the observation that one can only trust a statement if he/she can explain it through rules and proofs that can themselves be trusted.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

8.3.1.1. Internships

Lars Kegel, a PhD student at the university of Dresden, is visiting the team since September 2017. He is working on the systematic description of time series with features that capture the global, structural characteristics of a series in a lower dimensional space.

CELTIQUE Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. *The ANR AnaStaSec project*

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

Static program analysis, Security, Secure compilation

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

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

5.1.2. *The ANR Binsec project*

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

Binary code, Static program analysis

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

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

5.1.3. *The ANR MALTHY project*

Participant: David Cachera.

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

5.1.4. *The ANR AJACS project*

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

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

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

5.1.5. The ANR DISCOVER project

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

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

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

The project runs from October 2014 to September 2019.

5.2. European Initiatives

5.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: CA COST Action CA15123

Project acronym: EUTYPES

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

Duration: 03/2016 to 03/2020

Coordinator: Herman Geuvers (Radboud University Nijmegen, The Netherlands)

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

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

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

Sandrine Blazy is Substitute Member of the Management Committee for France.

5.3. International Initiatives

5.3.1. Inria International Partners

5.3.1.1. Declared Inria International Partners

WEBCERT

Title: Verified Trustworthy web Applications

International Partner (Institution - Laboratory - Researcher):

Imperial College London - Department of Computing - Philippa Gardner

Duration: 2015 - 2019

Start year: 2015

See also: [JSCert web page](#)

The WebCert partnership focuses on applying formal methods to the JavaScript language: mechanized specification, development of an executable formal specification, design of a program logic, development of verification tools, and study of secure sub-languages.

CHROMA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

Participants: Laetitia Matignon, Olivier Simonin, Alessandro Renzaglia, Jilles Dibangoye.

Project of the Informatics Federation of Lyon (FIL) between two teams of two laboratories: 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.

9.1.2. *CORDES ADT Inria project, 2017-18*

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

The project CORDES (Coordination d'une Flotte de Drones Connectés pour la Cartographie 3D d'édifices) is an Inria ADT coordinated by Olivier Simonin. It funds an Inria expert engineer position in Chroma (Vincent Le Doze, 10/17-11/19) focusing on UAVs control and path-planning. The project aims to deploy a fleet of UAVs able to autonomously fly over an unknown infrastructure and to build a 3D map.

9.1.3. *Regional AAP ARC6 project, 2015-18*

Participants: Olivier Simonin, Anne Spalanzani, Fabrice Valois [Insa de Lyon, Inria AGORA].

Regional project (Rhône-Alpes) "Mobilité au sein de flottes de robots sous contrainte de maintien de la connectivité" ARC6, 2015-2018. Leader : O. Simonin.

This project funds the PhD thesis of Mihai-Ioan Popescu, who started on november 2015, and co-advized by O. Simonin, A. Spalanzani and F. Valois. The project involves also the Pole de compétitivité "Via Meca".

9.1.4. *Regional AAP ARC6 project 'TENSIVE', 2016-19*

Participants: Remi Cambuzat, Gérard Bailly [CNRS, GIPSA Lab. Grenoble], Olivier Simonin, Anne Spalanzani.

Regional project (Rhône-Alpes) "TENSIVE Robots de Téléprésence : Navigation Sociale et Interaction Verbale immersives" ARC6, 2016-2019. Leader : G. Bailly.

This project funds the PhD thesis of Remi Cambuzat who started on october 2016, and co-advized by G. Bailly (Dir.), O. Simonin and A. Spalanzani.

9.2. National Initiatives

9.2.1. *ANR*

9.2.1.1. *ANR "VIMAD" (2015-17)*

The VIMAD project, led by A. Martinelli, aims at developing a robust and reliable perception system, only based on visual and inertial measurements, to enhance the navigation capabilities of fully autonomous micro aerial drones. It also aims at acquiring a deep theoretical comprehension of the problem of fusing visual and inertial measurements, by investigating its observability properties in challenging scenarios.

The activities related to this project, followed the work-plan (first year). They regarded the usage of our closed-form solution (recently published on the journal of computer vision, [64]) in the framework of micro aerial navigation in order to:

1. automatically perform state initialization;
2. improve the data matching process.

Additionally, the activities of VIMAD regarded the investigation of an unsolved problem in control theory, which is the unknown input observability problem in the nonlinear case, and its applications to the visual-inertial structure from motion problem.

See section 3.2.5 for a description of the results obtained during this year of the project.

9.2.1.2. ANR "Valet" (2016-18)

The ANR VALET project proposes a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers. An optimal routing algorithm is in charge of defining platoons drivers' routes to the parking areas where the followers are parked in a complete automated mode. The consortium is made of 2 academic partners : Inria (RITS, Chroma, Prima) and Ircyyn Ecole Centrale de Nantes and the AKKA company. The PhD student (Pavan Vashista) recruited in this project focus 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 started in february 2016 and is codirected by D. Vaufreydaz (Inria/PervasiveInteraction).

9.2.1.3. ANR "HIANIC" (2017-20)

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 (Magma team) and LS2N laboratory (ARMEN and PACCE teams). A. Spalanzani is the leader of this project.

9.2.1.4. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: ECSEL

Project acronym: ENABLE-S3

Project title: European Initiative to Enable Validation for Highly Automated Safe and Secure Systems

Duration: June 2016 – May 2019

Coordinator: AVL List GesmbH

Other partners: Major European Organizations, including academic partners (such as Inria or KIT) and a Large number of industrial partners from various application domains such as automotive industry or Aeronautics or Train industry

Abstract: ENABLE-S3 is *industry-driven* and therefore aims to foster the leading role of the European industry. This is also reflected in its *use case driven approach*. The main technical objectives are extracted from the use cases defined by the industrial partners, in order to validate the success of the developed methods and tools.

The ENABLE-S3 project will provide European industry with leading-edge technologies that *support the development of reliable, safe and secure functions for highly automated and/or autonomously operating systems* by enabling the *validation and verification at reduced time and costs*.

Enables-S3 is a large European consortium, involving a French consortium led by Renault and Inria Grenoble Rhône-Alpes. The Inria Tamis team (Rennes) is also involved in the project.

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 für Technologie (KIT, Germany)

Autonomous Driving (student exchanges and common project).

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).

9.4. International Initiatives

9.4.1. Inria International Labs

Program: International Center of Excellence

Duration: 2012 – 2017

Coordinator: C. Laugier

Other partners: UPMC & CNRS (France), NTU (Taiwan)

The iCeIRA⁰ international robotics laboratory led by Prof. Ren Luo from NTU (Taiwan) and strongly supported by the Taiwanese government, has been launched in 2012 for 5 years. Christian Laugier (Inria) and Raja Chatila (UPMC & CNRS) have actively participated to the starting of this laboratory in 2012 and are external Principal Investigators. The addressed research is about the concept of Human centered robotics.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- UC Berkeley & Stanford University (CA, USA)
Subject: Autonomous Driving (postdoc in the scope of Inria@SV, common publications and patent).
- NUS Singapore & NTU Singapore.
Subject: Autonomous Driving (visits, common ICT Asia project, common organization of workshops, review of PhD students).
- Massachusetts Institute of Technology (MIT), Cambridge, MA (USA)
Subject: Decentralized Control of Markov Decision Processes.
Subject: Autonomous Driving (visits and common organization of a workshop).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Visits of researchers from University Babes-Bolyai, Cluj-Napoca (Romania). In the context of our PHC "DRONEM" (2017-18), some members from the MLYRE team visited CHROMA, at CITI lab. in Lyon, July 8-13. Prof. Gabriela Czibula, Dr. Istvan-Gergely Czibula, Dr. Marian Zsuzsanna-Edit and Diana Lucia-Miholca given some talks about Machine Learning.

⁰International Center of Excellence in Intelligent Robotics and Automation Research.

CIDRE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **Region Bretagne ARED Grant** : the PhD of Mourad Leslous on malicious codes in Android applications is supported by a grant from the Région Bretagne.
- **Labex COMINLABS contract (2014-2017): "Kharon-Security"** - <http://kharon.gforge.inria.fr>

Google Play offers more than 800'000 applications (apps), and this number increases every day. Google play users have performed more than 25 billion app downloads. These applications vary from games to music, video, books, tools, etc. Unfortunately, each of these application is an attack vector on Android. The number of malicious applications (pieces of malware) discovered during the first six months of 2013 exceeds the number of pieces of malware discovered during the 2010 to 2012 period, more than 700 thousand malicious and risky applications were found in the wild. In this context, we propose the Kharon-Security project to stem the progression of Android pieces of malware. We propose to combine static and dynamic monitoring to compute a behavioral signature of Android malware. Behavioral signatures are helpful to understand how malware infect the devices and how they spread information in the Android operating system. Static analysis is essential to understand which particular event or callback triggers malware payload.

In the project we have already developed GroddDroid a tool dedicated to automatic identification and execution of suspicious code. We have also built a dataset of Android malware. In this dataset, all malware are entirely manually reverse and documented. We have also developed an analysis platform. This platform is been deployed at the High Research Laboratory.

- **Labex COMINLABS contract (2015-2018): "HardBlare-Security"** - <http://www.hardblare.cominlabs.ueb.eu/>

The general context of the HardBlare project is to address Dynamic Information Flow Tracking (DIFT) that generally consists in attaching marks to denote the type of information that is saved or generated within the system. These marks are then propagated when the system evolves and information flow control is performed in order to guarantee a safe execution and storage within the system. Existing solutions imply a large overhead induced by the monitoring process. Some attempts rely on a hardware-software approach where DIFT operations are delegated to a coprocessor. Nevertheless, such approaches are based on modified processors. Beyond the fact hardware-assisted DIFT is hardly adopted, existing works do not take care of coprocessor security and multicore/multiprocessor embedded systems.

We plan to implement DIFT mechanisms on boards including a non-modified ARM processor and a FPGA such as those based on the Xilinx Zynq family. The HardBlare project is a multidisciplinary project between CentraleSupélec IETR SCEE research team, CentraleSupélec Inria CIDRE research team and UBS Lab-STICC laboratory. Mounir Nasr Allah is doing his PhD in the context of this project. The main objective of this PhD is to study how hybrid analysis could improve hardware assisted DIFT using static analysis performed at compile-time. Another objective is to manage labels for persistent memory (i.e., files) using a modified OS kernel.

- **Labex COMINLABS contract (2016-2019): "BigClin"** - <http://www.bigclin.cominlabs.ueb.eu/>

Health Big Data (HBD) is more than just a very large amount of data or a large number of data sources. The data collected or produced during the clinical care process can be exploited at different levels and across different domains, especially concerning questions related to clinical and translational research. To leverage these big, heterogeneous, sensitive and multi-domain clinical data,

new infrastructures are arising in most of the academic hospitals, which are intended to integrate, reuse and share data for research.

Yet, a well-known challenge for secondary use of HBD is that much of detailed patient information is embedded in narrative text, mostly stored as unstructured data. The lack of efficient Natural Language Processing (NLP) resources dedicated to clinical narratives, especially for French, leads to the development of ad-hoc NLP tools with limited targeted purposes. Moreover, the scalability and real-time issues are rarely taken into account for these possibly costly NLP tools, which make them inappropriate in real-world scenarios. Some other today's challenges when reusing Health data are still not resolved: data quality assessment for research purposes, scalability issues when integrating heterogeneous HBD or patient data privacy and data protection. These barriers are completely interwoven with unstructured data reuse and thus constitute an overall issue which must be addressed globally.

In this project, we plan to develop distributed methods to ensure both the scalability and the online processing of these NLP/IR and data mining techniques; In a second step, we will evaluate the added value of these methods in several real clinical data and on real use-cases, including epidemiology and pharmaco-vigilance, clinical practice assessment and health care quality research, clinical trials.

9.2. National Initiatives

9.2.1. ANR

- **ANR INFRA Project: SOCIOPLUG (2013-2017)** - http://socioplug.univ-nantes.fr/index.php/SocioPlug_Project

SocioPlug is a collaborative ANR project involving Inria (ASAP and CIDRE teams), the Nantes University, and LIRIS (INSA Lyon and Université Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more or less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

- **ANR Project: PAMELA (2016-2020)** - <https://project.inria.fr/pamela/>

PAMELA is a collaborative ANR project involving Rennes 1 university (ASAP and CIDRE teams in Rennes), Inria Lille (MAGNET team), LIP6 (MLIA team) and two start-ups, Mediego and Snips. It aims at developing machine learning theories and algorithms in order to learn local and personalized models from data distributed over networked infrastructures. The project seeks to provide first answers to modern information systems built by interconnecting many personal devices holding private user data in the search of personalized suggestions and recommendations. More precisely, we will focus on learning in a collaborative way with the help of neighbors in a network. We aim to lay the first blocks of a scientific foundation for these new types of systems, in effect moving from graphs of data to graphs of data and learned models. CIDRE's contribution in this project involves the design of adversary models and privacy metrics suitable to the privacy-related issues of this distributed learning paradigm.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

Emmanuelle Anceaume is actively working with Leonardo Querzoni from the University La Sapienza, Italy, on data streams algorithms and engines. Their cooperation gave rise to one publication in *Algotel* 2017 [25].

Valérie Viet Triem Tong has shortly visited Prof Alexander Pretchner at TU Munchen in June 2017. She has participated to a workshop about Android Malware analysis.

9.4. International Research Visitors

9.4.1. Research Stays Abroad

In the context of the project with HP Inc Labs, Ronny Chevalier and Guillaume Hiet collaborate with the security team of HP Labs in Bristol. They are working more specifically with David Plaquin and Maugan Villatel, who are co-authors of the article published at ASCAC. Ronny Chevalier has spent 3 months at HP Labs at Bristol.

Mounir Nasr Allah is currently visiting ARM R&D labs at Cambridge for 6 months in the context of the HardBlare project. This visit has been funded by the EIT Digital Doctoral School Program. He is working with **Alastair Reid** on the use of formal methods to prove that some hardware security mechanisms of ARM embedded processors effectively enforce information flow policies.

Mourad Leslous did an international mobility of three months at the Technical University of Munich, in the team of Professor Alexander Pretschner. This mobility was part of the program of EIT Digital Doctoral School, a European institute that promotes entrepreneurship and innovation among PhD students. During this mobility, he worked on control flow and data flow dependencies in order to detect the malicious code inside Android applications.

COAST Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Region Lorraine TV Paint (2016–2017)

Participants: Claudia-Lavinia Ignat [contact], Gérald Oster, Quang Vinh Dang, Matthieu Nicolas.

Partners: TVPaint Development, Inria COAST project-team

Website: <https://www.tvpaint.com/>

This is a project in collaboration with TVPaint Development financed by Region Lorraine. The goal is to contribute to the creation of a collaborative system dedicated to animation movies, that allows to manipulate high quantities of digital artifacts in a collaborative way.

7.1.2. Region Grand Est TV Paint (2017–2019)

Participants: Claudia-Lavinia Ignat [contact], Gérald Oster.

Partners: TVPaint Development, Inria COAST project-team

Website: <https://www.tvpaint.com/>

This is a follow-up project in collaboration with TVPaint Development financed by Region Grand Est.

The goal is to contribute to the creation of a collaborative system dedicated to manage the production of animated movies. This system has to manipulate a large amount of data in a safe and secure manner. Based on the previously proposed architecture and prototype, this project intends to design and implements a commercial product. In the framework of this project, we bring our expertise in data management, business process management, distributed systems and collaborative systems.

Coast funding : 81,600 €

7.2. National Initiatives

7.2.1. OpenPaas NG (2015–2019)

Participants: Claudia-Lavinia Ignat, François Charoy [contact], Gérald Oster, Olivier Perrin, Jean-Philippe Eisenbarth, Phillippe Kalitine, Matthieu Nicolas, Mohammed Riyadh Abdmeziem, Kahina Bessai, Victorien Elvinger, Quentin Laporte Chabasse, Hoai Le Nguyen, Hoang Long Nguyen.

Partners: Linagora, XWiki SAS, Nexedi, COAST project-team (Université de Lorraine, LORIA), DaScim team (LIX).

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

This project is financed by BpiFrance and involves French industrial leaders in open-source software development (Linagora, Nexedi, XWiki) and academic partners in collaborative work (COAST team) and recommender systems (DaScim team, LIX). The goal of the project is to develop next generation cloud enabled virtual desktop based on an Enterprise Social Network to provide advanced collaborative and recommendation services. COAST team is responsible of the work package dedicated to the design of the peer-to-peer collaborative middleware. In this context, we bring our expertise on data replication for collaborative data in peer-to-peer environments and on trust and access control and identity management in distributed collaborative information systems.

7.3. International Initiatives

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

7.3.1.1. USCOAST2

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

Wright State University (United States) - Department of Psychology, Knoesis - Valerie Shalin

Start year: 2016

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

The proposed project addresses the perception of trust by users, the appropriateness of a trust-based security approach and the role of trust metrics in the management of distributed work. The main challenge of this project is how to measure trust based on user behaviour and to verify by means of experimental studies with users that the trust-based mechanism is acceptable by users. We plan to apply this trust-based mechanism for two types of applications. The first one is collaborative editing where user trust will be computed based on the quality of user contributions for a document or project. The second type of application is in the management of work over a large group of people in order to conduct efficient, high-yield, high-density real time crowdsourcing activities.

Partners of USCOAST2 project have complementary expertise. COAST provides expertise in collaborative methods, systems and related technologies. Coast will propose algorithms that track and manipulate trust metrics. Kno.e.sis provides expertise on the analysis of human work-related behavior, including methods of data collection and data analysis, as well as a theoretical foundation for the evaluation of human performance. Knoesis will analyse trust from a psychological phenomenon point of view.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Valerie Shalin from Wright State University spent one month and a half (May-July 2017) in our team as part of the USCoast2 Inria associated team.

Weihai Yu from Arctic University of Norway spent two weeks in March 2017 in the team as invited professor.

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

- Béatrice Linot spent 3 months at Wright State University as part of our collaboration with Dr Valerie Shalin and Prof. Amit Sheth, funded by her LUE PhD grant.

COATI Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR Blanc STINT, 2014-2017

Participants: Julien Bensmail, Jean-Claude Bermond, David Coudert, Frédéric Havet, Luc Hogue, William Lochet, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

The STINT project (*Structures INTerdites*) is led by the MC2 group (LIP, ENS-Lyon) and involves the G-SCOP laboratory (Grenoble).

The aim of STINT was to answer the following fundamental question: *given a (possibly infinite) family ψ of graphs, what properties does a ψ -free graph have?* To this end, it has firstly establish bounds on some classical graph parameters (e.g., clique number, stability number, chromatic number) for ψ -free graphs. Then, it has design efficient algorithms to recognize ψ -free graphs and to determine or approximate some parameters for those graphs. These studies have result in the development of new proof techniques.

(<http://www.ens-lyon.fr/LIP/MC2/STINT/>)

8.1.2. GDR Actions

8.1.2.1. Action ResCom, ongoing (since 2006)

Réseaux de communications, working group of GDR RSD, CNRS.

(<http://rescom.asr.cnrs.fr/>)

8.1.2.2. Action Graphes, ongoing (since 2006)

Action Graphes, working group of GDR IM, CNRS.

(<http://gtgraphes.labri.fr/>)

8.2. International Initiatives

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

8.2.1.1. ALDYNET

Title: distributed ALgorithms for DYnamic NETworks

International Partner (Institution - Laboratory - Researcher):

Universidad Adolfo Ibañez (Chile) - Facultad de Ingeniería y Ciencias - Karol SUCHAN

Duration: 2013-2018

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

The main goal of this Associate Team is to design and implement practical algorithms for computing graph structural properties. We will then use these algorithms on a concrete case of study which concerns the transportation network of the Santiago metropolitan area. We are both interested in theoretical results concerning the feasibility of computing graph properties, and by their practical implementation (using [Sagemath](#)) for our application and their diffusion in the scientific community. See the [ALDYNET](#) project web page for more details.

8.2.2. Inria International Partners

8.2.2.1. Informal International Partners

Apart from formal collaboration COATI members maintain strong connections with the following international teams, with regular visits of both sides.

Universidade Federal do Ceará (Fortaleza, Brazil), ParGO team;
 Universidade Estadual do Ceará (Fortaleza, Brazil), Prof. Leonardo Sampaio;
 Univ. of Southern Denmark (Odense, Denmark), Prof. Jørgen Bang-Jensen;
 RWTH Aachen Univ., Lehrstuhl II für Mathematik (Aachen, Germany), Prof. Arie M.C.A. Koster;
 Concordia Univ. (Montréal, Québec, Canada), Prof. Brigitte Jaumard.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Jørgen Bang-Jensen
 University of Southern Denmark, Odense, Denmark. January 2017.

Ararat Harutyunyan
 Université de Toulouse III, France. February 2017.

Takako Kodate
 Tokyo Woman's Christian University, Japan. From March 2017 until April 2017.

Claudia Linhares-Sales
 Universidade Federal do Ceará, Fortaleza, Brazil. January 2017.

Joseph Peters
 School of computing Science, Simon Fraser University, BC Canada. Since October 2017.

Leonardo Sampaio Rocha
 Universidade Estadual do Ceará, Fortaleza, Brazil. June 2017.

Ana Shirley Ferreira Da Silva
 Universidade Federal do Ceará, Fortaleza, Brazil. January 2017.

Karol Suchan
 Universidad Adolfo Ibáñez, Chile. From February 2017 until March 2017.

Laurent Viennot
 Inria Paris (EP Gang), France. February 2017.

Min-Li (Joseph) Yu
 Univ. of the Fraser valley, Abbotsford, (BC), Canada. From March 2017 until April 2017.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

Julien Bensmail
 LaBRI, Université de Bordeaux, April 24-28 and October 9-13, 2017.

Christelle Caillouet
 Reunion Island University, LIM Laboratory, October 20-November 19, 2017.

David Coudert
 Gran Sasso Science Institute (GSSI), L'Aquila, Italy, April 19-21, 2017;
 Concordia University, Montréal, Québec, Canada, July 1-14, 2017;

Univ. Adolfo Ibáñez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AIDyNet, November 17-December 2, 2017.

Guillaume Ducoffe

Faculty of Mathematics and Informatics, University of Bucharest, January 18-August 31, 2017.

Frédéric Giroire

Department of Computer Science and Software Engineering, Concordia University, Montréal, Canada, October 11-24, 2017.

Frédéric Havet

Laboratoire ICube, Université de Strasbourg, November 8-10, 2017;

LABRI, Bordeaux, November 14-17, 2017.

William Lochet

LABRI, Université de Bordeaux, October 8-13, 2017;

LIRMM, Université de Montpellier, June 13-15, 2017.

Nicolas Nisse

LIF, Aix-Marseille Université, July 9-13, 2017;

Univ. Adolfo Ibáñez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AIDyNet, November 17-December 2, 2017.

Fionn Mc Inerney

Université de Montréal, Montréal, Canada, July 3-August 4, 2017;

Univ. Adolfo Ibáñez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AIDyNet, November 17-December 2, 2017.

Bruce Reed

IMPA, Unité CNRS Mixte, Rio de Janeiro, Brazil, January 1-March 24, 2017;

School of Computer Science, McGill University, November 1-December 31, 2017.

Andrea Tomassilli

Concordia University, Montréal, Canada, October 1-December 28, 2017.

COFFEE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The team is involved in the IDEX project UCA-JEDI.

- PhD of Laurence Beaudé (october 2015 - december 2018) co-funded by BRGM and Region PACA and dealing with the simulation of geothermal systems, supervised by Roland Masson, Konstantin Brenner from LJAD-Inria and by Simon Lopez, Farid Smai from BRGM.

8.2. National Initiatives

8.2.1. ANR

- ANR CHARMS (Quantitative Reservoir Models for Complex Hydrothermal Systems): december 2016 - december 2020, partners BRGM (leader), LJAD-Inria, Storengy, MdS, LJLL.

8.2.2. National and European networks

- GdR MANU.

The research group MANU has activities centered around scientific computing, design of new numerical schemes and mathematical modelling (upscaling, homogenization, sensitivity studies, inverse problems,...). Its goal is to coordinate research in this area, as well as to promote the emergence of focused groups around specific projects

- S. Junca is involved in GdR 3437 DYNOLIN “Dynamique non linéaire” and GdR MecaWave.
- LJAD-Inria and BRGM are the French partners of the Norwegian, German French project InSPiRE “International Open Source Simulation Software Partnership in Research and Education” which has just been accepted by the Research Council of Norway with the code COMPASS as one of the softwares of this project together with Dune, Dumux and OPM.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Felix Kwok, one month in may 2017: nonlinear domain decomposition methods for the Richards equation with Roland Masson and Victorita Dolean.

8.3.1.1. Internships

- Internship of Willy Bonneuil (March 2017-August 2017) funded by EDF Chatou on nonlinear solvers based on variable switches for the Richards equation, supervision Konstantin Brenner and Roland Masson from LJAD-Inria and Jerome Bonnelle and Raphael Lamouroux from EDF.

COMETE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. OPTIMEC

Project title: Optimal Mechanisms for Privacy Protection

Funded by: DigiCosme

Duration: September 2016 - August 2019

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

Other PI's: Serge Haddadm ENS Cachan.

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

7.2. National Initiatives

7.2.1. REPAS

Program: ANR Blanc

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

Duration: October 2016 - September 2021

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

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

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

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. LOGIS

Title: Logical and Formal Methods for Information Security

Inria principal investigator: Konstantinos Chatzikokolakis

International Partners:

Mitsuhiro Okada, Keio University (Japan)

Yusuke Kawamoto, AIST (Japan)

Tachio Terauchi, JAIST (Japan)

Masami Hagiya, University of Tokyo (Japan)

Start year: 2016

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

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

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

Giovanni Cherubin, Royal Holloway, University of London, UK
 Geoffrey Smith, Florida International University, USA
 Carroll Morgan, NICTA , Australia
 Annabelle McIver, Maquarie University, Australia
 Moreno Falaschi, Professor, University of Siena, Italy
 Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil
 Camilo Rueda, Professor, Universidad Javeriana de Cali, Colombia
 Carlos Olarte, Universidade Federal do Rio Grande do Norte, Brazil
 Camilo Rocha, Associate Professor, Universidad Javeriana de Cali, Colombia

7.3.3. Participation in Other International Programs

7.3.3.1. CLASSIC

Program: Colciencias - Conv. 712.
 Project acronym: CLASSIC.
 Project title: Concurrency, Logic and Algebra for Social and Spatial Interactive Computation.
 Duration: Oct 2016 - Oct 2019.
 URL: <http://goo.gl/Gv6Lij>
 Coordinator: Camilo Rueda, Universidad Javeriana de Cali, Colombia.
 Other PI's and partner institutions: Carlos Olarte, Universidade Federal do Rio Grande do Norte, Brazil. Frank Valencia, CNRS-LIX and Inria Saclay.
 Abstract: This project will advance the state of the art of domains such as mathematical logic, order theory and concurrency for reasoning about spatial and epistemic behaviour in multi-agent systems..

7.3.3.2. EPIC

Program: STIC-Amsud.
 Project acronym: EPIC.
 Project title: EPistemic Interactive Concurrency/
 Duration: Oct 2016 - Oct 2019.
 URL: <https://sites.google.com/site/sticamsudepic/>
 Coordinator: Frank Valencia, CNRS-LIX and Inria Saclay.
 Other PI's and partner institutions: Carlos Olarte, Universidade Federal do Rio Grande do Norte, Brazil. Camilo Rueda, Universidad Javeriana de Cali, Colombia.
 Abstract: The aim of the project is to coherently combine and advance the state of the art of domains such as concurrency theory, information theory and rewriting systems for reasoning about social networks.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

David de Frutos Escrig, Professor, Universidad Complutense Madrid, Spain. Jan-Feb 2017

Giovanni Cherubin, PhD student, Royal Holloway, University of London, UK. May 2017 and Oct 2017

Yusuke Kawamoto, Assistant Professor, National Institute of Advanced Industrial Science and Technology (AIST), Japan. July 2017 and Nov 2017

Carlos Olarte, Assistant Professor, Universidade Federal do Rio Grande do Norte, Brazil. July 2017

Camilo Rocha, Associate Professor, Universidad Javeriana de Cali, Colombia. Oct 2017

Camilo Rueda, Professor, Universidad Javeriana de Cali, Colombia. Nov 2017

Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil. Dec 2017

7.4.2. Internships

Anna Pazii. Univ. of Kiev, Ukraine. From July 2016 until Jan 2017.

Hector Delgado, Universidad Javeriana de Cali, Colombia. From May 2017 until July 2017.

Marco Romanelli. Univ. of Siena, Italy. From June 2017 until Sept 2017.

Georgi Dikov. Tech. Univ. of Munich, Germany. From Sept 2017 until Nov 2017.

Joaquin Felici. Univ. of Cordoba, Argentina. From Sept 2017 until Jan 2018.

Santiago Quintero, Universidad Javeriana de Cali, Colombia. From Nov until Dec 2017.

COML Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Collaboration with the Willow Team:

- co-advising with J. Sivic and I. Laptev of a PhD student: Ronan Riochet.
- construction of a naive physics benchmark

9.2. National Initiatives

9.2.1. ANR

Transatlantic Platform "Digging into Data". Title: "Analysis of Children's Language Experiences Around the World. (ACLEW)"; (coordinating PI : M. Soderstrom; Leader of tools development and co-PI : E. Dupoux), (2017–2020. 5 countries; Total budget: 1.4M€)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

ERC Advanced Grant (BOOTPHON, PI: E. Dupoux, Budget 2.4M€).

9.4. International Initiatives

9.4.1. Informal International Partners

- Johns Hopkins University, Baltimore, USA: S. Kudanpur, H. Hermansky
- RIKEN Institute, Tokyo, Japan: R. Mazuka

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Valentina Gliozzi (Professor, Univ. di Torino, Visiting Professor Spring 2017)

COMMANDS Project-Team**9. Partnerships and Cooperations****9.1. Regional Initiatives**

- Gaspard Monge Program for Optimization and Operational Research (Fondation Jacques Hadamard)

Title : Optimal control of partial differential equations using parameterizing manifolds, model reduction, and dynamic programming,
 Funding : 10,000 Euro (for 2016-17), 7,000 Euro (for 2017-2018)
 PI : Axel Kröner, U. Humboldt and Inria
 Period : 2015 – 2018
 Members : Frédéric Bonnans (Inria Saclay and CMAP, École Polytechnique),
 Mickaël Chekroun (UCLA, Los Angeles), Martin Gubisch (U. of Konstanz),
 Honghu Liu (Virginia Tech),
 Karl Kunisch (University of Graz), Hasnaa Zidani (ENSTA ParisTech).

9.2. National Initiatives**9.2.1. IPL***9.2.1.1. Cosy*

Inria Project Lab COSY (started in 2017) aims at exploiting the potential of state-of-art biological modelling, control techniques, synthetic biology and experimental equipment to achieve a paradigm shift in control of microbial communities. More precisely, we plan to determine and implement control strategies to make heterogeneous communities diversify and interact in the most profitable manner. Study of yeast cells has started in collaboration with team Lifeware (G. Batt) in the framework of the PhD of V. Andreani.

9.2.1.2. Algae in Silico

Inria Project Lab ALGAE IN SILICO (started in 2014) is dedicated to provide an integrated platform for numerical simulation of microalgae “from genes to industrial process“. The project has now reached a stage where we can tackle the optimization aspects. Commands is currently joining the IPL, in the following of our previous collaborations with teams Modemic and Biocore on bioreactors, see [35], [23]

9.3. International Research Visitors**9.3.1. Internships**

Joao Miguel Machado, from FGV (Rio de Janeiro), spent his master internship in our team from sept-dec 2017, working with F. Bonnans and M.S. Aronna (EMAP-FGV) on the second order necessary and sufficient optimality conditions for optimal control problems of ODEs with broken extremals, i.e., with discontinuous control. We are currently extending the classical theory to the case of a jump between interior and boundary values for the control.

CONVECS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. 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), Ioannis Parissis and Christophe Deleuze (LCIS, Valence).

8.2. National Initiatives

8.2.1. PIA (*Programme d'Investissements d'Avenir*)

8.2.1.1. 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.

8.2.2. Competitiveness Clusters

8.2.2.1. SECURIOT-2

Participants: Lian Apostol, Hubert Garavel [correspondent], 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.

8.2.3. Other National Collaborations

We had sustained scientific relations with the following researchers:

- Pierre Boullier (Inria, team ALPAGE),
- Anne-Lise Courbis (Ecole des Mines, Alès, France),
- Christophe Deleuze and Ioannis Parissis (LCIS, Valence),
- Xavier Etchevers (Orange Labs, Meylan),
- Laurent Georget (Centrale/Supelec, Rennes, France),
- Claude Girault (LIP6, Paris),
- Fabrice Kordon and Lom Messan Hillah (LIP6, Paris),
- Xavier Leroy (Inria, team GALLIUM),
- Pascal Poizat (LIP6, Paris).

8.3. European Initiatives

8.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: PHC Amadeus

Project acronym: RIDINGS

Project title: Rigorous Development of GALS Systems

Duration: January 2017 – December 2018

Coordinator: Inria Grenoble – Rhône-Alpes / CONVECS

Other partners: TU Graz, Institute of Software Technology (Austria)

Abstract: GALS systems, composed of synchronous components (driven by local clocks) that communicate through a network, are increasingly spreading with the development of the IoT. GALS systems are intrinsically complex due to the interplay of synchronous and asynchronous aspects, which make their development and debugging difficult. Therefore, it is necessary to adopt rigorous design methodologies, based on formal methods assisted by efficient validation tools. The RIDINGS project aims at enhancing the design flow of a GALS system by integrating the automatic generation of conformance tests from the formal model and the temporal properties used for verifying the system. This yields a double benefit for the designer: (i) it makes possible to check that a physical implementation conforms to the verified model; (ii) the development cost of the model and properties is distributed on the verification and testing phases of the design process, therefore increasing the return on investment.

8.3.2. Collaborations with Major European Organizations

The CONVECS project-team is member of the FMICS (*Formal Methods for Industrial Critical Systems*) working group of ERCIM⁰. H. Garavel and R. Mateescu are members of the FMICS board, H. Garavel being in charge of dissemination actions.

8.4. International Initiatives

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

⁰<http://fmics.inria.fr>

8.4.1. Inria International Partners

8.4.1.1. 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.

8.4.2. Other International Collaborations

In 2017, we had scientific relations with several universities and institutes abroad, including:

- University of Málaga, Spain (Francisco Duran),
- University of Boumerdes, Algeria (Sarah Chabane),
- Saarland University, Germany (Alexander Graf-Brill),
- ISTI/CNR, Pisa, Italy (Franco Mazzanti),
- FBK, Torino, Italy (Gianni Zampedri),
- RWTH Aachen, Germany (Christian Dehnert),
- University of Twente, The Netherlands (Enno Ruijters),
- University of York, UK (Jan Staunton),
- University Rio Grande do Norte, Brazil (Wellison Raul Mariz Santos),
- University of Cali, Colombia (Camilo Rocha),
- Utah State University, USA (Nazmus Sakib and Zhen Zhang).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Mahsa Shirmohammadi (University of Oxford, UK) visited us on February 23–24, 2017. She gave a talk on February 24, entitled “*Minimal Probabilistic Automata have to make Irrational Choices*”.
- Josip Bozic, Birgit Hofer, Hermann Felbinger, and Franz Wotawa (TU Graz, Austria) visited us from May 15 to May 19, 2017, and attended the 1st RIDINGS Workshop held on May 17, 2017 at Inria Grenoble – Rhône-Alpes. J. Bozic gave a talk entitled “*Security Testing Based on Attack Patterns and Planning*”. B. Hofer gave a talk entitled “*Fault Localization in Software and Spreadsheets*”. H. Felbinger gave a talk entitled “*Test-Suite Reduction Does Not Necessarily Require Executing The Program Under Test*”. F. Wotawa gave a talk entitled “*Research Activities at the Institute for Software Technology / TU Graz*”.
- Soren Enevoldsen (Aalborg University, Denmark) visited us from September 27 to December 27, 2017. He gave a talk entitled “*Parallel Model Checking and Quantitative Models*” on October 24, 2017.

8.5.2. Visits to International Teams

- H. Garavel is an invited professor at Saarland University (Germany) as a holder of the Gay-Lussac Humboldt Prize.
- G. Salaün visited the University of Málaga (Spain) from May 31 to June 14, 2017.
- L. Marsso and W. Serwe visited TU Graz (Austria) from November 13 to November 17, 2017 in the framework of the PHC RIDINGS project.

CORSE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. HEAVEN Persyval Project

- Title: Heterogeneous Architectures: Versatile Exploitation and programming
- HEAVEN leaders: François Broquedis, Olivier Muller [TIMA lab]
- CORSE participants: François Broquedis, Frédéric Desprez, Georgios Christodoulis
- Computer architectures are getting more and more complex, exposing massive parallelism, hierarchically-organized memories and heterogeneous processing units. Such architectures are extremely difficult to program as they most of the time make application programmers choose between portability and performance.

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

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

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

The main objective of this project is to improve the accessibility of heterogeneous architectures containing FPGA accelerators to parallel application programmers. The proposed project focuses on three main aspects:

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

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

8.1.2. AGIR DEREVES

- Title: DEcentralised Run-Time Verification and Enforcement of distributed and cyber-physical Systems
- DEREVES leader: Yliès Falcone
- CORSE participants: Yliès Falcone, Antoine El-Hokayem, Raphaël Jakse
- DEREVES aims at advancing the theory of decentralized run-time verification and enforcement for distributed systems, with the objective of proposing realistic monitoring and monitor-synthesis algorithms for expressive specifications that can be used for the efficient monitoring of multi-threaded, distributed and cyber-physical systems. The project shall help transferring run-time verification and enforcement to a wider audience of programmers of distributed systems by providing them techniques and tools to help them guaranteeing the correctness of their systems.

8.2. National Initiatives

8.2.1. PIA ELCI

- Title: Software environment for computation-intensive applications
- Coordinator: Corinne Marchand (BULL SAS)
- CORSE participants: François Broquedis, Philippe Viroulet
- INRIA Partners: Avalon, Cardamon, Myriads; Realopt, Roma, Storm, Tadaam
- Other Partners: Algo'Tech, CEA, Cenaero, CERFACS, CORIA, Kitware, Onera, SAFRAN
- Duration: from Sept. 2014 to Sept. 2017
- Abstract: The ELCI project main goal is to develop a highly-scalable new software stack to tackle high-end supercomputers, from numerical solvers to programming environments and run-time systems. In particular, the CORSE team is studying the scalability of OpenMP run-time systems on large scale shared memory machines through the PhD of Philippe Viroulet, co-advised by researchers from the CORSE and AVALON Inria teams. This work intends to propose new approaches based on a compiler/run-time cooperation to improve the execution of scientific task-based programs on NUMA platforms. The PhD of Philippe Viroulet is funded by this project.

8.2.2. 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. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Mont-Blanc2

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

Program FP7

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

Coordinator: Barcelona Supercomputing Center (BSC)

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

CORSE contact: Jean-François Méhaut

CORSE participants: Brice Videau, Kevin Pouget

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

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

1. To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support
2. To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system
3. To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips)
4. To provide continued support for the Mont-Blanc consortium, namely operations of the original Mont-Blanc prototype, the new developer kit clusters and hands-on support for our application developers

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

8.3.1.2. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Commissariat A L Energie Atomique et Aux Energies Alternatives (France)

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

INRIA contact: Michel Kern

CORSE contact: Jean-François Méhaut

CORSE participants: Jean-François Méhaut, Frédéric Desprez and Francieli Zanon Boito

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

Francieli Zanon Boito started in November 2017 as post-doc for the EoCoe project. She is working with Frédéric Desprez, Thierry Deutsch (CEA INAC) and Jean-François Méhaut. Francieli is investigating the data storage issues for the scientific workflows on the nano-scale characterization center (PFNC@Minatec http://inac.cea.fr/en/Phoce/Vie_des_labos/Ast/ast_technique.php?id_ast=217).

8.3.1.3. HPC4e

Title: HPC for Energy (HPC4E), Brazil and Europe

<https://hpc4e.eu>

H2020 European program

2 Years Duration (December 2015 - November 2017)

H2020 program: consortium

Coordinator: Barcelona Supercomputing Center

Partners:

Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)

Inria (France)

Queen Mary University of London (United Kingdom)

Iberdrola Renovables Energia (Spain)

Repsol (Spain)

Total S.A. (France)

COPPE Federal University of Rio de Janeiro (Brazil)

Laboratório Nacional Computação Científica (LNCC), Petropolis, (Brazil)

Instituto Tecnológico de Aeronautica (ITA), Brazil

Universidade Federal do Rio Grande do Sul (UFRGS), Brazil

Universidade Federal de Pernambuco (Brazil)

Petrobras (Brazil)

INRIA contact: Stephane Lanteri

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

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyze atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewably and reduction of CO₂ emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feed-stock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial fuels. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modeling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

Emmanuelle Saillard was one year post-doc for the HPC4e project. She used the BOAST framework on the Alya application (BSC) and the Hou10ni application (Inria Magique 3D). Emmanuelle Saillard got an Inria Research position (CR2) in the Storm team at Bordeaux.

Two papers [18], [16] were accepted this year with the Brazilian researchers at UFRGS and also with the Magique3D team.

Jean-François Méhaut got a *Chaire* position at Laboratório Nacional Computação Científica (LNCC) in Petrópolis (Brazil). The LNCC is also partner of the HPC4e project. Jean-François Méhaut is working on the optimization of the MHM (Multiscale Hybrid-Mixed Methods) simulator by using the binLPT loop scheduling strategies and also new memory allocators.

8.3.1.4. PRACE-5IP

Title: PRACE-5IP (PRACE Fifth Implementation Phase)

Program H2020

Duration: 01/01/2013 - 30/04/2019

Inria partners: Hiepacs team (Inria Bordeaux Sud-Ouest), Storm team (Inria Bordeaux Sud-Ouest), Nachos team (Inria Sophia Antipolis Méditerranée), CORSE team (Inria Grenoble Rhône Alpes)
INRIA contact: Stéphane Lanteri (Nachos, Sophia Antipolis)

CORSE contact: Jean-François Méhaut

CORSE participants: François Broquedis, Jean-François Méhaut

The objectives of PRACE-5IP 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 transition to PRACE2 including analysis of TransNational Access;
- strengthening the internationally recognized PRACE brand;
- continuing and extend advanced training which so far provided more than 18800 person-training days;
- preparing strategies and best practices towards Exascale computing;
- coordinating and enhancing the operation of the multi-tier HPC systems and services;
- supporting users to exploit massively parallel systems and novel architectures.

The INRIA contribution is in the prolongation of involvement (jointly with CINES) in PRACE 4IP – WP7. The participation of Inria’s researchers has been enlarged to include project-teams that were all involved in the C2S@Exa Inria Project Lab. The Inria teams will contribute to the WP7 and the following sub-tasks:

- Task 7.1: Applications Enabling Services for PRACE systems
- Task 7.4 Provision of Numerical Libraries for Heterogeneous/Hybrid Architectures

The activities are organized along two complementary lines

- Generic (or transverse) technologies for simulation software
- Specific (or vertical) technologies i.e. simulation software

The CORSE activities for PRACE-5IP will start with the hiring of one year postdoc in 2018. We will work on the DIOGENEs (DisOntinuous GalErkin Nanoscale Solvers) software suite developed in the Nachos team. The post-doc will investigate the new vectorization features of processors.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: ArVI

Project title: Run-Time Verification beyond Monitoring

Duration: December 2014 - Dec 2018

Coordinator: Martin Leucker, University of Lubeck

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

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

an enormous impact in terms of the new class of designs enabled and their reliability and cost effectiveness.

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

8.4. International Initiatives

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

8.4.1.1. 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: 2015

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

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

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

8.4.1.2. PROSPIEL

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

8.4.2. Participation in Other International Programs

- EnergySFE (STIC-Amsud)
 - Leader: University Federal of Santa Catarina (UFSC): Mârcio Castro
 - Partners: UFSC (Florianapolis, Brazil), UFRGS (Porto Alegre, Brazil), ESPE (Ecuador), CNRS (LIG/CORSE, TIMA, LSPSC)
 - <http://energysfe.ufsc.br/>
 - Duration: January 2016 - December 2017
 - CORSE participants: Jean-François Méhaut, François Broquedis, Frédéric Desprez
 - The main goal of the EnergySFE research project is to propose fast and scalable energy-aware scheduling and fault tolerance techniques and algorithms for large-scale highly parallel architectures. To achieve this goal, it will be crucial to answer the following research questions:
 - * How to schedule tasks and threads that compete for resources with different constraints while considering the complex hierarchical organization of future Exascale supercomputers?
 - * How to tolerate faults without incurring in too much overhead in future Exascale supercomputers?
 - * How scheduling and fault tolerance approaches can be adapted to be energy-aware?

The first EnergySFE workshop was organized by the CORSE team at the INRIA Minatéc building in September 2016.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Julien Langou (UCDenver) is visiting professor from September 2016 till July 2017
- Henrique Cota de Freitas (PUC Minas) visited the team for a week in April 2017 (Pedro Penna's thesis)
- Philippe Navaux (UFRGS) visited the team for a week in February 2017. (HPC4e project)
- Paolo Rech (UFRGS) visited the team for a week in September 2017 (EnergySFE project).
- Mohamad Jaber (American University of Beirut, Lebanon) visited the team for a week in January 2017.
- Maurice Tchunte (Yaoundé 1) visited the team for a week in June 2017 (related to Thomas Messi Nguele's thesis).
- Márcio Castro (UFSC) visited the team for two weeks in February 2017 (EnergySFE project).
- Laercio Pilla (UFSC) visited the team for a week in December 2017 (EnergySFE project).

8.5.2. Visits to International Teams

- Jean-François Méhaut visited for one week (July 2017) the UFRGS (Porto Alegre) and the GPPD group for the HPC4e project.
- Jean-François Méhaut visited for one week (July 2017) the Federal University of Rio de Janeiro for the HPC4e project.
- Jean-François Méhaut visited for one day (July 2017) the LNCC to prepare the research work for the chaire position and also for the HPC4e project.
- Jean-François Méhaut visited for a week (August 2017) the LaPeSD and ECL laboratories at UFSC (Florianapolis). He was member of the master jury of Pedro Penna. This visit was funded by the EnergySFE project.

- Jean-François Méhaut visited for one week (August 2017) the PUC Minas to prepare the cotutelle agreement of the Pedro Penna's PhD. This agreement is signed between PUC Minas, LIG, Ecole Doctorale MSTII, Post-Graduation program of PUC Minas and the COMUE Grenoble Alpes.
- Jean-François Méhaut visited for one day (December 2017) the French consulate in Rio de Janeiro and the CNRS Bureau. He presented the first results of the research work at LNCC.

8.5.2.1. Sabbatical programme

- Fabrice Rastello is on sabbatical at Colorado State University (USA) from July 2017 till July 2018

8.5.2.2. Research Stays Abroad

- Jean-François Méhaut holds a *Chaire* position at Laboratório Nacional Computação Científica (LNCC) in Petrópolis (Brazil). This *Chaire* position is funded by the LNCC and the French Consulate in Rio de Janeiro.

CQFD Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Piece (2013-2017) of the program *Jeunes chercheuses et jeunes chercheurs* of the ANR

Piecewise Deterministic Markov Processes (PDMP) are non-diffusive stochastic processes which naturally appear in many areas of applications as communication networks, neuron activities, biological populations or reliability of complex systems. Their mathematical study has been intensively carried out in the past two decades but many challenging problems remain completely open. This project aims at federating a group of experts with different backgrounds (probability, statistics, analysis, partial derivative equations, modelling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

9.1.2. ANR StocMC (2014-2018) of the program *Project Blanc* of the ANR

The involved research groups are Inria Rennes/IRISA Team SUMO; Inria Rocquencourt Team Lifeware; LIAFA University Paris 7; Bordeaux University.

The aim of this research project is to develop scalable model checking techniques that can handle large stochastic systems. Large stochastic systems arise naturally in many different contexts, from network systems to system biology. A key stochastic model we will consider is from the biological pathway of apoptosis, the programmed cell death.

9.1.3. ANR BNPSI: *Bayesian Non Parametric methods for Signal and Image Processing*

Statistical methods have become more and more popular in signal and image processing over the past decades. These methods have been able to tackle various applications such as speech recognition, object tracking, image segmentation or restoration, classification, clustering, etc. We propose here to investigate the use of Bayesian nonparametric methods in statistical signal and image processing. Similarly to Bayesian parametric methods, this set of methods is concerned with the elicitation of prior and computation of posterior distributions, but now on infinite-dimensional parameter spaces. Although these methods have become very popular in statistics and machine learning over the last 15 years, their potential is largely underexploited in signal and image processing. The aim of the overall project, which gathers researchers in applied probabilities, statistics, machine learning and signal and image processing, is to develop a new framework for the statistical signal and image processing communities. Based on results from statistics and machine learning we aim at defining new models, methods and algorithms for statistical signal and image processing. Applications to hyperspectral image analysis, image segmentation, GPS localization, image restoration or space-time tomographic reconstruction will allow various concrete illustrations of the theoretical advances and validation on real data coming from realistic contexts.

9.1.4. Gaspard Monge Program for Optimisation and Operational Research (2017-2018)

The involved research groups are Inria Bordeaux Sud-Ouest Team CQFD and Thales Optronique. This new collaboration with Thales Optronique that started in October 2017 is funded by the Fondation Mathématique Jacques Hadamard. This is the continuation of the PhD Thesis of A. Geeraert. The objective of this project is to optimize the maintenance of a multi-component equipment that can break down randomly. The underlying problem is to choose the best dates to repair or replace components in order to minimize a cost criterion that takes into account costs of maintenance but also the cost associated to the unavailability of the system for the customer. In the PhD thesis of A. Geeraert, the model under consideration was rather simple and only a numerical approximation of the value function was provided. Here, our objective is more ambitious. A more realistic model will be considered and our aim is to provide a tractable quasi-optimal control strategy that can be applied in practice to optimize the maintenance of such equipments.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

- Program: Direccion General de Investigacion Cientifica y Tecnica, Gobierno de Espana
- Project acronym: GAMECONAPX
- Project title: Numerical approximations for Markov decision processes and Markov games
- Duration: 01/2017 - 12/2019
- Coordinator: Tomas Prieto-Rumeau, Department of Statistics and Operations Research, UNED (Spain)
- Abstract:

This project is funded by the Gobierno de Espana, Direccion General de Investigacion Cientifica y Tecnica (reference number: MTM2016-75497-P) for three years to support the scientific collaboration between Tomas Prieto-Rumeau, Jonatha Anselmi and Francois Dufour. This research project is concerned with numerical approximations for Markov decision processes and Markov games. Our goal is to propose techniques allowing to approximate numerically the optimal value function and the optimal strategies of such problems. Although such decision models have been widely studied theoretically and, in general, it is well known how to characterize their optimal value function and their optimal strategies, the explicit calculation of these optimal solutions is not possible except for a few particular cases. This shows the need for numerical procedures to estimate or to approximate the optimal solutions of Markov decision processes and Markov games, so that the decision maker can really have at hand some approximation of his optimal strategies and his optimal value function. This project will explore areas of research that have been, so far, very little investigated. In this sense, we expect our techniques to be a breakthrough in the field of numerical methods for continuous-time Markov decision processes, but particularly in the area of numerical methods for Markov game models. Our techniques herein will cover a wide range of models, including discrete- and continuous-time models, problems with unbounded cost and transition rates, even allowing for discontinuities of these rate functions. Our research results will combine, on one hand, mathematical rigor (with the application of advanced tools from probability and measure theory) and, on the other hand, computational efficiency (providing accurate and ?applicable? numerical methods). In this sense, particular attention will be paid to models of practical interest, including population dynamics, queueing systems, or birth-and-death processes, among others. So, we expect to develop a generic and robust methodology in which, by suitably specifying the data of the decision problem, an algorithm will provide the approximations of the value function and the optimal strategies. Therefore, the results that we intend to obtain in this research project will be of interest for researchers in the fields of Markov decision processes and Markov games, both for the theoretical and the applied or practitioners communities

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

Tree-Lab, ITT. TREE-LAB is part of the Cybernetics research line within the Engineering Science graduate program offered by the Department of Electric and Electronic Engineering at Tijuana's Institute of Technology (ITT), in Tijuana Mexico. TREE-LAB is mainly focused on scientific and engineering research within the intersection of broad scientific fields, particularly Computer Science, Heuristic Optimization and Pattern Analysis. In particular, specific domains studied at TREE-LAB include Genetic Programming, Classification, Feature Based Recognition, Bio-Medical signal analysis and Behavior-Based Robotics. Currently, TREE-LAB incorporates the collaboration of several top researchers, as well as the participation of graduate (doctoral and masters) and undergraduate students, from ITT. Moreover, TREE-LAB is actively collaborating with top researchers from around the world, including Mexico, France, Spain, Portugal and USA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Tomas Prieto-Rumeau (Department of Statistics and Operations Research, UNED, Madrid, Spain) visited the team during 2 weeks in 2017. The main subject of the collaboration is the approximation of Markov Decision Processes.

Oswaldo Costa (Escola Politécnica da Universidade de São Paulo, Brazil) collaborate with the team on the theoretical aspects of continuous control of piecewise-deterministic Markov processes. He visited the team during two weeks in 2017.

CTRL-A Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. HPES action-team of the Labex Persyval-lab

The Labex Persyval-lab is a large regional initiative, supported by ANR, where we are contributing through the project *Equipe-action HPES*.

This project (2013-17) groups members from Inria, LIG, Gipsa-lab, TIMA and Gipsa-lab, around the topic of High-Performance Computing benefitting from technologies originally developed for Embedded Systems : <https://persyval-lab.org/en/sites/hpes>. Ctrl-A is directly involved in the co-advising of the PhD of Naweiluo Zhou, with J.F. Méhaut (Corse team of Inria/LIG), on the topic of autonomic management of software transactional memory mechanisms : <https://persyval-lab.org/en/research/phd/autonomic-thread-parallelism-and-mapping-control-software-transactional-memory>.

In 2017 we organized a workshop on Autonomic Computing and Control in Grenoble, supported by HPES (<https://team.inria.fr/ctrl-a/members/eric-rutten/autoctrl/>).

8.1.2. EcoSesa Cross-Disciplinary Project of the Idex

The Eco-SESA project, “Eco-district: Safe, Efficient, Sustainable and Accessible energy”, aims to produce knowledge, concepts, tools and methods to rethink the planning, management and governance of urban energy systems and the design of their components. Ctrl-A contributes to the research front 4 : Architectures for integration of renewable on-the-spot generation. A Post-doctoral position shared with G2Elab research lab will be funded.

8.2. National Initiatives

8.2.1. 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, InPixa.

In Ctrl-A, it is funding a post-doc position, hired in Grenoble and co-advised with Lorient : Soguy Gueye. A PhD based in Brest, Chabha Hireche, is co-advised by Stéphane Mocanu.

8.2.2. 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.

8.2.3. 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).

8.2.4. 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), Orange labs (J. Pulou, T. Coupaye, G. Privat, Anne Roch).

8.3. International Initiatives

8.3.1. 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 7th Workshop of the JLESC at Urbana-Champaign in July 2017.

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

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

We have ongoing relations with international colleagues in the emerging community on our topic of control for computing e.g., in Sweden at Lund (K.E. Arzen, M. Maggio) and Linnaeus Universities (D. Weyns, N. Khakpour), in the Netherlands at CWI/leiden University (F. Arbab), in China at Heifei University (Xin An), in Italy at University Milano (C. Ghezzi, A. Leva), in the USA at Ann Arbor University (S. Lafortune) and UMass (P. Shenoy, E. Cecchet).

DANTE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. IXXI

9.1.1.1. ISI Torino / Dante

Participant: Márton Karsai [correspondant].

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 IXXI PhD student, Jacobo Levy Abitbol, 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.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. Equipex FIT (*Futur Internet of Things*)

Participant: Éric Fleury [correspondant].

FIT is one of 52 winning projects in the Equipex research grant program. It will set up a competitive and innovative experimental facility that brings France to the forefront of Future Internet research. FIT benefits from 5.8 million euro grant from the French government Running from 22.02.11 – 31.12.2019. The main ambition is to create a first-class facility to promote experimentally driven research and to facilitate the emergence of the Internet of the future.

9.2.1.2. ANR GRAPHSIP (*Graph Signal Processing*)

Participants: Paulo Gonçalves [correspondant], Éric Fleury, Thomas Begin, Sarra Ben Alaya.

An increasing number of application areas require the processing of massive datasets. These data can often be represented by graphs in order to encode complex interactions. When data vectors are associated with graph vertices, a so-called graph signal is obtained. The processing of such graph signals includes several open challenges because of the nature of the involved information. Indeed graph theory and signal and image processing methodologies do not combine readily. In particular, such a combination requires new developments, allowing classical signal processing methods to work on irregular grids and non Euclidean spaces. Considering the significant success of classical signal processing tools, it appears essential to generalise their use to graph signals. The GRAPHSIP project aims at developing a set of advanced methods and algorithms for the processing of graph signals: multi-scale transforms and solutions of variational problems on graphs. The major outcomes of this project are expected to lead to significant breakthroughs for graph data processing. The project will also focus on two novel applications on instances of graph signals: brain networks and 3D colour point clouds. They will exemplify and illustrate the proposed methodological advances on emerging applications.

9.2.1.3. ANR INFRA DISCO (*DIstributed SDN COntrollers for rich and elastic network services*)

Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guerin Lassous, Huu Nghi Nguyen.

The DANTE team will explore the way SDN (Software Designed Network) can change network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. More specifically, the team will address the issues regarding the positioning of SDN controllers within the network, and the implementation of an admission control that can manage IP traffic prioritisation.

9.2.1.4. ANR REFLEXION (*REsilient and FLEXible Infrastructure for Open Networking*)

Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guerin Lassous, Zidong Su.

The DANTE team will work on the monitoring of NFV proposing passive and light-weight metrology tools. They will then investigate the modelling of low-level resources consumptions and finally propose methods to dynamically allocate these resources taking into account performance constraints.

9.2.1.5. ANR CONTINT CODDDE

Participants: Éric Fleury [correspondant], Christophe Crespelle, Márton Karsai.

It is a collaborative project between the ComplexNetwork team at LIP6/UPMC; Linkfluence and Inria Dante. The CODDDE project aims at studying critical research issues in the field of real-world complex networks study:

- How do these networks evolve over time?
- How does information spread on these networks?
- How can we detect and predict anomalies in these networks?

In order to answer these questions, an essential feature of complex networks will be exploited: the existence of a community structure among nodes of these networks. Complex networks are indeed composed of densely connected groups of that are loosely connected between themselves.

The CODDDE project will therefore propose new community detection algorithms to reflect complex networks evolution, in particular with regards to diffusion phenomena and anomaly detection.

These algorithms and methodology will be applied and validated on a real-world online social network consisting of more than 10 000 blogs and French media collected since 2009 on a daily basis (the dataset comprises all published articles and the links between these articles).

9.2.1.6. ANR SoSweet

Participants: Jean Pierre Chevrot, Éric Fleury, Márton Karsai [correspondant], Jean-Philippe Magué [PI].

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.

9.2.1.7. ANR DylNet

Participants: Jean Pierre Chevrot, Jean-Philippe Magué, Éric Fleury [correspondant], Márton Karsai.

The DylNet project aims to observe and to characterise the relationships between childhood sociability and oral-language learning at kindergarten. With a view to this, it takes an multidisciplinary approach combining work on language acquisition, sociolinguistics, and network science. It will be implemented by following all the children (≈ 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.

9.2.2. CNRS

9.2.2.1. CNRS CO3I

Participants: Jean Pierre Chevrot [correspondant], Éric Fleury, Jean-Philippe Magué, Márton Karsai.

The CO3i project (Cognition individuelle et connaissance collective) is funded by the Mission pour l'Interdisciplinarité du CNRS. CO3i is an interdisciplinary theoretical project that aims at reanalyse and better articulate two distinctions: collective vs. individual and social vs. cognitive. Generally, the study of cognition is associated to the individual, whereas the social phenomena are seen as collective. In fact, there is an individual social cognition and there is a collective social knowledge. We have organised three days of interdisciplinary workshop confronting the views of sociologists, cognitive scientists, network scientists, linguists, and philosophers of science. Nourished by projects using various methodologies (massive data, experimentation, observation, corpus), the reflection will be finalised towards the publication of an international book. See: <https://co3i.hypotheses.org/>

9.2.3. Inria

9.2.3.1. Inria PRE LIAISON

Participants: Márton Karsai [correspondant], Éric Fleury.

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.

9.2.4. HCERES

9.2.4.1. HCERES/Inria

Participants: Éric Fleury, Eric, Philippe 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 revitalised 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,

9.2.5. Inria

9.2.5.1. IPL BetterNet

Participant: Eric, Philippe Guichard.

BETTERNET: An Observatory to Measure and Improve Internet Service Access from User Experience ⁰. 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.

⁰<https://www.inria.fr/en/research/research-teams/inria-project-labs>

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. EMBERS

Title: Enabling a Mobility Back-End as a Robust Service

Programm: H2020

Duration: December 2015 - November 2018

Coordinator: UPMC

Partners:

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Technische Universitat Berlin (Germany)

Universite Pierre et Marie Curie - Paris 6 (France)

Ubiwhere Lda (Portugal)

Inria contact: Eric Fleury

EMBERS will bring to market a back-end for smart city mobility that is developed by a European small enterprise based upon its smart parking and smart traffic management products that two municipalities in Portugal currently deploy. The Mobility Back-end as a Service (MBaaS) replaces such all-in-one systems, in which a municipality purchases the full set of components from a single vendor. Instead, the city manager can purchase best-of-breed devices and apps developed by third parties, with the only constraint being that they interoperate with the back-end via a free, open, smart city mobility API. This domain-specific API lowers barriers to entry for app and device developers, making it easier for innovative SMEs to enter the market. Furthermore, the API is offered via a variety of generic interfaces, including oneM2M, ETSI M2M, OMA LWM2M, and FIWARE NGSI. EMBERS thus clears the way for developers and to municipalities that have adopted any one of these potential emerging machine-to-machine (M2M) communication standards. Beyond its primary goal of bringing the MBaaS to market, EMBERS will stimulate development of an entire ecosystem around the MBaaS smart city mobility API. Separating out the back-end from the other components will, however, require rigorous testing. EMBERS will experiment with the system on two testbeds that are part of the FIRE OneLab facility: the FUSECO Playground, for M2M communications, and FIT IoT-LAB, for wireless sensor devices. EMBERS will host a hackathon and an app challenge to bring in third party developers. The project will also include three demonstrators by third parties via an open call. These activities will contribute back to FIRE by demonstrating successful experimentation by SMEs developing close-to-market products. The project will also conduct real world pilots in two or more cities as a final step in bringing the MBaaS to market.

9.3.1.2. ARMOUR

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

Programm: H2020

Duration: 2015 Dec to 2018

Coordinator: UPMC

Partners:

Synelixis Lyseis Pliroforikis Automatismou & Tilepikoinonion Monoprosopi EPE (Greece)

Smartesting Solutions & Services (France)

Unparallel Innovation, Lda (Portugal)

Easy Global Market (France)

ODIN Solutions (Spain)

Universite Pierre et Marie Curie - Paris 6 (France)

Inria contact: Eric Fleury

ARMOUR will provide duly tested, benchmarked and certified Security & Trust solutions for large-scale IoT using upgraded FIRE large-scale IoT/Cloud testbeds properly-equipped for Security & Trust experimentations. ARMOUR takes the top large-scale FIT IoT-LAB testbed à a FIRE OpenLAB / FIT IoT LAB facility à and enhances it as to enable experimentally-driven research on a key research dimension: large-scale IoT Security & Trust. Presently, no proper installations exist to experiment IoT Security & Trust on large-scale conditions; ARMOUR will develop and install such capability.

9.3.1.3. CLARIN-PLUS

Title: European Research Infrastructure for Language Resources and Technology

Programm: H2020 and part of CLARIN ERIC

Duration: 28 months, from September 2015 to December 2017

Coordinator: Franciska de Jong, CLARIN ERIC

Partners:

CLARIN ERIC,

EKUT,

UCPH,

CUNI

Inria contact: Jean-Philippe Magué

CLARIN-PLUS is dedicated to enhancing CLARIN. Following the recommendations of the 2013 ESFRI Assessment Expert Group, CLARIN-PLUS proposes to accelerate the implementation and to strengthen and consolidate CLARIN in the following areas: 1. The central (technical) hub; 2. The central office; 3. Partnerships with other infrastructures; 4. Outreach; 5. Governance.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Declared Inria International Partners

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

Algorithms research group of the University of Bergen, Norway. PICS project of CNRS on graph editing problems for analysis and modeling of complex networks.

University of Massachusetts, Amherst, USA.

9.4.1.2. Informal International Partners

University of Namur: Department of Mathematics/Naxys (Belgium). Collaboration with Renaud Lambiotte on dynamical processes on dynamical networks and communities detections.

Aalto University: Department of Biomedical Engineering and Computational Science (Finland). Collaboration with Jari Saramaki on modeling temporal networks and community like modular structure

Central European University (Hungary). Collaboration with János Kertész on modeling complex contagion phenomena.

ISI Foundation (Italy). Collaboration with Laetitia Gauvin on multiplex networks and transportation systems

University of South California (USA). Collaboration with Antonio Ortega on Graph Signal Processing

University of Pennsylvania (USA). Collaboration with Alejandro Ribeiro on Graph Signal Processing

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

College of Information and Computer Sciences at the University of Massachusetts Amherst.

University of California, Santa Cruz (USA). Collaboration with Alexandre Brandwajn on the solutions to multi-server queues.

9.4.2. Participation in Other International Programs

STIC AMSUD MOTIf with Grand Data from Argentina and LNCC from Brazil. ,

The general goal of the MOTIf project is to understand, model, and predict individual behavior embedded in social and technological environments. We propose to work in two directions in order to tackle this challenge: (1) aim to understand spatiotemporal patterns of service usage of individuals to learn when, where, and what people are doing. (2) aim to understand the fine-grained sociodemographic structure of society and see how the demographic characteristics of individuals in a social network correlate with the dynamics of their egocentric and global network evolution.

9.4.2.1. PHC Peridot

Participants: Mohammed Amer, Thomas Begin, Anthony Busson, Isabelle Guerin Lassous.

Framework for Control and Monitoring of Wireless Mesh Networks (WMN) using Software-Defined Networking (SDN). The main objective of this project is propose mechanisms and modifications in the SDN architecture, specifically in the OpenFlow, which allow SDN mechanisms to operate over WMN considering the dynamic network topology that WMN may experience and some other relevant characteristics. The project will involve devising mechanisms for controlling mesh switches through controllers in a wireless environment, which will require developing novel and WMN-specific rules, actions and commands. The project will involve proposing mechanism that consider dynamic environment of WMN along with providing redundancy in the network. Besides, there is a requirement to have an adaptive measurement API for WMN. This is the second objective of our research project. The proposed measurement API will enable the network operators to monitor network traffic over WMN which may be content-specific or host-specific. This is a joint project between DANTE and M. A. Jinnah University, Islamabad. It started in June 2015 and will end in June 2018.

9.5. International Research Visitors

- Maximiliano Bueno Lopez from NTNU visited the Dante team for one week. His visit was part of an ERCIM program on Empirical Mode Decomposition.
- Alexandre Brandwajn, Professor Emeritus, Computer Engineering from UCSC (University of California, Santa Cruz) visited the Dante team for two months during Spring 2017. His visit was funded by ENS Lyon and Milyon labex.
- Cristhian Iza Paredes from UPC (Polytechnic University of Catalonia) visited the Dante team for three months. His visit was part of a Fonds Recherche project of ENS Lyon.
- Isabel Martin Faus from UPC (Polytechnic University of Catalonia) visited the Dante team for one month. Her visit was part of a Fonds Recherche project of ENS Lyon.
- Mukhtiar Bano and Sherjeel Gilani visited the Dante team for two weeks. Their visit was part of a Peridot project (PHC with Pakistan).
- Amir Qayyum visited the Dante team for one week. His visit was part of a Peridot project (PHC with Pakistan).
- Amer Mouawad (University of Bergen) visited the Dante team for one week in November 2017. His visit was part of a PICS project of CNRS with the Algorithms group of the University of Bergen, Norway.

- G. Iniguez from Aalto University visited M. Karsai two times for one week. One of these visits was financed from the CODDDE project, while the other was financed by the Finnish partner.

9.5.1. Visits of International Scientists

9.5.1.1. Internships

- Giuseppe Torrisi from Sapienza University, Erasmus Learning Agreement Student Mobility for Traineeships

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Philippe Nain stayed at UMass from September 2016 to January 2017.

DATAMOVE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **ANR grant MOEBIUS (2013-2017).** Multi-objective scheduling for large computing platforms. Coordinator: Grenoble-INP (DataMove). Partners: Grenoble-INP, Inria, BULL-ATOS .
- **ANR grant GRECO (2017-2020).** Resource manager for cloud of things. Coordinator: Quarnot Computing. Partners: Grenoble-INP, Inria,

9.1.2. Competitvity Clusters

- **PIA Avido (2015-2018).** In situ analysis and visualization for large scale numerical simulation. Coordinator: EDF SA. Partners: EDF SA, Total SA, Kitware SAS , Université Pierre et Marie CURIE, Inria (DataMove).
- **FUI OverMind (2015-2017).** Task planification and asset management for the cartoon productions. Coordinator: Teamto Studio. Partners: Teamto Studio, Folimage Studio, Ecole de Gobelins, Inria (DataMove).

9.1.3. Inria

- Inria PRE COSMIC (exploratory research project), 2017-2019. Photovoltaic Energy Management for Distributed Cloud Platforms. Myriads, DataMove.

9.2. International Initiatives

9.2.1. Inria International Labs

9.2.1.1. 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).

9.2.2. Participation in Other International Programs

9.2.2.1. LICIA

Title: International Laboratory in High Performance and Ubiquitous Computing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2011 - 2018

See also: <http://licia-lab.org/>

The LICIA is an Internacional Laboratory and High Performance and Ubiquitous Computing born in 2011 from the common desire of members of Informatics Institute of the Federal University of Rio Grande do Sul and of Laboratoire d'Informatique de Grenoble to enhance and develop their scientific partnership that started by the end of the 1970. LICIA is an Internacional Associated Lab of the CNRS, a public french research institution. It has support from several brazilian and french research funding agencies, such as CNRS, Inria, ANR, European Union (from the french side) and CAPES, CNPq, FAPERGS (from the Brazilian side). DataMove is deeply involved in the animation of LICIA. Bruno Raffin is LICIA associate director.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

PhD in progress: Danilo Carastan Dos Santos, Dynamic Scheduling of Tasks in High Performance Platforms with Machine Learning (Sao Paulo, Brasil). 1 year "sandwich" visit. Local adviser: Denis Trystram

PhD in progress: Jorge Veiga Fachal, High Performance Map-Reduce, Universidade da Coruña, Spain. 3 month stay. Local adviser: Bruno Raffin.

9.3.2. Visits to International Teams

Yes Denneulin spent 3 months at University of Los Andes, Bogota, Columbia.

PhD in progress: Clement Mommessin spent 6 months at ANL, Argonne, USA. Adviser: Tom Perterka.

DATASHAPE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR TOPDATA

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

- Acronym : TopData.
- Type : ANR blanc.
- Title : Topological Data Analysis: Statistical Methods and Inference.
- Coordinator : Frédéric Chazal (DATASHAPE).
- Duration : 4 years from October 2013 to September 2017.
- Others Partners: Département de Mathématiques (Université Paris Sud), Institut de Mathématiques (Université de Bourgogne), LPMA (Université Paris Diderot), LSTA (Université Pierre et Marie Curie).
- Abstract: TopData aims at designing new mathematical frameworks, models and algorithmic tools to infer and analyze the topological and geometric structure of data in different statistical settings. Its goal is to set up the mathematical and algorithmic foundations of Statistical Topological and Geometric Data Analysis and to provide robust and efficient tools to explore, infer and exploit the underlying geometric structure of various data.

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

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

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. GUDHI

Title: Algorithmic Foundations of Geometry Understanding in Higher Dimensions

Programm: FP7

Type: ERC

Duration: February 2014 - January 2019

Coordinator: Inria

Inria contact: Jean-Daniel Boissonnat.

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

9.3. International Initiatives

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

9.3.1.1. CATS

Title: Computations And Topological Statistics

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2015

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

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Ramsay Dyer, Mathematical Sciences Publishers, Canada (June and November 2017)

Arijit Ghosh, Indian Statistical Institute, Kolkata (June and november 2017)

Kim Jisu, CMU, Pittsburgh, USA (November 2017).

Wolfgang Polonik, UC Davis, USA (June 2017).

Konstantin Mischaikow, Rutgers University, USA, (November 2017).

Magnus Botnan, TU Munich, Germany (March 2017).

Sara Kalisnik, MPI, Germany (November 2017).

9.4.1.1. Internships

Divyansh Pareek, IIT Bombay (May-July 2017)

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Vincent Divol, UC Davis (April-June 2017)

DATASPHERE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

L'équipe est hébergée dans l'IXXI, l'Institut Rhônalpin des Systèmes Complexes au sein de l'ENS de Lyon, et très impliquée dans les partenariats interdisciplinaires.

8.2. National Initiatives

- Chaire Castex, Ecole Militaire, Paris
- AMNECYS (Alpine Multidisciplinary NEtwork on CYber-security Studies), University of Grenoble-Alpes

8.3. International Initiatives

8.3.1. 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

DEDUCTEAM Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR PROGRAMme

This is an ANR for junior researcher Liesbeth Demol (CNRS, UMR 8163 STL, University Lille 3) to which G. Dowek participates. The subject is: “What is a program? Historical and Philosophical perspectives”. This project aims at developing the first coherent analysis and pluralistic understanding of “program” and its implications to theory and practice.

7.2. International Initiatives

7.2.1. Participation in Other International Programs

7.2.1.1. International Initiatives

FoQCoSS

Title: Foundations of Quantum Computation: Syntax and Semantics

International Partners (Institution - Laboratory - Researcher):

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

CNRS (France) - Simon Perdrix

Universidade Federal de Santa Maria (Brazil) - Juliana Kaizer Vizzotto

Duration: 2016 - 2017

Start year: 2016

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

7.3. International Research Visitors

7.3.1. Visits of International Scientists

A. Díaz-Caro (Universidad Nacional de Quilmes, Argentina) visited Deducteam 3 weeks.

7.3.2. Visits to International Teams

7.3.2.1. Research Stays Abroad

F. Thiré has visited the Computation and Logic Group at McGill University for three months.

G. Dowek has visited the university of Quilmes in Buenos Aires for two weeks.

G. Dowek has visited the Pontifical University at Rio for three weeks.

DEFI Project-Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Participation in Other International Programs

8.1.1.1. International Initiatives

QUASI

Title: Qualitative Approaches to Scattering and Imaging

International Partner (Institution - Laboratory - Researcher):

University of Rutgers (United States) - Fioralba Cakoni

Duration: 2013 - 2017

Start year: 2013

We concentrate on the use of qualitative methods in acoustic and electromagnetic inverse scattering theory with applications to nondestructive evaluation of materials and medical imaging. In particular, we would like to address theoretical and numerical reconstruction techniques to solve the inverse scattering problems using either time harmonic or time dependent measurements of the scattered field. The main goal of research in this field is to not only detect but also identify geometric and physical properties of unknown objects in real time.

8.2. International Research Visitors

8.2.1. Visits of International Scientists

- Fioralba Cakoni (2 weeks)
- David Colton (1 week)
- Armin Lechleiter (1 week)
- Rainer Kress (1 week)

8.2.1.1. Internships

- Marwa Kchaou (ENIT) 6 months
- FatmeMustapha (EDF) 6 months
- DucVu (Inria) 3 months

DEFROST Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Inserm

Olivier Goury was hired as a postdoctoral researcher by the "Réhabilitation chirurgicale mini-invasive et robotisée de l'audition" to collaborate with the DEFROST team on the simulation of Cochlear Implant surgery. The contract stopped since Olivier has been recruited as a Research scientist. The collaboration with Inserm has been continued since, with the hiring of Piyush Jain as an engineer.

9.1.2. ANR

- **Tremplin ERC** Christian Duriez recieved a ANR grant "tremplin ERC" (150k€) given the result obtained last year on the ERC proposal (evaluated at "grade A"). The project has allowed to allocate new resources on the developments that were presented in this ERC.
- **CO2DMod** Control-Oriented Data-Driven Modeling of Complex System. The goal of this project was to propose Data-Driven Modelling technique (model reduction as well as model identification) that provides an Uncertainty Certificate (UC). The goal of these certificates are (i) to guarantee that the models obtained from data are good enough for control, (ii) to help the user determine the class of controller design problem the model is tuned for. Unfortunately, the project has not been funded. It was resubmitted this year with hopefully a better outcome.
- **ROBOCOP** ROBOTization of COchlear imPlant. ROBOCOP aims at creating a new prototype of cochlear implant, and robotize (i.e. actuate and control) its insertion process to facilitate the work of surgeon, to increase the success ratio, and to decrease the probability of trauma. Partnership with IEMN (Institute of Electronics, Microelectronics and Nanotechnology), OTICON Medical and UMRS-1159 at Inserm. This project was submitted in 2017 and we are awaiting the answer from the ANR.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: FEDER

Project acronym: COMOROS

Project title: Control of deformable robots for surgery

Duration april 2017 to march 2020 (in two phases)

Coordinator: C. Duriez

Abstract: Surgical procedures are often carried out using instruments made of stiff materials that interact with delicate biological tissues such as internal organs, blood vessel walls and small cavities. This incompatibility of stiffness is one of the sources of danger in many surgical procedures. The use of robots made of soft materials, also called soft robots, would limit such risks by reducing contact pressures and stress concentrations. Their intrinsic deformability would also increase the ability to manoeuvre in confined spaces. However, the promising concept of using soft robots for surgical procedures cannot be practically implemented, due to the lack of precise modelling and control methods for soft robots. This scientific obstacle, identified as a pending issue by major surveys in this field, becomes particularly challenging when interacting with an environment as complex as the human anatomy. Drawing on our background in soft tissue simulation, contact models, surgical applications and soft robotics, our ambition in this project is to:

- Develop accurate and generic numerical methods for continuum mechanics, adapted to strong real-time constraints in order to demonstrate the ability to model soft mechatronics systems.
- Reconsider parametrization methodologies of digital models of the patient anatomy through the observation of mechanical interactions with soft robots via embedded sensors and medical imaging.
- Rethink motion generation and teleoperation control with force feedback so as to be compatible with the large number of degrees of freedom of soft robots and be based on accurate, rapidly-computed deformable models and interaction models.

The project also targets the development of software with the required performance and features, as well as the experimental validation of models and methods using prototypes in realistic environments.

9.2.2. Collaborations with Major European Organizations

- Université Libre Brussels, Pr. Terwagne, Pr. Massar and Mr Tillema
- Artificial Intelligence Algorithms for the control of soft robots, based on the simulation (associated north-european team 2016-2017)
- University of Luxembourg: Pr Bordas
- Model order reduction and topological changes (journal in 2013 & submission of a proposal in 2017)
- King's college: Pr Liu
- Robotic catheter navigation and control and soft surgical robotics (conference publication at IROS in 2017)

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Margaret Koehler is a PhD student in Mechanical Engineering from the Collaborative Haptics and Robotics in Medicine (CHARM) Lab at Stanford University, led by Allison Okamura. Her PhD topic is "Design and Control of Soft Haptic Devices." Supported by a Chateaubriand Fellowship in partnership with Inria, she is conducting a 6-month research internship with the DEFROST team from September 2017 through February 2018. Her internship is part of a year-long collaboration between the DEFROST team and the CHARM Lab. In 2018, Christian Duriez will spend six months as a visiting scholar in the CHARM Lab to continue this exchange. The collaboration focuses on the development of a soft haptic device using the SOFA framework and soft robot control methods developed by the DEFROST team for design and control.

DIANA Project-Team

8. Partnerships and Cooperations

8.1. Inria internal funding

ADT ACQUA: In the context of the Inria ADT call, we have a funding for a two year engineering position on the ACQUA project for the 2015-2017 period. Thierry Spetebroot is hired on this position. In 2017, this ADT got extended by six months beyond the two years period to therefore end on March 2018.

IPL BetterNet: The Diana team is part of the Inria Project Lab BetterNet (<http://project.inria.fr/betternet/>). Within this lab, Inria has funded two PhD students in 2017 co-supervised by Chadi Barakat from the Diana project-team. The first PhD student is Thibaut Ehlinger hosted within the Diana team and co-supervised by Vassilis Christophides from the MiMove team in Paris. The second PhD student is Imane Taibi hosted by the Dionysos team in Rennes and co-supervised by Gerardo Rubino and Yassine Hadjadj-Aoul. Both PhDs started on the 1st of November 2017.

8.2. Regional Initiatives

ElectroSmart: This project benefits from the following fundings:

- a three year engineering position from the UCN@Sophia Labex for the 2016-2018 period (Ravi Mondy is hired on this position)
- 30KEuros from academy 1 of UCAJedi
- a two years engineering position from an Inria ADT for 2017/2018 (Abdelhakim Akodadi)
- a one year business developer from Inria ATT for june 2017-june 2018(David Migliacci)
- a 3 years 2017/2020 Ph.D. thesis from academy 1 of UCAJedi (Yanis Boussad)

D2D Indoor: This project is joint with the NFCOM startup in Nice, specialized in the development of new services for mobile phones. The project aims at leveraging mobile to mobile communications for offloading the cellular infrastructure, and will target a solution based on algorithms previously developed in the Diana project-team (BitHoc and HBSD). The project got a funding for one year engineer from the Labex. A position is open.

8.3. National Initiatives

8.3.1. ANR

- **ANR FIT** (2011-2018): FIT (Future Internet of Things) aims at developing an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's Equipements of Excellence (Equipex) research grant programme. The project will benefit from a 5.8 million euro grant from the French government. Other partners are UPMC, IT, Strasbourg University and CNRS. See also <http://fit-equipex.fr/>.

- **ANR DISCO** (2014-2017): DISCO (Distributed SDN COntrollers for rich and elastic network services) aims at exploring the way how Software Defined Networking changes network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. The project works throughout experimentations and application use cases on the next generation of Software-Defined Networking solutions for large and critical distributed systems. The project studied the distribution of the current SDN control plane and the optimization of network operations that the integrated system view of cloud computing-based architectures allows. See also <http://anr-disco.ens-lyon.fr/>.
- **ANR REFLEXION** (2015-2017): REFLEXION (REsilient and FLEXible Infrastructure for Open Networking) research project will study the robustness and scalability of the current SDN architectures and the flexibility leveraged by SDN for provisioning resources and virtualized network functions (VNF). The project will address four main scientific objectives: (1) Fault and disruption management for virtualized services, (2) Robust and scalable control plane for next generation SDN, (3) Dynamic performance management of low level resources in SDN/NFV environments and (4) Distribution and optimization of virtual network functions in SDN environments. Our contribution in this project was focused on fault and disruption management for virtualized services. See also <http://anr-reflexion.telecom-paristech.fr/>.
- **ANR BottleNet** (2016-2019): BottleNet aims to deliver methods, algorithms, and software systems to measure Internet Quality of Experience (QoE) and diagnose the root cause of poor Internet QoE. This goal calls for tools that run directly at users' devices. The plan is to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. ANR BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

8.4. European Initiatives

8.4.1. FP7 & H2020 Projects

Program: FP7 FIRE programme

Project acronym: Fed4Fire+

Project title: Federation for FIRE Plus

Duration: January 2017 - December 2021

Coordinator: iMinds (Belgium)

Other partners: 20 european partners including IMEC (Belgium), UPMC (Fr), Fraunhofer (Germany), TUB (Germany), etc.

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

Abstract: The Fed4FIRE+ project has the objective to run and further improve Fed4FIRE as best-in-town federation of experimentation facilities for the Future Internet Research and Experimentation initiative. Federating a heterogeneous set of facilities covering technologies ranging from wireless, wired, cloud services and open flow, and making them accessible through common frameworks and tools suddenly opens new possibilities, supporting a broad range of experimenter communities covering a wide variety of Internet infrastructures, services and applications. Fed4FIRE+ will continuously upgrade and improve the facilities and include technical innovations, focused towards increased user satisfaction (user-friendly tools, privacy-oriented data management, testbed SLA and reputation, experiment reproducibility, service-level experiment orchestration, federation ontologies, etc.). It will open this federation to the whole FIRE community and beyond, for experimentation by industry and research organisations, through the organization of Open Calls and Open Access

mechanisms. The project will also establish a flexible, demand-driven framework which allows test facilities to join during the course of its lifetime by defining a set of entry requirements for new facilities to join and to comply with the federation. FIRE Experimental Facilities generate an ever increasing amount of research data that provides the foundation for new knowledge and insight into the behaviour of FI systems. Fed4FIRE+ will participate in the Pilot on Open Research Data in Horizon 2020 to offer open access to its scientific results, to the relevant scientific data and to data generated throughout the project's lifetime. Fed4FIRE+ will finally build on the existing community of experimenters, testbeds and tool developers and bring them together regularly (two times a year) in engineering conferences to have maximal interaction between the different stakeholders involved.

8.5. International Initiatives

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

8.5.1.1. UHD-on-5G

Title: Ultra High Definition video streaming on future 5G networks

International Partner (Institution - Laboratory - Researcher):

National Institute of Information and Communications Technology (NICT) (Japan) ICN project-team - Hitoshi Asaeda

Start year: 2016

See also: <https://team.inria.fr/diana/uhd-on-5g/>

The aim of this collaboration is to design and develop efficient mechanisms for streaming UHD video on 5G networks and to evaluate them in a realistic and reproducible way by using novel experimental testbeds.

Our approach leverages and extends when necessary ICN and SDN technologies to allow very high quality video streaming at large scale. We also plan to use Virtual Network Functions (VNF) in order to place easily and dynamically different functions (e.g. transcoding, caching) at strategic locations within the network. Specifically, the placement of these functions will be decided by SDN controllers to optimize the quality of experience (QoE) of users. Moreover, we plan to integrate ICN functionalities (e.g., name-based forwarding and multipath transport using in-network caching) with SDN/NFV to provide better QoE and mobility services support to users than traditional IP architectures. Monitoring mechanisms such as the Contrace tool we developed in the SIMULBED associated team will be helpful to provide an accurate view of the network at the SDN controllers side. In addition, we will build a large-scale testbed to evaluate our solutions through reproducible experimentations based on two testbeds: the ICN wired CUTEi testbed developed by NICT and the wireless R2lab testbed developed by Inria.

8.6. International Research Visitors

8.6.1. Visits of International Scientists

Katia Obraczka is Professor of Computer Engineering and Graduate Director at Department of Computer Engineering, UC Santa Cruz where she leads the Internetworking Research Group (i-NRG). She has visited us for four weeks in July 2017. The Labex UCN@Sophia has supported two one-month visits at the DIANA project-team, in July 2017 and during summer 2018 to work in particular on the decentralization of the SDN control plane applied to Intelligent Transport Systems (ITS).

8.6.1.1. Internships

Neha Agarwal

Date: from Apr 2017 until Sep 2017

Institution: Ubinet Master intern, University of Nice Sophia Antipolis

Supervisor: Arnaud Legout

Subject: Automated Tests for ElectroSmart in Android Studio

Yanis Boussad

Date: from Mar 2017 until Aug 2017

Institution: Ubinet Master intern, University of Nice Sophia Antipolis

Supervisor: Arnaud Legout

Subject: Exploration of Electromagnetic Fields Metrics

Pretesh Chauhan

Date: from May 2017 until Jul 2017

Institution: Third year intern, National Institute of Technology, Hamirpur, INDIA.

Supervisor: Arnaud Legout

Subject: User Exposure Profiles in ElectroSmart

Giuseppe Di Lena

Date: from Mar 2017 until Aug 2017

Institution: Ubinet Master intern, University of Nice Sophia Antipolis

Supervisor: Damien Saucez and Thierry Turletti

Subject: Robust Virtualized services in OpenStack

David Migliacci

Date: from Jul 2017

Institution: Intern, Skema Business School

Supervisor: Arnaud Legout

Subject: Business Development for ElectroSmart

Yassir Mrabet

Date: from Mar 2017 until Aug 2017

Institution: Ubinet Master intern, University of Nice Sophia Antipolis

Supervisor: Walid Dabbous and Thierry Turletti

Subject: Anechoic Chamber Characterization for Trustful Evaluation of Wireless Protocols.

Imane Taibi

Date: from Mar 2017 until Aug 2017

Institution: Ubinet Master intern, University of Nice Sophia Antipolis

Supervisor: Chadi Barakat

Subject: Experimenting and modeling Web Quality of Experience

8.6.2. Visits to International Teams

Thierry Turletti visited NICT in Tokyo Japan in the context of the UHD-on-5G associated team in December 2017.

DIONYSOS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Sofiène Jelassi is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yassine Hadjadj-Aoul is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yann Busnel is a member of the three following projects: SocioPlug granted by the ANR (ANR-13-INFR-0003), INSHARE granted by the ANR (ANR-15-CE19-0024) and BigClin granted by the LabEx CominLabs (ANR-10-LABX-07-01).

9.1.2. IPL (Inria Project Lab) BetterNet

Yassine Hadjadj-Aoul, Gerardo Rubino and Bruno Tuffin are members of the IPL (Inria Project Lab) BetterNet: An Observatory to Measure and Improve Internet Service Access from User Experience, 2016-2020.

BetterNet aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where: 1) tools, models and algorithms/heuristics will be provided to collect data, 2) acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society, and 3) new value-added services will be proposed to end-users.

9.2. European Initiatives

9.2.1. Eurostars Camion Project

Participants: Yassine Hadjadj-Aoul

We were involved in a 30 months Eurostars European Project named Camion, which started on October 2014, aiming at offering cost-efficient, QoE-optimized content delivery, allowing for faster content access, as well as offline operation, while improving wireless network capacity and coverage. Camion is leaded by JCP-Connect, and the partners are a SME (FON) and our team. The project ended by June 2017.

9.2.2. Collaborations in European Programs

9.2.2.1. FINTEROP

Program: H2020-ICT-12-2015

Project acronym: F-Interop

Project title: FIRE+ online interoperability and performance test tools to support emerging technologies from research to standardization and market launch

Duration: November 2015 – October 2018

Coordinator: UPMC-LIP6

Other partners: 9 partners including (F. Sismondi and C. Viho (Dionysos); T. Watteyne (Eva))

Abstract: The goal of F-Interop is to extend FIRE+ with online interoperability and performance test tools supporting emerging IoT-related technologies from research to standardization and to market launch for the benefit of researchers, product development by SME, and standardization processes.

9.2.3. Collaborations with Major European Organizations

Partner 1: Sapienza University of Rome, Italy.

We work with Nicolás Rivetti and Leonardo Querzoni on the analysis of stream processing systems.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- We maintain a strong line of collaborations with the Technical University Federico Santa María (UTFSM), Valparaíso, Chile. Over the years, this has taken different forms (associated team Manap, Stic AmSud project “AMMA”, Stic AmSud project “DAT”). In 2017, we had a joint PhD work running (PhD of Nicolás Jara, to be defended at the beginning of next year), and a new joint PhD to be started in 2018 (PhD of Jonathan Olavarría). The first one is on optical network analysis and design, the second one on modeling evaluation techniques, with focus on Stochastic Activity Networks.
- We started a collaboration with the Faculty of Sciences of the university of the Republic, in Uruguay, on the application of mathematical modeling tools to a better understanding of a cognitive disease called semantic dementia. This involves Prof. Eduardo Mizraji and Jorge Graneri, PhD student, whose co-advisors are Prof. Mizraji and G. Rubino from Dionysos. Our contribution to this project is around the use of mathematical models, in particular around neural structures.

9.3.2. Participation in Other International Programs

9.3.2.1. International Initiatives

SM-HCD-HDD

Title: Statistical methods for highly complex and/or high dimensional data

International Partner (Institution - Laboratory - Researcher):

Universidad de la Republica Uruguay (Uruguay), Faculty of Sciences; Resp.: Ricardo Fraiman, Department of Mathematics

CNRS (France); Resp.: Catherine Aaron

Universidad Nacional del Litoral (Argentina); Resp.: Liliana Forzani

Duration: 3 years

Start year: 2016

In this project we work on specific statistical tools, mainly concerning predicting the behavior of time series. Our goal is to improve our tools for Perceptual Quality evaluation.

9.3.2.2. International Initiatives

MOCQUASIN

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

International Partner (Institution - Laboratory - Researcher):

Université de Montréal (Canada) - DIRO - Pierre L'Ecuyer

Duration: 3 years

Start year: 2013

See also: http://www.irisa.fr/dionysos/pages_perso/tuffin/MOCQUASIN/

The goal of this team is to compute integrals, sums or to solve equations or optimization problems by means of Monte Carlo methods, which are statistical tools used when the models have a high complexity (for instance a large dimension). They are unavoidable tools in areas such as finance, electronics, seismology, computer science, engineering, physics, transport, biology, social sciences... Nonetheless, they have the reputation of being slow, i.e. to require a large computational time to reach a given precision. The goal of the project is to work on acceleration techniques, meaning methods allowing to reach the targeted precision in a shorter computational time. A typical framework is that of rare event simulation for which getting even only one occurrence of the event of interest could require a very long time. In this case, there are two main acceleration techniques: importance sampling and splitting, on which we work.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Pierre L'Ecuyer holds an Inria International Chair, Nov. 2013- Oct. 2018.
- Marvin Nakayama (New Jersey Institute of Technology, NJ, USA) visited us 3 days in October to work on the estimation of quantiles in the case of rare events.
- Jonathan Olavarría, from UTFSM, Chile, from January to March (for two months), to work on stochastic models.
- Prof. Leslie Murray, from University of Rosario, Argentina (one month, February) to work on Monte Carlo techniques for rare event analysis.
- Jorge Graneri, from UDELAR, Uruguay (two months in the last quarter of the year, to work on biological applications).
- Prof. Claudio Risso, from UDELAR, Uruguay (two weeks in the last quarter of the year, to work on time series predictions).
- Prof. Gustavo Guerberooff, from UDELAR, Uruguay (two weeks in the last quarter of the year, to work on time series predictions).

DISCO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

DIGITEO Project (DIM LSC) ALMA3

Project title: Mathematical Analysis of Acute Myeloid Leukemia (AML) and its treatments

September 2014 - August 2017

Coordinator: Catherine Bonnet

Other partners: Inria Paris-Rocquencourt, France, L2S, France, UPMC, St Antoine Hospital Paris

Abstract: this project follows the regional projects ALMA (2010-2014) and ALMA2 (2011-2013). Starting from the work of J. L. Avila Alonso's PhD thesis in ALMA the aim of this project was to provide a refined coupled model of healthy and cancer cell dynamics in AML whose (stability) analysis may enable evaluation of polychemiotherapies delivered in the case of AML which have a high level of Flt-3 duplication (Flt-3-ITD).

9.2. National Initiatives

9.2.1. Industrial-Academic Institute

Guillaume Sandou is the head of the RISEGrid Institute. The Institute is dedicated to the study, modelling and simulation of smart electric distribution grids and their interactions with the whole electric power system. It is located in CentraleSupélec and gathers about 20 people (academic and industrial researchers, PhD students, post-doctoral researchers).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: ITN

Project acronym: TEMPO

Project title: Training in Embedded Predictive Control and Optimization

Duration: January 2014 - January 2018

Coordinator: Tor Arne Johanson; with Sorin Olaru (as French PI)

Other partners: U. Freiburg, Oxford, Imperial College; NTNU Trondheim; STUBA Bratislava; EPFL Lausanne; KU Leuven, Renault, ABB, Ampyx Power

Abstract: TEMPO is an international PhD program for highly motivated young scientists, where state-of-the-art research is combined with a comprehensive training program. The network is funded by the European Community's Seventh Framework program. The European Commission wants to make research careers more attractive to young people and therefore offers early-stage researchers (ESRs) a PhD program the opportunity to improve their research skills, join established research teams and enhance their career prospects via the Marie Curie Initial Training Networks (ITN) in the area of Embedded Predictive Control and Optimization.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: PHC BOSPHORE 2016 (Turkey)

Project title: Robust Control of Time Delayed Linear Parameter Varying Systems via Switched Controllers.

Duration: January 2016 - December 2017

Coordinator: Frédéric Mazenc (France), Hitay Özbay (Turkey).

Abstract: The main goal of this project is to develop computational algorithms for robust controller design for different classes of time delay systems appearing in various engineering applications such as chemical processes, transportation systems and communications networks. The participants will consider control problems of significant practical implications in this area: (i) developing new computational techniques for simple (low order) reliable and scalable decentralized controllers for control of (and control over) networks; and (ii) reducing conservatism in recently developed dwell-time based stability results for the analysis of switched time delay systems. Moreover, design of scalable low order controllers for reducing the effect of time delays is an important problem investigated in this project. One of the objectives of this collaboration is to generalize the design techniques already developed by the French and Turkish teams to larger classes of time delay systems, in particular multi-input-multi-output (MIMO) systems with time varying delays.

Program: **PHC BRANCUSI 2017 (Romania)**

Project acronym: ProCo

Project title: Systems with propagation: New approaches in control design for oscillation quenching

Duration: January 2016 - December 2018

Coordinator: Islam Boussaada (France) et Daniela Danciu (Romania)

Abstract: The project aims to building a unitary framework for the modeling, the analysis and the control of distributed-parameters systems (DPS) described by hyperbolic partial differential equations in one space variable and non-standard boundary conditions. This main objectives are modeling of DPS and the corresponding functional differential equations, the construction of reduced-order models approximating DPS by both numerical and computational modeling, the design of new control methods for oscillations quenching in DPS.

Program: **PHC CARLSO FINLEY 2017 (Cuba)**

Project title: MODELISATION ET COMMANDE POUR LE PROCESSUS DE CRYOCONSERVATION.

Duration: June 2017 - December 2017

Coordinator: Sorin Olaru (France), Marcos Martinez Montero (Turkey).

Abstract: The aim of this project is to initiate a collaboration on subjects related to the mathematical modelling of the dynamics involved in the cryopreservations process. In particular, the viability analysis of the vegetal material subject to cryogeny is one of the main objectives. The approach will rely on the evaluation electric leakage properties.

Program: **COST Action**

Project acronym: FRACTAL

Project title: Fractional-order systems; analysis, synthesis and their importance for future design

Duration: November 2016 - October 2020

Coordinator: Jaroslav Koton Czech Republic

Abstract: Fractional-order systems have lately been attracting significant attention and gaining more acceptance as generalization to classical integer-order systems. Mathematical basics of fractional-order calculus were laid nearly 300 years ago and since that it has gained deeply rooted mathematical concepts. Today, it is known that many real dynamic systems cannot be described by a system of simple differential equation or of integer-order system. In practice we can encounter such systems in electronics, signal processing, thermodynamics, biology, medicine, control theory, etc. The Action will favor scientific advancement in above mentioned areas by coordinating activities of academic research groups towards an efficient deployment of fractal theory to industry applications.

9.4. International Initiatives

Catherine Bonnet is the co-supervisor together with André Fioravanti of a PhD student of Unicamp (Brazil).

Frédéric Mazenc is the co-supervisor together with Hitay Ozbay of a PhD Student of Bilkent University (Turkey).

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- College of Mathematics and Information Science, Shaanxi Normal University, China
- School of Control Science and Engineering, Dalian University of Technology, Dalian, China
- Louisiana State University, Baton Rouge, USA
- School of Electrical Engineering at the Tel-Aviv University, Israel
- The University of Texas at Austin, Dept. of Aerospace Engineering & Engineering Mechanics, USA
- Bilkent University, Turkey
- Universidad de Chile, Chile
- School of Mathematics, University of Leeds, U.K.
- University Federale Rio de Janeiro, Brazil
- UNICAMP, Brazil
- Kyoto University, Japan

9.4.2. Participation in Other International Programs

9.4.2.1. International Initiatives

STADE

Title: Stability and Dichotomies in Differential Equations (Ordinary & Delay).

International Partners (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Mathematics Department - Gonzalo Robledo

Universidad de la Republica Uruguay (Uruguay) - Faculty of Engineering - Pablo Monzon

Duration: 2016 - 2017

Start year: 2016

See also: <http://www.stade.cl/pages/list.html>

The ship-flags of this project are the concepts of dichotomy and stability in an ODE & DDE framework. We intend to study some theoretical and applied problems involving these concepts and its relations. In particular, converse stability results (expressed in the existence of density functions), feedback stabilization, stability in delay differential equations and some applications to bioprocesses.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Stefanella Boatto, Federale University Rio de Janeiro, Brazil, 1 January-31 December.

André Fioravanti, UNICAMP, Sao Paulo, Brazil, 7 January-28 February.

Yutaka Yamamoto, Kyoto University, Japan, 17 May -2 August.

Hitay Ozbay, Bilkent University, Turkey, 15 November 2017 - 18 November 2017.

9.5.2. Visits to International Teams

Stefanella Boatto visited the Department of Mathematics, Universidade de Lisboa, Portugal, 19-23 June 2017. Frédéric Mazenc visited the Department of Mathematics of the Louisiana State University, Baton Rouge USA, 2 April - 14 April 2017, the Departamento de Ingeniaria de Control y Robotico of the Universidad Nacional Autonoma de Mexico, Mexico-city 14 August 2017 - 16 August and 18 August - 27 August 2017, the Laboratoire Franco-Mexicain d'Informatique et d'Automatique (LAFMIA), Mexico-City, 17 August 2017, Universidad de Chile, Santiago de Chile, 15 October 2017 to 28 October 2017.

DIVERSE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. SOPRANO

- Coordinator: CEA
- CEA, University of Paris-Sud, Inria Rennes, OcamlPro, Adacore
- Dates: 2014-2017
- Abstract: Today most major verification approaches rely on automatic external solvers. However these solvers do not fill the current and future needs for verification: lack of satisfying model generation, lack of reasoning on difficult theories (e.g. floating-point arithmetic), lack of extensibility for specific or new needs. The SOPRANO project aims at solving these problems and prepare the next generation of verification-oriented solvers by gathering experts from academia and industry. We will design a new framework for the cooperation of solvers, focused on model generation and borrowing principles from SMT (current standard) and CP (well-known in optimisation). These ideas will be implemented in an open-source platform, with regular evaluations from the industrial partners.

9.1.1.2. VaryVary ANR JCJC

- Coordinator: Mathieu Acher
- DiverSE, Inria/IRISA Rennes
- Dates: 2017-2021
- Abstract: Most modern software systems (operating systems like Linux, Web browsers like Firefox or Chrome, video encoders like x264 or ffmpeg, servers, mobile applications, etc.) are subject to variation or come in many variants. Hundreds of configuration options, features, or plugins can be combined, each potentially with distinct functionality and effects on execution time, memory footprint, etc. Among configurations, some of them are chosen and do not compile, crash at runtime, do not pass a test suite, or do not reach a certain performance quality (e.g., energy consumption, security). In this JCJC ANR project, we follow a thought-provocative and unexplored direction: We consider that the variability boundary of a software system can be specialized and should vary when needs be. The goal of this project is to provide theories, methods and techniques to make vary variability. Specifically, we consider machine learning and software engineering techniques for narrowing the space of possible configurations to a good approximation of those satisfying the needs of users. Based on an oracle (e.g., a runtime test) that tells us whether a given configuration meets the requirements (e.g. speed or memory footprint), we leverage machine learning to retrofit the acquired constraints into a variability that can be used to automatically specialize the configurable system. Based on a relative small number of configuration samples, we expect to reach high accuracy for many different kinds of oracles and subject systems. Our preliminary experiments suggest that varying variability can be practically useful and effective. However, much more work is needed to investigate sampling, testing, and learning techniques within a variety of cases and application scenarios. We plan to further collect large experimental data and apply our techniques on popular, open-source, configurable software (like Linux, Firefox, ffmpeg, VLC, Apache or JHipster) and generators for media content (like videos, models for 3D printing, or technical papers written in LaTeX).

9.1.1.3. CLARITY

- Coordinator: Obéo
- Other partners: AIRBUS, Airbus Defence and Space, All4tec, ALTRAN Technologies, AREVA, Artal, C.E.S.A.M.E.S., Eclipse Foundation Europe, Inria Sophia Antipolis Méditerranée, PRFC, Scilab Enterprises, Thales Global Services, Thales Alenia Space, Thales Research & Technology, Thales Systèmes Aéroportés, Université de Rennes 1.
- Dates: 2014-2017
- Abstract: The CLARITY project aims to establish an international dimension ecosystem around Melody/Capella modeling workbench for systems engineering (MBSE) and engineering architectures (system, software, hardware).

9.1.1.4. Occiware

- Coordinator: Open Wide
- Open Wide, ActiveEon SA, CSRT - Cloud Systèmes Réseaux et Télécoms, Institut Mines-Télécom/Télécom SudParis, Inria, Linagora, Obeo, OW2 Consortium, Pôle Numérique, Université Joseph Fourier,
- Dates: 2014-2017
- Abstract: The Occiware project aims to establish a formal and equipped framework for the management of all cloud resource based on the OCCI standard.

9.1.2. DGA

9.1.2.1. FPML (CYBERDEFENSE)

- Coordinator: DGA
- Partners: DGA MI, Inria
- Dates: 2014-2017
- Abstract: in the context of this project, DGA-MI and the Inria team DiverSE explore the existing approaches to ease the development of formal specifications of domain-Specific Languages (DSLs) dedicated to paquet filtering, while guaranteeing expressiveness, precision and safety. In the long term, this work is part of the trend to provide to DGA-MI and its partners a tooling to design and develop formal DSLs which ease the use while ensuring a high level of reasoning.

9.1.3. Cominlabs

9.1.3.1. PROFILE

- Coordinator: Université de Rennes 1
- Partners: Inria, Université de Rennes 2
- Dates: 2016-2019
- Abstract: The PROFILE project brings together experts from law, computer science and sociology to address the challenges raised by online profiling, following a multidisciplinary approach. More precisely, the project will pursue two complementary and mutually informed lines of research: (i) Investigate, design, and introduce a new right of opposition into the legal framework of data protection to better regulate profiling and to modify the behavior of commercial companies towards being more respectful of the privacy of their users; (ii) Provide users with the technical means they need to detect stealthy profiling techniques as well as to control the extent of the digital traces they routinely produce. As a case study, we focus on browser fingerprinting, a new profiling technique for targeted advertisement. The project will develop a generic framework to reason on the data collected by profiling algorithms, to uncover their inner working, and make them more accountable to users. PROFILE will also propose an innovative protection to mitigate browser fingerprinting, based on the collaborative reconfiguration of browsers.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. FP7 STREP HEADS

- Coordinator: SINTEF
- Other partners: Inria, Software AG, ATC, Tellu, eZmonitoring
- Dates: 2013-2017
- Abstract: The idea of the HEADS project is to leverage model-driven software engineering and generative programming techniques to provide a new integrated software engineering approach which allow advanced exploitation the full range of diversity and specificity of the future computing continuum. The goal is to empower the software and services industry to better take advantage of the opportunities of the future computing continuum and to effectively provide new innovative services that are seamlessly integrated to the physical world making them more pervasive, more robust, more reactive and closer (physically, socially, emotionally, etc.) to their users. We denote such services HD-services. HD-services (Heterogeneous and Distributed services) characterize the class of services or applications within the Future Internet whose logic and value emerges from a set of communicating software components distributed on a heterogeneous computing continuum from clouds to mobile devices, sensors and/or smart-objects.

9.2.1.2. H2020 ICT-10-2016 STAMP

- Coordinator: Inria Rennes
- Other partners: ATOS, ActiveEon, OW2, TellU, Engineering, XWiki, TU Delft, SINTEF
- Dates: 2016-2019
- Abstract: Leveraging advanced research in automatic test generation, STAMP aims at pushing automation in DevOps one step further through innovative methods of test amplification. It will reuse existing assets (test cases, API descriptions, dependency models), in order to generate more test cases and test configurations each time the application is updated. Acting at all steps of development cycle, STAMP techniques aim at reducing the number and cost of regression bugs at unit level, configuration level and production stage.

STAMP will raise confidence and foster adoption of DevOps by the European IT industry. The project gathers 3 academic partners with strong software testing expertise, 5 software companies (in: e-Health, Content Management, Smart Cities and Public Administration), and an open source consortium. This industry-near research addresses concrete, business-oriented objectives. All solutions are open source and developed as microservices to facilitate exploitation, with a target at TRL 6.

9.2.2. Collaborations with Major European Organizations

- SINTEF, ICT (Norway): Model-driven systems development for the construction of distributed, heterogeneous applications. We collaborate since 2008 and are currently in two FP7 projects together.
- Université du Luxembourg, (Luxembourg): Models runtime for dynamic adaptation and multi-objective elasticity in cloud management; model-driven development.
- KTH, the Royal Institute of Technology (Sweden): continuous software testing, perturbation and diversification.

9.3. International Initiatives

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

9.3.1.1. ALE

- Title: Agile Language Engineering

- International Partner (Institution - Laboratory - Researcher):
 - CWI (Netherlands)
- Start year: 2017
- See also: <http://gemoc.org/ale/>
- Software engineering faces new challenges with the advent of modern software-intensive systems such as complex critical embedded systems, cyber-physical systems and the Internet of things. Application domains range from robotics, transportation systems, defense to home automation, smart cities, and energy management, among others. Software is more and more pervasive, integrated into large and distributed systems, and dynamically adaptable in response to a complex and open environment. As a major consequence, the engineering of such systems involves multiple stakeholders, each with some form of domain-specific knowledge, and with an increasingly use of software as an integration layer. Hence more and more organizations are adopting Domain Specific Languages (DSLs) to allow domain experts to express solutions directly in terms of relevant domain concepts. This new trend raises new challenges about designing DSLs, evolving a set of DSLs and coordinating the use of multiple DSLs for both DSL designers and DSL users. ALE will contribute to the field of Software Language Engineering, aiming to provide more agility to both language designers and language users. The main objective is twofold. First, we aim to help language designers to leverage previous DSL implementation efforts by reusing and combining existing language modules. Second, we aim to provide more flexibility to language users by ensuring interoperability between different DSLs and offering live feedback about how the model or program behaves while it is being edited (aka. live programming/modeling).

9.3.2. *Inria International Partners*

9.3.2.1. *Informal International Partners*

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

9.3.3. *Participation in Other International Programs*

The GEMOC studio has been sustained through the creation of a Research Consortium at the Eclipse Foundation.

9.3.4. *International initiative GEMOC*

The GEMOC initiative (cf. <http://www.gemoc.org>) is an open and international initiative launched in 2013 that coordinate research partners worldwide to develop breakthrough software language engineering (SLE) approaches that support global software engineering through the use of multiple domain-specific languages. GEMOC members aim to provide effective SLE solutions to problems associated with the design and implementation of collaborative, interoperable and composable modeling languages.

The GEMOC initiative aims to provide a framework that facilitates collaborative work on the challenges of using of multiple domain-specific languages in software development projects. The framework consists of mechanisms for coordinating the work of members, and for disseminating research results and other related information on GEMOC activities. The framework also provides the required infrastructure for sharing artifacts produced by members, including publications, case studies, and tools.

The governance of the GEMOC initiative is ensured by the Advisory Board. The role of the Advisory Board is to coordinate the GEMOC work and to ensure proper dissemination of work products and information about GEMOC events (e.g., meetings, workshops).

Benoit Combemale is the co-founder and currently acts as principal coordinator of the GEMOC initiative. Benoit Combemale and Jean-Marc Jézéquel are part of the Advisory Board, and 9 DIVERSE members are part of the GEMOC initiative.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Yves Le Traon, Professor at the University of Luxembourg, visited the team in June and July 2017.

Tanja Mayerhofer, Junior Researcher at the TU Wien, visited the team in March 2017.

François Fouquet, Junior Researcher at the SnT (Lux), visited the team in November 2017.

9.4.1.1. Internships

Koko armando Nguepi kenfack, Master interships at the University of Namur, visited the team from September 2017 to January 2018.

9.4.2. Visits to International Teams

Manuel Leduc visited CWI for 3 weeks in September 2017

Benoit Combemale visited Professor Jorg Kienzle at McGill University (Canada) for 3 months in 2017; and made several short visits at CWI (The Netherlands).

9.4.2.1. Research Stays Abroad

Marcelino Rodriguez-Cancio visited Vanderbilt University from November 2016 to September 2017.

DOLPHIN Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- CPER “data” (2015-2020): This project is jointly supported by the government together with the region. The Advanced Data Science and Technology (Data) CPER project aims to conduct a research program on data intelligence at a high international level in a strong synergy with the regional economic fabric and to set up a research infrastructure in line with the associated challenges. It focuses on three areas of research: Internet of Things, Intelligence of Data and Knowledge, High Performance Computing (HPC) and Optimization, and four main levers: (i) research infrastructure, (ii) attractiveness - particularly researchers from EPST, (iii) demonstrators, (iv) Transfer for innovation to SMEs. Dolphin (N. Melab) is the scientific leader of the HPC and optimization scientific area and the research infrastructure lever (Grid’5000 part). The budget for this part is 1.2M€. C. Dhaenens is coordinator of the project for the University of Lille.
- CPER ELSAT (2015-2019) of CPER (Contrat Plan Etat Région): transversal research action “Planning and scheduling of maintenance logistics in transportation”.

9.2. National Initiatives

9.2.1. ANR

- ANR project Modèles Numériques “NumBBO - Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers” (2012-2016) in collaboration with Inria Saclay, TAO team, Ecole des Mines de St. Etienne, CROCUS team, and TU Dortmund University, Germany (2012-2016)
- ANR project TECSAN (Technologies pour la Santé) “ClinMine - Optimisation de la prise en Charge des Patients à l’Hôpital”, in collaboration with University Lille 1, University Lille 2, Inria, CHRU Lille, CHICL, Alicante (6 partners) (2014-2017) - Coordinator C. Dhaenens
- Bilateral ANR/RGC France/Hong Kong PRCI “Big Multiobjective Optimization” (2016-2021) in collaboration with City University of Hong Kong
- PGM0 project “Towards a Complexity Theory for Black-Box Optimization”, together with Carola Doerr (CNRS, LIP6), Benjamin Doerr (Ecole Polytechnique), Anne Auger, Nikolaus Hansen (both Inria Saclay), Timo Koetzing (University of Jena, Germany), Johannes Lengler (ETH Zurich, Switzerland), and Jonathan Rowe (The University of Birmingham, UK), (2014-2016)
- PGM0 project “Demand side management in smart grids”, together with EDF, (2015-2017)
- PGM0 project “Multi-home Demand side management in micro grids”, together with EDF, (2017-2019)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: H2020

Project acronym: SYNERGY

Project title: Synergy for Smart Multi-Objective Optimisation

Duration: 02 2016 - 01 2019

Coordinator: Jožef Stefan Institute (JSI), Ljubljana, Slovenia

Other partners: University of Lille (France), Cologne University of Applied Sciences (Germany)

Abstract: Many real-world application areas, such as advanced manufacturing, involve optimization of several, often time-consuming and conflicting objectives. For example, they require the maximization of the product quality while minimizing the production cost, and rely on demanding numerical simulations in order to assess the objectives. These, so-called multi-objective optimization problems can be solved more efficiently if parallelization is used to execute the simulations simultaneously and if the simulations are partly replaced by accurate surrogate models.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: COST CA15140

Project acronym: ImAppNIO

Project title: Improving applicability of nature-inspired optimization by joining theory and practice

Duration: 2016-2019

Coordinator: Thomas Jansen

Abstract: The main objective of the COST Action is to bridge this gap and improve the applicability of all kinds of nature-inspired optimisation methods. It aims at making theoretical insights more accessible and practical by creating a platform where theoreticians and practitioners can meet and exchange insights, ideas and needs; by developing robust guidelines and practical support for application development based on theoretical insights; by developing theoretical frameworks driven by actual needs arising from practical applications; by training Early Career Investigators in a theory of nature-inspired optimisation methods that clearly aims at practical applications; by broadening participation in the ongoing research of how to develop and apply robust nature-inspired optimisation methods in different application areas.

9.3.3. Collaborations with Major European Organizations

University of Luxembourg: (Luxembourg)

Energy aware scheduling in Cloud computing systems

University of Oviedo: (Spain)

Optimization under uncertainty for fuzzy flow shop scheduling

University of Elche and University of Murcia: (Spain)

Matheuristics for DEA

9.4. International Initiatives

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

9.4.1.1. MOHA

Title: Mixed Multi-objective Optimization using Hybrid Algorithms: Application to smart grids

International Partner (Institution - Laboratory - Researcher):

Ecole Mohammadia d'Ingénieurs (Morocco) - LERMA (Laboratoire d'Etudes et de Recherches en Mathématiques Appliquées) - Rachid Ellaia

Start year: 2016

See also: <https://ocm.univ-lille1.fr/~talbi/momh/>

The key challenge of this project is to propose new optimization models and new hybrid algorithms to the demand side management of smart grids in a context of uncertainty and in the presence of several conflicting objectives.

Those complex optimization problems are also characterized by the presence of both continuous and discrete variables. We need to design new efficient optimization algorithms combining state-of-the-art exact and metaheuristic algorithms from the global optimization and combinatorial optimization communities

9.4.1.2. *s3-bbo*

Title: Threefold Scalability in Any-objective Black-Box Optimization (s3-bbo)

International Partner (Institution - Laboratory - Researcher):

Shinshu University, Japan

Duration: 2015-2017

See also: <http://francejapan.gforge.inria.fr/doku.php?id=associateteam>

The main scientific goals of this collaboration is to theoretically derive, analyze, design, and develop scalable evolutionary and other stochastic local search algorithms for large-scale optimization considering three different axes of scalability: (i) decision space, (ii) objective space, and (iii) availability of distributed and parallel computing resources. This research will allow us to design, control, predict, analyze and optimize parameters of recent complex, large-scale, and computationally expensive systems, providing the basic support for problem solution and decision-making in a variety of real world applications. For single-objective continuous optimization, we want to theoretically derive variants of the state-of-the-art CMA-ES with linear time and space complexity scalings with respect to the number of variables. We will exploit the information geometry framework to derive updates using parametrization of the underlying family of probability distribution involving a linear number of components. The challenges are related to finding good representations that are theoretically tractable and meaningful. For the design of robust algorithms, implementing the derived updates, we plan to follow the same approach as for the design of CMA-ES. For multi- and many-objective optimization, we will start by characterizing and defining new metrics and methodologies to analyze scalability in the objective space and in terms of computational resources. The first challenge is to accurately measure the impact of adding objectives on the search behavior and on the performance of evolutionary multi- and many- objective optimization (EMyO) algorithms. The second challenge is to investigate the new opportunities offered by large-scale computing platforms to design new effective algorithms for EMyO optimization. To this end, we plan to follow a feature-based performance analysis of EMyO algorithms, to design new algorithms using decomposition-based approaches, and to investigate their mapping to a practical parallel and distributed setting.

9.4.1.3. *Informal International Partners*

- Collaboration with Université de Mons (UMONS). The collaboration consists mainly in the joint supervision of the Phd thesis of Jan Gmys started in 2014.
- University of Coimbra, Portugal
- University of Lisbon, Portugal
- University of Manchester, United Kingdom
- University of Elche, Spain

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

- Prof. Fred Glover (University of Colorado, USA), Feb 2017
- Prof. Rachid Ellaia (EMI, Univ. Rabat, Morocco), Nov 2017
- Prof. Oliver Schutez (CINVESTAV, Mexico), Nov 2017
- Manuel López-Ibáñez, Manchester University (United Kingdom), June 2017
- Kiyoshi Tanaka, Shinshu University (Japan), March 2017
- Qingfu Zhang, City University (Hong Kong), April 2017
- Manuel López-Ibáñez, Manchester University (United Kingdom), June 2017
- Kiyoshi Tanaka, Shinshu University (Japan), March 2017
- Qingfu Zhang, City University (Hong Kong), April 2017

9.5.1.1. Internships

- Oliver Cuate, CINVESTAV, Mexico
- Jihene Serrar, EMI, Morocco
- Zineb Hattab, EMI, Morocco

9.5.2. Visits to International Teams*9.5.2.1. Sabbatical programme*

Prof. El-Ghazali Talbi has been at Sabbatical from the University of Lille (2016-2017) visiting many Universities at International level (USA, Spain, Italy, Mexico, Morocco, Luxembourg, ...).

9.5.2.2. Research Stays Abroad

- B. Derbel: University of Lisbon (Portugal), 2 months
- A. Liefoghe: Shinshu University (Japan), 1 month, May 2017
- B. Derbel: Shinshu University (Japan), 1 month, June-July 2017
- E-G. Talbi: EMI, University of Rabat (Morocco), 1 month, 2017
- E-G. Talbi, JSI, Ljubljana (Slovenia), 1 month, 2017

DRACULA Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

In the context of the chair of applied mathematics “OQUAIDO”, driven by Olivier Roustand (Mines de St Etienne), Celine Vial is the scientific responsible of a contract with the BRGM (Orléans) 2016-2018: “Study of a submergence problem: identify the critical offshore conditions for coastal flooding”.

7.2. National Initiatives

7.2.1. ANR

- Olivier Gandrillon participates in the ANR (Investissement d’Avenir) Iceberg (head Gregory Batt (Inria)) “From population models to model populations: single cell observation, modeling, and control of gene expression”. 2012-2017 (<https://contraintes.inria.fr/~batt/iceberg/home.html>).
- Thomas Lepoutre is a member of the ANR KIBORD (head L. Desvillettes) dedicated to “kinetic and related models in biology”. 2014-2017: <https://www.ljll.math.upmc.fr/kibord/>.
- Céline Vial participates in the ANR PEPITO (head M. Henner) dedicated to “Design of Experiment for the Industry of transportation and Optimization”. 2014-2018: <http://www.agence-nationale-recherche.fr/?Project=ANR-14-CE23-0011>.

7.2.2. Other projects

- Inria ADT : SiMuScale "Simulations Multi-Échelles de Populations Cellulaires", 2014-2017.
Participants: Samuel Bernard [Coordinator], Fabien Crauste, Olivier Gandrillon, David Parsons.
- Association France Alzheimer Sciences Médicales: PAMELA “Prion et Alzheimer : Modélisation et Expérimentation d’une Liaison Agressive”, 2014-2017 (<https://www.youtube.com/watch?v=X0mLf8IJhV4>).
Participants: Mostafa Adimy, Samuel Bernard, Thomas Lepoutre, Laurent Pujo-Menjouet [Coordinator], Léon Tine.
- Thomas Lepoutre is a member of the ERC MESOPROBIO (head V. Calvez) dedicated to "Mesoscopic models for propagation in biology". 2015-2020: http://cordis.europa.eu/project/rcn/193664_en.html.

7.3. International Initiatives

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

- Associate Teams Inria project, "Modelling Leukemia", 2014-2017.
 - Participants (Dracula): Mostafa Adimy, Samuel Bernard, Apollos Besse, Abdenasser Chekroun, Raouf El-Cheikh, Thomas Lepoutre [Coordinator], Laurent Pujo-Menjouet, Léon Tine, Céline Vial.
 - Partners: This is joint with Center for Scientific Computing and Applied Mathematical Modeling (Doron Levy) at University of Maryland (USA) (http://dracula.univ-lyon1.fr/modelling_leukemia.php).

- The project Modelling Leukemia is devoted to the modeling of several aspects of Chronic Myeloid Leukemia. Leukemia is the most famous disease of the blood cell formation process (hematopoiesis). Chronic myeloid leukemia results in a uncontrolled proliferation of abnormal blood cells. As the hematopoiesis involves stem cells (not accessible to observations), mathematical modeling is here a great tool to test hypothesis. We want to add up the expertise of Inria team DRACULA specialized on the modeling of blood cell formation and the Center for Scientific Computation and Applied Mathematical Modeling (CSCAMM, University of Maryland, College Park).

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Claudia Pio Ferreira helded an Invited Professor position in the dracula team for two months (October 14th - December 14th), she is affiliated to the Sao Paulo State University (UNESP), Institute of Biosciences, Department of Biostatistics, Botucatu, Brazil.

DYLISS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Regional initiative: the Ecosyst project

Participants: Damien Eveillard, Marie Chevallier, Clémence Frioux, Anne Siegel, Camille Trottier.

EcoSyst is a Biogenouest inter-regional federating project (Brittany & Pays de la Loire) aiming at the emergence of Systems Ecology at the level of western France regions. Drawing on the strengths and skills involved, EcoSyst targets the incubation of new ideas and new projects at disciplinary interfaces. Thanks to this community project, we want to develop the skills of Ecology, Environment, Modeling, Bioinformatics and Systems Biology and their application to organisms and ecosystems of interest in agronomy, sea and health. EcoSyst includes also the identification of the major issues and concerns, the fundamental and essential methods and the very real needs of the community (training, tools, ...); this in order to consider the construction of a community platform (or an offer of service within an existing platform) on complex systems modeling, meeting expectations of the community as fully as possible.

9.1.2. Regional partnership with computer science laboratories in Nantes

Participants: Anne Siegel, Jérémie Bourdon, Damien Eveillard, François Coste, Maxime Folschette, Jacques Nicolas.

Methodologies are developed in close collaboration with the LS2N (fusion of LINA and IRCCyN) located at University of Nantes and École centrale de Nantes. This is acted through the Biotempo and Idealg ANR projects and co-development of common software toolboxes within the Renabi-GO platform support. C. Trottier is a co-supervised bioanalysis and software development engineer within the Idealg project. M. Chevallier is a co-supervised development and animation engineer within the regional initiative "Ecosyst". In addition, the ongoing Ph-D student J. Laniau is co-supervised with a member of the LS2N laboratory. Finally, M. Folschette is a PostDoc working on a project aiming at analyzing TGF-beta-related pathways evolutions after epithelial-mesenchymal transition in liver cancer, which is a recognized biological process leading to metastasis. This project is based on a topic shared with the LS2N: the use of graph coloring and reconstruction to witness expression changes, and is funded by the Université Bretagne Loire.

9.1.3. Regional partnership in Marine Biology

Participants: Meziane Aite, Arnaud Belcour, Catherine Belleannée, Jérémie Bourdon, Jean Coquet, François Coste, Damien Eveillard, Olivier Dameron, Clémence Frioux, Jeanne Got, Julie Laniau, Jacques Nicolas, Camille Trottier, Anne Siegel.

A strong application domain of the Dyliss project is marine Biology. This application domain is co-developed with the station biologique de Roscoff and their three UMR and involves several contracts. Our approach based on parcimonious modelling allowed an in silico characterization of processes required within sea urchin translation [83], [95]. We are also strongly involved in the IDEALG consortium, a long term project (10 years, ANR Investissement avenir) aiming at the development of macro-algae biotechnology. Among the research activities, we are particularly interested in the analysis and reconstruction of metabolism and the characterization of key enzymes. Our methods based on combinatorial optimization for the reconstruction of genome-scale metabolic networks and on classification of enzyme families based on local and partial alignments allowed the *E. Siliculosus* seaweed metabolism to be deciphered [97], [67]. As a further study, we reconstructed the metabolic network of a symbiot bacterium *Ca. P. ectocarpi* [69] and used this reconstructed network to decipher interactions within the **algal-bacteria holobiont** [21].

9.1.4. Regional partnership in agriculture and environmental sciences

Participants: Catherine Belleannée, François Coste, Olivier Dameron, Xavier Garnier, François Moreews, Jacques Nicolas, Anne Siegel, Denis Tagu.

We have a strong and long term collaboration with biologists of INRA in Rennes : PEGASE and IGEPP units. F. Moreews is a permanent engineer from PEGASE center hosted in the team to develop methods for integrative biology applied to species of interest in agriculture. D. Tagu is a research director at INRA/IGEPP who spends 20% of his time in the team to develop collaborative projects. This partnership has been supported by the co-supervision of PhDs, post-docs and engineers. This collaboration was also reinforced by collaboration within ANR contracts (MirNadapt, FatInteger).

In collaboration with researchers from the PEGASE center (INRA) focused on breeding animals, we have contributed to several studies aiming at better integrating and investigating data in order to facilitate animal selection and alimentation. The *NutritionAnalyzer* prototype was developed to understand better the impact of several diaries or treatments for lactary cows over the composition of milk [37]. Our work on the identification of upstream regulators within large-scale knowledge databases (prototype *KeyRegulatorFinder*) [59] and on semantic-based analysis of metabolic networks [54] was also very valuable for interpreting differences of gene expression in pork meat [79] and figure out the main gene-regulators of the response of porks to several diets (see [74], [76] and [18]).

In addition, constraints-based programming also allows us to decipher regulators of reproduction for the pea aphid, an insect that is a pest on plants in the framework of the *MirNAdapt* project. In terms of biological output of the network studies on the pea aphid microRNAs, we have identified one new microRNA (apmir-3019, not present in any known species other than the pea aphid) who has more than 900 putative mRNA targets. All these targets, as well as apmir3019, are differentially expressed between sexual and asexual embryos [85], [119].

9.1.5. Regional partnership in health

Participants: Jean Coquet, Olivier Dameron, Victorien Delannée, Marine Louarn, Anne Siegel, Nathalie Théret, Pierre Vignet.

We also have a strong and long term collaboration in health, namely with the IRSET laboratory at Univ. Rennes 1. N. Théret, research director at INSERM, is hosted in the team to strengthen our collaborative projects. Our collaborations are acted by the co-supervised Ph-D theses of V. Delannée [14], M. Conan (Metagenotox project, funded by Anses) and J. Coquet [12]. This partnership was reinforced by the ANR contract Biotempo ended at the end of 2014. In 2015, the project of combining semantic web technologies and bi-clustering classification based on formal concept analysis was applied to systems biology within the PEPS CONFOCAL project. This scientific project has been recently pushed forward in the recent TGFSYSBio project funded by Plan Cancer on the modelling of the microenvironment of TGFbeta signaling network (P. Vignet has been recruited on this contract at the end of 2016).

A new application was initiated in 2017 through a collaboration with Rennes hospital, supported by a Inria-INSERM Ph-D thesis (M. Louarn).

9.2. National Initiatives

9.2.1. ANR Idealg

Participants: Meziane Aite, Arnaud Belcour, Jérémie Bourdon, Marie Chevallier, François Coste, Damien Eveillard, Clémence Frioux, Jeanne Got, Julie Laniau, Jacques Nicolas, Anne Siegel.

IDEALG is one of the five laureates from the national call 2010 for Biotechnology and Bioresource and will run until 2020. It gathers 18 different partners from the academic field (CNRS, IFREMER, UEB, UBO, UBS, ENSCR, University of Nantes, INRA, AgroCampus), the industrial field (C-WEED, Bezhin Rosko, Aleor, France Haliotis, DuPont) as well as a technical center specialized in seaweeds (CEVA) in order to foster biotechnology applications within the seaweed field. We are participating to the tasks related to the establishment of a virtual platform for integrating omics studies on seaweeds and the integrative analysis of seaweed metabolism, in cooperation with SBR Roscoff. Major objectives are the building of brown algae metabolic maps, flux analysis and the selection of symbiotic bacteria to brown algae. We will also contribute to the prediction of specific enzymes (sulfatases) [\[More details\]](#).

9.2.2. Programs funded by research institutions

9.2.2.1. PEPS PEPS: a platform for supporting studies in pharmaco-epidemiology using medico-administrative databases

Participants: Olivier Dameron, Yann Rivault.

As a partner of the PEPS platform, several teams at Inria Rennes develop generic methods supporting efficient and semantically-rich queries for pharmaco-epidemiology studies on medico-administrative databases. The leader is Thomas Guyet (Inria team Lacodam). We showed that Semantic Web technologies are technically suited for representing patients' data from medico-administrative databases as RDF and querying them using SPARQL. We also demonstrated that this approach is relevant as it supports the combination of patients' data with hierarchical knowledge in order to address the problem of reconciling precise patients data with more general query criteria [\[45\]](#), [\[99\]](#), [\[98\]](#). This work is mostly conducted by Yann Rivault, whose PhD thesis is supervised by Olivier Dameron and Nolwenn LeMeur (Ecole des Hautes Etudes en Santé Publique).

9.2.2.2. Cancer Plan: TGFSysBio

Participants: Jean Coquet, Olivier Dameron, Maxime Folschette, Vijay Ingalalli, Jacques Nicolas, Anne Siegel, Nathalie Théret, Pierre Vignet.

The TGFSYSBIO project aims to develop the first model of extracellular and intracellular TGF-beta system that might permit to analyze the behaviors of TGF-beta activity during the course of liver tumor progression and to identify new biomarkers and potential therapeutic targets. Based on collaboration with Jérôme Feret from ENS, Paris, we will combine a rule-based model (Kappa language) to describe extracellular TGF-beta activation and large-scale state-transition based (Cadbiom formalism) model for TGF-beta-dependent intracellular signaling pathways. The multi-scale integrated model will be enriched with a large-scale analysis of liver tissues using shotgun proteomics to characterize protein networks from tumor microenvironment whose remodeling is responsible for extracellular activation of TGF-beta. The trajectories and upstream regulators of the final model will be analyzed with symbolic model checking techniques and abstract interpretation combined with causality analysis. Candidates will be classified with semantic-based approaches and symbolic bi-clustering technics. The project is funded by the national program "Plan Cancer - Systems biology" from 2015 to 2018.

9.2.2.3. ANR Samosa

Participants: Mael Conan, Damien Eveillard, Jeanne Got, Anne Siegel.

Oceans are particularly affected by global change, which can cause e.g. increases in average sea temperature and in UV radiation fluxes onto ocean surface or a shrinkage of nutrient-rich areas. This raises the question of the capacity of marine photosynthetic microorganisms to cope with these environmental changes both at short term (physiological plasticity) and long term (e.g. gene alterations or acquisitions causing changes in fitness in a specific niche). *Synechococcus* cyanobacteria are among the most pertinent biological models to tackle this question, because of their ubiquity and wide abundance in the field, which allows them to be studied at all levels of organization from genes to the global ocean.

The SAMOSA project is funded by ANR from 2014 to 2018, coordinated by F. Gaczarek at the Station Biologique de Roscoff/UPMC/CNRS. The goal of the project is to develop a systems biology approach to characterize and model the main acclimation (i.e., physiological) and adaptation (i.e. evolutionary) mechanisms involved in the differential responses of *Synechococcus* clades/ecotypes to environmental fluctuations, with the goal to better predict their respective adaptability, and hence dynamics and distribution, in the context of global change. For this purpose, following intensive omics experimental protocol driven by our colleagues from — Station Biologique de Roscoff —, we aim at constructing a gene network model sufficiently flexible to allow the integration of transcriptomic and physiological data.

9.2.2.4. ANSES Mecagenotox

Participants: Victorien Delannée, Mael Conan, Anne Siegel, Nathalie Théret.

The objective of Mecagenotox project is to characterize and model the human liver ability to bioactivate environmental contaminants during liver chronic diseases in order to assess individual susceptibility to xenobiotics. Indeed, liver pathologies which result in the development of fibrosis are associated with a severe dysfunction of liver functions that may lead to increased susceptibility against contaminants. In this project funded by ANSES and coordinated by S. Langouet at IRSET/inserm (Univ. Rennes 1), we will combine cell biology approaches, biochemistry, biophysics, analytical chemistry and bioinformatics to 1) understand how the tension forces induced by the development of liver fibrosis alter the susceptibility of hepatocytes to certain genotoxic chemicals (especially Heterocyclic Aromatic Amines) and 2) model the behavior of xenobiotic metabolism during the liver fibrosis. Our main goal is to identify "sensitive" biomolecules in the network and to understand more comprehensively bioactivation of environmental contaminants involved in the onset of hepatocellular carcinoma.

9.2.3. Programs funded by Inria

9.2.3.1. ADT Complex-biomarkers and ADT Proof of concept

Participants: Jeanne Got, Marie Chevallier, Meziane Aite, Anne Siegel.

These projects started in Oct. 2014 and aims at designing a working environment based on workflows to assist molecular biologists to integrate large-scale omics data on non-classical species. The main goal of the workflows will be to facilitate the identification of set of regulators involved in the response of a species when challenged by an environmental stress. Applications target extremophile biotechnologies (biomining) and marine biology (micro-algae).

9.2.3.2. IPL Algae in silico

Participants: Meziane Aite, Jeanne Got, Julie Laniau, Anne Siegel.

Microalgae are recognized for the extraordinary diversity of molecules they can contain: proteins, lipids (for biofuel or long chain polyunsaturated fatty acids for human health), vitamins, antioxidants, pigments. The project aims at predicting and optimizing the productivity of microalgae. It involves mainly the inria teams BIOCORE (PI), ANGE and DYLISS. Dyliss is in charge of the identification of physiological functions for microalgae based on their proteomes, which is undergone through the reconstruction of the metabolic network of the *T. lutea* microalgae.

9.2.3.3. IPL Neuromarkers

Participants: Olivier Dameron, Anne Siegel.

The project aims at identifying the main markers of pathologies through the production and the integration of imaging and bioinformatics data. It involves mainly the inria teams Aramis (PI) Dyliss, Genscale and Bonsai. Dyliss is in charge of facilitating the interoperability of imaging and bioinformatics data.

9.2.3.4. FederatedQueryScaler (Exploratory Research Action)

Participants: Olivier Dameron, Xavier Garnier, Vijay Ingalalli.

This project aims at developing automatic generation of abstractions for biological data and knowledge in order to scale federated queries in the context of semantic web technologies. It is a common project with the WIMMICS Inria team.

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

Partner: Aachen university (Germany)

Title: Modeling the logical response of a signalling network with constraints-programming.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. Other IIL projects

We have a cooperation with Univ. of Chile (MATHomics, A. Maass) on methods for the identification of biomarkers and software for biochip design. It aims at combining automatic reasoning on biological sequences and networks with probabilistic approaches to manage, explore and integrate large sets of heterogeneous omics data into networks of interactions allowing to produce biomarkers, with a main application to biomining bacteria. The program is co-funded by Inria and CORFO-chile from 2012 to 2016. In this context, Integrative-BioChile was an Associate Team between Dyliss and the Laboratory of Bioinformatics and Mathematics of the Genome hosted at Univ. of Chile funded from 2011 to 2016. The collaboration is now supported by Chilean programs.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- **Niger.** University of Maradi [O. Abdou-Arbi]
- **Poland.** Politechnika Wroclawska [W. Dyrka]
- **India.** VIT University, Vellore [K. Lakshmanan]

9.5.2. Visits to International Labs

- **Chile.** University of Chile [A. Siegel, C. Frioux]

9.5.2.1. Research Stays Abroad

- **Germany.** University of Potsdam [L. Bourneuf, 3 months (nov 2017 - jan 2018)]

DYOGENE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

DYOGENE is associated to the Laboratory of Information, Networking and Communication Sciences (LINCS) <http://www.lincs.fr/> co-founded in 2010 by Inria, Institut Mines-Télécom and UPMC, with Bell Labs Nokia (formerly Alcatel-Lucent) and SystemX joining it as strategic partners in 2011 and 2014, respectively. The LINCS is dedicated to research and innovation in the domains of future information and communication networks, systems and services.

9.2. National Initiatives

9.2.1. GdR GeoSto

Members of Dyogene participate in Research Group GeoSto (Groupement de recherche, GdR 3477) <http://gdr-geostoch.math.cnrs.fr/> on Stochastic Geometry led by Pierre Calka [Université de Rouen], Viet Chi Tran [Université de Lille] and David Coupier [Université de Valenciennes].

This is a collaboration framework for all French research teams working in the domain of spatial stochastic modeling, both on theory development and in applications.

9.2.2. GdR IM

Members of Dyogene participate in GdR-IM (Informatique-Mathématiques), <https://www.gdr-im.fr/>, working groups ALEA and SDA2 (Systèmes dynamiques, Automates et Algorithmique).

9.2.3. GdR RO

Members of Dyogene participate in GdR-RO (Recherche Opérationnelle; GdR CNRS 3002), <http://gdrro.lip6.fr/>, working group COSMOS (Stochastic optimization and control, modeling and simulation), lead by A. Busic and E. Hyon (LIP 6); <http://gdrro.lip6.fr/?q=node/78>

9.2.4. PGM0

Gaspard Monge Program for Optimization and Operations Research project Decentralized control for renewable integration in smart-grids (2015-17). PI: A. Busic.

9.2.5. ANR MARMOTE

Markovian Modeling Tools and Environments - coordinator: Alain Jean-Marie (Inria Maestro); local coordinator (for partner Inria Paris-Rocquencourt): A. Bušić; Started: January 2013; Duration: 48 months; partners: Inria Paris-Rocquencourt (EPI DYOGENE), Inria Sophia Antipolis Méditerranée (EPI MAESTRO), Inria Grenoble Rhône-Alpes (EPI MESCAL), Université Versailles-St Quentin, Telecom SudParis, Université Paris-Est Creteil, Université Pierre et Marie Curie.

The aim of the project was to realize a modeling environment dedicated to Markov models. One part developed the Perfect Simulation techniques, which allow one to sample from the stationary distribution of the process. A second one developed parallelization techniques for Monte Carlo simulation. A third one developed numerical computation techniques for a wide class of Markov models. All these developments were integrated into a programming environment allowing the specification of models and their solution strategy. Several applications have been studied in various scientific disciplines: physics, biology, economics, network engineering.

The project terminated in October 2017.

9.2.6. ANR JCJC PARI

Probabilistic Approach for Renewable Energy Integration: Virtual Storage from Flexible Loads. The project started in January 2017. PI — A. Bušić. This project is motivated by current and projected needs of a power grid with significant renewable energy integration. Renewable energy sources such as wind and solar have a high degree of unpredictability and time variation, which makes balancing demand and supply challenging. There is an increased need for ancillary services to smooth the volatility of renewable power. In the absence of large, expensive batteries, we may have to increase our inventory of responsive fossil-fuel generators, negating the environmental benefits of renewable energy. The proposed approach addresses this challenge by harnessing the inherent flexibility in demand of many types of loads. The objective of the project is to develop decentralized control for automated demand dispatch, that can be used by grid operators as ancillary service to regulate demand-supply balance at low cost. We call the resource obtained from these techniques virtual energy storage (VES). Our goal is to create the necessary ancillary services for the grid that are environmentally friendly, that have low cost and that do not impact the quality of service (QoS) for the consumers. Besides respecting the needs of the loads, the aim of the project is to design local control solutions that require minimal communications from the loads to the centralized entity. This is possible through a systems architecture that includes the following elements: i) local control at each load based on local measurements combined with a grid-level signal; ii) frequency decomposition of the regulation signal based on QoS and physical constraints for each class of loads.

9.3. International Initiatives

9.3.1. PARIS

Title: Probabilistic Algorithms for Renewable Integration in Smart Grid

International Partner (Institution - Laboratory - Researcher):

University of Florida (United States) - Laboratory for Cognition & Control in Complex Systems - Sean Meyn.

Start year: 2015

See also: <http://www.di.ens.fr/~busic/PARIS/>

The importance of statistical modeling and probabilistic control techniques in the power systems area is now evident to practitioners in both the U.S. and Europe. Renewable generation has brought unforeseen volatility to the grid that require new techniques in distributed and probabilistic control. In a series of recent papers the two PIs have brought together their complementary skills in optimization, Markov modeling, simulation, and stochastic networks that may help to solve some pressing open problems in this area. This new research also opens many exciting new scientific questions.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

- O. Mirsadeghi [Sharif University, Tehran],
- V. Anantharam [UC Berkeley],
- D. Yogeshwaran [Indian Statistical Institute].

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Venkat Anantharam [UC Berkeley, from Jun 2017 until Jul 2017]
- Prabir Barooah [University of Florida, from May 2017 until Jun 2017]
- Milan Bradonjic [Nokia, until Jan 2017]

- Adithya Munegowda Devraj [University of Florida, from Aug 2017 until Sep 2017]
- Christian Hirsch [LMU Munich, Sep 2017]
- Yuting Ji [Stanford, Oct 2017]
- Marc Olivier Buob [Bell Labs (Alcatel)]
- Josu Doncel [University of the Basque Country, Jul 2017]
- Mir Omid Haji Mirsadeghi [Sharif University, Tehran]

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- B. Blaszcyszyn, October 1st – December 15th, Specially Appointed Professor at The School of Computing, Tokyo Institute of Technology.

ECUADOR Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. MAIDESC

Ecuador is coordinator of the ANR project MAIDESC, with Inria team Gamma3, University of Montpellier II, CEMEF-Ecole des Mines, Inria-Bordeaux, Lemma and Transvalor. MAIDESC concentrates on mesh adaptation and in particular meshes for interfaces, third-order accuracy, meshes for boundary layers, and curved meshes. Project MAIDESC terminated in november 2017.

8.2. International Initiatives

8.2.1. Inria International Labs

Ecuador participates in the Joint Laboratory for Exascale Computing (JLESC) together with colleagues at Argonne National Laboratory. Laurent Hascoët visited Argonne National Laboratory, december 11-18.

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. Aster

- Title: Algorithms and Software for Third gEneration Rna sequencing
- Coordinator: H  l  ne Touzet, University of Lille and Inria EPI Bonsai.
- ERABLE participants: Vincent Lacroix (ERABLE coordinator), Clara Beno  t-Pilven, Audric Cologne, Alex di Genova, Leandro I. S. de Lima, Arnaud Mary, Marie-France Sagot, Camille Sessegolo, Blerina Sinimeri.
- Type: ANR (2016-2020).
- Web page: <http://bioinfo.cristal.univ-lille.fr/aster/>.

8.1.1.2. ExHyb

- Title: Exploring genomic stability in hybrids
- Coordinator: C. Vieira
- ERABLE participant(s): C. Vieira
- Type: ANR (2014-2018)
- Web page: Not available

8.1.1.3. GraphEn

- Title: Énumération 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/>

8.1.1.4. 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

8.1.1.5. *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

8.1.1.6. IMetSym

- Title: Immune and Metabolic Control in Intracellular Symbiosis of Insects

- Coordinator: A. Heddi
- ERABLE participant(s): H. Charles, S. Colella
- Type: ANR Blanc (2014-2017)
- Web page: Not available

8.1.1.7. *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

8.1.1.8. *Suzukill*

- Title: Managing cold tolerance and quality of mass-produced *Drosophila suzukii* flies to facilitate the application of biocontrol through incompatible and sterile insect techniques
- Coordinator: H. Colinet
- ERABLE participant(s): F. Vavre
- Type: ANR PCRI (2015-2018)
- Web page: Not available

8.1.1.9. *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

8.1.2. *ADT Inria*

8.1.2.1. *ADT Inria Kirikomix*

- Main objective: Development of a portal to increase the visibility of the tools and resources elaborated by Erable around the analysis – using omics data – of metabolic networks modelled by hypergraphs, and enable to visualise the results. (the web page is for now private, it will be made public later in the project).
- Duration: 2016-2017, renewable one more year.
- Person responsible for ADT: Arnaud Mary with David Parsons (Inria).
- Beneficiary of ADT: Martin Wannagat.
- Funds received: Salary for engineer.

8.1.3. *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.

8.1.3.1. *Advanced computational methodologies for the analysis of biomedical data*

- Title: Advanced computational methodologies for the analysis of biomedical data
- Coordinator: P. Milazzo
- ERABLE participant(s): R. Grossi, N. Pisanti
- Type: PRA, MIUR PRIN, Italian Ministry of Research National Projects (2017-2018)
- Web page: Not available

8.1.3.2. *Advanced Tools and Techniques for the analysis of criminal networks*

- Title: Advanced Tools and Techniques for the analysis of criminal networks
- Coordinator: G. Italiano
- ERABLE participant(s): G. Italiano
- Type: LEONARDO SpA (2015-2018)
- Web page: Not available

8.1.3.3. *Amanda*

- Title: Algorithmics for MAssive and Networked DAta
- Coordinator: G. Di Battista (University of Roma 3)
- ERABLE participant(s): R. Grossi, G. Italiano, N. Pisanti
- Type: MIUR PRIN, Italian Ministry of Research National Projects (2014-2017)
- Web page: <http://www.dia.uniroma3.it/~amanda/>

8.1.3.4. *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>

8.1.3.5. *Statistical Models for Structural Genetic Variants in the Genome of the Netherlands*

- Title: Statistical Models for Structural Genetic Variants in the Genome of the Netherlands
- Coordinator: A. Schönhuth
- ERABLE participant(s): A. Schönhuth
- Type: Nederlandse Wetenschappelijke Organisatie (NWO) (2013-2018)
- Web page: Not available

8.1.3.6. *TALS and splicing*

- Title: Development of bioinformatic methods for the analysis of splicing events in patients with the Taybi-Linder Syndrome (TALS)
- Coordinator: P. Edery
- ERABLE participant(s): C. Benoît-Pilven, Audric Cologne, V. Lacroix
- Type: INSERM
- Web page: Not available

8.2. European Initiatives

8.2.1. *FP7 & H2020 Projects*

8.2.1.1. *MicroWine*

- Title: Microbial metagenomics and the modern wine industry

- Duration: January 2015 - January 2019
- Coordinator: Lars Hestbjerg Hansen, University of Copenhagen
- ERABLE participant(s): A. Marchetti-Spaccamela, A. Mary, H. T. Pusa, M.-F. Sagot, L. Stougie
- Type: H2020-MSCA-ETN-2014
- Web page: <https://team.inria.fr/erable/en/microwine/> and <http://www.microwine.eu/>

8.2.2. Collaborations in European Programs, Except FP7 & H2020

8.2.2.1. Combinatorics of co-evolution

- Title: The combinatorics of co-evolution
- Duration: 2015 - 2018
- Coordinator: Katharina Huber, University of Warwick, UK
- ERABLE participant(s): M.-F. Sagot, B. Sinaimeri
- Type: The Royal Society
- Web page: not available

8.2.3. Collaborations with Major European Organisations

By itself, ERABLE is built from what initially were collaborations with some major European Organisations (CWI, Sapienza University of Rome, Universities of Florence and Pisa, Free University of Amsterdam) and now has become a European Inria Team.

8.3. International Initiatives

8.3.1. Inria International Labs

ERABLE participates in a project within the Inria-Chile CIRIC (Communication and Information Research and Innovation Center) titled “Omics Integrative Sciences”. The main objectives of the project are the development and implementation of mathematical and computational methods and the associated computational platforms for the exploration and integration of large sets of heterogeneous omics data and their application to the production of biomarkers and bioidentification systems for important Chilean productive sectors. The project started in 2011 and is coordinated in Chile by Alejandro Maass, Mathomics, University of Chile, Santiago. It is in the context of this project that we hosted Alex di Genova in ERABLE as a PhD sandwich student (for 18 months in 2015-2017). Alex has now defended his PhD. He was co-supervised by Gonzalo Ruz from the University Adolfo Ibañez, Santiago, Chile. He now, since Dec 2017, joined again ERABLE as postdoc.

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

ALEGRIA

- Title: ALgorithms for ExplorinG the inteRactions Involving Apicomplexa and kinetoplastida
- Duration: 2015-2017
- Coordinator: On the Brazilian side, Andréa Rodrigues Ávila; on the French side, Marie-France Sagot
- ERABLE participant(s): M. Ferrarini, L. Ishi Soares de Lima, A. Mary, H. T. Pusa, M.-F. Sagot, M. Wannagat
- Web page: <http://team.inria.fr/erable/en/alegria/>

8.3.3. Participation in Other International Programs

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

ERABLE has a Stic AmSud project that started in 2016 for 2 years. The title of the project is “Methodological Approaches Investigated as Accurately as possible for applications to biology”, and its acronym MAIA. This project involves the following partners: (France) Marie-France Sagot, ERABLE Team, Inria; (Brazil) Roberto Marcondes César Jr, Instituto de Matemática e Estatística, Universidade de São Paulo; and Paulo Vieira Milreu, TecSinapse; (Chile) Vicente Acuña, Centro de Modelamiento Matemático, Santiago; and Gonzalo Ruz, University Adolfo Ibañez, Santiago. One of them, TecSinapse, is an industrial partner. MAIA has two main goals: one methodological that aims to explore how accurately hard problems can be solved theoretically by different approaches – exact, approximate, randomised, heuristic – and combinations thereof, and a second that aims to better understand the extent and the role of interspecific interactions in all main life processes by using the methodological insights gained in the first goal and the algorithms developed as a consequence. A succinct web page for MAIA is available at this address: <http://team.inria.fr/erable/en/projects/maia/>.

ERABLE also participated to the BASIS project. This was funded by the European Community Seventh Framework Programme (Grant 242006 - 2010-2015). It was led by Dr. Mike Stratton and involved six European countries. It was primarily focused on ER+/HER2- breast cancers, but during the course of the project, was merged with the HER2+ French-ICGC and triple negative UK-ICGC projects, resulting in the analysis of the whole spectrum of breast cancers. The French group was initiated by Dr. Gilles Thomas and was pursued by Alain Viari after the loss of Dr. Thomas in 2014. The project resulted in the sequencing and thorough analysis of 560 breast cancer whole genomes (Nik-Zainai *et al.*, *Nature*, 534:47-54, 2016), including 75 HER2+ performed by the French working group (Ferrari *et al.*, *Nature Communications*, 7, 2016) and funded by the Institut National du Cancer and by Inserm.

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 other Portuguese partner.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

In 2017, ERABLE greeted the following International scientists:

- In France: Katharina Huber and Vincent Moulton (University of Warwick, UK), Ifigeneia Kyrkou (Aarhus University, Denmark), three members of the LIA LIRIO (Arnaldo Zaha from the Federal University of Rio Grande do Sul, Maria Cristina Motta from the Federal University of Rio de Janeiro, and Ana Tereza Vasconcelos from the LNCC, both in Brazil), two members of the Inria Associated Team Alegria (Andréa Ávila and Helisson Faoro), Ariel Silber (University of São Paulo, Brazil), Susana Vinga and various members of her team (IST Portugal).
- In Italy: May Alzamel, Lorraine A. K. Ayad, Panagiotis Charalampopoulos, Costas Iliopoulos, and Solon Pissis (King’s College, London, UK) visited the University of Pisa as did Luca Cardelli (Microsoft Research), Giulia Bernardini (University of Milano Bicocca), Anthony Cox (Illumina) and Raffaele Giancarlo (University of Palermo); Loukas Georgiadis (University of Ioannina, Greece), Shahbaz Khan (University of Vienna, Austria), and Adam Karczmarsz, (University of Warsaw, Poland) visited the University of Rome Tor Vergata.
- In the Netherlands: Martin Dyer (Leeds University, England), Frans Schalekamp (Cornell University, Ithaca, New York, USA), and Anke van Zuylen (College of William and Mary, Virginia, USA) visited the FU & CWI.

8.4.2. Internships

In 2017, ERABLE greeted the following internship students:

- In France: Irene Ziska, Master Free University Berlin (6 months).

8.4.3. Visits to International Teams

In 2017, members of ERABLE visited the following International teams:

- From France: Visit to members of the LIA LIRIO at the LNCC in Brazil, the Department of Computer Science of the University of São Paulo and to members of the TecSinapse company in Brazil, Susana Vinga and members of her team (IST Portugal).

EVA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

- EVA has a collaboration with Vedecom. **Paul Muhlethaler** supervises Younes Bouchaala's PhD funded by Vedecom. This PhD aims at studying vehicle-to-vehicle communication to improve roads safety.
- EVA has an ongoing collaboration with SODEAL company, which exploits the Cap d'Agde marina, as part of the SmartMarina project.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

The H2020 following projects are ongoing:

- H2020 F-Interop, <http://f-interop.eu/>, Nov 2015 – Oct 2018.
- H2020 ARMOUR, <https://www.armour-project.eu/>, Feb 2016 – Jan 2018.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

9.2.2.1. Collaborations with Major European Organizations

Inria-EVA has collaboration in 2017 with ETSI (the European Telecommunications Standards Institute) to organize the F-Interop 6TiSCH Interop Event in July 2017 in Prague.

9.3. International Initiatives

9.3.1. Inria International Labs

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

9.3.2.1. REALMS

- Title: Real-Time Real-World Monitoring Systems
- International Partner (Institution - Laboratory - Researcher):
 - University of California Berkeley (United States) - Civil and Environmental Engineering - Steven Glaser
 - University of Michigan (United States) - Civil and Environmental Engineering - Branko Kerkez
- Start year: 2015
- See also: <http://glaser.berkeley.edu> et <http://www-personal.umich.edu/~bkerkez/>
- The Internet of Things revolution prompted the development of new products and standards; The IEEE802.15.4e (2012) standard introduced the Time Synchronized Channel Hopping (TSCH) which can provide end-to-end reliability of 99.999 % and an energy autonomy of many years. This exceptional performance prompted the IETF to create the 6TiSCH working group to standardize the integration of TSCH networks in the Internet. While the first experimental data have highlighted the great robustness of these networks, there is no data of a real network, accessible in real time, on a large scale and over a long period. Such data is needed to better model network performance and produce better products and standards. Teams of Professors Glaser and Kerkez are successfully deploying such networks to study mountain hydrology, monitor water quality and manage rainwater in urban environments. A model is missing to assist in the deployment and operation of these networks, as well as to monitor an operational network.

9.3.2.2. DIVERSITY

- Title: Measuring and Exploiting Diversity in Low-Power Wireless Networks
- International Partner (Institution - Laboratory - Researcher):
 - University of Southern California (United States) - Autonomous Networks Research Group (ANRG) - Bhaskar Krishnamachari
- Start year: 2016
- The goal of the DIVERSITY associate team is to develop the networking technology for tomorrow's Smart Factory. The two teams comes with a perfectly complementary background on standardization and experimentation (Inria-EVA) and scheduling techniques (USC-ANRG). The key topic addressed by the joint team will be networking solutions for the Industrial Internet of Things (IIoT), with a particular focus on reliability and determinism.

9.3.3. Inria International Partners

9.3.3.1. Declared Inria International Partners

Inria-EVA has a long-standing Memorandum of Understanding with the OpenMote company (<http://www.openmote.com/>), which runs until 2020. OpenMote emerged as a spin-off of the OpenWSN project, co-lead by **Thomas Watteyne** and Prof. Xavier Vilajosana, Professor at the Open University of Catalonia and Chief Technical Officer at OpenMote.

The collaboration has been ongoing since 2012 and at the time of writing has resulted in:

- Joint academic publications, including 7 journal articles, 1 letter, 1 book chapter, 5 conference papers, 2 tutorials and invited talks.
- Joint standardization activities, in particular in the IETF 6TiSCH working group, co-chaired by **Thomas Watteyne** and for which Prof. Xavier Vilajosana is a key contributor. This activity has resulted in the joint participation in 12 IETF face-to-face meetings, joint participation in over 100 audioconferences, co-authorship of 3 Internet-Drafts and joint organization of 2 interop events.
- Joint software development, as both institutions closely collaborate in the maintenance, development, promotion and research along the OpenWSN project, including the development of the protocol stack, the integration of novel hardware technologies, the support to the community and the participation in standardization activities and interoperability events.

This MOU is NOT a commitment of funds by any part.

9.3.3.2. Informal International Partners

The Inria-EVA collaborates extensively with Prof. Pister's group at UC Berkeley on the OpenWSN and Smart Dust projects. This activity translated into several members of the Pister team visiting Inria-EVA and vice-versa in 2017.

9.3.4. Participation in Other International Programs

9.3.4.1. International Initiatives

- **PEACH**
- Title: PrEcision Agriculture through Climate researchH
- International Partners (Institution - Laboratory - Researcher):
 - Universidad Diego Portales (Chile) - Diego Dujovne
 - Universidad Tecnológica de Mendoza (Argentina) - Gustavo Mercado
- Duration: 2016 - 2017

- In 2013, 85% of the peach production in the Mendoza region (Argentina) was lost because of frost. Because less fruit was produced in the region, 600.000 less work days were needed to process the harvest between November 2013 and March 2014, a reduction in work force of 10.600 people. Across the Mendoza region, frost has caused a loss of revenue of 950 million Argentine pesos - roughly 100 million USD - in the peach business alone. A frost event happens when the temperature is so low that the crops cannot recover their tissue or internal structure from the effects of water freezing inside or outside the plant. For the peach production, a critical period is when the trees are in bloom and fruit set (Aug./Sept. in Mendoza), during which the temperature needs to be kept above -3 C. Even a few hours below that temperature causes flowers to fall, preventing fruits to grow. Because of the huge economic impact, countermeasures exist and are used extensively. Today, virtually all industrial peach orchards are equipped with a small number of meteorological stations which monitor temperature and humidity. If the temperature drops dangerously low, the most effective countermeasures is to install a number of furnaces in the orchard (typically coal-fueled) and fly helicopters above the orchard to distribute the heat and avoid cold spots. This countermeasure is effective, but suffers from false negatives (the helicopters are called in, but there is no frost event) and false positives (the meteorological stations don't pick up a frost event happening in some part of the orchard). What is missing is a dense real-time monitoring solution deployed in the orchard, and feeding a frost prediction model. For this, having a couple of meteorological stations doesn't provide the measurement density needed. Frost events are micro-climatic: cold and hot air have a different density, wind blows irregularly between the trees, so different parts of an orchard are affected very differently by frost. What is needed are a large number of sensing points (humidity, temperature, wind speed), at different elevations, throughout the orchard. Low-power wireless mesh networking technology has evolved significantly over recent years. With this technology, a node is the size of a deck of cards, is self-contained and battery-operated. When switched on, nodes form a multi-hop low-power wireless network, automatically. Off-the-shelf commercial solutions are available today which offer >99.999% end-to-end data reliability and a decade of battery lifetime. Rather than being installed at a fixed location, these nodes can be hung directly in the trees. A network is deployed in an orchard in a matter of hours, and if needed, sensing points can be moved to improve the accuracy of the prediction model in minutes. And this solution is cheap, too: for the price one meteorological station, one can build 10 low-power wireless mesh sensing nodes. We use machine learning and pattern recognition to build an micro-climate predictive model by continuously analyzing the gathered sensor data in real time. This model generates early frost warnings. If successful, the solution can be extended to other crops, and other regions. The goal of this project is to dramatically increase the predictability of frost events in peach orchards by using dense monitoring using low-power wireless mesh networking technology. The project is designed to be completed in 24-month, and involves: (1) building a dense sensing solution based on off-the-shelf networking and sensing products, (2) developing accurate frost prediction models based on the sensing data gathered, (3) conducting real-world deployments on peach orchards in the Mendoza region. This project brings together world experts in agronomic and networking fields in a symbiotic manner. Perfectly in line with the philosophy of STIC-AmSud, the teams are already conducting cutting-edge research in their respective fields the funding we are applying for would enable the teams to collaborate together in a cross-disciplinary manner.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

1. *David Burnett (UC Berkeley)*, Micro-Motes, collaboration with **Thomas Watteyne**, 30 November 2017.
2. *Prof. Xavi Vilajosana (UOC/OpenMote)*, OpenMote B, 6TiSCH, collaboration with **Thomas Watteyne** and Tengfei Chang, 20 November – 19 December 2017.
3. *Pablo Modernell (UOC)*, F-Interop, collaboration with Remy Leone and **Thomas Watteyne**, 20–27 November 2017.

4. *Malisa Vucinic (U Montenegro)*, 6TiSCH Security, collaboration with **Thomas Watteyne**, 06-24 November 2017.
5. *Carlos Oroza (UC Berkeley)*, Machine-Learning Based Placement Strategy, collaboration with **Thomas Watteyne**, 18 October – 06 November 2017.
6. *Prof. Xavi Vilajosana (UOC/OpenMote)*, OpenMote B, the greatest thing since sliced bread, collaboration with **Thomas Watteyne** and Tengfei Chang, 19–20 September 2017.
7. *Felipe Lallane (Inria Chile)*, Exploiring collaboration opportunities with Inria-Chile around IoT, collaboration with **Thomas Watteyne**, 19–20 June 2017.
8. *Cristina Cano (UOC, Barcelona)*, Wireless Coexistence, collaboration with **Thomas Watteyne**, 16 May 2017.
9. *Ryan Grammenos (Univ. College London)*, Machine Learning for 6TiSCH networks, collaboration with Keoma Brun-Laguna and **Thomas Watteyne**, 15–19 May 2017.
10. *Craig Schindler (UC Berkeley)*, Industrial Process Control with 6TiSCH, collaboration with Tengfei Chang and **Thomas Watteyne**, 9–19 May 2017.
11. *Pedro Henrique Gomez (USC)*, Exploiting Diversity in 6TiSCH Networks, collaboration with Tengfei Chang and **Thomas Watteyne**, 5 June – 9 July 2017.
12. *Prof. Diego Dujovne (UDP, Chile)*, Advanced Scheduling in 6TiSCH networks, collaboration with **Thomas Watteyne**, 5–22 July 2017.
13. *Prof. Steven Glaser (UC Berkeley)*, Real-time real-world remote sensing, collaboration with Ziran Zhang, Keoma Brun-Laguna, **Thomas Watteyne**, 27 May – 3 June 2017.
14. *Prof. Xavi Vilajosana (UOC/OpenMote)*, OpenWSN core-team meet-up, collaboration with **Thomas Watteyne** and Tengfei Chang, 3–7 April 2017.

9.4.2. Internships

1. **Felipe Moran Correa Meyer**, sub-100 μ s synchronization and sub-m RTLS with SmartMesh IP (ENSTA), September 2017 – August 2018.
2. **Fatima Adda**, simulation of active signaling in TDMA networks (Paris VI), March-August 2017.
3. **Nasr Khouaja Mohamed Hassine**, positioning with wireless networks (ENSTA), April-June 2017.

9.4.3. Visits to International Teams

9.4.3.1. Research Stays Abroad

- **Thomas Watteyne** spent the month of August 2017 at UC Berkeley, working with Prof. Glaser on the SnowHow project, and with Prof. Pister on Smart Dust and OpenWSN.
- Keoma Brun-Laguna spent summer 2017 with the Dust Networks product team at Analog Devices in Silicon Valley as part of an internship.

EX-SITU Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. MoveIT – Modeling the Speed/Accuracy Trade-Off of Human Aimed Movement with the Tools of Information Theory

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2015-2018

Coordinator: Olivier Rioul (Institut Mines Telecom)

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to conduct fundamental studies of aimed movements based on information theory. The project studies the interaction phenomena involved in pointing, in order to discover novel, more effective pointing techniques. This project funds Wanyu Liu, a joint Ph.D. student between the COMELEC and VIA groups at Institut Mines Telecom and ExSitu.

8.1.2. SensoMotorCVE – Sensor-motor Interface for Collaborative Virtual Environments with Heterogeneous Devices: Application to Industrial Design

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2014-2017

Coordinator: Patrick Bourdot (LIMSI-CNRS)

Partners: Univ. Paris-Sud, Inria, CNRS

Inria contact: Cédric Fleury

Abstract: In the context of collaborative virtual environments, the goal of this project is to develop a sensorimotor interface model for CAD data manipulation that supports heterogeneous interactive systems such as wall-sized displays or immersive virtual reality rooms. This project funds Yujiro Okuya, a joint Ph.D. student between the VENISE group at LIMSI and ExSitu.

8.1.3. An Augmented-Reality System for Collaborative Physical Modeling and Design

Type: Equipment

Funding: STIC Paris-Saclay

Duration: 2017-2018

Coordinator: Theophanis Tsandilas

Partners: Univ. Paris-Sud, Inria

Inria contact: Theophanis Tsandilas

Abstract: The goal of the project is to develop an augmented-reality system to support collaboration over 3D models and enhance digital-fabrication approaches. It is a collaboration with the AVIZ group and provides funding (8k) for equipment.

8.1.4. Le Plateau des Recherches Infinies

Type: Equipment and subcontracting

Funding: Learning Center Paris-Saclay

Duration: 2017-2018

Coordinator: Michel Beaudouin-Lafon

Partners: Univ. Paris-Sud

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project (30k) is to create an interactive installation presenting the portraits of a hundred researchers from Université Paris-Saclay. It is a collaboration with portrait photographer Didier Goupy. The installation is designed to be exhibited in various sites of Université Paris-Saclay until it is permanently installed in the Learning Center of Université Paris-Saclay. This project supported Shubhangi Gupta, an intern, for two months over the summer.

8.2. National Initiatives

8.2.1. *Investissements d'Avenir*

8.2.1.1. *Digiscope - Collaborative Interaction with Complex Data and Computation*

Type: EQUIPEX (Equipement d'Excellence)

Duration: 2011-2021

Coordinator: Michel Beaudouin-Lafon

Partners: FCS Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, Ecole Centrale Paris, Université Versailles - Saint-Quentin, ENS Cachan, Maison de la Simulation

Overall budget: 22.5 Meuros, including 6.7 Meuros public funding from ANR

Abstract: The goal of the project is to create ten high-end interactive rooms interconnected by high-speed networks and audio-video facilities to support remote collaboration across interactive visualization environments. The equipment will be open to outside users and targets four main application areas: scientific discovery, product lifetime management, decision support for crisis management, and education and training. Digiscope includes the existing WILD room, and funded the WILDER room. ExSitu contributes its expertise in the design and evaluation of advanced interaction techniques and the development of distributed software architectures for interactive systems. At the end of 2017, all ten rooms and the telepresence network are operational. The project was successfully evaluated by an international jury in June, 2017.

8.3. European Initiatives

8.3.1. *European Research Council (ERC)*

8.3.1.1. *Creating Human-Computer Partnerships*

Program: ERC Advanced Grant

Project acronym: CREATIV

Project title: Creating Human-Computer Partnerships

Duration: mois année début - mois année fin

Coordinator: Wendy Mackay

Abstract: CREATIV explores how the concept of co-adaptation can revolutionize the design and use of interactive software. Co-adaptation is the parallel phenomenon in which users both adapt their behavior to the system's constraints, learning its power and idiosyncrasies, and appropriate the system for their own needs, often using it in ways unintended by the system designer. A key insight in designing for co-adaptation is that we can encapsulate interactions and treat them as first class objects, called interaction instruments. This lets us focus on the specific characteristics of how human users express their intentions, both learning from and controlling the system. By making instruments co-adaptive, we can radically change how people use interactive systems, providing incrementally learnable paths that offer users greater expressive power and mastery of their technology. The initial goal of the CREATIV project is to fundamentally improve the learning and expressive capabilities of advanced users of creative software, offering significantly enhanced methods for expressing and exploring their ideas. The ultimate goal is to radically transform interactive systems for everyone by creating a powerful and flexible partnership between human users and interactive technology.

8.3.1.2. Unified Principles of Interaction

Program: ERC Advanced Grant

Project acronym: ONE

Project title: Unified Principles of Interaction

Duration: October 2016 - September 2020

Coordinator: Michel Beaudouin-Lafon

Abstract: The goal of ONE is to fundamentally re-think the basic principles and conceptual model of interactive systems to empower users by letting them appropriate their digital environment. The project addresses this challenge through three interleaved strands: empirical studies to better understand interaction in both the physical and digital worlds, theoretical work to create a conceptual model of interaction and interactive systems, and prototype development to test these principles and concepts in the lab and in the field. Drawing inspiration from physics, biology and psychology, the conceptual model combines *substrates* to manage digital information at various levels of abstraction and representation, *instruments* to manipulate substrates, and *environments* to organize substrates and instruments into digital workspaces.

8.4. International Initiatives

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

8.4.1.1. DECibel

Title: Discover, Express, Create – Interaction Technologies For Creative Collaboration

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical and Computer Engineering,
Center for Magnetic Resonance Research - Bjoern Hartmann

Start year: 2016

See also: <https://www.inria.fr/en/associate-team/decibel>

The DECibel associated team includes Inria's ExSitu and the CITRIS Connected Communities Initiative (CCI) at UC Berkeley. ExSitu explores extreme interaction, working with creative professionals and scientists who push the limits of technology to develop novel interactive technologies that offer new strategies for creative exploration. ExSitu's research activities include: developing underlying theory (co-adaptive instruments and substrates), conducting empirical studies (participatory design with creative professionals), and implementing interactive systems (creativity support tools). The CITRIS Connected Communities Initiative investigates collaborative discovery and design through new technologies that enhance education, creative work, and public engagement. It develops interactive tools, techniques and materials for the rapid design and prototyping of novel interactive products, expertise sharing among designers, and citizen science investigations. DECibel will combine the strengths of these two groups to investigate novel tools and technologies that support Discovery, Expressivity, and Creativity.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Mobile Life research team (KTH, Sweden) 20 researchers visited ExSitu in January, 2017.
- Susanne Bødker (Aarhus University, Denmark) visited ExSitu in April, 2017.
- Joanna McGrenere (University of British Columbia, Canada) Inria Chair, visited ExSitu in June-July, 2017.

8.5.1.1. Internships

- Alessandro Silacci, Haute Ecole d'Ingenierie et d'Architecture de Fribourg (Suisse), "Cross-Surface Expressive Gesture Interactions in Collaboration Scenarios": Michel Beaudouin-Lafon
- Shubhangi Gupta, "Design and Prototyping of Web Interface to the 'Plateau des Recherches Infinies' Installation": Michel Beaudouin-Lafon
- Alexander Eiselmayer, University of Zurich, "Touchstone II": Wendy Mackay and Michel Beaudouin-Lafon

FLOWERS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Poppy Education

Poppy Education

Program: Feder - Région Aquitaine

Duration: January 2014 - December 2017

Coordinator: PY Oudeyer, Inria Flowers

Partners: Inria Flowers

Funding: 1 million euros (co-funded by Feder/EU Commission, Region Aquitaine and Inria)

Poppy Education aims to create, evaluate and disseminate pedagogical kits “turnkey solutions” complete, open-source and low cost, for teaching computer science and robotics. It is designed to help young people to take ownership with concepts and technologies of the digital world, and provide the tools they need to allow them to become actors of this world, with a considerable socio-economic potential. It is carried out in collaboration with teachers and several official french structures (French National Education/Rectorat, Highschools, engineering schools, ...). It targets secondary education and higher education, scientific literacy centers, Fablabs.

Poppy robotic platform used in the project is free hardware and software, printed in 3D, and is intended primarily for:

- learning of computer science and robotics,
- introduction to digital manufacturing (3D printing ...)
- initiation to the integration of IT in physical objects in humanoid robotics, mechatronics.
- artistic activities.

Educational sectors covered by the project are mainly: Enseignement d’exploration ICN en seconde, enseignement ISN en terminale S et bientôt en 1ère , filière STI2D, MPS seconde. Web: <http://www.poppy-project.org/education> .

9.1.1.1. Perseverons Project

The Perseverons project (Perseverance with / by digital objects), carried by the university via the ESPE (Higher School of Teaching and Education) of Aquitaine, and by the Rectorate of Bordeaux via the DANE (Academic Delegation digital education), aims to measure the real effectiveness of digital techniques in education to improve school motivation and perseverance, and, in the long term, reduce dropout. The project proposes to analyze the real effects of the use of two types of objects, robots, tablets, by comparing the school and non-school contexts of the *fablabs*. He is one of the 22 winners <http://www.gouvernement.fr/efran-les-22-laureats> of the "E-Fran" call for projects (training, research and digital animation spaces), following the Monteil mission on digital education, as part of the Investissement d’Avenir 2 program <http://ecolenumerique.education.gouv.fr/2016/09/23/1244/>. Formed of 12 sub-projects, "perseverons" has many partnerships, especially with the Poppy Education project <http://perseverons.espe-aquitaine.fr/sp6-robotique-inria/>.

9.1.1.2. Partner schools

In 2017, we have 36 partner schools (show Fig 25). 15 directly from the Poppy Education project. 19 new establishments were equipped in September 2017 by the Perseverons project. 21 of these establishments are located in Gironde. We have 27 high schools, 5 middle school.

Attachement	Type	Name	Adresse	Tel	Web
Poppy Éducation	High School	Alfred Kastler	14 Avenue de l'Université,33402 Talence, France	+33 5 57 35 40 70	http://www.lyceekastler.fr/
Poppy Éducation	Middle School	Anatole France	28 Rue des Micocouliers,33410 Cadillac, France	+33 5 56 62 98 42	http://www.afcadillac.net/
PERSEVERONS	High School	André Malraux	3 Rue du 8 Mai 1945,64200 Biarritz, France	+33 5 59 01 20 40	http://lycee-malraux-biarritz.fr/
Poppy Éducation	High School	Camille Jullian	29 Rue de la Croix Blanche,33000 Bordeaux, France	+33 5 56 01 47 47	http://www.camillejullian.com/
Poppy Éducation	Middle School	de France	Rue du Cimetière Saint-Benoist,75005 Paris, France	+33 1 44 27 12 11	http://www.college-de-france.fr/
Poppy Éducation	High School	des Graves	238 Cours du Général de Gaulle,33170 Gradignan, France	+33 5 56 75 77 56	http://www.grandlebrun.com/
PERSEVERONS	High School	Élie Faure	63 Avenue de la Libération,33310 Lormont, France	+33 5 56 38 23 23	http://www.lyc-eliefauvre.fr/
PERSEVERONS	High School	Elisée Reclus	7 Avenue de Verdun,33220 Pineuilh, France	+33 5 57 41 92 50	http://lycee-foyen.fr/
Poppy Éducation	High School	François Mauriac	1 Rue Henri Dunant,33000 Bordeaux, France	+33 5 56 38 52 82	http://lyceemauriac.fr/
PERSEVERONS	High School	Gaston Febus	20 Avenue Georges Moutet,64300 Orthez, France	+33 5 59 67 07 26	http://webtab.ac-bordeaux.fr/cite-gaston-febus-orthez/
PERSEVERONS	Middle School	Giraud de Borneil	10 Boulevard André Dupuy,24160 Excideuil, France	+33 5 53 62 21 16	http://www.gdeborneil.fr/
PERSEVERONS	High School	Grand Air	Avenue du Docteur Lorentz Monod,33120 Arcachon, France	+33 5 56 22 38 00	http://webtab.ac-bordeaux.fr/lycee-grand-air/
PERSEVERONS	High School	Gustave Eiffel	143 Rue Ferbos,33000 Bordeaux, France	+33 5 56 33 83 00	http://www.eiffel-bordeaux.org/
PERSEVERONS	High School	Jacques Monod	10 Rue du Parvis,64230 Lescar, France	+33 5 59 77 92 00	http://lyceejacquesmonod.fr/
Poppy Éducation	High School	Jean Moulin	Avenue de la République,33210 Langon, France	+33 5 56 63 62 30	http://webtab.ac-bordeaux.fr/lycee-jean-moulin-langon/
Poppy Éducation	Middle School	Jean Zay	41 Rue Henri Cochet,33380 Biganos, France	+33 5 57 17 01 70	http://collegebiganos.fr/
Poppy Éducation	High School	La Morlette	62 Rue du Docteur Roux,33150 Cenon, France	+33 5 57 80 37 00	http://lycee-lamorlette.fr/
PERSEVERONS	High School	Les Iris	13 Rue Sourbès,33310 Lormont, France	+33 5 57 80 10 60	http://www.lyceeesiris.fr/
PERSEVERONS	High School	Louis Barthou	2 Boulevard Barbanègre,64000 Pau, France	+33 5 59 98 98 00	http://www.cyberlycee.fr/
PERSEVERONS	High School	Louis de Foix	4 Avenue Jean Rostand,64100 Bayonne/Bayona/Baiona, France	+33 5 59 63 31 10	http://www.louisdefoix.com/
PERSEVERONS	High School	Maine de Biran	108 Rue Valette,24100 Bergerac, France	+33 5 53 74 50 00	http://webtab.ac-bordeaux.fr/lycee-maine-de-biran/
Poppy Éducation	Middle School	Mios	Route du Pujeau,33380 Mios, France	+33 5 56 03 00 77	http://www.villemios.fr/enfance-jeunesse/college/
PERSEVERONS	High School	Nord Bassin	128 Avenue de Bordeaux,33510 Andernos-les-Bains, France	+33 5 56 82 20 77	http://www.lyceenordbassin.com/
Forum Poppy	Primary School	Notre-Dame du Mur	19 Rue de Kermadiou,29600 Morlaix, France	+33 2 98 88 18 69	http://lycee.ecmorlaix.fr/
PERSEVERONS	High School	Pape Clément	1 Rue Léo Lagrange,33600 Pessac, France	+33 5 57 26 63 00	http://lyceepapeclément.fr/
PERSEVERONS	High School	Pays de Soule	Avenue Jean Monnet,64130 Chéraute, France	+33 5 59 28 22 28	http://www.lyceedupaysdesoule.fr/index.php
PERSEVERONS	High School	Pré De Cordy	5 Avenue Joséphine Baker,24200 Sarlat-la-Canéda, France	+33 5 53 31 70 70	http://lycee-predcordy-sarlat.com/
Poppy Éducation	High School	Raoul Follereau	9 Boulevard Saint-Exupéry,58000 Nevers, France	+33 3 86 60 36 00	http://lyc58-renardfollereau.ac-dijon.fr/
PERSEVERONS	High School	René Cassin	2 Rue de Lassegutte,64100 Bayonne/Bayona/Baiona, France	+33 5 59 58 42 00	http://webtab.ac-bordeaux.fr/lycee-rene-cassin/
PERSEVERONS	High School	Saint-Cricq	4 Piste Cyclable,64000 Pau, France	+33 5 59 30 50 55	http://www.lycee-saint-cricq.org/
Poppy Éducation	High School	Saint-Genès	160 Rue de Saint-Genès,33000 Bordeaux, France	+33 5 56 33 84 84	http://www.saint-genes.com/
PERSEVERONS	High School	Saint-John Perse	2 Chemin de Barincou,64000 Pau, France	+33 5 59 62 73 11	http://www.lycee-saint-john-perse.fr/
Poppy Éducation	High School	Sainte-Marie Grand Lebrun	164 Rue François Mauriac,33200 Bordeaux, France	+33 5 56 08 32 13	http://www.grandlebrun.com/
inria	High School	Sainte-Saintonge	12 Rue de Saintonge,33000 Bordeaux, France	+33 5 56 99 39 29	http://www.lyceesaintefamille.com/
Poppy Éducation	High School	Sud-Médoc	Piste du Médoc Bleu,33320 Le Taillan-Médoc, France	+33 5 56 70 10 10	http://www.lyceesudmedoc.fr/
Poppy Éducation	High School	Victor Louis	2 Rue de Mégret,33400 Talence, France	+33 5 56 80 76 40	http://lyceevictorlouis.fr/

Figure 25. List of partner schools of the Poppy Education project

9.1.2. ENSAM

The orientation of a (high school) student, choosing a career, is often based on an imagined representation of a discipline, sector of activity or training. Moreover, higher education is sometimes for a college student or a student a self centered universe, with inaccessible teaching methodologies and level of competence.

The Arts and Métiers campus at Bordeaux-Talence in partnership with Inria contributes with its educational and scientific expertise to the development of new teaching methods and tools. The objective is to develop teaching sequences based on a project approach relying on an attractive multidisciplinary technological system: the humanoid Inria Poppy robot. These teaching sequences will be built and tailored to different levels of training, from high schools to Engineer schools.

The new formation "Bachelor of Technology", started in September 2014 at Ensam Bordeaux, is resolutely turned towards a project based pedagogy, outlining concepts from concrete situations. The humanoid Inria Poppy robot offers an open platform capable of providing an unifying thread for the different subjects covered during the 3-years of the Bachelor formation: mechanics, manufacturing (3D printing), electrical, mechatronics, computer sciences, design. . .

For the 1st and 2nd year of the ENSAM Engineer cursus, the Poppy robot is now used to support the teaching and to conduct further investigation.

9.1.3. KidLearn and Region Aquitaine

A Conseil Régional d'Aquitaine Project (KidLearn, 2015-) began, coordinated by Manuel Lopes entitled KidLearn. Will fund 50% of a 3 years PhD student.

We propose here a research project that aims at elaborating algorithms and software systems to help humans learn efficiently, at school, at home or at work, by adapting and personalizing sequences of learning activities to the particularities of each individual student. This project leverages recent innovative algorithmic models of human learning (curiosity in particular, developed as a result of ERC European project of the Flowers team), and combines it with state-of-the-art optimization algorithms and an original integration with existing expert knowledge (human teachers). Given a knowledge domain and a set of possible learning activities, it will be able to propose the right activity at the right time to maximize learning progress. It can be applied to many learning situations and potential users: children learning basic knowledge in schools and with the support of their teachers, older kids using educational software at home, of adults needing to acquire new skills through professional training ("formation professionnelle"). Because it combines innovations in computational sciences (machine learning and optimization) with theories of human cognition (theories of human learning and of education), this project is also implementing a strong cross-fertilization between technology and human sciences (SHS).

9.1.4. Comacina Capsule Creative Art/Science project and Idex/Univ. Bordeaux

The artist community is a rich source of inspiration and can provide new perspectives to scientific and technological questions. This complementarity is a great opportunity that we want to enforce in the Poppy project by making the robot accessible to non-robotic-expert users. The Comacina project, in collaboration with the Flowers team and supported by funding from Idex/Univ. Bordeaux, explored the role of movements and light in expressing emotions: <http://comacina.org> . This project was implemented through several residencies during the year, and several performances at various cultural places in Aquitaine, including at Pole Evasion in Ambares-et-Lagrave. a report is available at <https://flowers.inria.fr/RencontreAutourDuGeste.pdf> . It benefited from funding from the Art/Science Idex call for project.

9.2. National Initiatives

PY Oudeyer collaborated with Aymar de Rugy, Daniel Cattaert, Mathilde Couraud, Sébastien Mick and Florent Paclet (INCIA, CNRS/Univ. Bordeaux) about the design of myoelectric robotic prostheses based on the Poppy platform, and on the design of algorithms for co-adaptation learning between the human user and the prosthesis. This was funded by a PEPS CNRS grant.

D. Roy is the Inria leader of project "Voyageurs du Code - Code Décode" <https://www.bibliosansfrontieres.org/tag/les-voyageurs-du-codecode-decode/>, <https://www.code-decode.net/> which provides teachers and animators formations and learning games to initiate young people to computer science and robotics.

Around Robotics for education, many collaborations were put in place. With the LSRO Laboratory from EPFL (Lausanne) and others collaborations with French National Education/Rectorat d'Aquitaine, with Canopé Educational Network, with ESPE (teacher's school) Aquitaine, ESPE Martinique, ESPE Poitiers, LINE Laboratory (ESPE Nice University), National Directorate of Digital Education, Fondation "La Main à la Pâte", Maison for Science in Bordeaux University, Orange Fondation.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. 3rd HAND

Title: Semi-Autonomous 3rd Hand

Programm: FP7

Duration: October 2013 - September 2017

Coordinator: Inria

Partners:

Technische Universität Darmstadt (Germany)

Universität Innsbruck (Austria)

Universität Stuttgart (Germany)

Inria contact: Manuel Lopes

Robots have been essential for keeping industrial manufacturing in Europe. Most factories have large numbers of robots in a fixed setup and few programs that produce the exact same product hundreds of thousands times. The only common interaction between the robot and the human worker has become the so-called 'emergency stop button'. As a result, re-programming robots for new or personalized products has become a key bottleneck for keeping manufacturing jobs in Europe. The core requirement to date has been the production in large numbers or at a high price. Robot-based small series production requires a major breakthrough in robotics: the development of a new class of semi-autonomous robots that can decrease this cost substantially. Such robots need to be aware of the human worker, alleviating him from the monotonous repetitive tasks while keeping him in the loop where his intelligence makes a substantial difference. In this project, we pursue this breakthrough by developing a semi-autonomous robot assistant that acts as a third hand of a human worker. It will be straightforward to instruct even by an untrained layman worker, allow for efficient knowledge transfer between tasks and enable an effective collaboration between a human worker with a robot third hand. The main contributions of this project will be the scientific principles of semi-autonomous human-robot collaboration, a new semi-autonomous robotic system that is able to: i) learn cooperative tasks from demonstration; ii) learn from instruction; and iii) transfer knowledge between tasks and environments. We will demonstrate its efficiency in the collaborative assembly of an IKEA-like shelf where the robot acts as a semiautonomous 3rd-Hand.

9.3.1.2. DREAM

Title: Deferred Restructuring of Experience in Autonomous Machines

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: UPMC

Partners:

Armines (ENSTA ParisTech)

Queen Mary University London (England)

University of A Coruna (Spain)

Vrije University Amsterdam (Holland)

Contact: David Filliat

Abstract: A holy grail in robotics and artificial intelligence is to design a machine that can accumulate adaptations on developmental time scales of months and years. From infancy through adulthood, such a system must continually consolidate and bootstrap its knowledge, to ensure that the learned knowledge and skills are compositional, and organized into meaningful hierarchies. Consolidation of previous experience and knowledge appears to be one of the main purposes of sleep and dreams for humans, that serve to tidy the brain by removing excess information, to recombine concepts to improve information processing, and to consolidate memory. Our approach – Deferred Restructuring of Experience in Autonomous Machines (DREAM) – incorporates sleep and dream-like processes within a cognitive architecture. This enables an individual robot or groups of robots to consolidate their experience into more useful and generic formats, thus improving their future ability to learn and adapt. DREAM relies on Evolutionary Neurodynamic ensemble methods (Fernando et al, 2012 Frontiers in Comp Neuro; Bellas et al., IEEE-TAMD, 2010) as a unifying principle for discovery, optimization, restructuring and consolidation of knowledge. This new paradigm will make the robot more autonomous in its acquisition, organization and use of knowledge and skills just as long as they comply with the satisfaction of pre-established basic motivations. DREAM will enable robots to cope with the complexity of being an information-processing entity in domains that are open-ended both in terms of space and time. It paves the way for a new generation of robots whose existence and purpose goes far beyond the mere execution of dull tasks. <http://www.robotsthatdream.eu>

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. IGLU

Title: Interactive Grounded Language Understanding (IGLU)

Programm: CHIST-ERA

Duration: October 2015 - September 2018

Coordinator: University of Sherbrooke, Canada

Partners:

University of Sherbrooke, Canada

Inria Bordeaux, France

University of Mons, Belgium

KTH Royal Institute of Technology, Sweden

University of Zaragoza, Spain

University of Lille 1, France

University of Montreal, Canada

Inria contact: Pierre-Yves Oudeyer

Language is an ability that develops in young children through joint interaction with their caretakers and their physical environment. At this level, human language understanding could be referred as interpreting and expressing semantic concepts (e.g. objects, actions and relations) through what can be perceived (or inferred) from current context in the environment. Previous work in the field of artificial intelligence has failed to address the acquisition of such perceptually-grounded knowledge in virtual agents (avatars), mainly because of the lack of physical embodiment (ability to interact physically) and dialogue, communication skills (ability to interact verbally). We believe that robotic agents are more appropriate for this task, and that interaction is a so important aspect of human language learning and understanding that pragmatic knowledge (identifying or conveying intention)

must be present to complement semantic knowledge. Through a developmental approach where knowledge grows in complexity while driven by multimodal experience and language interaction with a human, we propose an agent that will incorporate models of dialogues, human emotions and intentions as part of its decision-making process. This will lead anticipation and reaction not only based on its internal state (own goal and intention, perception of the environment), but also on the perceived state and intention of the human interactant. This will be possible through the development of advanced machine learning methods (combining developmental, deep and reinforcement learning) to handle large-scale multimodal inputs, besides leveraging state-of-the-art technological components involved in a language-based dialog system available within the consortium. Evaluations of learned skills and knowledge will be performed using an integrated architecture in a culinary use-case, and novel databases enabling research in grounded human language understanding will be released. IGLU will gather an interdisciplinary consortium composed of committed and experienced researchers in machine learning, neurosciences and cognitive sciences, developmental robotics, speech and language technologies, and multimodal/multimedia signal processing. We expect to have key impacts in the development of more interactive and adaptable systems sharing our environment in everyday life. <http://iglu-chistera.github.io/>

9.4. International Initiatives

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

9.4.1.1. NEUROCURIOSITY

Title: NeuroCuriosity

International Partner (Institution - Laboratory - Researcher):

Columbia Neuroscience (United States) - Cognitive Neuroscience - JACQUELINE GOTTLIEB

Start year: 2016

See also: <https://flowers.inria.fr/neurocuriosity>

Curiosity can be understood as a family of mechanisms that evolved to allow agents to maximize their knowledge of the useful properties of the world. In this project we will study how different internal drives of an animal, e.g. for novelty, for action, for liking, are combined to generate the rich variety of behaviors found in nature. We will approach such challenge by studying monkeys, children and by developing new computational tools.

9.4.1.2. Informal International Partners

Pierre-Yves Oudeyer and Didier Roy have create a collaboration with LSRO EPFL and Pr Francesco Mondada, about Robotics and education. The two teams co-organize the annual conference "Robotics and Education" in Bordeaux. Didier Roy teaches "Robotics and Education" in EPFL several times a year.

Pierre-Yves Oudeyer collaborated with Edith Law's HCI research group at University of Waterloo on the topic of "Curiosity in HCI system". They co-organized the "Designing for curiosity" workshop at CHI 2017, Denver, Colorado, and obtained a grant from Univ. Bordeaux to set up a project with Inria Potioc team and with Dana Kulic, Robotics lab, Univ. Waterloo.

Didier Roy has created a collaboration with HEP VAud (Teachers High School) and Bernard Baumberger and Morgane Chevalier, about Robotics and education. Scientific discussions and shared professional training.

Florian Golemo is in an active collaboration with Aaron Courville from MILA Montreal to work on the IGLU project together.

William Schueller visited Vittorio Loreto's team in Rome from January till August 2017, funded by the IDEX program of the University of Bordeaux. Vittorio Loreto is an Associate Professor in Physics at University Sapienza of Rome, and head of the research team Social Dynamics Lab. William Schueller also participated to a conference organized by V. Loreto in Rome, the Kreyon Conference, by giving a talk and presenting a user experiment: an interactive Naming Game.

9.4.2. Participation in Other International Programs

David Filliat participates in the ITEA3 DANGUN project with Renault S.A.S. in France and partners in Korea. The purpose of the DANGUN project is to develop a Traffic Jam Pilot function with autonomous capabilities using low-cost automotive components operating in France and Korea. By incorporating low-cost advanced sensors and simplifying the vehicle designs as well as testing in different scenarios (France & Korea), a solution that is the result of technical cooperation between both countries should lead to more affordable propositions to respond to client needs in the fast moving market of intelligent mobility.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Georges Kachergis, University of Radboud, The Netherlands
- Cynthia Liem, University of Delft, The Netherlands
- Mike Schaekermann, Univ. Waterloo, Canada
- Roboy team, University of Munich, Germany
- Lauriane Rat-Fiseher, Univ. Toulouse, France
- Lisa Jacquey, LPP, Paris (May 12th, 2017)
- Mai Nguyen, ENST Bretagne, France

9.5.1.1. Internships

- Kelian Schindowski, project Poppy Education
- Octave Delorme, project Poppy Education
- Alexandre Péré, Deep learning and intrinsic motivation
- Pierre Manceron, Deep Reinforcement Learning
- Timothée Anne, Intrinsically Motivated Goal Exploration

FLUMINANCE Project-Team**9. Partnerships and Cooperations****9.1. National Initiatives****9.1.1. Comins'lab: SEACS : Stochastic modEl-dAta-Coupled representationS for the analysis, simulation and reconstruction of upper ocean dynamics****Participants:** Pierre Derian, Cédric Herzet, Etienne Mémin.

duration 48 months. The SEACS project whose acronym stands for: "Stochastic modEl-dAta-Coupled representationS for the analysis, simulation and reconstruction of upper ocean dynamics" is a Joint Research Initiative between the three Brittany clusters of excellence of the "Laboratoires d'Excellence" program: Cominlabs, Lebesgue and LabexMer centered on numerical sciences, mathematics and oceanography respectively. Within this project we aim at studying the potential of large-scale oceanic dynamics modeling under uncertainty for ensemble forecasting and satellite image data assimilation.

9.1.2. ANR JCJC GERONIMO : Advanced GEophysical Reduced-Order Model construction from IMage Observations**Participants:** Mamadou Diallo, Cédric Herzet.

duration 48 months. The GERONIMO project which started in March 2014 aims at devising new efficient and effective techniques for the design of geophysical reduced-order models from image data. The project both arises from the crucial need of accurate low-order descriptions of highly-complex geophysical phenomena and the recent numerical revolution which has supplied the geophysical scientists with an unprecedented volume of image data. The project is placed at the intersection of several fields of expertise (Bayesian inference, matrix factorization, sparse representations, etc.) which will be combined to handle the uncertainties associated to image measurements and to characterize the accurate reduced dynamical systems.

9.1.3. ANR BECOSE : Beyond Compressive Sensing: Sparse approximation algorithms for ill-conditioned inverse problems.**Participants:** Dominique Heitz, Cédric Herzet.

duration 48 months. The BECOSE project aims to extend the scope of sparsity techniques much beyond the academic setting of random and well-conditioned dictionaries. In particular, one goal of the project is to step back from the popular L1-convexification of the sparse representation problem and consider more involved nonconvex formulations, both from a methodological and theoretical point of view. The algorithms will be assessed in the context of tomographic Particle Image Velocimetry (PIV), a rapidly growing imaging technique in fluid mechanics that will have strong impact in several industrial sectors including environment, automotive and aeronautical industries. The consortium gathers the Fluminance and Panama Inria research teams, the Research Center for Automatic Control of Nancy (CRAN), The Research Institute of Communication and Cybernetics of Nantes (IRCCyN), and ONERA, the French Aerospace Lab.

9.1.4. ANR-MN: H2MNO4 project**Participants:** Yvan Crenner, Benjamin Delfino, Jean-Raynald de Dreuz, Jocelyne Erhel, Lionel Lenôtre.

Contract with ANR, program Modèles Numériques

Duration: four years from November 2012 until April 2017.

Title: Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology.

Coordination: Jocelyne Erhel and Géraldine Pichot, with Fabienne Cuyollaa.

Partners: Geosciences Rennes, University of Poitiers, University of Lyon 1, Andra, Itasca.

International collaborations: University of San Diego (USA), UPC, Barcelona (Spain)

Web page: <http://h2mno4.inria.fr/>

Abstract: The project H2MNO4 develops numerical models for reactive transport in heterogeneous media. It defines six mathematical and computational challenges and three applications for environmental problems with societal impact.

9.1.5. GDR MANU

Participants: Yvan Crenner, Jocelyne Erhel, Bastien Hamlat.

Title: Mathematics for Nuclear industry

Duration: From 2016 to 2019

Coordination: C. Cancès

Webpage: <http://gdr-manu.math.cnrs.fr/>

Abstract: The working group MANU is a follow-up to the group MOMAS. It covers many subjects related to mathematical modeling and numerical simulations for problems arising from nuclear industry and nuclear waste disposal. The team organizes a workshop on reactive transport, Paris, February 2018.

9.2. International Initiatives

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

9.2.1.1. LFD-FLU

Title: Large-scale Fluid Dynamics analysis from FLOW Uncertainty

International Partner (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (Argentina) - Department of Computer Science and Electrical Engineering - Guillermo Artana

Start year: 2016

See also: <http://www.irisa.fr/prive/memin/LFD-FLU/>

The first objective of this associate team is primarily concerned with the establishment of efficient fluid flow image data analysis procedures. This concerns for instance data assimilation issues to reconstruct meaningful numerical representation of experimental fluid flows for analysis purpose. The second objective focuses on the incorporation of uncertainties in the flow dynamical evolution models

9.2.1.2. Informal International Partners

Imperial College, London (UK), Collaboration with Dan Crisan and Darryl Holm on Stochastic transport for the upper ocean dynamics

Chico California State University (USA), We have pursued our collaboration with the group of Shane Mayor on the GPU implementation of wavelet based motion estimator for Lidar data. This code is developed in coproperty between Inria and Chico.

9.2.2. Participation in Other International Programs

Royal Society funding, collaboration between Dominique Heitz, Etienne Mémin and Sylvain Laizet (Imperial College) on Stochastic large-eddies simulation and data assimilation for the reconstruction of 3D turbulent flows.

China Scholarship Council funding, Collaboration between Etienne Memin, Shengze Cai and Chao Xu (Zhejiang University, College of Control Science & Engineering), on turbulent motion estimation and modeling under uncertainty.

9.3. International Research Visitors

- 3 weeks visit of Alejandro Gronskis (Researcher Conicet Argentina) to work with Dominique Heitz, Etienne Mémin and Pranav Chandramouli within the associate team LFD
- Sojourn of 12 month of Shengze Cai PhD student in the College of Control Science & Engineering, Zhejiang University to work with Etienne Mémin

FOCUS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- ELICA (Expanding Logical Ideas for Complexity Analysis) is an ANR project that started on October 2014 and that will finish on September 2018. ELICA focuses on methodologies for the static analysis of programs and their resource consumption. The project's aim is to further improve on logical methodologies for complexity analysis (type systems, rewriting, etc.). More specifically, one would like to have more powerful techniques with less false negatives, being able at the same time to deal with nonstandard programming paradigms (concurrent, probabilistic, etc.). Main persons involved: Avanzini, Dal Lago, Hirschhoff, Martini, Sangiorgi.
- REPAS (Reliable and Privacy-Aware Software Systems via Bisimulation Metrics) is an ANR Project that started on October 2016 and that will finish on October 2020. The project aims at investigating quantitative notions and tools for proving program correctness and protecting privacy. In particular, the focus will be put on bisimulation metrics, which are the natural extension of bisimulation to quantitative systems. As a key application, we will develop a mechanism to protect the privacy of users when their location traces are collected. Main persons involved: Dal Lago, Gavazzo, Sangiorgi.
- COCAHOLA (Cost models for Complexity Analyses of Higher-Order Languages) is an ANR Project that started on October 2016 and that will finish on October 2019. The project aims at developing complexity analyses of higher-order computations. The focus is not on analyzing fixed programs, but whole programming languages. The aim is the identification of adequate units of measurement for time and space, i.e. what are called *reasonable* cost models. Main persons involved: Dal Lago, Martini.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

- ICT COST Action IC1405 (Reversible computation - extending horizons of computing). Initiated at the end of April 2015 and with a 4-year duration, this COST Action studies reversible computation and its potential applications, which include circuits, low-power computing, simulation, biological modeling, reliability and debugging. Reversible computation is an emerging paradigm that extends the standard forwards-only mode of computation with the ability to execute in reverse, so that computation can run backwards as naturally as it can go forwards.
Main persons involved: Lanese (vice-chair of the action).
- ICT COST Action IC1402 ARVI (Runtime Verification beyond Monitoring). Initiated in December 2014 and with a 4-year duration, this COST Action studies runtime verification, a computing analysis paradigm based on observing a system at runtime to check its expected behaviour.
Main persons involved: Bravetti, Lanese.

8.2.2. Collaborations with Major European Organizations

We list here the cooperations and contacts with other groups, without repeating those already listed in previous sections.

- ENS Lyon (on concurrency models and resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi, Vignudelli. Some visit exchanges during the year, in both directions. A joint PhD started in September 2016 (Adrien Durier).

- Inria EPI Spades (on models and languages for components, reversibility). Contact person(s) in Focus: Lanese.
- Universitat Politècnica de Valencia, Spain (on reversibility for Erlang). Contact person(s) in Focus: Lanese. Some visit exchanges during the year, in both directions.
- Laboratoire d'Informatique, Université Paris Nord, Villetaneuse (on implicit computational complexity). Contact person(s) in Focus: Dal Lago, Martini.
- Institut de Mathématiques de Luminy, Marseille (on lambda-calculi, linear logic and semantics). Contact person(s) in Focus: Dal Lago, Martini.
- Team PPS, IRIF Lab, University of Paris-Diderot Paris 7 (on logics for processes, resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi. Some short visits in both directions during the year.
- IRILL Lab, Paris (on models for the representation of dependencies in distributed package based software distributions). Contact person(s) in Focus: Gabbrielli, Zavattaro. Some short visits in both directions during the year.
- LMU Munich (M. Hofmann) (on implicit computational complexity and IntML). Contact person(s) in Focus: Dal Lago.
- IMDEA Software, Madrid (G. Barthe) (on implicit computational complexity for cryptography). Contact person(s) in Focus: Dal Lago, Sangiorgi. Some visits during the year.
- Facultad de Informática, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project "Desarrollo y Análisis formal de sistemas complejos en contextos DistribuidOS: fundamentos, herramientas y aplicaciones (DAR-DOS)" (Development and formal analysis of complex systems in distributed contexts: foundations, tools and applications) January 2016 - December 2018, funded by the Spanish Ministerio de Economía y Competitividad.

8.3. International Initiatives

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

8.3.1.1. CRECOGI

Title: Concurrent, Resourceful and Effectful Computation, by Geometry of Interaction

International Partner (Institution - Laboratory - Researcher):

Tokyo (Japan) - Department of Computer Science, Graduate School of Information Science and Technology - Ichiro HASUO

Start year: 2015

See also: <http://crecogi.cs.unibo.it>

Game semantics and geometry of interaction (GoI) are two closely related frameworks whose strength is to have the characters of both a denotational and an operational semantics. They offer a high-level, mathematical (denotational) interpretation, but are interactive in nature. The formalization in terms of movements of tokens through which programs communicate with each other can actually be seen as a low-level program. The current limit of GoI is that the vast majority of the literature and of the software tools designed around it have a pure, sequential functional language as their source language. This project aims at investigating the application of GoI to concurrent, resourceful, and effectful computation, thus paving the way to the deployment of GoI-based correct-by-construction compilers in real-world software developments in fields like (massively parallel) high-performance computing, embedded and cyberphysical systems, and big data. The presence of both the Japanese GoI community (whose skills are centered around effects and coalgebras) and the French GoI community (more focused on linear logic and complexity analysis) will bring essential, complementary, ingredients.

8.3.2. Participation in Other International Programs

Focus has taken part in the creation of the Microservices Community (<http://microservices.sdu.dk/>), an international community interested in the software paradigm of Microservices. Main aims of the community are: i) sharing knowledge and fostering collaborations about microservices among research institutions, private companies, universities, and public organisations (like municipalities); ii) discussing open issues and solutions from different points of view, to create foundations for both innovation and basic research.

U. Dal Lago is “Partner Investigator” in the project “Verification and analysis of quantum programs”, whose Chief Investigator is Prof Yuan Feng, University of Technology Sydney. The project is funded by the Australian Research Council.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

The following researchers have visited Focus for short periods; we list them together with the title of the talk they have given during their stay, or the topic discussed during their stay.

- German Vidal and Adrián Palacios: “A Reversible Semantics for Erlang.” (2 visits, during the year)
- Matteo Acclavio: "Proof Diagrams for Multiplicative Linear Logic: Syntax and Semantics."
- Ken Sakayori: "A Truly Concurrent Game Model of the Asynchronous pi-Calculus."
- Marco Carbone: "Multiparty Session types and Linear Logic."
- Beniamino Accattoli: "The Complexity of Abstract Machines."
- Ulrich Schoepp, on Complexity analysis of probabilistic programs.

8.4.2. Visits to International Teams

U. Dal Lago has spent two weeks in Japan (University of Kyoto and University of Tokyo). Topics: geometry of interaction for continuous probabilistic programming languages, and categorical models for multitoken machines.

FUN Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. StoreConnect

Participants: Nathalie Mitton [correspondant], Valeria Loscri, Antonio Costanzo, Abdoul Aziz Mbacke.

Title: StoreConnect

Type: FUI

Duration: September 2016 - October 2018

Coordinator: NEOSSENSYS

Others partners: Inria FUN, SPIRALS and STARS, TeVolys, Ubudu, Smile, STIME, Leroy Merlin

The aim of StoreConnect is to provide French large retailers with efficient and powerful tools in the in-store customer interaction. This project has yield to several publications in 2017: [50], [23], [24].

9.1.2. PIPA

Participants: Nathalie Mitton [correspondant], Farouk Mezghani.

Title: Partager de l'Info Partout à bas coût

Type: Chercheur citoyen

Duration: Dec 2015 - Dec 2017

Coordinator: Inria FUN

Others partners: SpotTrotter

PIPA project aims to provide an innovative low cost solution to share information in places where communication infrastructure are lacking, insuffisant or not adapted, going beyond technical, economical or political limitations. This project has yield to several publications in 2017: [27], [28], [44].

9.2. National Initiatives

9.2.1. Inria Project Lab

9.2.1.1. CityLab@Inria

Participants: Valeria Loscri, Abdoul Aziz Mbacke, Nathalie Mitton [correspondant].

- Title: CityLab@Inria
- Type: IPL
- Duration: 2015 - 2019
- Coordinator: Valerie Issarny
- CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. Obviously, running urban-scale experiments is a central concern of the Lab, so that we are able to confront proposed approaches to actual settings. The Lab's research leverages relevant effort within Inria project-teams that is further revisited as well as integrated to meet the challenges of smart cities. Research themes span: energy-efficient wireless communication protocols, urban-scale social and physical sensing, privacy by design, cloud-based urban data management, data assimilation, visual analysis, and urban system software engineering. In addition, CityLab Inria research builds upon collaborative effort at the International level, and especially collaboration in the context of the Inria SiliconValley program. This project has yield to the set up of a full course on Smart Cities via a MOOC [51], [52], [53], [54] and a set of publications [23], [24], [32].

9.2.2. ADT

9.2.2.1. RFunID

Participants: Ibrahim Amadou, Nathalie Mitton [correspondant], Julien Vandaele.

Duration: September 2015 - December 2017

Coordinator: Inria FUN

The purpose of this project is to deploy a large scale experimental RFID platform that enables remote programming of RFID scenario on heterogeneous devices.

9.2.2.2. Catimex

Participants: Matthieu Berthome, Nathalie Mitton [correspondant], Julien Vandaele.

Duration: September 2017 - June 2019

Coordinator: Inria FUN

The purpose of this project is to foster research transfer in IoT from ADT members to their industrial partners by widening experimental features and PoC realization.

9.2.3. Equipements d'Excellence

9.2.3.1. FIT

Participants: Nathalie Mitton [correspondant], Julien Vandaele, Matthieu Berthome.

Title: Future Internet of Things

Type: EquipEx

Duration: March 2010 - December 2019

Coordinator: UPMC

See also: <http://fit-equipex.fr/>

Abstract: FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Equipements d'Excellence" (Equipex) research grant program. Coordinated by Professor Serge Fdida of UPMC Sorbonne Universités and running over a nine-year period, the project will benefit from a 5.8 million euro grant from the French government. This project has yield to [39].

9.3. European Initiatives

9.3.1. H2020 Projects

9.3.1.1. VESSEDIA

Participants: Simon Duquennoy, Nathalie Mitton [correspondant], Allan Blanchard.

- Title: VERIFICATION ENGINEERING OF SAFETY AND SECURITY CRITICAL DYNAMIC INDUSTRIAL APPLICATIONS
- Program: H2020
- Duration: January 2017 - Dec. 202019
- TECHNIKON FORSCHUNGS UND PLANUNGSGESELLSCHAFT MBH (TEC)

The VESSEDIA project will bring safety and security to many new software applications and devices. In the fast evolving world we live in, the Internet has brought many benefits to individuals, organizations and industries. With the capabilities offered now (such as IPv6) to connect billions of devices and therefore humans together, the Internet brings new threats to the software developers and VESSEDIA will allow connected applications to be safe and secure. VESSEDIA proposes to enhance and scale up modern software analysis tools, namely the mostly open-source Frama-C Analysis platform, to allow developers to benefit rapidly from them when developing connected applications. At the forefront of connected applications is the IoT, whose growth is exponential and whose security risks are real (for instance in hacked smart phones). VESSEDIA will take this domain as a target for demonstrating the benefits of using our tools on connected applications. VESSEDIA will tackle this challenge by 1) developing a methodology that allows to adopt and use source code analysis tools efficiently and produce similar benefits than already achieved for highly-critical applications (i.e. an exhaustive analysis and extraction of faults), 2) enhancing the Frama-C toolbox to enable efficient and fast implementation, 3) demonstrating the new toolbox capabilities on typical IoT (Internet of Things) applications including an IoT Operating System (Contiki), 4) developing a standardization plan for generalizing the use of the toolbox, 5) contributing to the Common Criteria certification process, and 6) defining a label "Verified in Europe" for validating software products with European technologies such as Frama-C.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. Agrinet

Participants: Abdoul Aziz Mbacke, Nathalie Mitton [correspondant].

Agrinet

Title: Agrinet

International Partner (Institution - Laboratory - Researcher):

Type: LIRIMA Associate team

Duration: 2017-2020

See also: <https://team.inria.fr/agrinet/>

The current drought and limited water resources in many parts of Southern Africa and beyond, already have a significant impact on agriculture and hence, food production. Sustainable food security depends upon proper plant and crop management respectful of soils and natural resources, such as water. This includes very important South African farming areas, such as the Western Cape and Northern Cape. In France, agriculture is also hugely important. Not just nationally, but also in Europe. The system proposed can be applied to a variety of crops. The economic- and social consequences are profound and any contribution towards more efficient farming within increasingly onerous natural constraints, should be a priority. To address these constraints, we propose to develop a flexible, rapidly deployable, biological/agricultural data acquisition platform and associated machine learning algorithms to create advanced agricultural monitoring and management techniques, to improve crop management and use of natural resources. The project also addresses an industry with very high socioeconomic impact.

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

9.4.2.1. DepIoT

Participants: Simon Duquennoy [correspondant], Nathalie Mitton.

Title: DepIoT: Coexistence and Security for Dependable Internet of Things

Type: North-European Inria Associate Team with SICS, Sweden

Duration: Sept 2016 - August 2018

Abstract: In order to foster the adoption of IoT technologies, dependability must be guaranteed. We will tackle this challenge by ensuring operation even in the presence of other networks sharing the same frequency band (coexistence) and by enabling a secure communication.

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

Università Mediterranea di Reggio Calabria (UNIC) (Italy) Objective of this collaboration is the design of an innovative architecture that enables autonomic and decentralized fruition of the services offered by the network of smart objects in many heterogeneous and dynamic environments, in a way that is independent of the network topology, reliable and flexible. The result is an 'ecosystem' of objects, self-organized and self-sustained, capable of making data and services available to the users wherever and whenever required, thus supporting the fruition of an 'augmented' reality thanks to a new environmental and social awareness. This collaboration has allowed students and researchers exchanges and joint publications, among them for 2017: [30].

9.4.3.2. Informal International Partners

Southern University, China

The purpose of this collaboration is to study the green (or energy-efficient) communication problem in vehicular ad hoc networks (VANETs) and the application of vehicular network communication in green transportation. In this framework, Nathalie Mitton visited the Nanjing University. It gave birth to joint project submission, joint conference organization (WCSP 2017) and joint publications, among them, in 2017 [40].

Arun Sen from Arizona State University, USA

The purpose of this collaboration is to study the joint scheduling and trajectory of RFID readers in a mobile environment. In this framework, Arun Sen visited the FUN team for 6 months in 2015 and in July 2016. It gave birth to joint project submission, joint conference submission and joint publications, among them in 2017 [12].

Anna-Maria Vegni from Roma Tre University, Italy

The purpose of this collaboration is to study alternative communication paradigms and investigate their limitations and different effects on performances. In this framework, joint publications have been obtained, among them in 2017 [14], [15], [20], [35], [47], [48].

9.4.4. Participation in Other International Programs

9.4.4.1. CROMO

Participants: Valeria Loscri, Nathalie Mitton [correspondant].

Title: Crowd Data In the mobile cloud

Duration: January 2015 - December 2019

CroMo (Crowd Data In the mobile cloud) is a submission to the CAPES-COFECUB project call lead by Inria from the French side and University of Rio de Janeiro from Brazilian Side. Other partner institutions are Université Pierre et Marie Curie and Université de la Rochelle.

Mobile cloud computing is an emerging paradigm to improve the quality of mobile applications by transferring part of the computational tasks to the resource-rich cloud. The multitude data sources combined with the known difficulties of wireless communications represent an important issue for mobile cloud computing. Therefore, the additional computational power added by the cloud has to deal with the constraints of the wireless medium. One could imagine a situation where different sensors collect data and require intensive computation. This data must be transmitted at high rates before becoming stale. In this case, the network becomes the main bottleneck, not the processing power or storage size. To circumvent this issue, different strategies can be envisioned. As usual alternatives, wireless data rates must be increased or the amount of data sent to the cloud must be reduced. CROMO tackles challenges from all these three components of the mobile clouds (data generation, collect and processing) to then integrate them as a whole enhanced mobile cloud with improved network performances in terms of delay, energy consumption, availability, and reliability. In this context, joint exchanges and crossed visits have been done (Aziz went to Rio, Dianne went to Lille). The project yield to several publications such as [16], [41].

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Several researchers have visited our group in 2017, mainly from our partner universities but not only:

- Luis Henrique Costa, Brazil, December 2017
- Milan Erdej, UTC, France, December 2017
- Pedro Braconnot Velloso, UFRJ, Brasil, July 2017
- Essia Hamouda, Riverside University, USA, May 2017
- Felipe Lalanne, Inria Chile, June 2017
- Nicola Accettura, CNRS, March 2017
- Jacques Tiberghien, ULB, Brussels, May 2017
- Jens Gerlach, Fraunhofer FOKUS, March 2017
- Virgile Prevosto, CEA, March 2017

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Abdoul Aziz Mbacke visited Stellenbosch university from October to December 2017
- Jad Nassar visited Metropolitan Autonomous University Cuajimalpa Campus, Mexico in September 2017

GALEN Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

Program: ANR Blanc International

Project acronym: ADAMANTIUS

Project title: Automatic Detection And characterization of residual Masses in pAtients with lymphomas through fusioN of whole-body diffusion-weighted mrI on 3T and 18F-flUorodeoxyglucoSe pet/ct

Duration: 9/2012-8/2015

Coordinator: CHU Henri Mondor - FR

Program: ANR JCJC

Project acronym: HICORE

Project title: HIERarchical COmpositional REpresentations for Computer Vision

Duration: 10/2010-9/2014

Coordinator: ECP - FR

Program: ANR JCJC

Project acronym: LearnCost

Project title: Learning Model Constraints for Structured Prediction

Duration: 2014-2018

Coordinator: Inria Saclay - FR

Program: ANR JCJC

Project acronym: MajIC

Project title: Majorization-Minimization Algorithms for Image Computing

Duration: 2017-2021

Coordinator: E. Chouzenoux

Program: ITMOs Cancer & Technologies pour la santé d'Aviesan / INCa

Project acronym: CURATOR

Project title: Slice-to-Image Deformable Registration towards Image-based Surgery Navigation & Guidance

Duration: 12/2013-11/2015

Coordinator: ECP - FR

9.1.2. Others

Program: CNRS MASTODONS

Projet acronym: TABASCO

Project title: Traitement du bruit non Gaussien en spectroscopie

Duration: 2016-2018

Coordinator: E. Chouzenoux

Program: CNRS-CEFIPRA
Project acronym: NextGenBP
Project title: Looking Beyond Backpropagation in Deep Learning
Duration : 2017-2019
Coordinator: E. Chouzenoux

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. MOBOT

Title: Intelligent Active MObility Aid RoBOT integrating Multimodal Communication

Programm: FP7

Duration: February 2013 - January 2016

Coordinator: Technische Universität München

Partners:

Bartłomiej Marcin Stanczyk (Poland)

Athena Research and Innovation Center in Information Communication & Knowledge Technologies (Greece)

Bethanien Krankenhaus - Geriatisches Zentrum - Gemeinnützige (Germany)

Diaplasia Rehabilitation Center (Greece)

Ecole Centrale des Arts et Manufactures (France)

Institute of Communication and Computer Systems (Greece)

Technische Universitaet Muenchen (Germany)

Ruprecht-Karls-Universitaet Heidelberg (Germany)

Inria contact: Iasonas Kokkinos

Mobility disabilities are prevalent in our ageing society and impede activities important for the independent living of elderly people and their quality of life. The MOBOT project aims at supporting mobility and thus enforcing fitness and vitality by developing intelligent active mobility assistance robots for indoor environments that provide user-centred, context-adaptive and natural support. Our driving concept envisions cognitive robotic assistants that act (a) proactively by realizing an autonomous and context-specific monitoring of human activities and by subsequently reasoning on meaningful user behavioural patterns, as well as (b) adaptively and interactively, by analysing multi-sensory and physiological signals related to gait and postural stability, and by performing adaptive compliance control for optimal physical support and active fall prevention. Towards these targets, a multimodal action recognition system will be developed to monitor, analyse and predict user actions with a high level of accuracy and detail. The main thrust of our approach will be the enhancement of computer vision techniques with modalities such as range sensor images, haptic information as well as command-level speech and gesture recognition. Data-driven multimodal human behaviour analysis will be conducted and behavioural patterns will be extracted. Findings will be imported into a multimodal human-robot communication system, involving both verbal and nonverbal communication and will be conceptually and systemically synthesised into mobility assistance models taking into consideration safety critical requirements. All these modules will be incorporated in a behaviour-based and context-aware robot control framework. Direct involvement of end-user groups will ensure that actual user needs are addressed. Finally, user trials will be conducted to evaluate and benchmark the overall system and to demonstrate the vital role of MOBOT technologies for Europe's service robotics.

9.2.1.2. Strategie

Title: Statistically Efficient Structured Prediction for Computer Vision and Medical Imaging

Programm: FP7

Duration: January 2014 - December 2017

Coordinator: Inria

Inria contact: Matthew Blaschko

'Inference in medical imaging is an important step for disease diagnosis, tissue segmentation, alignment with an anatomical atlas, and a wide range of other applications. However, imperfections in imaging sensors, physical limitations of imaging technologies, and variation in the human population mean that statistical methods are essential for high performance. Statistical learning makes use of human provided ground truth to enable computers to automatically make predictions on future examples without human intervention. At the heart of statistical learning methods is risk minimization - the minimization of the expected loss on a previously unseen image. Textbook methods in statistical learning are not generally designed to minimize the expected loss for loss functions appropriate to medical imaging, which may be asymmetric and non-modular. Furthermore, these methods often do not have the capacity to model interdependencies in the prediction space, such as those arising from spatial priors, and constraints arising from the volumetric layout of human anatomy. We aim to develop new statistical learning methods that have these capabilities, to develop efficient learning algorithms, to apply them to a key task in medical imaging (tumor segmentation), and to prove their convergence to optimal predictors. To achieve this, we will leverage the structured prediction framework, which has shown impressive empirical results on a wide range of learning tasks. While theoretical results giving learning rates are available for some algorithms, necessary and sufficient conditions for consistency are not known for structured prediction. We will consequently address this issue, which is of key importance for algorithms that will be applied to life critical applications, e.g. segmentation of brain tumors that will subsequently be targeted by radiation therapy or removed by surgery. Project components will address both theoretical and practical issues.'

9.2.2. I-SUPPORT

Title: ICT-Supported Bath Robots

Project-Team GALEN 17

Program: FP7

Duration: March 2015 - March 2018

Coordinator: Robotnik Automation S.L.L.

Partners:

Bethanien Krankenhaus - Geriatisches Zentrum - Gemeinnutzige GMBH (Germany)

Fondazione Santa Lucia (Italy)

Institute of Communication and Computer Systems (Greece)

Karlsruher Institut für Technologie (Germany)

Theofanis Alexandridis Kai Sia Ee (OMEGATECH) (Greece)

Robotnik Automation SII (Spain)

Scuola Superiore di Studi Universitari E di Perfezionamento Sant'Anna (Italy)

Frankfurt University of Applied Sciences (Germany)

Inria contact: Iasonas Kokkinos

The I-SUPPORT project envisions the development and integration of an innovative, modular, ICTsupported service robotics system that supports and enhances older adults' motion and force abilities and assists them in successfully, safely and independently completing the entire sequence of bathing tasks, such as properly washing their back, their upper parts, their lower limbs, their buttocks and groin, and to effectively use the towel for drying purposes. Advanced modules of cognition, sensing, context awareness and actuation will be developed and seamlessly integrated into the service robotics system to enable the robotic bathing system to adapt to the frail elderly population' capabilities and the frail elderly to interact in a master-slave mode, thus, performing bathing activities in an intuitive and safe way. Adaptation and integration of state-of-the-art, cost-effective, soft-robotic manipulators will provide the hardware constituents, which, together with advanced human-robot force/compliance control that will be developed within the proposed project, will form the basis for a safe physical human-robot interaction that complies with the most up-to-date safety standards. Human behavioural, sociological, safety, ethical and acceptability aspects, as well as financial factors related to the proposed service robotic infrastructure will be thoroughly investigated and evaluated so that the I-SUPPORT end result is a close-to-market prototype, applicable to realistic living settings.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

Sup'Com Tunis - Collaborative research with Amel Benazza-Benhayia. Collaboration Topic: Multi-spectral imaging.

Universidad Tecnica Federico Santa Maria - Collaborative research with Luis M. Briceno Arias. Collaboration Topics: Variational approaches for monotone inclusions.

University of Patras, Greece - Collaborative research with V. Megalooikonomou. Collaboration Topic: Biosignal analysis.

University of Pennsylvania - Collaborative research with Aristeidis Sotiras. Collaboration Topic: Higher Order Graphs in biomedical image analysis.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

The following international students did an internship at CVN in the past year:

Huidong Liu, Stony Brook University, NY (may 2017)

Zhixin Shu, Stony Brook University, NY (may 2017)

Vu Nguyen, Stony Brook University, NY (jul. 2017)

Han Anh Vu Le, Houston University (jul. 2017)

Anisia Florescu, University of Galati Romania (feb. 2017)

Vyacheslav Dudar, Taras Sheuchenko National University of Kyiv (nov. 2017)

Carla Bertolocchi, Universita degli studi di Modena e Reggio Emilia (dec. 2017)

Yana Vedel, Taras Sheuchenko National University of Kyiv (dec. 2017)

GALLIUM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR projects

9.1.1.1. Vocal

Participants: Armaël Guéneau, Xavier Leroy, François Pottier, Naomi Testard.

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

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

9.1.2. FUI Projects

9.1.2.1. Secur-OCaml

Participants: Damien Doligez, Fabrice Le Fessant.

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

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. Deepsea

Participants: Umut Acar, Vitalii Aksenov, Arthur Charguéraud, Adrien Guatto, Michael Rainey.

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

9.2.2. ITEA3 Projects

9.2.2.1. Assume

Participants: Xavier Leroy, Luc Maranget.

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

9.3. International Initiatives

9.3.1. Informal International Partners

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

GAMBLE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

We organized, with colleagues of the mathematics department (Institut Elie Cartan Nancy) a regular working group about geometry and probability.

9.2. National Initiatives

9.2.1. ANR SingCAST

The objective of the young-researcher ANR grant SingCAST is to intertwine further symbolic/numeric approaches to compute efficiently solution sets of polynomial systems with topological and geometrical guarantees in singular cases. We focus on two applications: the visualization of algebraic curves and surfaces and the mechanical design of robots.

After identifying classes of problems with restricted types of singularities, we plan to develop dedicated symbolic-numerical methods that take advantage of the structure of the associated polynomial systems that cannot be handled by purely symbolic or numerical methods. Thus we plan to extend the class of manipulators that can be analyzed, and the class of algebraic curves and surfaces that can be visualized with certification.

The project has a total budget of 100k€. It started on March 1st 2014 and will finished in August 2018. It is coordinated by Guillaume Moroz, with a participation of 60%, and Marc Pouget with a participation of 40%.

Project website: <https://project.inria.fr/singcast/>.

9.3. International Initiatives

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

9.3.1.1. Astonishing

Title: ASSociate Team ON Non-ISH euclIdeaN Geometry

International Partners (Institution - Laboratory - Researcher):

University of Groningen (Netherlands) - Johann Bernoulli Institute of Mathematics and Computer Science - Gert Vegter

University of Luxembourg - Mathematics Research Unit - Jean-Marc Schlenker

Université Paris Est Marne-la-Vallée - Laboratoire d'Informatique Gaspard Monge - Éric Colin de Verdière

Start year: 2017

See also: <https://members.loria.fr/Monique.Teillaud/collab/Astonishing/>

Some research directions in computational geometry have hardly been explored. The spaces in which most algorithms have been designed are the Euclidean spaces R^d . To extend further the scope of applicability of computational geometry, other spaces must be considered, as shown by the concrete needs expressed by our contacts in various fields as well as in the literature. Delaunay triangulations in non-Euclidean spaces are required, e.g., in geometric modeling, neuromathematics, or physics. Topological problems for curves and graphs on surfaces arise in various applications in computer graphics and road map design. Providing robust implementations of these results is a key towards their reusability in more applied fields. We aim at studying various structures and algorithms in other spaces than R^d , from a computational geometry viewpoint. Proposing algorithms operating in such spaces requires a prior deep study of the mathematical properties of the objects considered, which raises new fundamental and difficult questions that we want to tackle.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Gert Vegter spent three weeks in GAMBLE in the framework of the Astonishing associate team.

9.4.2. Visits to International Teams

Olivier Devillers spent one month at Computational Geometry Lab of Carleton University [http://
cglab.ca/about.html](http://cglab.ca/about.html).

GAMMA3 Project-Team

6. Partnerships and Cooperations

6.1. European Initiatives

6.1.1. FP7 & H2020 Projects

- UMRIDA <https://sites.google.com/a/numeca.be/umrida/>

6.2. International Initiatives

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

6.2.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

Mississippi State University (United States) - Center for Advanced Vehicular Systems -
Computational Fluid Dynamics Dept. (CAVS-CFD) - Marcum David

Start year: 2017

See also: http://pages.saclay.inria.fr/frederic.alauzet/AssociateTeam_AM2NS/AT_am2ns.html

The purpose of the AM2NS Associate Team is to mutualize the knowledge of all teams in order to develop the next generation of meshing methods and their parallelization to address the new challenges in numerical simulations for industrial problems. The Associate Team is composed of four partners: Inria, Mississippi State University, The Boeing Company and Massachusetts Institute of Technology.

6.2.1.2. MODIS

Title: High-order discrete geometric modeling

International Partner (Institution - Laboratory - Researcher):

Polytechnique Montréal (Canada) - Computer Science - François Guibault

Start year: 2017

In the area of geometric modeling, major challenges are linked to the efficient visualization of CAD surfaces and to the generation of meshes adapted to numerical simulation. In this context, the conception of a discrete geometric model provides a simple and universal representation model, without the need for CAD. A first study has been carried out for the conception of a model of order 1 (one) defined by a “triangulation” composed of quadrilaterals and triangles. The advantage of this model of order 1 lies in its geometric simplicity. However, in the case of complex surfaces, it may require a very large number of elements, and besides it is not sufficiently rich to give certain essential characteristics like geometric curvatures. The main goal of this project is to extend this discrete model of order 1 to higher orders.

GANG Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Laboratory of Information, Networking and Communication Sciences (LINCS)*

Gang is participating to the LINCS, a research centre co-founded by Inria, Institut Mines-Télécom, UPMC and Alcatel-Lucent Bell Labs, dedicated to research and innovation in the domains of future information and communication networks, systems and services. Gang contributes to work on online social networks, content centric networking and forwarding information verification.

8.2. National Initiatives

8.2.1. *ANR DESCARTES*

Participants: Carole Delporte-Gallet, Hugues Fauconnier, Pierre Fraigniaud, Adrian Kosowski, Laurent Viennot.

Cyril Gavoille (U. Bordeaux) leads this project that grants 1 Post-Doc. H. Fauconnier is the local coordinator (This project began in October 2016).

Despite the practical interests of reusable frameworks for implementing specific distributed services, many of these frameworks still lack solid theoretical bases, and only provide partial solutions for a narrow range of services. We argue that this is mainly due to the lack of a generic framework that is able to unify the large body of fundamental knowledge on distributed computation that has been acquired over the last 40 years. The DESCARTES project aims at bridging this gap, by developing a systematic model of distributed computation that organizes the functionalities of a distributed computing system into reusable modular constructs assembled via well-defined mechanisms that maintain sound theoretical guarantees on the resulting system. DESCARTES arises from the strong belief that distributed computing is now mature enough to resolve the tension between the social needs for distributed computing systems, and the lack of a fundamentally sound and systematic way to realize these systems.

8.2.2. *ANR MultiMod*

Participants: Adrian Kosowski, Laurent Viennot.

David Coudert (Sophia Antipolis) leads this project. L. Viennot coordinates locally. The project begins in 2018.

The MultiMod project aims at enhancing the mobility of citizens in urban areas by providing them, through a unique interface enabling to express their preferences, the most convenient transportation means to reach their destinations. Indeed, the increasing involvement of actors and authorities in the deployment of more responsible and cost-effective logistics and the progress made in the field of digital technology have made possible to create synergies in the creation of innovative services for improving the mobility in cities. However, users are faced with a number of solutions that coexist at different scales, providing complementary information for the mobility of users, but that make very complex to find the most convenient itinerary at a given time for a specific user. In this context, MultiMod aims at improving the mobility of citizens in urban areas by proposing contextualized services, linking users, to facilitate multimodal transport by combining, with flexibility, all available modes (planned/dynamic carpooling, public transport (PT), car-sharing, bicycle, etc.).

We consider the use of carpooling in metropolitan areas, and so for short journeys. Such usage enables itineraries that are not possible with PT, allows for opening up areas with low PT coverage by bringing users near PT (last miles), and for faster travel-time when existing PT itineraries are too complex or with too low frequency (e.g., one bus per hour). In this context, the application must help the driver and the passenger as much as possible. In particular, the application must propose the meeting-point, indicate the driver the detour duration, and indicate the passenger how to reach this meeting-point using PT. Here, the time taken by drivers and passengers to agree becomes a critical issue and so the application must provide all needed information to quickly take a decision (i.e., in one click).

In addition, the era of Smart City gathers many emerging concepts, driven by innovative technological players, which enables the exploitation of real-time data (e.g., delay of a bus, traffic jam) made available by the various actors (e.g., communities in the framework of Open Data projects, users via their mobile terminals, traffic supervision authorities). In the MultiMod project, we will use these rich sources of data to propose itineraries that are feasible at query-time. Our findings will enable the design of a mobility companion able not only to guide the user along her journey, including when and how to change of transportation mean, but also to propose itinerary changes when the current one exceeds a threshold delay. The main originality of this project is thus to address the problem of computing itineraries in large-scale networks combining PT, carpooling and real-time data, and to satisfy the preferences of users. We envision that the outcome of this project will significantly improve the daily life of citizens.

The targeted metropolitan area for validating our solutions is Ile-de-France. Indeed, Instant-System is currently developing the new application “Vianavigo lab” which will replace the current “Vianavigo” application for the PT network of Ile-de-France. Our findings will therefore be tested at scale and eventually be integrated and deployed in production servers and mobile applications. The smaller networks of Bordeaux and Nice will be used to perform preliminary evaluations since Instant System already operates applications in these cities (Boogi Nice, Boogi Bordeaux). An important remark is that new features and algorithms can contractually be deployed in production every 4 months, thus enabling Instant System to measure and challenge the results of the MultiMod project in continue. This is a chance for the project to maximize its impact.

8.2.3. ANR FREDDA

Participants: Carole Delporte-Gallet, Hugues Fauconnier, Pierre Fraigniaud.

Arnaud Sangnier (IRIF, Univ Paris Diderot) leads this project that grants 1 PhD. (This project began in October 2017).

Distributed algorithms are nowadays omnipresent in most systems and applications. It is of utmost importance to develop algorithmic solutions that are both robust and flexible, to be used in large scale applications. Currently, distributed algorithms are developed under precise assumptions on their execution context: synchronicity, bounds on the number of failures, etc. The robustness of distributed algorithms is a challenging problem that has not been much considered until now, and there is no systematic way to guarantee or verify the behavior of an algorithm beyond the context for which it has been designed. We propose to develop automated formal method techniques to verify the robustness of distributed algorithms and to support the development of robust applications. Our methods are of two kinds: statically through classical verification, and dynamically, by synthesizing distributed monitors, that check either correctness or the validity of the context hypotheses at runtime.

8.2.4. ANR Distancia

Participants: Pierre Charbit, Michel Habib, Laurent Viennot.

Victor Chepoi (Univ. Marseille) leads this project. P. Charbit coordinates locally. The project begins in early-2018.

The theme of the project is Metric Graph Theory, and we are concerned both on theoretical foundations and applications. Such applications can be found in real world networks. For example, the hub labelling problem in road networks can be directly applied to car navigation applications. Understanding key structural properties of large-scale data networks is crucial for analyzing and optimizing their performance, as well as

improving their reliability and security. In prior empirical and theoretical studies researchers have mainly focused on features such as small world phenomenon, power law degree distribution, navigability, and high clustering coefficients. Although those features are interesting and important, the impact of intrinsic geometric and topological features of large-scale data networks on performance, reliability and security is of much greater importance. Recently, there has been a surge of empirical works measuring and analyzing geometric characteristics of real-world networks, namely the Gromov hyperbolicity (called also the negative curvature) of the network. It has been shown that a number of data networks, including Internet application networks, web networks, collaboration networks, social networks, and others, have small hyperbolicity.

Metric graph theory was also indispensable in solving some open questions in concurrency and learning theory in computer science and geometric group theory in mathematics. Median graphs are exactly the 1-skeletons of CAT(0) cube complexes (which have been characterized by Gromov in a local-to-global combinatorial way). They play a vital role in geometric group theory (for example, in the recent solution of the famous Virtual Haken Conjecture). Median graphs are also the domains of event structures of Winskel, one of the basic abstract models of concurrency. This correspondence is very useful in dealing with questions on event structures.

Many classical algorithmic problems concern distances: shortest path, center and diameter, Voronoi diagrams, TSP, clustering, etc. Algorithmic and combinatorial problems related to distances also occur in data analysis. Low-distortion embeddings into ℓ_1 -spaces (theorem of Bourgain and its algorithmical use by Linial et al.) were the founding tools in metric methods. Recently, several approximation algorithms for NP-hard problems were designed using metric methods. Other important algorithmic graph problems related to distances concern the construction of sparse subgraphs approximating inter-node distances and the converse, augmentation problems with distance constraints. Finally, in the distributed setting, an important problem is that of designing compact data structures allowing very fast computation of inter-node distances or routing along shortest or almost shortest paths. Besides computer science and mathematics, applications of structures involving distances can be found in archeology, computational biology, statistics, data analysis, etc. The problem of characterizing isometric subgraphs of hypercubes has its origin in communication theory and linguistics. To take into account the recombination effect in genetic data, the mathematicians Bandelt and Dress developed in 1991 the theory of canonical decompositions of finite metric spaces. Together with geneticists, Bandelt successfully used it over the years to reconstruct phylogenies, in the evolutionary analysis of mtDNA data in human genetics. One important step in their method is to build a reduced median network that spans the data but still contains all most parsimonious trees. As mentioned above, the median graphs occurring there constitute a central notion in metric graph theory.

With this project, we aim to participate at the elaboration of this new domain of Metric Graph Theory, which requires experts and knowledge in combinatorics (graphs, matroids), geometry, and algorithms. This expertise is distributed over the members of the consortium and a part of the success of our project it will be to share these knowledges among all the members of the consortium. This way we will create a strong group in France on graphs and metrics.

8.2.5. ANR HOSIGRA

Participants: Pierre Charbit, Michel Habib.

This project starting in early-2018, led by Reza Naserasr, explores the connection between minors and colorings, exploiting the notion of signed graphs. With the four colour theorem playing a central role in development of Graph Theory, the notions of minor and coloring have been branded as two of the most distinguished concepts in this field. The geometric notion of planarity has given birth to the theory of minors among others, and coloring have proven to have an algebraic nature through its extension to the theory of graph homomorphisms. Great many projects have been completed on both subjects, but what remains mostly a mystery is the correlation of the two subjects. The four color theorem itself, in slightly stronger form, claims that if a complete graph on five vertices cannot be formed by minor operation from a given graph, then the graph can be homomorphically mapped into the complete graph on four vertices (thus a 4-coloring). Commonly regarded as the most challenging conjecture on graph theory, the Hadwiger conjecture claims that

five and four in this theorem can be replaced with n and $n - 1$ respectively for any value of n . The correlation of these two concepts has been difficult to study, mainly for the following reason: While the coloring or homomorphism problems roots back into intersections of odd-cycles, the minor operation is irrelevant of the parity of cycles. To overcome this barrier, the notion of signed graphs has been used implicitly since 1970s when coloring results on graphs with no odd- K_4 is proved, following which a stronger form of the Hadwiger conjecture, known as Odd Hadwiger conjecture, was proposed by P. Seymour and B. Gerards, independently. Being a natural subclass of Matroids and a superclass of graphs, the notion of minor of signed graphs is well studied and many results from graph minor are either already extended to signed graphs or it is considered by experts of the subject. Observing the importance, and guided by some earlier works, in particular that of B. Guenin, we then started the study of algebraic concepts (coloring and homomorphisms) for signed graphs. Several results have been obtained in the past decade, and this project aims at exploring more of this topic.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Amos Korman has an ERC Consolidator Grant entitled “Distributed Biological Algorithms (DBA)”, started in May 2015. This project proposes a new application for computational reasoning. More specifically, the purpose of this interdisciplinary project is to demonstrate the usefulness of an algorithmic perspective in studies of complex biological systems. We focus on the domain of collective behavior, and demonstrate the benefits of using techniques from the field of theoretical distributed computing in order to establish algorithmic insights regarding the behavior of biological ensembles. The project includes three related tasks, for which we have already obtained promising preliminary results. Each task contains a purely theoretical algorithmic component as well as one which integrates theoretical algorithmic studies with experiments. Most experiments are strategically designed by the PI based on computational insights, and are physically conducted by experimental biologists that have been carefully chosen by the PI. In turn, experimental outcomes will be theoretically analyzed via an algorithmic perspective. By this integration, we aim at deciphering how a biological individual (such as an ant) “thinks”, without having direct access to the neurological process within its brain, and how such limited individuals assemble into ensembles that appear to be far greater than the sum of their parts. The ultimate vision behind this project is to enable the formation of a new scientific field, called algorithmic biology, that bases biological studies on theoretical algorithmic insights.

8.3.2. LIA Struco

Pierre Charbit is director of the LIA STRUCO, which is an Associated International Laboratory of CNRS between IÚUK, Prague, and IRIF, Paris. The director on the Czech side is Pr. Jaroslav Nešetřil. The primary theme of the laboratory is graph theory, more specifically: sparsity of graphs (nowhere dense classes of graphs, bounded expansion classes of graphs), extremal graph theory, graph coloring, Ramsey theory, universality and morphism duality, graph and matroid algorithms and model checking.

STRUCO focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work.

One of the main goals of STRUCO is to provide a sustainable and reliable structure to help Czech and French researchers cooperate on long-term projects, disseminate the results to students of both countries and create links between these students more systematically. The chosen themes of the project indeed cover timely and difficult questions, for which a stable and significant cooperation structure is needed. By gathering an important number of excellent researchers and students, the LEA will create the required environment for making advances, which shall be achieved not only by short-term exchanges of researchers, but also by a strong involvement of Ph. D students in the learning of state-of-the-art techniques and in the international collaborations.

STRUCO is a natural place to federate and organize these many isolated collaborations between our two countries. Thus, the project would ensure long-term cooperations and allow young researchers (especially PhD students) to maintain the fruitful exchanges between the two countries in the future years, in a structured and federated way.

8.4. International Initiatives

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

Carole Delporte-Gallet and Hugues Fauconnier are members of the Inria-MEXICO Equipe Associée LiDiCo (At the Limits of Distributed Computability, <https://sites.google.com/site/lidicoequipeassociee/>).

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Ofer Feinerman (Physics department of complex systems, Weizmann Institute of Science, Rehovot, Israel), is a team member in Amos Korman's ERC project DBA. This collaboration has been formally established by signing a contract between the CNRS and the Weizmann Institute of Science, as part of the ERC project.

Rachid Guerraoui (School of Computer and Communication Sciences, EPFL, Switzerland) maintains an active research collaboration with Gang team members (Carole Delporte, Hugues Fauconnier).

Pierluigi Crescenzi (University of Florence, Italy) is a frequent visitor to the team and maintains an active research collaboration with Gang team members (Pierre Fraigniaud).

Sergio Rajsbaum (UNAM, Mexico) is a regular collaborator of the team, also involved formally in a joint French-Mexican research project (see next subsection).

Boaz Patt-Shamir (Tel Aviv University, Israel) is a regular collaborator of the team, also involved formally in a joint French-Israeli research project (see next subsection).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

[chercheurs invités, profs invités (via université), Les internships sont à mettre dans la subsection suivante.]

Sergio Rajsbaum (UNAM-Mexico) was invited for two months (May-June).

Eli Gafni visited the team for one month (mid-June to mid-July).

Lalla Mouatadid visited the group for 2 weeks in 2017. She is finishing her PhD in computer. Science at University of Toronto, under the supervision of prof. Derek Corneil and Alan Borodin.

8.5.2. Visits to International Teams

Carole Delporte-Gallet and Hugues Fauconnier have visited 2x10 days Sergio Rajsbaum at UNAM (Mexico) in September and November 2017.

GECO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Starting from the end of 2015, we have been funded by PGM0 (Gaspard Monge Program for Optimisation and operational research) through a grant on Geometric Optimal Control. The grant is coordinated by Mario Sigalotti.

8.2. National Initiatives

8.2.1. ANR

The ANR SRGI starts at the end of 2015, for a duration of four years. GECO is one of one of the partners of the ANR. The national coordinator is Emmanuel Trélat (UPMC) and the local one Ugo Boscain.

SRGI deals with sub-Riemannian geometry, hypoelliptic diffusion and geometric control.

8.2.2. Other initiatives

Ugo Boscain and Mario Sigalotti are members of the project DISQUO of the program Inphyniti of the CNRS. Coordinator: Thomas Chambrion (Nancy).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Program: ERC Proof of Concept

Project acronym: ARTIV1

Project title: An artificial visual cortex for image processing

Duration: From April 2017 to September 2018.

Coordinator: Ugo Boscain

Abstract: The ERC starting grant GECOMETHODS, on which this POC is based, tackled problems of diffusion equations via geometric control methods. One of the most striking achievements of the project has been the development of an algorithm of image reconstruction based mainly on non-isotropic diffusion. This algorithm is bio-mimetic in the sense that it replicates the way in which the primary visual cortex V1 of mammals processes the signals arriving from the eyes. It has performances that are at the state of the art in image processing. These results together with others obtained in the ERC project show that image processing algorithms based on the functional architecture of V1 can go very far. However, the exceptional performances of the primary visual cortex V1 rely not only on the particular algorithm used, but also on the fact that such algorithm runs on a dedicated hardware having the following features: 1. an exceptional level of parallelism; 2. connections that are well adapted to transmit information in a non-isotropic way as it is required by the algorithms of image reconstruction and recognition. The idea of this POC is to create a dedicated hardware (called ARTIV1) emulating the functional architecture of V1 and hence having on one hand a huge degree of parallelism and on the other hand connections among the CPUs that reflect the non-isotropic structure of the visual cortex V1. Such a hardware that we plan to build as an integrated circuit with an industrial partner will be a veritable artificial visual cortex. It will be fully programmable and it will be able to perform many biomimetic image processing tasks that we expect to be exceptionally performant. ARTIV1 will come to the marked accompanied by some dedicated software for image reconstruction and image recognition. However we expect that other applications will be developed by customers, as for instance softwares for optical flow estimation or for sound processing.

8.4. International Initiatives

8.4.1. Informal International Partners

SISSA (Scuola Internazionale Superiore di Studi Avanzati), Trieste, Italy.

Sector of Functional Analysis and Applications, Geometric Control group. Coordinator: Andrei A. Agrachev.

We collaborate with the Geometric Control group at SISSA mainly on subjects related with sub-Riemannian geometry. Thanks partly to our collaboration, SISSA has established an official research partnership with École Polytechnique.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Andrei Agrachev (SISSA, Italy) has been visiting the GECO team for one year, ending in June 2017.

8.5.1.1. Internships

Gontran Lance has made an internship in GECO, under the supervision of Mario Sigalotti and Emmanuel Trélat on the turnpike phenomenon in the orbital transfer problem.

GENSCALE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Rennes Hospital, Hematology service

Participants: Dominique Lavenier, Patrick Durand.

The collaboration with the Hematology service of the Rennes hospital aims to set up advanced bioinformatics pipelines for cancer diagnosis. More precisely, we evaluated a new method of predictions of small cancer-related mutations (such as SNPs and small insertions/deletions) from raw DNA sequencing data.

9.1.2. Partnership with INRA in Rennes

Participants: Susete Alves Carvalho, Cervin Guyomar, Dominique Lavenier, Fabrice Legeai, Claire Lemaitre, Sebastien Letort, Pierre Peterlongo.

The GenScale team has a strong and long term collaboration with biologists of INRA in Rennes: IGEPP and PEGASE units. This partnership concerns both service and research activities and is acted by the hosting of two INRA engineer (F. Legeai, S. Alves Carvalho) and one PhD student (C. Guyomar).

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. Project HydroGen: Metagenomic applied to ocean life study

Participants: Dominique Lavenier, Pierre Peterlongo, Claire Lemaitre, Guillaume Rizk, Gaetan Benoit.

Coordinator: P. Peterlongo (Inria/Irisa, GenScale, Rennes)

Duration: 42 months (Nov. 2014 – Apr. 2018)

Partners: CEA (GenoScope, Evry), INRA (AgroParisTech, Paris – MIG, Jouy-en-Jossas).

The HydroGen project aims to design new statistical and computational tools to measure and analyze biodiversity through comparative metagenomic approaches. The support application is the study of ocean biodiversity based on the analysis of seawater samples available from the Tara Oceans expedition.

9.2.1.2. Project SpeCrep: speciation processes in butterflies

Participants: Dominique Lavenier, Jeremy Gauthier, Fabrice Legeai, Claire Lemaitre, Pierre Peterlongo.

Coordinator: M. Elias (Museum National d'Histoire Naturelle, Institut de Systematique et d'Evolution de la Biodiversite, Paris)

Duration: 48 months (Jan. 2015 – Dec. 2018)

Partners: MNHN (Paris), INRA (Versailles-Grignon), Genscale Inria/IRISA Rennes.

The SpeCrep project aims at better understanding the speciation processes, in particular by comparing natural replicates from several butterfly species in a suture zone system. GenScale's task is to develop new efficient methods for the assembly of reference genomes and the evaluation of the genetic diversity in several butterfly populations.

9.2.2. PIA: Programme Investissement d'Avenir

9.2.2.1. RAPSODYN: Optimization of the rapeseed oil content under low nitrogen

Participants: Dominique Lavenier, Claire Lemaitre, Sebastien Letort, Pierre Peterlongo.

Coordinator: N. Nesi (Inra, IGEPP, Rennes)

Duration: 7.5 year (2012-2019)

Partners: 5 companies, 9 academic research labs.

The objective of the Rapsodyn project is the optimization of the rapeseed oil content and yield under low nitrogen input. GenScale is involved in the bioinformatics work package to elaborate advanced tools dedicated to polymorphism and application to the rapeseed plant. (<http://www.rapsodyn.fr>)

9.2.2.2. *Institut Français de Bioinformatique: Plant node*

Participant: Fabrice Legeai.

Coordinator: Hadi Quesneville (INRA, Versailles)

The aim of the Institut Francais de Bioinformatique (IFB) offers resources for a large community of French biologist. With INRA and CIRAD, we were part of the plant node of IFB, and focused on delivering efficient tools for sharing agronomical data, such as Askomics.

9.2.3. *Programs from research institutions*

9.2.3.1. *Inria ADT DiagCancer*

Participants: Dominique Lavenier, Patrick Durand.

Since October 1st, 2016, Genscale started a one-year Inria ADT called DiagCancer. It aims at: (1) including the DiscoSnp++ tool within the current data production pipeline at Pontchaillou Hospital (Rennes), (2) providing a new prediction tool applied to the calling of cancer related mutations from DNA sequencing data and (3) creating new analysis tools to facilitate the interpretation of results by end-users (biologists, doctors). The project is done in close collaboration with Haematology Service, CHU Pontchaillou, Rennes.

9.2.3.2. *CNRS Mastodons program: C3G*

Participants: Dominique Lavenier, Pierre Peterlongo, Claire Lemaitre, Camille Marchet, Lolita Lecompte.

High-throughput sequencing applications now cover all life sciences: from medicine to agronomy. The 3rd generation sequencing produces very long reads, but the reads are extremely noisy, which has a strong impact on the quality of bioinformatics analyses. The challenge of the C3G project is to bring this type of data to a high level of quality through the development of new correction strategies.

9.2.3.3. *Inria Project Lab: Neuromarkers*

Participants: Dominique Lavenier, Pierre Peterlongo, Claire Lemaitre.

The IPL Neuromarkers aims to design imaging biomarkers of neurodegenerative diseases for clinical trials and study of their genetic associations. In this project, GenScale bring its expertise in the genomic field.

9.3. International Initiatives

9.3.1. *Inria Associate Team: HipcoGen*

- Title: High-Performance Combinatorial Optimization for Computational Genomics
- International Partner (Institution - Laboratory - Researcher):
 - Los Alamos National Laboratory (LANL)-NM, United States, CCS-3, Hristo Djidjev
- Start year: 2017
- Teams' web site: <https://team.inria.fr/genscale/presentation/associated-team/>

Genome sequencing and assembly, the determination of the DNA sequences of a genome, is a core experiment in computational biology. During the last decade, the cost of sequencing has decreased dramatically and a huge amount of new genomes have been sequenced. Nevertheless, most of recent genome projects stay unfinished and nowadays the databases contain much more incompletely assembled genomes than whole stable reference genomes. The main reason is that producing a complete genome, or an as-complete-as-possible-genome, is an extremely difficult computational task (an NP-hard problem) and, in spite of the efforts and the progress done by the bioinformatics community, no satisfactory solution is available today. New sequencing technologies (such as PacBio or Oxford Nanopore) are being developed that tend to produce longer DNA sequences and offer new opportunities, but also bring significant new challenges. The goal of this joint project—a cooperation between Los Alamos National Laboratory, US and Inria, is to develop a new methodology and tools based on novel optimization techniques and massive parallelism suited to these emerging technologies and able to tackle the complete assembly of large genomes.

9.3.2. Informal International Partners

- Free University of Brussels, Belgium: Genome assembly [P. Perterlongo, A. Limasset]

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Visit of Hristo Djidjev from Los Alamos National Laboratory, June 5 to July 4, 2017

9.4.2. Visits to International Teams

- Visit of R. Andonov at LANL from May 4th to May 30th. Work on Task 2 from HipcoGen project.
- Visit of S. Francois at LANL from May 4th to May 30th and from August 2 to August 23. Work on Task 2 from HipcoGen project.
- Visit of Pierre Peterlongo at LANL, May 2017 (one week). Talk to SFAF conference: "Assembly of heterozygous genomes".

GEOSTAT Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

GEOSTAT is working with the following regional partners:

- CNRS LOMA (Laboratoire Ondes et Matière d'Aquitaine) and RAS Institute (Russia): collaboration on the analysis/modeling of heartbeat physiological time series (A. Arneodo, E. Gerasimova, F. Argoul).
- GEOSTAT has a decade-long close scientific collaboration with team SYSCO2 (LEGOS LABORATORY UMR 5566): V. Garçon, B. Dewitte, J. Sudre.
- Laboratoire d'Astrophysique de Bordeaux (S. Bontemps, N. Schneider, GENESIS project).
- Collaboration with L. Bourrel (GET Toulouse / IRD) and F. Frappart (GET/UMR EPOC) Flood monitoring in Equator.
- With Bruno Castelle (EPOC).
- With D. Gibert (OSUR) on signal and image processing.
- CHU Bordeaux : Prof. Wassilios Meissner (IMN), Dr. Solange Milhé de Saint Victor (service ORL).
- CHU Toulouse : Dr. Anne Pavy Le traon (service Neurologie), Prof. Virginie Woisard (service ORL).
- IRT : Prof. Régine André-Obrecht, Dr. Julie Mauclair.
- IMT (Institut de Mathématique de Toulouse) : Dr. Sébastien Déjean, Dr. Laurent Risser.
- Mercator Océan: Dr. A. El Moussaoui. UMR EPOC).

9.2. National Initiatives

- ANR project *Voice4PD-MSA*, led by K. Daoudi, which targets the differential diagnosis between Parkinson's disease and Multiple System Atrophy. The total amount of the grant is 468555 euros, from which GeoStat has 203078 euros. The duration of the project is 42 months. Partners: CHU Bordeaux (Bordeaux), CHU Toulouse, IRT, IMT (Toulouse).
- PhD grant for C. Artnana from UPMC University, under co-supervision with H. Yahia and C. Provost (LOCEAN, Paris).
- PhD grant for G. Singh from IIT Roorkee, under co-supervision with D. Singh (IIT Roorkee).
- The PHC-Toubkal project "Caractérisation multi-capteurs et suivi spatio-temporel de l'Upwelling sur la côte atlantique marocaine par imagerie satellitaire", led by K. Daoudi, is in its second year. The partners in this project are: Faculté des sciences de Rabat, Centre Royal de Télédetection Spatiale, Mercator-Ocean and GEOSTAT.
- GEOSTAT is a member of ISIS (Information, Image & Vision) and AMF (Multifractal Analysis) GDRs.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: supported by Deutsche Forschungsgemeinde (DFG) and the Agence national de recherche (ANR).

Project acronym: GENESIS.

Project title: GENeration and Evolution of Structures in the ISm.

Duration: start 1.5. 2017, 3 years.

Coordinator: N. Schneider (I. Physik, Cologne).

Other partners: Cologne (R. Simon, N. Schneider, V. Ossenkopf, M. Roellig), LAB (S. Bontemps, A. Roy, L. Bonne, F. Herpin, J. Braine, N. Brouillet, T. Jacq), ATN Canberra (Australia), LERMA Paris (France), MPIfR Bonn (Germany), CEA Saclay (France), ITA/ZAH Heidelberg (Germany), Institute of Astronomy, Cardiff (UK), ESO (Germany, Chile), CfA Harvard (USA), IPAG Grenoble (France), Argelander Institut Bonn (Germany), CASS San Diego (USA), University of Sofia (Bulgaria).

Abstract: The formation of stars is intimately linked to the structure and evolution of molecular clouds in the interstellar medium (ISM). We propose to explore this link with a new approach by combining far infrared maps of dust (Herschel) and cooling lines(C+ with SOFIA) with molecular line maps. Dedicated analysis tools will be used and developed to analyze the maps and compare them to simulations in order to identify for the underlying physical processes. This joint project relies on the complementary expertise of the members of the Cologne KOSMA group (structure identification methods and SOFIA), the Bordeaux LAB star formation group (Herschel and spectro-imaging maps), and the Bordeaux GEOSTAT team of Inria. To understand the genesis of stars, it is necessary to disentangle the relative importance of gravity, turbulence, magnetic fields, and radiation from diffuse gas, to molecular clouds and collapsing cores, and to study the role of filaments. Using innovative new analyzing tools developed by the GeoStat team, we will analyze the Herschel images as well as new spectro-imaging surveys from ground-based telescopes, and THz spectroscopy using SOFIA. The comparison with similar analysis on simulated clouds will allow us to derive the underlying physical process which explains cloud evolution and the formation of dense structures. The project does not aim at a full understanding of star formation within 3 years, but it constitutes an important step forward as it will make systematic use of a wealth of existing, yet not fully exploited archival data, carefully chosen new observations, and sophisticated tools to analyze and interpret the data. As such, it will shed new light on how molecular clouds and stars form and may well be the starting point for many studies to follow.

9.4. International Initiatives

9.4.1. Inria International Partners

Funding from French-Indian IFCAM program (Visit of Prof. D. Singh in GEOSTAT, 2017).

9.4.1.1. Informal International Partners

- Visit of N. Brodu to Univ. UC Davis in the team of Prof. J. Crutchfield. Setting up of a collaboration on a formalism of statistical reconstruction from dynamic empirical data; the formalism involves markovian automata called Epsilon machines. The internal states of these machine correspond to equivalence classes of a physical system having similar causal relations.
- Laboratory LRIT from Rabat University (K. Minaoui, D. Aboutajdine).

9.4.2. Participation in Other International Programs

Participation in the IFCAM project with India (funding of the visit of Prof. D. Singh in 2017).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- N. Schneider (Cologne University, GENESIS project).
- Prof. D. Singh (IIT roorkee, on CEFIPRA-CNRS funding). Duration: 8 weeks, August and December 2017. Co-supervision of G. Singh PhD student, scientific collaboration with N. Brodu and K. Daoudi.

9.5.1.1. Internships

- G. Li. Master2, University Paris-Saclay.
- Q. Robin. Engineer, INP-Grenoble.
- F. G. Satsou. Master1, University Bordeaux 1.

9.5.2. Visits to International Teams*9.5.2.1. Research Stays Abroad*

June-July 2017: PhD student A. El Aouni was invited in the MERCATOR project by A. Moussaoui in the framework of the Toubkal project on ocean modeling.

GRACE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

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

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. PQCRYPTO

Title: Post-quantum cryptography for long-term security

Programm: H2020

Duration: March 2015 - March 2018

Coordinator: TECHNISCHE UNIVERSITEIT EINDHOVEN

Partners:

Academia Sinica (Taiwan)

Bundesdruckerei (Germany)

Danmarks Tekniske Universitet (Denmark)

Katholieke Universiteit Leuven (Belgium)

Nxp Semiconductors Belgium Nv (Belgium)

Ruhr-Universitaet Bochum (Germany)

Stichting Katholieke Universiteit (Netherlands)

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

Technische Universitaet Darmstadt (Germany)

University of Haifa (Israel)

Inria contact: Nicolas Sendrier

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

It might seem that having three systems offers enough variation, but these systems are all broken as soon as large quantum computers are built. The EU and governments around the world are investing heavily in building quantum computers; society needs to be prepared for the consequences, including cryptanalytic attacks accelerated by these computers. Long-term confidential documents such as patient health-care records and state secrets have to guarantee security for many years, but information encrypted today using RSA or elliptic curves and stored until quantum computers are available will then be as easy to decipher.

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

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

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

B. Smith has continued our successful informal partnership with the cryptography research group at Radboud University, Nijmegen (NL). 2017 has seen visits from researchers in both directions, and the production of the **qDSA** signature scheme package.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Beth Malmskog (Colorado College) visited the team from November 27 to December 1 2017 and gave a talk on locally recoverable codes based on fibre products of algebraic curves.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

B. Smith was an invited researcher in the Computer Science department at CINVESTAV (Mexico City, Mexico) for the month of August 2017, hosted by Professor Francisco Rodríguez Henríquez.

J. Lavauzelle visited Incidence Geometry team at Gent University (Belgium) for the month of April 2017, hosted by Professor Leo Storme.

E. Barelli visited the COMPUTE team in the DTU University at Lyngby (Danemark) during one month in february-march 2017, hosted by Professor Peter Beelen.

GRAPHDECO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Theo Thonat is funded in part by a Region PACA fellowship.

8.2. National Initiatives

8.2.1. ADT PicPlay

Participants: Sebastien Bonopera, George Drettakis.

The Technology Development Action (ADT) PicPlay a technology tranfer pre-maturation project, supported by Inria and by UCA Jedi. The objective is to create a startup company based on image based rendering technologies, taking benefit from the team's research and experience over the last 8 years. At this early stage, we evaluated the market and produced several Proof-of-Concept demonstrations for potential clients. One of the demonstrations is our new asset streaming capability that allows the use for huge datasets (see Fig. 10).

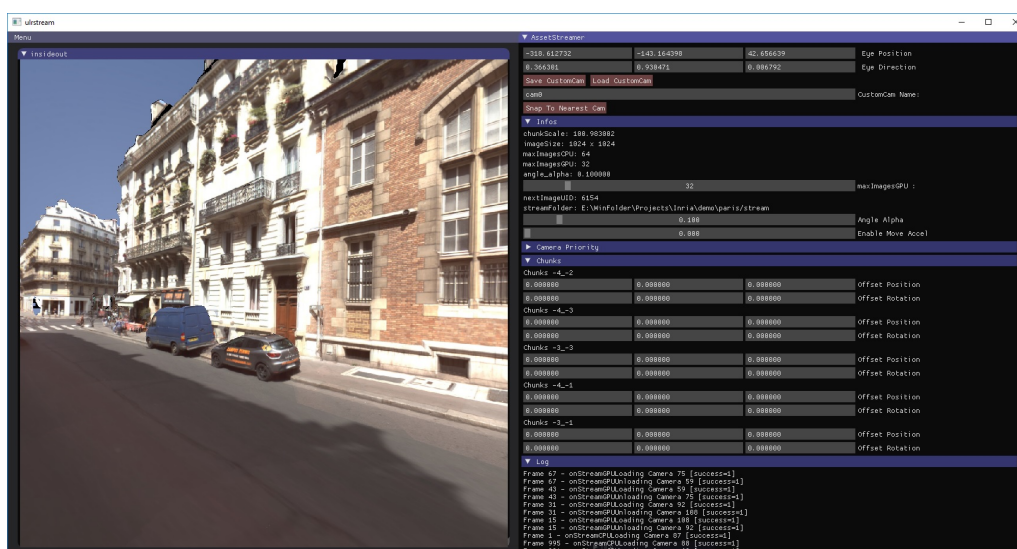


Figure 10. streamable dataset using 6500 pictures (usual not-streamable dataset has around 30 pictures)

We also developed a new solution to improve rendering quality. This solution uses a 3D mesh for each view and refines it according to this view only, before blending each view. Finally, PicPlay involved the development of several tools for converting and processing datasets.

8.2.2. ANR

8.2.2.1. ANR SEMAPOLIS

Participants: George Drettakis, Abdelaziz Djelouah, Theo Thonat.

This ANR project ended in September 2017. The goal was to use semantic information to improve urban reconstruction and rendering. The consortium was led by ENPC (R. Marlet) and includes the Inria Willow team and the GREY-C laboratory on image processing. Our contribution was in the rendering of urban models, in particular using image-based rendering algorithms. Our contribution resulted in several publications or planned publications (e.g., those described in Sec. 6.2.2 , 6.2.3)

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. *D³: Interpreting Drawings for 3D Design*

Type: ERC

Instrument: Starting Grant

Duration: February 2017 - February 2023

Participants: Adrien Bousseau, Yulia Gryaditskaya, Bastien Wailly.

Abstract. Designers draw extensively to externalize their ideas and communicate with others. However, drawings are currently not directly interpretable by computers. To test their ideas against physical reality, designers have to create 3D models suitable for simulation and 3D printing. However, the visceral and approximate nature of drawing clashes with the tediousness and rigidity of 3D modeling. As a result, designers only model finalized concepts, and have no feedback on feasibility during creative exploration. Our ambition is to bring the power of 3D engineering tools to the creative phase of design by automatically estimating 3D models from drawings. However, this problem is ill-posed: a point in the drawing can lie anywhere in depth. Existing solutions are limited to simple shapes, or require user input to "explain" to the computer how to interpret the drawing. Our originality is to exploit professional drawing techniques that designers developed to communicate shape most efficiently. Each technique provides geometric constraints that help viewers understand drawings, and that we shall leverage for 3D reconstruction.

Our first challenge is to formalize common drawing techniques and derive how they constrain 3D shape. Our second challenge is to identify which techniques are used in a drawing. We cast this problem as the joint optimization of discrete variables indicating which constraints apply, and continuous variables representing the 3D model that best satisfies these constraints. But evaluating all constraint configurations is impractical. To solve this inverse problem, we will first develop forward algorithms that synthesize drawings from 3D models. Our idea is to use this synthetic data to train machine learning algorithms that predict the likelihood that constraints apply in a given drawing. In addition to tackling the long-standing problem of single-image 3D reconstruction, our research will significantly tighten design and engineering for rapid prototyping.

8.3.1.2. *PhySound*

- Type: Training (ICT)
- Instrument: Marie-Curie Postdoctoral fellowship
- Partner: Columbia
- **Abstract:** Sound is as important as visuals in modern media (films, video-games). Yet, little effort has been devoted to the rendering of sound from digital environments, compared to the phenomenal advances of visual rendering. Sound is added to virtual scenes through the ad-hoc edition of real sounds, requiring recording phases and manual synchronization between recorded clips and visuals, while yielding limited and repetitive sounds. This project addresses this problem by generating sounds from virtual environments through physically based simulation, and focuses on a challenging family of objects: thin shells. Characteristic thin shell sounds include tearing cloth and paper, crushing cans and plastic bottles, and crumpling a piece of paper and a plastic bag. The high quality, offline simulation and rendering of thin shell sound will be addressed through a set of modeling

approaches and computational tools (model reduction, high frequency bandwidth extension and pre-computed sound databases), while the real-time but computationally constrained sound rendering will rely on data-driven approaches. This research will considerably widen the number of real life object sounds that can be digitally generated, and will contribute to the young research field of physically based sound rendering, which has the potential of becoming the next key technology of the media industry.

8.3.1.3. EMOTIVE

Type: COOPERATION (ICT)

Instrument: Research Innovation Action

Objectif: Virtual Heritage

Duration: November 2016 - October 2019

Coordinator: EXUS SA (UK)

Partner: Diginext (FR), ATHENA (GR), Noho (IRL), U Glasgow (UK), U York (UK)

Inria contact: George Drettakis

Abstract: Storytelling applies to nearly everything we do. Everybody uses stories, from educators to marketers and from politicians to journalists to inform, persuade, entertain, motivate or inspire. In the cultural heritage sector, however, narrative tends to be used narrowly, as a method to communicate to the public the findings and research conducted by the domain experts of a cultural site or collection. The principal objective of the EMOTIVE project is to research, design, develop and evaluate methods and tools that can support the cultural and creative industries in creating Virtual Museums which draw on the power of 'emotive storytelling'. This means storytelling that can engage visitors, trigger their emotions, connect them to other people around the world, and enhance their understanding, imagination and, ultimately, their experience of cultural sites and content. EMOTIVE does this by providing the means to authors of cultural products to create high-quality, interactive, personalized digital stories. GRAPHDECO contributes by developing novel image-based rendering techniques to help museum curators and archeologists provide more engaging experiences, and in particular for the offsite experience for one of the sites (see Fig. 11).

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

Canada. A. Bousseau collaborates regularly with the University of Toronto (K. Singh) and the University of British Columbia (A. Sheffer).

UK. G. Drettakis collaborates with UCL (G. Brostow, P. Hedman) and with R. Mantiuk (Cambridge).

United States. We regularly collaborate with Adobe Research (A. Hertzman, S. Paris). We also collaborate with Daniel Aliaga from Purdue University. We collaborate with M. Banks and A. Efros from University of California, Berkeley.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Several students and postdocs of F. Durand visited from MIT during 2017:

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

Fredo Durand was the recipient of the Inria International Chair and spent the academic year 2016-2017 in the group.

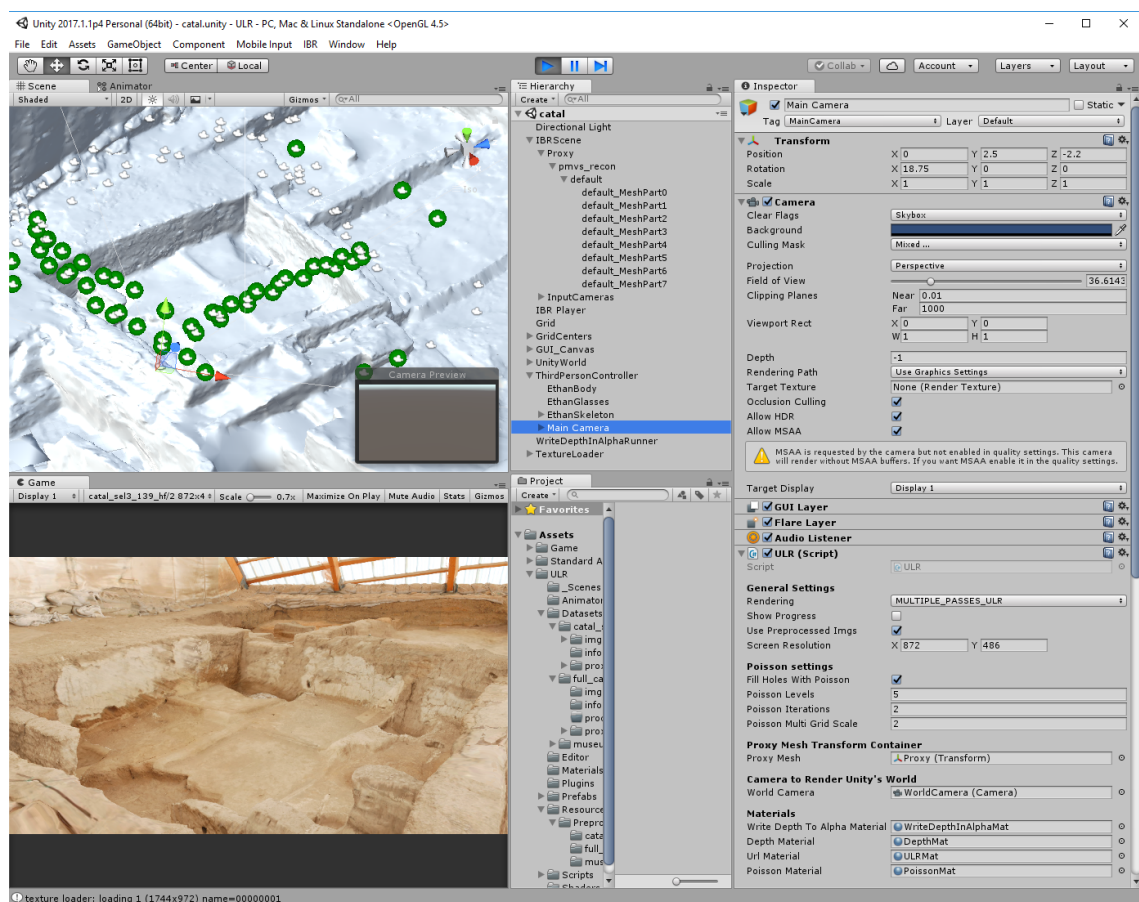


Figure 11. Screenshot of Unity IBR system developed for EMOTIVE.

8.5.2.2. Research Stays Abroad

Johanna Delanoy spent 6 months at Adobe Research as an intern to collaborate with Aaron Hertzmann. S. Rodriguez and T. Thonat visited the MIT CSAIL Computer Graphic Lab, in Boston, USA. V. Deschaintre Visited Frederic Durand and Miika Aittala at MIT October/November. Y. Gryaditskaya visited the research group of Daniel Sykora, CTU Prague, Czech Republic, and the Industrial Design Faculty of TU Delft, Netherlands in June.

GRAPHIK Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Projects

9.1.1.1. ASPIQ (ANR white, Jan. 2013-July 2017)

Participants: Jean-François Baget, Madalina Croitoru, Marie-Laure Mugnier.

ASPIQ (ASP technologies for Querying large scale multisource heterogeneous web information), coordinated by Odile Papini (LSIS), involves other participants from CRIL, LERIA and LSIS. <http://aspiq.lsis.org/>

The aim of this project is to propose:

- extensions of standard ASP for representing OWL2 tractable sublanguages;
- new operations for merging conflicting information in this extended ASP;
- the identification of subclasses of this extended ASP allowing for efficient query answering mechanisms;
- an implementation of a prototype reasoning system.
- *See Section 7.1 for this year's results. An international workshop (WASPIQ 2017) associated with the conference IEA/AIE 2017 was also organized (see Section 10.1.1)*

9.1.1.2. Pagoda (ANR JCJC, Jan. 2013-Dec. 2017)

Participants: Jean-François Baget, Meghyn Bienvenu, Marie-Laure Mugnier, Federico Ulliana.

Pagoda (Practical Algorithms for Ontology-based Data Access), coordinated by Meghyn Bienvenu, involves participants from IRISA, LIX, LIG, and the Anatomy Laboratory of Grenoble. <http://pagoda.lri.fr/>

The primary aim of this project is to address challenges brought by scalability and the handling of data inconsistencies by developing novel OBDA (Ontology Based Data Access) query answering algorithms and practical methods for handling inconsistent data.

- *See Section 7.1 for this year's results.*

9.1.1.3. Dur-Dur (ANR ALID, March 2014-Feb. 2017)

Participants: Pierre Bisquert, Patrice Buche, Madalina Croitoru, Jérôme Fortin, Abdelraouf Hecham, Rallou Thomopoulos.

Dur-Dur (Innovations agronomiques, techniques et organisationnelles pour accroître la DURabilité de la filière blé DUR), coordinated by Bernard Cuq (IATE), involves participants from 6 agronomy research units (including IATE), and 4 technical / professional partners. <http://umr-iate.cirad.fr/projets/dur-dur>

The Dur-Dur project develops a systematic approach to investigate the questions related to the management of the nitrogen, energy and contaminants, to guarantee a global quality of products throughout the production and the processing chain. The knowledge representation task of Dur-Dur proposes to map the stakeholders' objectives into a multicriteria cartography, as well as possible means to reach them, and computes the compatibility / incompatibility of these objectives on the basis of argumentation methods. The research methods used are qualitative and based both on argumentation theory and on Social Multi- Criteria Evaluation (SMCE) theory. They will be extended and adapted to the needs of the project to provide a formal framework of assessment of the various orientations considered for the durum wheat chain.

- *See Section 7.2 for this year's results.*

9.1.2. Other projects

9.1.2.1. ICODA (Inria Project Lab, 2017-2021)

Participants: Jean-François Baget, Michel Chein, Marie-Laure Mugnier.

The iCODA project (Knowledge-mediated Content and Data Interactive Analytics—The case of data journalism), coordinated by Guillaume Gravier and Laurent Amsaleg (LINKMEDIA), takes together four Inria teams: LINKMEDIA (with being the project leaders), CEDAR, ILDA and GraphIK, as well as three press partners: Ouest France, Le Monde (les décodeurs) and AFP.

Taking data journalism as an emblematic use-case, the goal of the project is to develop the scientific and technological foundations for knowledge-mediated user-in-the-loop big data analytics jointly exploiting data and content, and to demonstrate the effectiveness of the approach in realistic, high-visibility use-cases.

9.1.2.2. Docamex (CASDAR project, 2017-2020)

Participants: Patrice Buche, Madalina Croitoru, Jérôme Fortin, Clement Sipietier.

DOCaME_x (Développement de prOgiciels de Capitalisation et de Mobilisation du savoir-faire et de l'Expérience fromagers en filière valorisant leur terroir), let by CFTC (centre technique des fromages de Franche-Comté) involves 7 research units (including IATE and LIRMM), 8 technical centers and 3 dairy product schools. It represents five cheese-making chains (Comté, Reblochon, Emmental de Savoie, Salers, Cantal).

Traditional cheese making requires a lot of knowledge, expertise, and experience, which is usually acquired over a long time. This knowledge is today mainly transmitted by apprenticeship and a concrete risk of knowledge forgetting is raised by the evolutions of practices in the sector. Using new methods for expert capitalization and numeric representation, the main goal of the project is to develop a new approach for expert knowledge explication and representation and the development of a software dedicated to their manipulation. With this software, cheese makers will be able to easily access to these knowledge for decision making assistance, and more generally any learner in cheese making process will be able to use it to complete its knowledge. His sustainability will be assured by possibility of enrichment with new knowledge and experience feedback. The software will be delivered with a tool-box including a methodological guide and a software package to be informed to assured its usability. IATE, Heudyasic and Graphik will design the new version of CoGui-Capex software tool (based on Cogui) in this project. The original part of the reasoning tool will consist in representing and computing the efficiency and the reliability of actions undertaken to maintain a food quality descriptor. This new tool will be able to enrich information with new experiences.

9.1.2.3. Convergence Institute #DigitAg (2017-2023)

Participants: Patrice Buche, Madalina Croitoru, Marie-Laure Mugnier, Rallou Thomopoulos, Federico Ulliana.

Located in Montpellier, #DigitAg (for Digital Agriculture) gathers 17 founding members: research institutes, including Inria, the University of Montpellier and higher-education institutes in agronomy, transfer structures and companies. Its objective is to support the development of digital agriculture. GraphIK is involved in this project on the issues of designing data and knowledge management systems adapted to agricultural information systems, and of developing methods for integrating different types of information and knowledge (generated from data, experts, models).

9.1.2.4. Pack4Fresh (GloFoodS INRA-Cirad metaprogram, sept. 2015-sept 2017)

Participants: Pierre Bisquert, Patrice Buche, Madalina Croitoru, Bruno Yun.

Pack4Fresh is funded by the multi-year metaprogramme GloFoodS (Transitions to global food security), which is dedicated to the investigation of pathways to worldwide food security in a context of competition for land and natural resources, and is jointly conducted by INRA and Cirad. Involving research on crop yield and livestock systems, land use changes, food processing and waste, nutrition and governance, GloFoodS aims at articulating global modeling of food supply and demand, with local issues of production and access to food.

In this context, Pack4Fresh focuses on the big fragility of fresh foods which generates enormous post-harvest wastes, short shelf-life, and constitutes a major lock to their consumption and health benefit. This project aims at initiating an eco-design approach of the post-harvest phase of fresh foods working on the interdependency relation between environmental impact (1) positive for waste reduction, et (2) negative for technologies, which aims at reducing the waste, in order to minimize the ratio between those two parameters.

- See Section 7.2 for this year's results.

9.1.3. Informal National Partners

- A new collaboration started this year with Pierre Bourhis (SPIRALS Inria team, UMR CRISTAL) and Sophie Tison (LINKS Inria team, UMR CRISTAL) on the OMQA issue for the case of Key-Value stores [21].
- The team continues the collaboration with Michael Thomazo (CEDAR Inria team) on Ontology-Mediated Query Answering. This year we worked on extensions of conjunctive queries that enable regular path expressions [20].
- We continued our collaboration with Florence Dupin de Saint-Cyr (Paul Sabatier University, Toulouse) [15], since 2014.
- We continued our collaboration with Srdjan Vesic, Researcher (CNRS - CRIL), Lens, France, since 2016 [13].
- This year we started a collaboration with the Center for Structural Biochemistry of Montpellier (CBS), with Jérôme Bonnet and Sarah Gouiziou, on the encoding of Boolean functions in biological systems [42].
- A new collaboration started with Reza Akbarinia (ZENITH Inria team) on parallel query rewriting for OMQA [31].
- We collaborated with Marianne Huchard (MAREL team, LIRMM) on the combined application of our techniques to generate text under constraints [27].
- We continued our collaboration with Jean-Claude Léon (IMAGINE Inria team), since 2014 [36].

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. NoAW (H2020, Oct. 2016-Sept. 2020)

Participants: Patrice Buche, Pierre Bisquert, Madalina Croitoru, Nikolaos Karanikolas, Rallou Thomopoulos.

NoAW (No Agricultural Waste) is led by INRA-IATE. Driven by a "near zero-waste" society requirement, the goal of NoAW project is to generate innovative efficient approaches to convert growing agricultural waste issues into eco-efficient bio-based products opportunities with direct benefits for both environment, economy and EU consumer. To achieve this goal, the NoAW concept relies on developing holistic life cycle thinking able to support environmentally responsible R&D innovations on agro-waste conversion at different TRLs, in the light of regional and seasonal specificities, not forgetting risks emerging from circular management of agro-wastes (e.g. contaminants accumulation). GraphIK will contribute on two aspects. On one hand we will participate in the annotation effort of knowledge bases (using the @Web tool). On the other hand we will further investigate the interplay of argumentation with logically instantiated frameworks and its relation with social choice in the context of decision making. http://cordis.europa.eu/project/rcn/203384_en.html

9.2.2. Collaborations in European Programs, Except FP7 & H2020

9.2.2.1. FoodMC (European COST action, 2016-2020)

Participants: Patrice Buche, Madalina Croitoru, Rallou Thomopoulos.

COST actions aim to develop European cooperation in science and technology. FoodMC (CA 15118) is a cost action on Mathematical and Computer Science Methods for Food Science and Industry. Rallou Thomopoulos is co-leader of this action for France, and member of the action Management Committee, and several members of GraphIK (Patrice Buche, Madalina Croitoru) are participants. The action is organised in four working groups, dealing respectively with the modelling of food products and food processes, modelling for eco-design of food processes, software tools for the food industry, and dissemination and knowledge transfer.

<http://www6.inra.fr/foodmc>

9.3. International Initiatives

9.3.1. Informal International Partners

- Laval University (Quebec city, Canada): since 2012 we collaborate with Bernard Moulin on combined argumentation and simulation for decision support, and with Irène Abi-Zeid on Argumentation and multicriteria decision [33], [34].
- Birmingham University (UK), we continued our collaboration with Serafim Bakalis on decision support in agronomy [32].
- University of Toronto (Canada): this year a new collaboration started with Sheila McIlraith and her research group.
- Birkbeck College, University of London (UK): ongoing work with Michael Zacharyshev, Roman Kontchakov, and Stanislav Kikot on the OMQA issue.
- Sapienza University (Rome, Italy): collaboration with Riccardo Rosati, since 2012 [45].
- University of Bremen (Germany): collaboration with Carsten Lutz, since 2009 [44], [43].
- University of Liverpool (UK): collaboration with Frank Wolter, since 2009 [43], [44].
- Patras University (Greece): collaboration with Nikolaos Karanikolas, since 2017 (formerly postdoc in the team) [41], [25].

9.4. International Research Visitors

9.4.1. Visits to International Teams

- Meghyn Bienvenu visited the Birkbeck College, University of London for 1 week during February 2017 as for her collaboration with Michael Zacharyshev, Roman Kontchakov, Stanislav Kikot. She also visited the
- Rallou Thomopoulos visited the team of Alexandros Koulouris and Maria Papageorgiou at ATEI Thessaloniki, Greece (November 2017). He gave also the talk "Science for Food and Bioproduct Engineering at INRA: a knowledge engineering perspective".

9.4.1.1. Research Stays Abroad

- Meghyn Bienvenu will be visiting the Department of Computer Science of the University of Toronto from early August 2017 for nearly 12 months. She will collaborate with Sheila McIlraith and the rest of the Knowledge Representation group.

HEPHAISTOS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- CPER project MADORSON for the assistance to elderly people (with the STARS project)
- the project REVMED involving Hephaistos and the CHU team CobTeK has been funded by the local IDEX. It will allow us to continue our work on rehabilitation in an immersive environment.

9.2. National Initiatives

9.2.1. FHU

- the team has been involved for the FHU *INOVPAIN : Innovative Solutions in Refractory Chronic Pain* that has been labeled in December 2016

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

We have numerous international collaborations but we mention here only the one with activities that go beyond joint theoretical or experimental works:

- University of Bologna: 2 joint PhD student, publications
- University Innsbruck: joint conference organization
- Fraunhofer IPA, Stuttgart: joint conference organization
- Duisburg-Essen University: joint conference organization
- University of New-Brunswick: 1 joint PhD student
- University Laval, Québec: joint book
- University of Tokyo: joint conference organization
- Tianjin University, China: joint book

HIEPACS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. SOLHAR: SOLvers for Heterogeneous Architectures over Runtime systems

Participants: Emmanuel Agullo, Mathieu Faverge, Abdou Guermouche, Pierre Ramet, Jean Roman, Guillaume Sylvand.

Grant: ANR-MONU

Dates: 2013 – 2017

Partners: Inria (**REALOPT**, **STORM** Bordeaux Sud-Ouest et **ROMA** Rhone-Alpes), IRIT/INPT, CEA-CESTA et Airbus Group Innovations.

Overview:

During the last five years, the interest of the scientific computing community towards accelerating devices has been rapidly growing. The reason for this interest lies in the massive computational power delivered by these devices. Several software libraries for dense linear algebra have been produced; the related algorithms are extremely rich in computation and exhibit a very regular pattern of access to data which makes them extremely good candidates for GPU execution. On the contrary, methods for the direct solution of sparse linear systems have irregular, indirect memory access patterns that adversely interact with typical GPU throughput optimizations.

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computer equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. To date, the approaches proposed to achieve this objective are mostly based on a simple offloading of some computational tasks to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems. The development of a production-quality, sparse direct solver requires a considerable research effort along three distinct axes:

- linear algebra: algorithms have to be adapted or redesigned in order to exhibit properties that make their implementation and execution on heterogeneous computing platforms efficient and reliable. This may require the development of novel methods for defining data access patterns that are more suitable for the dynamic scheduling of computational tasks on processing units with considerably different capabilities as well as techniques for guaranteeing a reliable and robust behavior and accurate solutions. In addition, it will be necessary to develop novel and efficient accelerator implementations of the specific dense linear algebra kernels that are used within sparse, direct solvers;
- runtime systems: tools such as the **StarPU** runtime system proved to be extremely efficient and robust for the implementation of dense linear algebra algorithms. Sparse linear algebra algorithms, however, are commonly characterized by complicated data access patterns, computational tasks with extremely variable granularity and complex dependencies. Therefore, a substantial research effort is necessary to design and implement features as well as interfaces to comply with the needs formalized by the research activity on direct methods;
- scheduling: executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.

Given the wide availability of computing platforms equipped with accelerators and the numerical robustness of direct solution methods for sparse linear systems, it is reasonable to expect that the outcome of this project will have a considerable impact on both academic and industrial scientific computing. This project will moreover provide a substantial contribution to the computational science and high-performance computing communities, as it will deliver an unprecedented example of a complex numerical code whose parallelization completely relies on runtime scheduling systems and which is, therefore, extremely portable, maintainable and evolvable towards future computing architectures.

9.1.1.2. *DEDALES: Algebraic and geometric domain decomposition for subsurface/groundwater flows*

Participants: Emmanuel Agullo, Mathieu Faverge, Luc Giraud, Louis Poirel.

Grant: ANR-14-CE23-0005

Dates: 2014 – 2018

Partners: Inria EPI POMDAPI (leader); Université Paris 13 - Laboratoire Analyse, Géométrie et Applications; Maison de la Simulation; Andra.

Overview: Project **DEDALES** aims at developing high performance software for the simulation of two phase flow in porous media. The project will specifically target parallel computers where each node is itself composed of a large number of processing cores, such as are found in new generation many-core architectures. The project will be driven by an application to radioactive waste deep geological disposal. Its main feature is phenomenological complexity: water-gas flow in highly heterogeneous medium, with widely varying space and time scales. The assessment of large scale model is of major importance and issue for this application, and realistic geological models have several million grid cells. Few, if at all, software codes provide the necessary physical features with massively parallel simulation capabilities. The aim of the **DEDALES** project is to study, and experiment with, new approaches to develop effective simulation tools with the capability to take advantage of modern computer architectures and their hierarchical structure. To achieve this goal, we will explore two complementary software approaches that both match the hierarchical hardware architecture: on the one hand, we will integrate a hybrid parallel linear solver into an existing flow and transport code, and on the other hand, we will explore a two level approach with the outer level using (space time) domain decomposition, parallelized with a distributed memory approach, and the inner level as a subdomain solver that will exploit thread level parallelism. Linear solvers have always been, and will continue to be, at the center of simulation codes. However, parallelizing implicit methods on unstructured meshes, such as are required to accurately represent the fine geological details of the heterogeneous media considered, is notoriously difficult. It has also been suggested that time level parallelism could be a useful avenue to provide an extra degree of parallelism, so as to exploit the very large number of computing elements that will be part of these next generation computers. Project **DEDALES** will show that space-time DD methods can provide this extra level, and can usefully be combined with parallel linear solvers at the subdomain level. For all tasks, realistic test cases will be used to show the validity and the parallel scalability of the chosen approach. The most demanding models will be at the frontier of what is currently feasible for the size of models.

9.1.1.3. *TECSER: Novel high performance numerical solution techniques for RCS computations*

Participants: Emmanuel Agullo, Luc Giraud, Matthieu Kuhn.

Grant: ANR-14-ASTRID

Dates: 2014 – 2017

Partners: Inria EPI NACHOS (leader), Corida, HiePACS; Airbus Group Innovations, Nucléotides.

Overview: the objective of the TECSER projet is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Commissariat A L Energie Atomique et Aux Energies Alternatives (France)

Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)

Consiglio Nazionale Delle Ricerche (Italy)

The Cyprus Institute (Cyprus)

Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Forschungszentrum Julich (Germany)

Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany)

University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

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

9.2.1.2. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partners:

Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)

Iberdrola Renovables Energia (Spain)

Repsol (Spain)

Total S.A. (France)

Lancaster University (United Kingdom)

Inria contact: Stéphane Lanteri

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO₂ emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

9.3. International Initiatives

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

9.3.1.1. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Institute for Computational and Mathematical Engineering)

ICME - Eric Darve

Start year: 2012

See also: http://people.bordeaux.inria.fr/coulaud/projets/FastLA_Website/

In this project, we propose to study fast and scalable hierarchical numerical kernels and their implementations on heterogeneous manycore platforms for two major computational kernels in intensive challenging applications. Namely, fast multipole methods (FMM) and sparse linear solvers that appear in many intensive numerical simulations in computational sciences. For the solution of large linear systems, the ultimate goal is to design parallel scalable methods that rely on efficient sparse and dense direct methods using H-matrix arithmetic. Finally, the innovative algorithmic design will be essentially focused on heterogeneous manycore platforms by using task based runtime systems. The partners, Inria HiePACS, Lawrence Berkeley Nat. Lab and Stanford University, have strong, complementary and recognized experiences and backgrounds in these fields

HYBRID Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Labex Cominlabs SUNSET

Participants: Bruno Arnaldi, Guillaume Claude, Gautier Picard, Valérie Gouranton [contact].

SUNSET is a 4-year Labex Cominlabs project (2016-2020). SUNSET partners are MediCIS-LTSI (coordinator), Hybrid, Hycomes (IRISA/Inria), and CHU Rennes. SUNSET aims at developing an innovative training software suite based on immersive and collaborative virtual reality technology for training and evaluating non-technical skills. This approach will be implemented and evaluated in the context of training neurosurgical scrub nurses. We will notably integrate methods and systems developed in the S3PM project (see below). By relying on Human Factors approaches, the project also addresses training and evaluation of interpersonal skills. Whereas the developed technologies and approaches will be generic and adaptable to any surgical specialty, the project will evaluate the developed system within training sessions performed with scrub nurses. We ambition to propose novel approaches for surgical non-technical skill learning and assessment, and to install the developed training factory at the University Hospital of Rennes, and evaluate it with real-scale user studies.

9.1.2. Labex Cominlabs S3PM

Participants: Bruno Arnaldi, Guillaume Claude, Valérie Gouranton [contact].

S3PM ("Synthesis and Simulation of Surgical Process Models") is a 4-year Labex Cominlabs project (2013-2017). S3PM partners are MediCIS-LTSI (coordinator), Hybrid, Hycomes (IRISA/Inria), and CHU Rennes. The objective of S3PM is to propose a solution for the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution. The goal of the Hybrid team is to propose and use new models for collaborative and interactive virtual environments for procedural training. The Hybrid team also works on the creation of a surgical training application in virtual reality, exposing the different contributions.

9.1.3. Labex Cominlabs HEMISFER

Participants: Anatole Lécuyer [contact], Marsel Mano, Lorraine Perronnet.

HEMISFER is a 4-year project (2013-2017) funded by Labex CominLabs. It involves 4 Inria/IRISA teams (Hybrid, Visages (lead), Panama, Athena) and 2 medical centers: the Rennes Psychiatric Hospital (CHGR) and the Reeducation Department of Rennes Hospital (CHU Pontchaillou). The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. Clinical applications concern motor, neurological and psychiatric disorders (stroke, attention-deficit disorder, treatment-resistant mood disorders, etc).

9.1.4. Labex Cominlabs SABRE

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Nataliya Kos'Myna.

SABRE is a 3-year project (2014-2017) funded by Labex CominLabs. It involves 1 Inria/IRISA team (Hybrid) and 2 groups from TELECOM BREST engineering school. The goal of SABRE is to improve computational functionalities and power of current real-time EEG processing pipelines. The project will investigate innovative EEG solution methods empowered and speeded-up by ad-hoc, transistor-level, implementations of their key algorithmic operations. A completely new family of fully-hardware-integrated, new computational EEG imaging methods will be developed that are expected to speed up the imaging process of an EEG device of several orders of magnitude in real case scenarios.

9.1.5. IRT b<>com

Participants: Bruno Arnaldi [contact], Valérie Gouranton, Maud Marchal.

b<>com is a French Institute of Research and Technology (IRT). The main goal of this IRT is to fasten the development and marketing of tools, products and services in the field of digital technologies. Our team has already collaborated with b<>com within two 3-year projects: ImData (on "Immersive Interaction") and GestChir (on "Augmented Healthcare") which both ended in 2016. A new 3-year project called NeedleWare (on "Augmented Healthcare") has started on October 2016.

9.1.6. CNPAO Project

Participants: Valérie Gouranton [contact], Jean-Baptiste Barreau, Ronan Gaugne.

CNPAO ("Conservatoire Numérique du Patrimoine Archéologique de l'Ouest") is an on-going research project partially funded by the Université Européenne de Bretagne (UEB) and Université de Rennes 1. It involves IRISA/Hybrid and CReAAH. The main objectives are: (i) a sustainable and centralized archiving of 2D/3D data produced by the archaeological community, (ii) a free access to metadata, (iii) a secure access to data for the different actors involved in scientific projects, and (iv) the support and advice for these actors in the 3D data production and exploration through the latest digital technologies, modeling tools and virtual reality systems. This project involves a collaboration with Quentin Petit (SED Inria Rennes).

9.1.7. Imag'In CNRS IRMA

Participants: Bruno Arnaldi, Jean-Baptiste Barreau, Ronan Gaugne, Valérie Gouranton [contact], Théophane Nicolas.

The IRMA project is an Imag'In project funded by CNRS which aims at developing innovative methodologies for research in the field of cultural heritage based on the combination of medical imaging technologies and interactive 3D technologies (virtual reality, augmented reality, haptics, additive manufacturing). It relies on close collaborations with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET. The developed tools are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. We focus on a large number of archeological artefacts of different nature, and various time periods (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We can notably mention the oldest human bones found in Brittany (clavicle Beg Er Vil), a funeral urn from Trebeurden (22), or a Bronze Cauldron from a burial of the Merovingian necropolis "Crassés Saint-Dizier" (51). This project involves a collaboration with Quentin Petit (SED Inria Rennes) and Grégor Marchand (CNRS/UMR CReAAH).

9.2. National Initiatives

9.2.1. ANR-FRQSC INTROSPECT

Participants: Valérie Gouranton [contact], Bruno Arnaldi, Ronan Gaugne, Jean-Baptiste Barreau, Flavien Lecuyer.

INTROSPECT is a 3-year project funded by French ANR and "Fonds de Recherche Société et Culture" (FRQSC) from Quebec region, Canada. The collaboration involves researchers in computer science and archeology from France and Canada : Hybrid (Inria-IRISA), CReAAH, Inrap, company Image ET, University Laval and INRS-ETE. INTROSPECT aims to develop new uses and tools for archaeologists that facilitate access to knowledge through interactive numerical introspection methods that combine computed tomography with 3D visualization technologies, such as Virtual Reality, tangible interactions and 3D printing. The scientific core of the project is the systematization of the relationship between the artefact, the archaeological context, the digital object and the virtual reconstruction of the archaeological context that represents it and its tangible double resulting from the 3D printing. This axiomatization of its innovative methods makes it possible to enhance our research on our heritage and to make use of accessible digital means of dissemination. This approach changes from traditional methods and applies to specific archaeological problems. Several case studies will be studied in various archaeological contexts on both sides of the Atlantic. Quebec museums are partners in the project to spread our results among the general public.

9.2.2. *Ilab CertiViBE*

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Thierry Gaugry, Cédric Riou.

CertiViBE is a 2-year "Inria Innovation Lab" (2015-2017) funded by Inria for supporting the development of OpenViBE software, and notably its evolution in order to enable and fasten the medical transfer and the medical certification of products based on OpenViBE. This joint lab involves two partners: Hybrid and Mensia Technologies startup company. The project aims at setting up a quality environment, and developing a novel version of the software which should comply with medical certification rules.

9.2.3. *IPL BCI-LIFT*

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Hakim Si Mohammed, Lorraine Perronnet, Nataliya Kos'Myna.

BCI-LIFT is a 4-year "Inria Project Lab" initiative (2015-2019) funded by Inria for supporting a national research effort on Brain-Computer Interfaces. This joint lab involves several Inria teams: Hybrid, Potioc, Athena, Neurosys, Mjolnir, Demar; as well as external partners: INSERM-Lyon, and INSA Rouen. This project aims at improving several aspects of Brain-Computer Interfaces: learning and adaptation of BCI systems, user interfaces and feedback, training protocols, etc.

9.2.4. *ATT CONSORVIBE*

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren [contact].

CONSORVIBE is a 6-month ATT Inria Project funded by Inria for supporting a prospective effort and the feasibility study of building a consortium of partners dedicated to the sustainability and promotion of the OpenViBE software.

9.3. European Initiatives

9.3.1. *FP7 & H2020 Projects*

9.3.1.1. *HAPPINESS*

Title: Haptic Printed Patterned INtErfaces for Sensitive Surface

Programm: H2020

Duration: January 2015 - December 2017

Coordinator: CEA (France)

Partners:

Arkema France (France)

Robert Bosch (Germany)

Commissariat A L'Energie Atomique et Aux Energies Alternatives (France)

Fundacion Gaiker (Spain)

Integrated Systems Development S.A. (Greece)

University of Glasgow (United Kingdom)

Walter Pak SL (Spain)

Inria contact: Nicolas Roussel and Anatole Lécuyer

The Automotive HMI (Human Machine Interface) will soon undergo dramatic changes, with large plastic dashboards moving from the ‘push-buttons’ era to the ‘tactile’ era. User demand for aesthetically pleasing and seamless interfaces is ever increasing, with touch sensitive interfaces now commonplace. However, these touch interfaces come at the cost of haptic feedback, which raises concerns regarding the safety of eyeless interaction during driving. The **HAPPINESS** project intends to address these concerns through technological solutions, introducing new capabilities for haptic feedback on these interfaces. The main goal of the HAPPINESS project is to develop a smart conformable surface able to offer different tactile sensations via the development of a Haptic Thin and Organic Large Area Electronic technology (TOLAE), integrating sensing and feedback capabilities, focusing on user requirements and ergonomic designs. To this aim, by gathering all the value chain actors (materials, technology manufacturing, OEM integrator) for application within the automotive market, the HAPPINESS project will offer a new haptic Human-Machine Interface technology, integrating touch sensing and disruptive feedback capabilities directly into an automotive dashboard. Based on the consortium skills, the HAPPINESS project will demonstrate the integration of Electro-Active Polymers (EAP) in a matrix of mechanical actuators on plastic foils. The objectives are to fabricate these actuators with large area and cost effective printing technologies and to integrate them through plastic molding injection into a small-scale dashboard prototype. We will design, implement and evaluate new approaches to Human-Computer Interaction on a fully functional prototype that combines in packaging both sensors and actuator foils, driven by custom electronics, and accessible to end-users via software libraries, allowing for the reproduction of common and accepted sensations such as Roughness, Vibration and Relief. In this project, the role of Hybrid team is to design user studies on tactile perception, and study innovative usages of the technologies developed in HAPPINESS.

9.3.1.2. IMAGINE

Title: IMAGINE - Robots Understanding Their Actions by Imagining Their Effects

Programm: H2020

Duration: January 2017 - December 2020

Coordinator: Univ. Innsbruck (Austria)

Partners:

Univ. Innsbruck (Austria)

Univ. Göttingen (Germany)

Karlsruhe Institute of Technology (Germany)

INSA Rennes (France)

Institute of Robotics and Industrial Informatics (Spain)

Univ. Bogazici (Turkey)

Electro Cycling (Germany)

Inria contact: Maud Marchal

Today’s robots are good at executing programmed motions, but they do not understand their actions in the sense that they could automatically generalize them to novel situations or recover from failures. **IMAGINE** seeks to enable robots to understand the structure of their environment and how it is affected by its actions. “Understanding” here means the ability of the robot (a) to determine the applicability of an action along with parameters to achieve the desired effect, and (b) to discern to what extent an action succeeded, and to infer possible causes of failure and generate recovery actions. The core functional element is a generative model based on an association engine and a physics simulator. “Understanding” is given by the robot’s ability to predict the effects of its actions, before and during their execution. This allows the robot to choose actions and parameters based on their simulated performance, and to monitor their progress by comparing observed to simulated behavior. This scientific objective is pursued in the context of recycling of electromechanical appliances.

Current recycling practices do not automate disassembly, which exposes humans to hazardous materials, encourages illegal disposal, and creates significant threats to environment and health, often in third countries. IMAGINE will develop a TRL-5 prototype that can autonomously disassemble prototypical classes of devices, generate and execute disassembly actions for unseen instances of similar devices, and recover from certain failures. For robotic disassembly, IMAGINE will develop a multi-functional gripper capable of multiple types of manipulation without tool changes. IMAGINE raises the ability level of robotic systems in core areas of the work programme, including adaptability, manipulation, perception, decisional autonomy, and cognitive ability. Since only one-third of EU e-waste is currently recovered, IMAGINE addresses an area of high economical and ecological impact.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

This year, Hybrid team has welcomed for short periods:

- Gabriel Cirio, Universidad Rey Juan Carlos Madrid (Spain), May 2017
- Victoria Interrante, University of Minnesota (US), December 2017
- Geneviève Treyvaud and Pierre Francus, INRS (Canada), November 2017

9.4.2. Visits to International Teams

Ronan Gaugne and Valérie Gouranton made a short stay at University Laval (Canada) in August 2017

HYCOMES Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Ayman Aljarbough's PhD (see Section 5.1.3) was partially funded by an ARED grant of the Brittany Regional Council. His doctoral work took place in the context of the Modrio (completed in 2016) and Sys2Soft (completed in 2015) projects on hybrid systems modeling. Ayman Aljarbough is working on accelerated simulation techniques for hybrid systems. In particular, he is focusing on the regularisation, at runtime, of chattering behaviour and the approximation of Zeno behaviour.
- Benoît Caillaud and Aurélien Lamercurie are participating to the S3PM and SUNSET projects of the CominLabs excellence laboratory⁰. This project focuses on the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution [28]. The objective is to develop an enabling technology for procedural knowledge based computer assistance of surgery. In this project, we demonstrate its potential added value in nurse and surgeon training [36], [35]. In 2017, Benoît Caillaud and Aurélien Lamercurie have released Demodocos, a software synthesizing surgical process models from instances of surgical procedures.

7.2. National Initiatives

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

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

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

⁰<http://www.s3pm.cominlabs.ueb.eu/>

I4S Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MONEOL

Participants: Ivan Guéguen, Guillaume Gautier, Laurent Mevel.

Type: CEAtch PDL

Objectif: Modal analysis of wind turbines using new sensors

Duration: 09/2015 to 11/2017.

Coordinator: Louis Marie Cotineau (IFSTTAR)

Inria contact: Guillaume Gautier

Abstract: The MONEOL project aims to demonstrate the feasibility of using Morphosense as a vibration monitoring system for wind turbines. It is proposed to set up a demonstrator consisting of a monitoring system placed in the mast of the wind turbine, a vibration analysis system and a visualization of the vibratory state at the CEA-Tech premises, located on the Technocampus Ocean of Nantes allowing to visualize in real time (quasi) the modal deformations of the mast of the wind turbine.

The MONEOL (Wind turbine monitoring) project was concluded in September 2017. Morphosense ribbon was deployed on the mast of a wind turbine. Morphosense validation was conducted through the comparison with a classical vibration monitoring system. The relevance regarding the use of such a system was highlighted, especially due to reduced installation time. SSI algorithms, including modal parameters and damage identification, were implemented inside the Morphosense. Actually, wind turbine health condition is displayed in real time through a web page.

9.1.2. *Interactive Communication (InterCom): Massive random access to subsets of compressed correlated data*

Participants: Jean Dumoulin, Antoine Crinière, Frederic Gillot.

Type: Labex COMINLABS

Objectif: Massive random access to large-scale sensor network (Smart Cities)

Duration: Since November 2016 to Nov. 2019.

Coordinator :Aline Roumy, Thomas Maugey (Sirocco), Jean Dumoulin (I4S)

Partners: Elsa Dupraz (Lab-STICC), Aline Roumy (IRISA, Sirocco team), Michel Kieffer (L2S), Thomas Maugey (IRISA, Sirocco team), CentraleSupélec, Univ. Paris Sud.

Inria contact: Jean Dumoulin

Abstract: This project aims to develop novel compression techniques allowing massive random access to large databases. Indeed, we consider a database that is so large that, to be stored on a single server, the data have to be compressed efficiently, meaning that the redundancy/correlation between the data have to be exploited. The dataset is then stored on a server and made available to users that may want to access only a subset of the data. Such a request for a subset of the data is indeed random, since the choice of the subset is user-dependent. Finally, massive requests are made, meaning that, upon request, the server can only perform low complexity operations (such as bit extraction but no decompression/compression).

Algorithms for two emerging applications of this problem will be developed: Free-viewpoint Television (FTV) and massive requests to a database collecting data from a large-scale sensor network (such as Smart Cities) in which I4S is involved.

9.1.3. *MAG2C-Pont Tabarly*

Participants: Ivan Guéguen, Jean Dumoulin.

Type: GIS

Objectif: bridge instrumentation

Duration: Since 2014

Coordinator: LIRGEC

Partners: IFSTTAR, CSTB, Nantes Métropole, Université de Nantes

Inria contact: Ivan Guéguen

Abstract: The project deals with the instrumentation of the Tabarly Bridge. In collaboration with Nantes Métropole, CSTB, and Université de Nantes, instrumentation of both dynamical and InfraRed properties of an operational bridge are investigated. These measures coupled with a wireless data transmission system will allow remote monitoring of the evolution of the structure. Objective is to couple different kind of measurement to achieve thermo-vibration monitoring of the structure. This is a big milestone for the team and our objective to mix thermo-vibration data.

9.1.4. *MAG2C-MOSIWIND (MONitoring of Structural Integrity of an onshore WIND turbine slab foundation and tower)*

Participants: Xavier Chapeleau, Ivan Guéguen.

Type: GIS

Objectif: MONitoring of Structural Integrity of an onshore WIND turbine slab foundation and tower

Duration: Since 2015

Coordinator : LIRGEC

Partners: IFSTTAR, CSTB, Nantes Métropole, Université de Nantes, ECN, Valorem, Valréa and Valémo

Inria contact: Xavier Chapeleau

Abstract: The project deals with the instrumentation of an onshore WIND turbine's slab foundation and tower. The aim is to experiment sensors and methods for structural integrity monitoring of an onshore wind turbine under real conditions and to qualify them over long term. Before casting, the concrete slab foundation (20m in diameter, 3.85m high, 450m³ of concrete, 48T of reinforcement) was first instrumented with continuous optical fibers, optical strain gauges, temperature sensors and accelerometers. Afterwards, accelerometers were placed in the mast. Data obtained by these different sensors will help, on the one hand, to monitor changes in the dynamic behavior of the structure in order to verify that they remain within the limits fixed during the design and, on the other hand, to detect any damage that could be critical for the safety of the structure. For this, SSI methods under ambient vibration will be applied. Since July 2017, only the data of accelerometers measurements are logged periodically. The installation of systems of measurements for distributed fiber optics sensors and optical strains gauges remains to be done as soon as it can be possible to access to the wind turbine .

9.1.5. *Collaboration with GeM*

Participants: Laurent Mevel, Michael Doehler, Md Delwar Hossain Bhuyan.

Md Delwar Hossain Bhuyan has done his PhD on damage localisation on civil structures in collaboration with GeM (Institute of Civil and Mechanical Engineering), Université de Nantes. The thesis is co-directed by L. Mevel, and F. Schoefs from GeM, with supervision shared with M. Doehler and Y. Lecieux from GeM. It is funded by the Brittany region for 3 years and has been successfully defended in November 2017.

9.1.6. Collaboration with IETR

Participants: Vincent Le Cam, David Pallier.

The thesis is directed by Sébastien Pillement at IETR. It is funded by RFI WISE Electronique Professionnelle within the SENTAUR project.

The subject of the thesis is to study, implement and propose a deterministic and reliable dating solution for wireless sensor networks. This solution must take into account both the risks of loss of synchronization signals, environmental hazards and the desire to achieve the most sober possible solution in energy.

9.2. National Initiatives

9.2.1. High speed rail track instrumentation

Participant: Ivan Guéguen.

Type: IRT

Objective: rail track SHM

Duration: 11/2014 to 11/2018

Coordinator: RAILENIUM

Partners: IFSTTAR, EIFFAGE, RFF, LGCgE

Inria contact: Ivan Guéguen

Abstract: This project aims to orchestrate multiple sections of a high-speed route (classical section with granular layer, transition zone). The proposed instrumentation concerns all the different layers of the structure, and is designed to allow monitoring of the overall track behavior. Using accelerometers and weather station, this instrumentation will estimate the fatigue life and temperature changes in the track.

9.2.2. ANR Resbati

Participants: Ludovic Gaverina, Jean Dumoulin.

Type: ANR

Objectif: In-situ measurements of thermal wall resistance

Duration: 10/2016 to 10/2019

Coordinator: Laurent Ibos

Partners : IFSTTAR, CERTES, CEREMA, CSTB, LNE, THEMACS, AFNOR

Inria contact: Jean Dumoulin

Abstract: RESBATI is an applied research project whose objective is to develop a field measurement device that meets precise specifications to systematically measure the level of thermal insulation of building walls. The preferred metrological tool is infrared thermography.

9.2.3. Equipex Sense-City

Participants: Jean Dumoulin, Laurent Mevel, Antoine Crinière.

Through the ADT Cloud2SM, participation of I4S in SenseCity was possible. IFSTTAR's SensorBox developed by Jean Dumoulin was installed and presented at SENSECITY Kick off and is installed on-site. Cloud2IR and Cloud2SM software have been deployed within the ADT of A. Crinière. (<http://sense-city.ifsttar.fr/>)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Built to Specifications (Built2Spec)

Participant: Jean Dumoulin.

Type: Horizon 2020

Defi: Model Driven Physical Systems Operation

Objectif: Reduce the gap between a building's designed and as-built energy performance.

Duration: January 2015 to January 2019

Coordinator: Manager and project head : NOBATEK, Germain Adell. For CERMA : Marjorie Musy
Inria teams I4S

Inria contact: J. Dumoulin

Partners: Consortium of 20 Public and Industrial actors

Website: <http://built2spec-project.eu/>

Abstract: Built to Specifications (Built2Spec) is involving 20 European partners that seeks to reduce the gap between a building designed and as-built energy performance. To do this, the project put a new set of breakthrough technological advances for self-inspection checks and quality assurance measures into the hands of construction professionals. The project aims to deliver Building Information Modelling (BIM) and Thermal and 3D Imaging Tools among others.

The project is in collaboration with formers members of the team, Alexandre Nassiopoulos and Jordan Brouns, now working at Ecotropy, SME.

9.3.1.2. INFRASTAR(Innovation and Networking for Fatigue and Reliability Analysis of Structures – Training for Assessment of Risk)

Participants: Xavier Chapeleau, Antoine Bassil.

Call: H2020-MSCA-ITN-2015 (Horizon 2020 â Marie-Sklodowska Curie Actions â Innovative Training Networks)

Type of Action: MSCA-ITN-ETN

Objectif: Reduce the gap between a building's designed and as-built energy performance.

Duration: 48 months since 2016 May 1st

Coordinator: Odile Abraham (IFSTTAR)

Academic and industrial Partners: IFSTTAR, UNIVERSITY OF AALBORG, BAM, EPFL, GuD Consult GmbH, COWI A/S, NeoStrain, PHIMECA

Inria contact: X. Chapeleau

Website: <http://infrastar.eu/>

Abstract: The aim of INFRASTAR project is to develop tools combining modeling and measurements for the prediction of the fatigue behavior of concrete structures (bridges and foundations of wind turbines) with the ultimate objective of establishing an efficient strategy for inspection and reinforcement operations. In the second half of 2016, 12 young researchers were recruited to carry out and cross-examine research on monitoring and auscultation (WP 1), structural models (WP 2) and reliability of approaches for decision-making (WP 3). In this project, a phd student (Antoine Bassil) was recruited (Nov. 2016) on the fatigue monitoring of concrete structure by fibre-optic sensors. During the first 6 months of the thesis, a State of the Art on the use of fiber optic sensors for structural health monitoring in civil engineering was done and mostly by focusing on distributed optical fiber sensor's technology (DOFS) for crack detection in concrete. This State of the Art shows that distributed optical fiber sensor can localize accurately cracks in concrete if they propagate across the sensor. However, the quantification of the crack widths by distributed optical fiber sensor remains a scientific challenge. Indeed, it is necessary to take into account of the mechanical strain transfer of the fiber sensor. Now, the second part of the phd student work is to develop a theoretical model for the mechanical strain transfer function and to validate it by experimental tests. The main milestone of the modelling to overcome is to take into account of slippage and elasto-plastic effects

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. COST Action TU 1402

Participants: Michael Doehler, Laurent Mevel.

L. Mevel is member of the management committee of the COST Action.

M. Doehler is co-leader of working group 2 “SHM strategies and structural performance” and member of the steering committee.

Type: COST

Objectif: Quantifying the value of structural health monitoring

Duration: 11/2014 - 11/2018

Coordinator: S. Thoens (DTU Denmark)

Partner: 23 countries, see http://www.cost.eu/COST_Actions/tud/Actions/TU1402

Inria contact: Laurent Mevel

Abstract: Since 2014, until 2018, the COST Action has altogether around 120 participants from over 25 countries. This Action aims to develop and describe a theoretical framework, together with methods, tools, guidelines, examples and educational activities, for the quantification of the value of SHM. Progress of the action is presented in [40].

9.3.2.2. PROCOPE 37826QE

Participants: Michael Doehler, Laurent Mevel, Eva Viefhues.

Type: PHC PROCOPE

Objectif: Statistical damage localization for civil structures

Duration: 01/2017 - 12/2018

Coordinator: M. Doehler

Partner: BAM German Federal Institute for Materials Research and Testing

Inria contact: M. Doehler

Abstract: Our main objective is the development of a theoretically solid damage localization method that does not only work in simulations and lab experiments, but on structures in the field under real operational conditions. This German-French mobility grant is in support of Eva Viefhues' PhD thesis.

9.3.3. Collaborations with Major European Organizations

9.3.3.1. European Research Network on System Identification (ERNSI)

Participants: Qinghua Zhang, Michael Doehler, Laurent Mevel.

The I4S project-team is involved in the activities of the European Research Network on System Identification (ERNSI) federating major European research teams on system identification. Modeling of dynamical systems is fundamental in almost all disciplines of science and engineering, ranging from life science to process control. System identification concerns the construction, estimation and validation of mathematical models of dynamical physical or engineering phenomena from experimental data.

9.3.4. Other European Programs

9.3.4.1. Innobooster

Participants: Michael Doehler, Laurent Mevel.

Together with SVS, we got the Danish Innobooster innovation grant for industrial research and transfer. In 2017, the grant was awarded to transfer methods for the identification of mode shapes and their uncertainty [30] to SVS' ARTeMIS software.

9.4. International Initiatives

9.4.1. Informal International Partners

9.4.1.1. Collaboration with CNR, Italy

Participants: Jean Dumoulin, Nicolas Le Touz.

Non destructive testing on outdoor structures by coupling infrared thermography with ground penetrating radar is one of the topic addressed in this collaboration. A new one about TerHertz is starting. A proposal for associated lab is currently drafted.

9.4.1.2. Collaboration with British Columbia University, Canada

Participants: Laurent Mevel, Michael Doehler, Saeid Allahdadian.

Saeid Allahdadian was PhD student of professor Carlos Ventura in Vancouver. Following our recent papers, Michael Doehler has been invited to co-supervise the PhD of Saeid Allahdadian. The thesis has been defended this year.

9.4.1.3. Collaboration with BAM, Germany

Participants: Laurent Mevel, Michael Doehler, Eva Viefhues.

Eva Viefhues is currently PhD student of Laurent Mevel and Michel Doehler in Berlin, financed by BAM. M. Doehler is also associate researcher of the BAM institut since 2016.

9.4.1.4. Collaboration with Politecnico di Milano, Italy

Participants: Michael Doehler, Francesco Giordano.

During COST Action TU 1402 and professor M.P. Limongelli's research stay at IFSTTAR, collaboration with Politecnico di Milano has started, resulting in several joint publications in 2016 and 2017. PhD student F. Giordano has started at Politecnico Milano in November 2017 under the direction of M.P. Limongelli, M. Doehler is co-supervising.

9.4.1.5. Collaboration with Technical University of Denmark (DTU)

Participant: Michael Doehler.

During COST Action TU 1402 and previously at BAM, collaboration with Sebastian Thöns from DTU in Denmark started on risk analysis and SHM based reliability updating. Also, DTU's PhD student Lijia Long is involved [36].

9.4.1.6. Collaboration with Aalborg University, Denmark

Participant: Michael Doehler.

Together with Structural Vibration Solutions, collaboration with Aalborg University (professor Lars Damkilde, Department of Civil Engineering) has started during the PhD of Szymon Gres on damage detection methods [32].

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Within the PROCOPE mobility grant, E. Viefhues and F. Hille from BAM, Germany, visited Inria for one week each.

Prof. Xingwen Liu from Southwest University of China visited the I4S team for one week.

9.5.2. Visits to International Teams

Within the PROCOPE mobility grant and the collaboration in L. Long's PhD thesis with S. Thöns, M. Doehler spent 4 weeks at BAM, Germany.

Within the IFSTTAR foreign affair department grant and the existing collaboration, J. Dumoulin spent 2 weeks at Laval University, Canada.

Within the H2020 INFRASTAR Project A. Bassil spent 3 months at BAM.

IBIS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Project name	RNAfluo: Quantification d'ARN régulateurs in vivo
Coordinators IBIS participants Type	S. Lacour S. Lacour AGIR program, Université Grenoble Alpes (2016-2019)

8.2. National Initiatives

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

Project name	AlgaeInSilico: Prédire et optimiser la productivité des microalgues en fonction de leur milieu de croissance
Coordinator IBIS participants Type Web page	O. Bernard H. de Jong, N. Giordano Inria Project Lab (2015-2019) https://project.inria.fr/iplalgaesilico/

Project name	RESET – Arrest and restart of the gene expression machinery in bacteria: from mathematical models to biotechnological applications
Coordinator IBIS participants Type Web page	H. de Jong C. Boyat, E. Cinquemani, J. Geiselmann, H. de Jong, S. Lacour, L. Lancelot, Y. Markowicz, C. Pinel, D. Ropers Bioinformatics call, Investissements d'Avenir program (2012-2017) https://project.inria.fr/reset/

Project name	MEMIP – Modèles à effets mixtes de processus intracellulaires : méthodes, outils et applications
Coordinator IBIS participants Type	G. Batt E. Cinquemani, 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	H. de Jong C. Boyat, E. Cinquemani, J. Geiselmann, H. de Jong, C. Pinel, D. Ropers ANR project (2017-2021)

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

Project name	A web application for the analysis of time-series fluorescent reporter gene data
Coordinator IBIS participants Type	H. de Jong E. Cinquemani, J. Geiselmann, Y. Martin, M. Page, D. Ropers, V. Zulkower (University of Edinburgh) IFB call for development of innovative bioinformatics services for life sciences (2016-2017)

Project name	FluoBacTracker – Adaptation et valorisation scientifique du logiciel FluoBacTracker
Coordinator IBIS participants Type	H. de Jong, H. Berry C. Dutrieux, H. de Jong, J. Geiselmann Inria Hub (2016-2017)

Project name	CoSoft – Control software for a system of mini-bioreactors
Coordinator IBIS participants Type	E. Cinquemani E. Cinquemani, H. de Jong, J. Geiselmann, T. Muszbek Inria Hub (2017-2018)

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Laboratoire d'Automatique at Ecole Polytechnique Fédérale de Lausanne (Switzerland), Giancarlo Ferrari-Trecate

Control theory and systems identification with applications to systems biology

Automatic Control Lab at ETH Zürich (Switzerland), John Lygeros

Control theory and systems identification with applications to systems biology

Computational Microbiology research group, Institute of Food Research, Norwich (United Kingdom), Aline Métris and József Baranyi

Mathematical modelling of survival and growth of bacteria

ILDA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

ScaleGest. Surface Gestures for Advanced Graphical Interfaces: Which Gesture for What. (2014-2017) Funded by Digiteo. In collaboration with Telecom ParisTech: **109Keuros**. Participants: Caroline Appert (PI), Rafael Morales Gonzalez, Emmanuel Pietriga.

The project aims at designing gesture-based interaction for expert users who navigate and manipulate large datasets. In the context of advanced graphical applications, the number of gestures should be large-enough to cover the set of controls (*i.e.*, commands and parameter settings) but remain simple-enough to avoid exceeding human abilities. Making gesture-based interaction scale with graphical applications' growing complexity can be achieved only by understanding the foundational aspects of this input modality. This project is about characterizing and structuring both the space of application controls and the space of surface gestures in order to establish guidelines for appropriate control-gesture mappings. It is also about the definition of a sound and systematic evaluation methodology that will serve as a reference benchmark for evaluating these mappings. The resulting control-gesture mappings are demonstrated in the specific application domains of cartography and astronomy.

9.2. National Initiatives

9.2.1. ANR

MapMuxing - Multi-dimensional Map Multiplexing. (2014-2018) Funded by the French National Research Agency (ANR). In collaboration with IGN (Institut National de l'Information Géographique et Forestière): **208Keuros/499Keuros**. Participants: Emmanuel Pietriga (PI), Caroline Appert, Olivier Chapuis, Maria Jesus Lobo Gunther, Vit Rusnak. <http://mapmuxing.ign.fr>

The project explores novel ways of combining different maps and data layers into a single cartographic representation, and investigates novel interaction techniques for navigating in it. The project aims at going beyond the traditional pan & zoom and overview+detail interface schemes, and at designing and evaluating novel cartographic visualizations that rely on high-quality generalization, *i.e.*, the simplification of geographic data to make it legible at a given map scale, and symbol specification.

9.2.2. Inria - Ministère de la Culture

Visual Exploration of Linked Data on BnF's data portal (2017-2018) Funded by the French Ministère de la Culture and Inria. **65Keuros**. Participants: Emmanuel Pietriga (PI), Caroline Appert, Hande Gözükan, Marie Destandau, Dylan Lebout.

The project explores novel ways of visually navigating the data exposed by the Bibliothèque Nationale de France as linked data on <http://data.bnf.fr>.

9.2.3. Inria Project Lab

ILDA participates to Inria Project Lab iCODA : Data Journalism : knowledge-mediated Content and Data Interactive Analytics, that started in 2017. A key issue in data science is the design of algorithms that enable analysts to infer information and knowledge by exploring heterogeneous information sources, structured data, or unstructured content. With journalism data as a landmark use-case, iCODA aims to develop the scientific and technological foundation for collaborative, heterogeneous data analysis, guided by formalized, user-centric knowledge. The project relies on realistic scenarios in data-journalism to assess the contribution of the project to this area. iCODA is at the crossroads of several research areas (content analysis, data management, knowledge representation, visualization) and is part of a club of partners of the world of the press. Equipes-projets Inria : Graphik, Ilda, Linkmedia, Cedar. Press partners: Le Monde, OuestFrance, AFP. Participants: Anastasia Bezerianos (PI) and Emmanuel Pietriga.

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

- Deutsches Elektronen-Synchrotron (DESY): Scientific collaboration on the design and implementation of user interfaces for array operations monitoring and control for the Cherenkov Telescope Array (CTA) project, to be built in the Canary Islands (Spain) and in the Atacama desert (Chile).

9.4. International Initiatives

9.4.1. Inria International Labs

Inria Chile / CIRIC. From 2012 to 2015, Emmanuel Pietriga was the scientific leader of the Massive Data team at Inria Chile, working on projects in collaboration with the ALMA radio-telescope and the Millenium Institute of Astrophysics. He is now scientific advisor to Inria Chile's visualization lab, and is actively involved in the collaboration between Inria Chile and the LSST on the design and development of user interfaces for operations monitoring and control.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- KISTI (Korea). 2017. We investigated the potential of ultra-high-resolution wall-sized displays for the visualization of stream IOT data in the field of air quality monitoring in large and dense urban areas in Korea. The goal of the project was to design and implement an interactive multi-scale visualization of streamed data collected from vehicles (taxis) equipped with a battery of sensors and geolocation devices. The project focused on how to design effective visualizations that take advantage of the specific characteristics of large surfaces featuring a very high pixel density ; and on how to handle streams of IOT data, in this case the sensor data from all taxis, both live data streams and historical data retrieved from a database.
- University of Konstanz: Daniel Keim and Johannes Fuchs on mapping out the design space for visualization glyphs [16]. Participants: Anastasia Bezerianos.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Iftach Sadeh, DESY/CTA Observatory, February 2017

9.5.1.1. Internships

- María Grazia Prato, Inria Chile, October 2017
- Amanda Ibsen, Sebastian Pereira, María Grazia Prato, Inria Chile, June 2017

IMAGINE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *ARC6 PoTAsse (2015 - 2018)*

Participants: Pablo Coves, Jean-Claude Léon, Damien Rohmer.

We received a doctoral grant (AdR) from the ARC6 program to generate functional CAD assemblies from scanned data (*PoTAsse*: POint clouds To ASSEMBlies) as a collaboration between Imagine team (LJK/Inria) and Geomod team (LIRIS). Our PhD student Pablo Coves was advised by Jean-Claude Léon and Damien Rohmer at Imagine, Raphaëlle Chaîne and Julie Digne in Geomod team. This project was cancelled after Pablo Coves decided to abandon his PhD thesis.

8.2. National Initiatives

8.2.1. *InriaHub ADT ULTRAHD (January-December 2017)*

Participants: Rémi Ronfard, Frédéric Devernay, Alexandre Gauthier.

This one-year contract was funding Alexandre Gauthier as a research engineer, with the goal of re-writing the code from Vineet Gandhi's PhD thesis into a suite of NATRON plugins. The resulting software was entirely re-designed for supporting ultra high definition video. The suite of plugins is collectively known as "Kino AI". The software is being extensively tested 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.

8.2.2. *FUI LIVE360 (December 2015 - December 2018)*

Participants: Frédéric Devernay, Sandra Nabil.

This 3-year contract with industrial partner GoPRO is funding the PhD thesis of Sandra Nabil.

8.2.3. *FUI Collodi 2 (December 2016 - December 2018)*

Participants: Remi Ronfard, Maguelonne Beaud de Brives, Julien Daval, Damien Rohmer, Marie-Paule Cani.

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

8.2.4. *ANR E-ROMA (November 2017 - October 2020)*

Participants: Remi Ronfard, Stefanie Hahmann, Damien Rohmer, Marie-Paule Cani, Pierre Casati.

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.

8.2.5. *ANR FOLDYN (November 2017 - October 2020)*

Participants: Damien Rohmer, Marie-Paule Cani, Thomas Buffet.

This 3-year contract is a joint project with the University of Toulouse. The contract started in November 2018 and is funding the PhD thesis of Thomas Buffet.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ERC Grant Expressive

Title: EXPloring REsponsive Shapes for Seamless desIgn of Virtual Environments.

Programm: ERC Advanced Grant

Duration: 04/2012 - 03/2017

Inria contact: Marie-Paule Cani

To make expressive and creative design possible in virtual environments, the goal is to totally move away from conventional 3D techniques, where sophisticated interfaces are used to edit the degrees of freedom of pre-existing geometric or physical models: this paradigm has failed, since even trained digital artists still create on traditional media and only use the computer to reproduce already designed content. To allow creative design in virtual environments, from early draft to progressive refinement and finalization of an idea, both interaction tools and models for shape and motion need to be revisited from a user-centred perspective. The challenge is to develop reactive 3D shapes – a new paradigm for high-level, animated 3D content – that will take form, refine, move and deform based on user intent, expressed through intuitive interaction gestures inserted in a user-knowledge context. Anchored in Computer Graphics, this work reaches the frontier of other domains, from Geometry, Conceptual Design and Simulation to Human Computer Interaction. The contract ended successfully in March 2017.

8.3.1.2. PIPER

Title: Position and Personalize Advanced Human Body Models for Injury Prediction

Programm: FP7

Duration: November 2013 - April 2017

Inria contact: F. Faure

In passive safety, human variability is currently difficult to account for using crash test dummies and regulatory procedures. However, vulnerable populations such as children and elderly need to be considered in the design of safety systems in order to further reduce the fatalities by protecting all users and not only so called averages. Based on the finite element method, advanced Human Body Models for injury prediction have the potential to represent the population variability and to provide more accurate injury predictions than alternatives using global injury criteria. However, these advanced HBM are underutilized in industrial R&D. Reasons include difficulties to position the models – which are typically only available in one posture – in actual vehicle environments, and the lack of model families to represent the population variability (which reduces their interest when compared to dummies). The main objective of the project will be to develop new tools to position and personalize these advanced HBM. Specifications will be agreed upon with future industrial users, and an extensive evaluation in actual applications will take place during the project. The tools will be made available by using an Open Source exploitation strategy and extensive dissemination driven by the industrial partners. Proven approaches will be combined with innovative solutions transferred from computer graphics, statistical shape and ergonomics modeling. The consortium will be balanced between industrial users (with seven European car manufacturers represented), academic users involved in injury bio-mechanics, and partners with different expertise with strong potential for transfer of knowledge. By facilitating the generation of population and subject-specific HBM and their usage in production environments, the tools will enable new applications in industrial R&D for the design of restraint systems as well as new research applications. This contract ended successfully in April 2017.

INDES Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR AJACS

The AJACS project (Analyses of JavaScript Applications: Certification & Security) is funded by the ANR for 42 months, starting December 2014. The goal of the AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts. The Indes members are involved in the tasks WP2 Certified Analyses and WP3 Security of JavaScript Applications. The partners of this project include Inria teams Celtique (coordinator), Toccata, and Prosecco.

6.1.2. FUI UCF

The 3 years long UCF project aims at developing a reactive Web platforms for delivering multimedia contents. The partners of the project are the startups Alterway, OCamlPro, and XWiki, and the academic research laboratories of University Pierre et Marie Curie, and Denis Diderot.

6.1.2.1. Actions marquantes

Inria Sophia Antipolis Actions Marquantes is a special funding for 2 postdocs during one year to explore a new research direction. The joint project with DIANA team “User discrimination on the Web: measurement, causation and prevention” has obtained this funding. The goal of this project is to detect when users get discriminated on the Web, what are the technologies used to discriminate users and how we can prevent it without breaking the functionality and sometimes useful personalisation within Web applications.

6.2. European Initiatives

6.2.1. Collaborations in European Programs, Except FP7 & H2020

6.2.1.1. ICT Cost Action IC1405 on Reversible Computation

Program: ICT COST Action

Project title: Reversible computation - extending horizons of computing

Duration: November 2014 - November 2018

Coordinator: Irek Ulidowski, University of Leicester

Other partners: several research groups, belonging to 23 European countries.

Abstract: Reversible computation is an emerging paradigm that extends the standard mode of computation with the ability to execute in reverse. It aims to deliver novel computing devices and software, and to enhance traditional systems. The potential benefits include the design of reversible logic gates and circuits - leading to low-power computing and innovative hardware for green ICT, new conceptual frameworks and language abstractions, and software tools for reliable and recovery-oriented distributed systems. This is the first European network of excellence aimed at coordinating research on reversible computation.

6.2.1.2. Bilateral PICS project SuCCeSS

Program: CNRS PICS project

Project acronym: SuCCeSS

Project title: Security, Adaptability and time in Communication Centric Software Systems

Duration: June 2016 - June 2019

Coordinator: Cinzia Di Giusto, I3S, Sophia Antipolis

Partners: I3S, Inria, University of Groningen

Abstract: The project SuCCeSS is a CNRS-funded “Projet coopératif” (PICS 07313), involving two French teams in Sophia Antipolis (the MDSC team at the laboratory I3S, acting as coordinator, and the INDES team) and one Dutch team at the University of Groningen. The project started in June 2016 and is due to end in June 2019. The objective of the project is to study formal models for reliable distributed communication-centric software systems. The project focusses on analysis and validation techniques based on behavioural types, aimed at enforcing various properties (safety, liveness, security) of structured communications.

6.3. International Initiatives

6.3.1. Inria International Partners

6.3.1.1. Informal International Partners

Since 2009, the team has been collaborating with Mariangiola Dezani’s group at the University of Torino.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

In February-March, the team hosted for two weeks Professor Mariangiola Dezani-Ciancaglini from the University of Torino and Professor Paola Giannini from the University of Piemonte Orientale (Italy). The visit was partly funded by the COST Action on Reversibility.

Marc Feeley, professor at the University of Montréal has been visiting the team from April 1st to June 30th. The visit has been funded by the Labex UCN. M. Feeley has been working with M. Serrano on the compilation of functional languages in general, and JavaScript more specifically.

6.4.1.1. Internships

Web Tracking through invisible Web beacons

Imane Fouad made an internship from March 2017 until August 2017, followed by a second internship from October 2017 until December 2017. She is selected for a PhD in INDES, and will start on 1 January 2017.

Imane’s internship aimed at analyzing the new Web tracking technologies based on “Web beacon”, or “pixel image” tracking. This tracking technology uses an invisible 1x1 pixel image that is used to send information to third-party trackers, while being invisible to the user. Web beacon tracking is particularly invasive because it cannot be blocked by Private browsing mode, Adblock or Ghostery extensions, and not even by disabling JavaScript.

Imane Fouad has run automated Web experiments using the OpenWPM platform and performed large-scale measurement of the Web beacon tracking on the Web. She detected which companies use Web beacon, how this technology works, and is currently analysing cookie-based tracking techniques such as redirection chains and cookie synching with the ultimate goal to provide a fine-grained classification of existing Web tracking technologies.

INFINE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Equipex FIT

Participants: Cedric Adjih, Emmanuel Baccelli, Alexandre Abadie, Philippe Lubrano, Ichrak Amdouni, Alaeddine Weslati, Vincent Ladeveze.

Partners: Inria (Lille, Sophia-Antipolis, Grenoble), INSA, UPMC, Institut Telecom Paris, Institut Télécom Evry, LSIT Strasbourg.



Figure 3. FIT IoT-LAB site in Saclay

FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It provides this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project gives french internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the future internet. FIT was one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant program, in 2011.

One component of the FIT platform is the sets of IoT-LAB testbeds (see [the IoT-LAB web site](#)). These were motivated by the observation that the world is moving towards an "Internet of Things", in which most communication over networks will be between objects rather than people.

The Infine team is more specifically managing the FIT IoT-LAB site formerly at Rocquencourt, which recently moved to Saclay (on-going re-deployment), and is participating in the deployment of an additional IoT-lab testbed in Berlin (at Freie Universitaet Berlin).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. AGILE (H2020 project)

Participants: Emmanuel Baccelli, Cedric Adjih.

Program: H2020 ICT-30-2015 Topic: Internet of Things and Platforms for Connected Smart Objects

Project acronym: AGILE

Project title: Adoptive Gateways for dIverse muLtiPle Environments

Duration: 2015-2017

Coordinator: Emmanuel Baccelli

Other partners: Canonical (UK), Eclipse IoT Foundation (IE), Mobistar (BE), Libelium (ES), Startupbootcamp IoT (SP), CREATE-NET (IT), iMinds (BE), Atos (SP), Rulemotion (UK), Jolocom (DE), Passau University (DE), Sky-Watch (DN), BioAssist (GR), Graz Technical University (AT), Eurotech (IT), IoTango (US).

Abstract:

The AGILE project is a 3-year H2020 project started in January 2016, which will deliver an integrated framework of open source tools and platforms that interoperate for enabling the delivery of adaptive, self-configurable and secure IoT elements (both software and hardware) that can be utilized in a variety of scenarios. Such tools target actors with heterogeneous skills, including entrepreneurs, researchers, and individuals, aiming to enable the realization of IoT applications respecting user privacy and data ownership.

8.2.1.2. ARMOUR (H2020 project)

Participants: Emmanuel Baccelli, Cedric Adjih.

Program: H2020 ICT-12-2015 Topic: Integrating experiments and facilities in FIRE+

Project acronym: ARMOUR

Project title: Large-Scale Experiments of IoT Security Trust

Duration: 2016-2018

Coordinator: Serge Fdida (UPMC)

Other partners: UPMC (France), Synelixis (Greece), SMA (France), UI (Portugal), JRC (Belgium), EGM (France), OdinS (Spain).

Abstract: The ARMOUR project is a 2-year H2020 project started in February 2016. The ARMOUR project is aimed at providing duly tested, benchmarked and certified Security & Trust technological solutions for large-scale IoT using upgraded FIRE large scale IoT/Cloud testbeds properly-equipped for Security & Trust experimentations. To this, ARMOUR will: (1) Enhance two outstanding FIRE testbeds (> 2700 nodes; 500 users) with the ARMOUR experimentation toolbox for enabling large-scale IoT Security & Trust experiments; (2) Deliver six properly experimented, suitably validated and duly benchmarked methods and technologies for enabling Security & Trust in the large-scale IoT; and (3) Define a framework to support the design of Secure & Trusted IoT applications as well as establishing a certification scheme for setting confidence on Security & Trust IoT solutions.

8.2.2. Collaborations with Major European Organizations

8.2.2.1. EU CHIST-ERA MACACO

Participants: Aline Carneiro Viana, Emmanuel Baccelli, Eduardo Mucelli.

Program: EU CHIST-ERA, topic Context- and Content-Adaptive Communication Networks

Project acronym: MACACO

Project title: Mobile context-Adaptive CACHing for COntent-centric networking

Duration: 2013-2017 (extended until December 2017)

Coordinator: Aline Carneiro Viana

Other partners: INPT-ENSEEIH at University of Toulouse, University of Birmingham (UK), SUPSI (Switzerland), CNR (Italy) and Federal University of Minas Gerais (Brazil)

Abstract:

MACACO (Mobile context-Adaptive CACHing for Content-centric networking) is a 3-year CHIST-ERA European Project addressing the topic Context- and Content-Adaptive Communication Networks. Due to delay in funding access and data collection campaign we got an extension until December 2017. It is funded by ANR in France, SNSF in Switzerland, and ESPRC in UK. It focus on data offloading mechanisms that take advantage of context and content information. Our intuition is that if it is possible to extract and forecast the behaviour of mobile network users in the three dimensional space of time, location and interest (i.e. what, when and where users are pulling data from the network), it is possible to derive efficient data offloading protocols. Such protocols would pre-fetch the identified data and cache it at the network edge at an earlier time, preferably when the mobile network is less charged, or offers better quality of service. This project has officially started in November 2013.

8.3. International Initiatives

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

8.3.1.1. EMBRACE

Title: Leveraging Human Behavior and Uncertainty in 5G Networks to Build Robust Resource Allocation and Services Orchestration Models

International Partners (Institution - Laboratory - Researcher):

UTFPR (Brazil) - Departamento Academico de Informatica (DAINF) Curso de Pos-Graduacao em Engenharia Eletrica e Informatica Industrial (CPGEI) - Anelise Munaretto

UFG (Brazil) - Institute of Computational Mathematics and Scientific / Engineering Computing - Kleber Vieira Cardoso

UFMG (Brazil) - Dpt of Statistics - Antonio A. F. Loureiro

Start year: 2017

See also: <https://team.inria.fr/infine/embrace/>

EMBRACE propose une architecture novatrice pour gérer des ressources et des services opérationnels hétérogènes. EMBRACE se concentre sur les défis scientifiques liés des ensembles de données collectées dans le monde réel et décrivant le comportement du réseau des utilisateurs. En particulier, EMBRACE exploite la modélisation du comportement humain en termes de mobilité, de demande de contenu, d'intérêts communs et des interactions entre-utilisateurs. En construisant des modèles d'allocation des ressources tenant compte de l'utilisateur, EMBRACE a pour objectif de diminuer l'incertitude et mieux cerner les profils humains dans les réseaux 5G. La communication D2D sera également utilisée comme service opérationnel pour gérer la croissance du trafic mobile en libérant des ressources des réseaux cellulaires, sans augmenter les coûts. La nouveauté de l'architecture réside dans les algorithmes conçus qui exploiteront les caractérisations tirés de l'analyse du comportement des utilisateurs, l'hétérogénéité du réseau, et de l'incertitude. L'évaluation par simulation et l'émulation sera également l'un des thèmes clés. Enfin, les équipes concernées (Inria Infine, UFMG, UFG, UTFPR) ont un long historique de coopération sur ces thèmes.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

1. Renewed IOTPUSH collaboration with Freie Universitaet Berlin around the long-term stay of Emmanuel Baccelli in Berlin, on research topics about the Internet of Things, RIOT and Information-Centric Networking.

8.3.2.2. Informal International Partners

1. On-going collaboration with Freie Universitaet Berlin and Hamburg University of Applied Science around RIOT.
2. Informal collaborations with UIUC and UMass.

3. Informal collaborations with ENSI Tunis and Sesame Tunis.
4. On-going strong collaboration with Sapienza University of Rome, Italy.
5. On-going strong collaboration with CNR Torino, Italy.
6. On-going collaboration with University of Porto, Portugal.
7. On-going collaboration with ENSAE/CNRS, France.
8. On-going collaboration with University of Edinburgh, UK.

8.3.3. Participation in Other International Programs

8.3.3.1. Indo-French project

The Inria teams Infine and Eva are part of the "D2D Communication for LTE Advanced Cellular Network", a project funded by the Indo-French Centre for the Promotion of Advanced Research (CEFIPRA). With industrial partners, and also with Indian partners, this project is focusing on the evolution of cellular networks towards 5G: this includes exploration of device-to-device (D2D) communication, and more generally IoT communication in a cellular context. Research directions include efficient access for IoT devices (massive numbers of devices with low volume communication); combination of random access protocols/error coding/physical layer ; efficient neighbor discovery,

8.3.3.2. STIC AmSud MOTIf 2017

Participant: Aline Carneiro Viana.

Program: STIC AmSud

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

Duration: 2017-2019

Coordinators: Marton Karsai (ENS/Inria) and Jussara M. Almeida (UFMG) and Alejo Salles (Univ. of Buenos Aires)

Abstract: 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. 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 individual social behaviour. In other words our goal in general is to understand how individuals behave in a dynamic techno-social environment.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Rik Sarkar was Visiting Researcher at Infine for 3 days. He worked with Aline C. Viana and the internship Maria Astefanoaei on predicting new places to visit in human mobility decision.

Julinda Stefa was Visiting Researcher at Infine for 3 months. She worked with Aline C. Viana and the internship Adriano Di Luzio on the inference of human personality from mobile phones datasets.

Ana Aguiar was Visiting Researcher at Infine for 3 days. She worked with Aline C. Viana and the internship Emanuel Lima on data offloading decision via mobile crowdsensing.

8.4.1.1. Internships

Panagiota Katsikouli did an internship of 5 months at Infine working with Aline C. Viana and Marco Fiore on sampling frequency of human mobility.

Maria Astefanoaei did an internship of 5 months at Infine working with Aline C. Viana and Rik Sarkar on predicting new places to visit in human mobility decision.

Adriano Di Luzio did an internship of 4 months at Infine working with Aline C. Viana and Julinda Stefa on the inference of human personality from mobile phones datasets.

Emanuel Lima did an internship of 3 months at Infine working with Aline C. Viana and Ana Aguiar on data offloading decision via mobile crowdsensing.

Ayat Zaki Hindi did an internship of 6 months at Infine working with Cedric Adjih, Michel Kieffer and C. Weidmann on synchronization strategy in Information-Centric Networks.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Emmanuel Baccelli is Visiting Professor at Freie Universitaet (FU) Berlin, within the context of the formal collaboration IOTPUSH with this university on research topics about the Internet of Things, RIOT and Information-Centric Networking.

INOCS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The ELSAT research program addresses the issues involved in sustainable transportation and mobility. Within ELSAT, INOCS is involved on two projects devoted to hybrid optimization methods in logistics and to city logistics in collaboration with LAMIH (University of Valenciennes), LGI2A (University of Artois) and LEOST (IFSTTAR). ELSAT is supported by the CPER 2015-2020 (State-Region Contract).

9.2. National Initiatives

9.2.1. ANR

ANR project PI-Commodality “Co-modal freight transportation chains: an approach based on physical internet” in collaboration with CGS-ARMINES (Paris), LAAS (Toulouse), DHL (2016 - 2018). The PI-commodality project aims to design new sustainable logistic services between preset origins and destinations. It is based on innovative approaches both in terms of: 1) Logistics and transportation services: by considering the PI-internet approach, specifically: mesh logistics and transportation networks based on available capacities, by designing consistent integrated co-modal chains; 2) Methodology: by addressing the underlying problems according to two approaches: centralized and decentralized, by proposing new realistic models relevant for practitioner taking into account the consistency, by developing state-of-the-art decision making algorithms.

9.2.2. National Initiatives (Belgium)

Combinatorial Optimization: Meta-heuristics and Exact Methods (2012-2017), coordinator: Bernard Fortz (GOM-ULB/INOCS-Inria). Inter-university Attraction Pole funded by the Belgian Federal Science Policy Office. Study and modeling of combinatorial optimization problems; Advancements in algorithmic techniques; Implementation of solution methods for large-scale, practically relevant problems.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: TD1207

Project title: Mathematical Optimization in the Decision Support Systems for Efficient and Robust Energy Networks

Duration: 04/2014 - 04/2017

Coordinator: Thorsten Koch (ZIB, Germany)

INOCS partners: Bernard Fortz, Martine Labbé

Abstract: Energy Production and Distribution (EP&D) is among the biggest challenges of our time, since energy is a scarce resource whose efficient production and fair distribution is associated with many technical, economical, political and ethical issues like environmental protection and people health. EP&D networks have rapidly increased their size and complexity, e.g. with the introduction and interconnection of markets within the EU. Thus, there is an increasing need of systems supporting the operational, regulatory and design decisions through a highly interdisciplinary approach, where experts of all the concerned fields contribute to the definition of appropriate mathematical models. This is particularly challenging because these models require the simultaneous use of many different mathematical optimization tools and the verification by experts of the underlying engineering and financial issues. The COST framework is instrumental for this Action to be able to coordinate the inter-disciplinary efforts of scientists and industrial players at the European level.

Program: JPI Urban Europe

Project acronym: e4-share

Project title: Models for Ecological, Economical, Efficient, Electric Car-Sharing

Duration: 10/2014 - 09/2017

Coordinator: Markus Leitner (University of Vienna, Austria)

Other partners:

- Austrian Institute of Technology, Austria
- Université Libre de Bruxelles (INOCS), Belgium
- University of Bologna, Italy
- tbw research GesmbH, Austria

Abstract: Car-sharing systems and the usage of electric cars become increasingly popular among urban citizens. Thus, providing vast opportunities to meet today's challenges in terms of environmental objectives, sustainability and living quality. Our society needs to manage a transformation process that ultimately shall lead to fewer emissions and less energy consumption while increasing the quality of public space available. In e4-share, the team will lay the foundations for efficient and economically viable electric car-sharing systems by studying and solving the optimization problems arising in their design and operations. A main goal is to derive generic methods and strategies for optimized planning and operating in particular for flexible variants which best meet preferences of customers but impose nontrivial challenges to operators. This project will develop novel, exact and heuristic, numerical methods for finding suitable solutions to the optimization problems arising at the various planning levels as well as new, innovative approaches considering these levels simultaneously.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. BIPLOS

Title: Bilevel Problems in LOGistics and Security

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Instituto Sistemas Complejos de Ingeniería (ISCI) - Ordóñez Fernando

Start year: 2017

See also: <https://project.inria.fr/biplos/>

This project is devoted to bilevel optimisation problems with application in the security and logistics domains. Stackelberg games, including one defender and several followers, and competitive location problems will be considered. Mixed integer linear optimisation models and efficient algorithms to solve them will be developed.

Related publications: [29], [11], [66].

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

9.4.2.1. North-European associated team

Title: Physical-internet services for city logistics

International Partner (Institution - Laboratory - Researcher):

Norwegian School of Economics - Stein Wallace

Start year: 2017

In this project, we consider an urban logistic terminal and new logistics services which could be developed according to a Physical Internet approach. The main objective is to evaluate the services using optimization models created within the project. We are developing optimization models to identify win-win cooperation between carriers based on supply and demand. We aim to explore how to include stochasticity in the description of the supplies and demands, as well as travel times, and to what extent the plans within a day can improve by such knowledge. The second task is to develop solution algorithms for these models. These are real scientific challenges as we are facing stochastic mixed integer problems.

9.4.3. Inria International Partners

9.4.3.1. Informal International Partners

Department of Statistics and Operations Research, University of Vienna, Austria.
Centre for Quantitative Methods and Operations Management, HEC-Liège, Belgique.
Interuniversity Centre on Enterprise Networks, Transportation and Logistics (CIRRELT), Montreal, Canada.
Department of Industrial Engineering, Universidad de Talca, Curicó, Chile.
Instituto Sistemas Complejos de Ingeniería (ISCI), Santiago, Chile.
The Centre for Business Analytics, University College Dublin, Ireland.
Department of Electrical, Electronic, and Information Engineering, University of Bologna, Italy.
Department of Electrical and Information Engineering, University of Padova, Italy.
Department of Mathematics, University of Aveiro, Portugal.
Department of Statistics and Operations Research, University of Lisbon, Portugal.
Instituto de Matemáticas, University of Seville, Spain.
Departamento de Estadística e Investigación Operativa, Universidad de Murcia, Spain.
Dipartimento di Matematica, Università degli studi di Padova, Italy.

9.4.4. Participation in Other International Programs

STIC Algérie, University of Oran, Algeria.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Visiting Professors and Ph.D. students

Claudio Arbib, Professor at Università degli Studi dell'Aquila, Feb 2017.
Victor Bucarey, Postdoctoral researcher at Universidad de Chile, Dec 2017.
Paula Carroll, Professor at Centre for Business Analytics, School of Business, University College Dublin, Sep 2017.
Sebastián Dávila, Ph.D. student at Universidad de Chile, Dec 2017.
Bernard Gendron, Professor at Université de Montréal, Nov 2017.
Anton Kleywegt, Professor at Georgia Institute of Technology, from Jun 2017 until Jul 2017.
Marina Leal, Ph.D. student at Universidad de Sevilla, from Jun until Oct 2017.
Paulo Macedo, Ph.D. student at Universidade Federal do Ceará, from Mar 2017 until Jul 2017.
Vladimir Marianov, Professor at Pontificia Universidad Católica de Chile, from Nov until Dec 2017.
Alfredo Marín, Professor at Universidad de Murcia, Oct 2017.
Fernando Ordóñez, Professor at Universidad de Chile, Sep 2017.
Juan José Palacios Alonso, Professor at Universidad de Oviedo, from Sep until Dec 2017.
Mercedes Pelegrin Garcia, Ph.D. student at Universidad de Murcia, from Sep 2017 until Dec 2017.

9.5.1.2. Internships

Juan Alejandro Gomez Herrera, Ecole Polytechnique de Montréal, from Apr 2017 until Jul 2017.
Sebastien Michel, Centrale Lille, from Jun 2017 until Sep 2017.
Luis Salazar Zendeja, University of Monterrey, Mexico, from Apr 2017 until Aug 2017.
Grégoire Pellissier, Université Blaise Pascal, Clermont-Ferrand, from June 2017 until Sept 2017.

IPSO Project-Team

5. Partnerships and Cooperations

5.1. Regional Initiatives

- A. Crestetto is member of the project "Pari Scientifique Régional Exprodil".
- M. Lemou is member of the project "Défis" of the University of Rennes 1, leader Nicolas Seguin.

5.2. National Initiatives

5.2.1. ANR MOONRISE: 2015-2019

Participants: Francois Castella, Philippe Chartier, Nicolas Crouseilles, Mohammed Lemou, Florian Mehats.

The project *Moonrise* submitted by Florian Méhats has been funded by the ANR for 4 years, for the period 2015-2019. This project aims at exploring modeling, mathematical and numerical issues originating from the presence of high-oscillations in nonlinear PDEs from the physics of nanotechnologies (quantum transport) and from the physics of plasmas (magnetized transport in tokamaks). The partners of the project are the IRMAR (Rennes), the IMT (Toulouse) and the CEA Cadarache. In the IPSO team, François Castella, Philippe Chartier, Nicolas Crouseilles and Mohammed Lemou are members of the project Moonrise.

Postdocs

- Loïc Le Treust has been hired as a Postdoc, under the supervision of Philippe Chartier and Florian Méhats. His contract started in september 2015 and ended in august 2016. Loïc Le Treust is now assistant professor at the university of Marseille.
- Xiaofei Zhao has been hired as a Postdoc from september 2015 to september 2016 under the supervision of Florian Méhats.

5.2.2. ANR MFG: 2016-2020

Participant: Arnaud Debussche.

Mean Field Games (MFG) theory is a new and challenging mathematical topic which analyzes the dynamics of a very large number of interacting rational agents. Introduced ten years ago, the MFG models have been used in many areas such as, e.g., economics (heterogeneous agent models, growth modeling,...), finance (formation of volatility, models of bank runs,...), social sciences (crowd models, models of segregation) and engineering (data networks, energy systems...). Their importance comes from the fact that they are the simplest ("stochastic control"-type) models taking into account interactions between rational agents (thus getting beyond optimization), yet without entering into the issues of strategic interactions. MFG theory lies at the intersection of mean field theories (it studies systems with a very large number of agents), game theory, optimal control and stochastic analysis (the agents optimize a payoff in a possibly noisy setting), calculus of variations (MFG equilibria may arise as minima of suitable functionals) and partial differential equations (PDE): In the simplest cases, the value of each agent is found by solving a backward Hamilton-Jacobi equation whereas the distribution of the agents' states evolves according to a forward Fokker-Planck equation. The "Master" equation (stated in the space of probability measures) subsumes the individual and collective behaviors. Finally, modeling, numerical analysis and scientific computing are crucial for the applications. French mathematicians play a world-leading role in the research on MFG: The terminology itself comes from a series of pioneering works by J.-M. Lasry and P.-L. Lions who introduced most of the key ideas for the mathematical analysis of MFG; the last conference on MFG was held last June in Paris and organized by Y. Achdou, P. Cardaliaguet and J.-M. Lasry. As testifies the proposal, the number of researchers working on MFG in France (and also abroad) is extremely fast-growing, not only because the theoretical aspects are exciting and challenging, but also because MFG models find more and more applications. The aim of the project is to better coordinate the French mathematical research on MFG and to achieve significant progress in the theory and its applications.

The partners of the project are the CEREMADE laboratory (Paris Dauphine), the IRMAR laboratory (Rennes I), the university of Nice and of Tours.

5.2.3. ANR ACHYLLES: 2014-2018

Participant: Anais Crestetto.

The ACHYLLES project focuses on Long-Time Asymptotic-Preserving (LTAP) numerical schemes for hyperbolic systems of conservation laws supplemented by potentially stiff source terms. It ambitions to perform a breakthrough in the understanding and efficiency of LTAP scheme.

The partners are IMB (Bordeaux), LMV (Versailles) and LMJL (Nantes).

5.2.4. IPL FRATRES

IPSO is associated to IPL FRATRES which started in june 2015. The aim of this project is to organize Inria teams activities which develop mathematical and numerical tools in magnetically confined nuclear fusion. The ambition is to prepare the next generation of numerical modeling methodologies able to use in an optimal way the processing capabilities of modern massively parallel architectures. This objective requires close collaboration between a) applied mathematicians and physicists that develop and study mathematical models of PDE; b) numerical analysts developing approximation schemes; c) specialists of algorithmics proposing solvers and libraries using the many levels of parallelism offered by the modern architecture and d) computer scientists. The project road map ambitions to contribute in close connection with National and European initiatives devoted to nuclear Fusion to the improvement and design of numerical simulation technologies applied to plasma physics and in particular to the ITER project for magnetic confinement fusion.

Postdoc

- Xiaofei Zhao has been hired as a Postdoc, under the supervision of Nicolas Crouseilles and Sever Hirstoaga (Inria-Nancy). His contract started in october 2016 and ended in september 2017.

5.3. European Initiatives

5.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: EUROfusion Enabling Research

Project acronym: WPENR

Project title: Verification and development of new algorithms for gyrokinetic codes

Duration: january 2015 - december 2017.

Coordinator: E. Sonnendrücker (Max-Planck IPP, Germany)

Other partners: IPP, EPFL, CEA-Cadarache, university of Strasbourg, Toulouse, Marseille, Paris 6.

Abstract: Gyrokinetic codes play a major role in understanding the development and saturation of micro-turbulence in a magnetic fusion plasma and its influence on energy confinement time. The first aim of this proposal is to assess the reliability of gyrokinetic codes by extensive verification and benchmarking. All the major european gyrokinetic codes are involved in the proposal and this will enable them to define comparison elements, which ultimately will also facilitate the cross-validation of new physics. On the other hand we will develop new algorithms for extending the physics capabilities or the computational efficiency of different gyrokinetic codes. Finally we will also perform a prospective investigation of models and numerical methods that could help in the future to address physics where kinetic effects might play an important role but that cannot be handled with today's gyrokinetic codes, like L-H (low to high confinement) transition, edge physics or MHD time scales simulations.

5.4. International Initiatives

5.4.1. Informal International Partners

Members of the IPSO team have several international collaborations

- the group of S. Jin (university of Wisconsin, US).
- the group of W. Bao (university of Singapore).
- G. Vimart (university of Geneva, Switzerland).
- the group of A. Ostermann (university of Innsbruck).
- the SNS of Pisa (G. Da Prato).
- several US universities: Maryland (S. Cerrai), Chicago (C. Sparber), Colorado (O. Pinaud), ...
- ...

5.4.2. Participation in Other International Programs

- A. Crestetto is involved in the project PHC PROCOPE "Hétérogénéités Fortes dans les Modèles d'Ecoulement Fluide".

5.5. International Research Visitors

5.5.1. Visits to International Teams

- P. Chartier was invited by Fernando Casas, University of Castellon, Spain, July 6-9 2017.
- A. Crestetto was invited by Christian Klingenberg, Institute of Mathematics, Würzburg University, July 10-14 2017.
- M. Lemou was invited by Shi Jin, Jiao Tong university Shanghai, China, July 5-15 2017.
- M. Lemou was invited by Hao Wu, Tsinghua university Beijing, China, July 15-20 2017.

KAIROS Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. UCA project Smart IoT for Mobility

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

We have started a collaboration with Renault Software Lab and Orange in Sophia Antipolis to apply our system engineering to the field of connected vehicles. The goal is to model formally and with digital models contracts between car manufacturers (like Renault) and service providers that should provide new services for connected vehicles. The contract also involves the communication infrastructure provider (here Orange) that operates the communications. A project funded by Academy RISE of UCA Jedi has started in December 2017 with a Master student starting at the beginning of January 2018. This project is done in collaboration with the LEAT laboratory and the GREDEG Laboratory which provides experts on legal issues for connected objects.

8.2. National Initiatives

8.2.1. FUI CLISTINE

Participants: Robert de Simone, Amin Oueslati, Emilien Kofman.

This project was officially closed this year, but work had finished by the end of last year. The outcomes were somehow weakened by the fact that the original project leader failed to integrate the results of various partners into the promised innovative architecture of network-on-board.

8.2.2. Investissements d'Avenir: PIA Clarity

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

This project is funded by the LEOC Call (*Logiciel Embarqué et Objets Connectés*) of the national support programme *Investissements d'Avenir*. It will end in December 2017. Partners are: Thales (several divisions), Airbus, Areva, Altran, All4Tec, Artal, the Eclipse Foundation, Scilab Enterprises, CESAMES, U. Rennes, and Inria. The purpose of the project is to develop and promote an open-source version of the ARCADIA Melody system design environment from Thales, renamed CAPPELLA for that purpose. In this project we investigated extensions of Capella to enable simulation and analysis of mode automata in the context of model based system engineering.

8.2.3. PEPS CNRS INS³PECT

Participants: Marie Agnès Peraldi-Frati, Julien Deantoni, Frédéric Mallet.

The project is funded by CNRS-INS2I call PEPS 2017 Connected Objects Algorithms Algorithm, Application and Architecture. It ended in December 2017.

The focus is on System Level engineering for Secured Services for connected Objects. The idea is to have a high level modeling and verification of services that integrate hardware, communication and computing edges, and the software parts. Security is transversal in this value chain and is included as a viewpoint in the design. See <https://www.i3s.unice.fr/ins3pect/> for more information.

Academic partners are I3S (Sophia), LIG(Grenoble), LabSTICC (Lorient), LEAT (Sophia). An internal meeting was held in late Spring, while a more open Workshop was held in Sophia in December.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. LIAMA project SACCADES

This project was supported by the associated-team FM4CPS 8.3.1.2, with Vania Joloboff from EPI TEA in Inria Rennes as Prime Investigator. The chinese partner was ECNU Shanghai, whose status inside LIAMA was then to be established.

8.3.1.2. FM4CPS

Title: Formal Models and tools for Cyber-Physical Systems

International Partner (Institution - Laboratory - Researcher):

ECNU (China) - Artificial Intelligence Lab - Jifeng He

Start year: 2015

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

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

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

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

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

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

A Memorandum of Understanding (MoU) was signed a couple of years ago between Inria and ECNU Shanghai. The same kind of agreement was also concluded between University Côte d'Azur (UCA) and ECNU, covering mostly our collaboration, both on research and on academic student exchange sides.

We have an ongoing contractual collaborative project on our joint activities on co-modeling, named FIDEL, with the Computer Science department from the University of Verona; it is funded on their side by a specific University programme. The collaboration should be strengthened on our side with the arrival of Giovanni Liboni, formerly student there, as PhD student working with us on a CIFRE grant by SAFRAN on the same topic.

8.3.3. Participation in Other International Programs

We are active members of the International Joint Lab of Trustworthy Software (IJLTS), of which Eric Madelaine is Steering Committee Member. The lab is funded by the Chinese Ministry of Research, and headed by ECNU, Shanghai (together with CWI, ENS Rennes, ENS Lyon, as partners amongst others). This Joint Lab forms the counterpart of the FM4CPS associated team and SACCADES LIAMA project, and in particular funded the Chinese partners in joint actions and visits. All this is reported under the FM4CPS Associated-Team section 8.3.1.2 .

Marie-Agnes Peraldi Frati is involved in the DNITT (Danang International Institute of Technology) Institute in Vietnam which is co-managed by UCA and University of Danang. She visited the institute 10 days in May 2017 in the context of the IGLOO (Specific Domain Language For Experience Global Orchestration) research project. The research topic is on domain specific scenario language for Home care and eHealth.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Visiting Professors

Reinhard von Hanxleden

Date: July 2017 - Sept. 2017

Institution: University of Kiel (Germany)

Min ZHANG

Date: 2017 - 2017

East China Normal University (Shanghai, China)

Jing LIU

Date: December 2017 - January 2018

East China Normal University (Shanghai, China)

8.4.1.2. Visiting PhD students

Donddong AN

Date: Oct. 2016 - March 2018

ECNU Shanghai

Maroua El Hami

Date: Oct. 2017 - July 2018

ENISO, Sousse (Tunisia)

KERDATA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. OverFlow (2015–2019)

Participants: Alexandru Costan, Paul Le Noac’h.

- Project Acronym: OverFlow.
- Project Title: Workflow Data Management as a Service for Multisite Applications.
- Coordinator: Alexandru Costan.
- Duration: Octobre 2015–October 2019.
- Other Partners: None (Young Researcher Project).
- External collaborators: **Kate Keahey** (University of Chicago and Argonne National Laboratory), **Bogdan Nicolae** (Huawei Research) and **Christophe Blanchet** (Institut Français de Bioinformatique).
- Abstract: This JCJC project led by Alexandru Costan investigates approaches to data management enabling an efficient execution of geographically distributed workflows running on multi-site clouds.
- Progress: In 2017, we have reviewed in depth the technical and architectural needs of data storage for the use cases that drive OverFlow, in order to consolidate a set of requirements for its future architecture. Based on these workflow traces, in a second step, we have investigated the suitable benchmarks that reasonably represent them. In this direction, we have first focused on ingestion and storage optimisations for such complex deployments, in particular the novel support for concurrent writes. The project was successfully reviewed at T0+18.

8.1.1.2. KerStream (2017–2021)

Participant: Shadi Ibrahim.

- Project Acronym: KerStream.
- Project Title: Big Data Processing: Beyond Hadoop!
- Coordinator: Shadi Ibrahim .
- Duration: January 2017–January 2021.
- Other Partners: None (Young Researcher Project).
- Abstract: This JCJC project led by Shadi Ibrahim aims to address the limitations of Hadoop when running stream Big Data applications on large-scale clouds and to do a step beyond Hadoop by proposing a new approach, called KerStream, for scalable and resilient stream Big Data processing on clouds. The KerStream project can be seen as the first step towards developing the first French middleware that handles Stream Data processing at Scale.
- Note: Shadi Ibrahim left the KerData team in April 2017, so that this contract is no longer managed within the KerData team.

8.1.2. Other National Projects

8.1.2.1. ADT Damaris

Participants: Hadi Salimi, Alexandru Costan, Luc Bougé.

- Project Acronym: ADT Damaris
- Project Title: Technology development action for the Damaris environment.
- Coordinator: Alexandru Costan.
- Duration: 2016–2018.
- Abstract: This action aims to support the development of the Damaris software. Inria's *Technological Development Office* (D2T, *Direction du Développement Technologique*) provided 2 years of funding support for a senior engineer.

Hadi Salimi is funded through this project to document, test and extend the **Damaris** software and make it a safely distributable product.

8.1.2.2. Grid'5000

We are members of Grid'5000 community and run experiments on the Grid'5000 platform on a daily basis.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. BigStorage

Title: BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data.

Programme: H2020.

Duration: January 2015–December 2018.

Coordinator: Universidad Politécnica de Madrid (UPM).

Partners:

- Barcelona Supercomputing Center — Centro Nacional de Supercomputacion (Spain)
- CA Technologies Development Spain (Spain)
- CEA — Commissariat à l'énergie atomique et aux énergies alternatives (France)
- Deutsches Klimarechenzentrum (Germany)
- Foundation for Research and Technology Hellas (Greece)
- Fujitsu Technology Solutions (Germany)
- Johannes Gutenberg Universität Mainz (Germany)
- Universidad Politécnica de Madrid (Spain)
- Seagate Systems UK (United Kingdom)

Inria contact: **Gabriel Antoniu** and **Adrien Lèbre**.

URL: <http://www.bigstorage-project.eu/>.

Description: BigStorage is a European Training Network (ETN) whose main goal is to train future *data scientists*. It aims at enabling them and us to apply holistic and interdisciplinary approaches to take advantage of a data-overwhelmed world. This world requires *HPC* and *Cloud* infrastructures with a redefinition of *storage* architectures underpinning them — focusing on meeting highly ambitious performance and *energy* usage objectives. The KerData team is hosting 2 *Early Stage Researchers* in this framework and co-advises an extra PhD student.

8.2.2. Collaborations with Major European Organizations

Gabriel Antoniu and Alexandru Costan are serving as Inria representatives in the working groups dedicated to *HPC-Big Data* convergence within the **Big Data Value Association** (BDVA) and the **European Technology Platform in the area of High-Performance Computing** (ETP4HPC). They are contributing to the respective Strategic Research Agendas of BDVA and ETP4HPC.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. JLESC: Joint Laboratory on Extreme-Scale Computing

The **Joint Laboratory on Extreme-Scale Computing** is jointly run by Inria, UIUC, ANL, BSC, JSC and RIKEN/AICS. It has been created in 2014 as a follow-up of the Inria-UIUC JLPC, the *Joint Laboratory for Petascale Computing*.

The KerData team is collaborating with teams from ANL and UIUC within this lab since 2009 on several topics in the areas of I/O, storage and in situ processing and cloud computing. This collaboration has been initially formalized as the *Data@Exascale* Associate Team with ANL and UIUC (2013–2015) followed by *Data@Exascale 2* Associate Team with ANL (2016–2018). Our activities in this framework are described here: <http://www.irisa.fr/kerdata/data-at-exascale/>

Since 2015, Gabriel Antoniu serves as a topic leader for Inria for the *I/O, Storage and In Situ Processing* topic. Ongoing lab research directions and projects he is co-supervising in this area are described here: <https://jlesc.github.io/projects/> in the *I/O, Storage and In-Situ Processing* section.

Since 2017, Gabriel Antoniu is serving as *Vice-Executive Director of JLESC for Inria*.

8.3.1.1.1. Associate Team involved in the International Lab: Data@Exascale 2

Project Acronym: Data@Exascale 2.

Project Title: Convergent Data Storage and Processing Approaches for Exascale Computing and Big Data Analytics.

International Partner: Argonne National Laboratory (United States) — Mathematics and Computer Science Division (MCS) — **Rob Ross**.

Start year: 2013.

URL: <http://www.irisa.fr/kerdata/data-at-exascale/>.

Description: In the past few years, countries including United States, the European Union, Japan and China have set up aggressive plans to get closer to what appears to be the next goal in terms of high-performance computing (HPC): Exaflop computing, a target which is now considered reachable by the next-generation supercomputers in 2020-2023. While these government-led initiatives have naturally focused on the big challenges of Exascale for the development of new hardware and software architectures, the quite recent emergence of the Big Data phenomenon introduces what could be called a tectonic shift that is impacting the entire research landscape for Exascale computing. As data generation capabilities in most science domains are now growing substantially faster than computational capabilities, causing these domains to become data-intensive, new challenges appeared in terms of volumes and velocity for data to be stored, processed and analyzed on the future Exascale machines.

To face the challenges generated by the exponential data growth (a general phenomenon in many fields), a certain progress has already been made in the recent years in the rapidly-developing, industry-led field of cloud-based Big Data analytics, where advanced tools emerged, relying on machine-learning techniques and predictive analytics.

Unfortunately, these advances cannot be immediately applied to Exascale computing: the tools and cultures of the two worlds, HPC (High-Performance Computing) and BDA (Big Data Analytics) have developed in a divergent fashion (in terms of major focus and technical approaches), to the detriment of both. The two worlds share however multiple similar challenges and unification now appears as essential in order to address the future challenges of major application domains that can benefit from both.

The scientific program we propose for the Data@Exascale 2 Associate Team is defined from this new, highly-strategic perspective and builds on the idea that the design of innovative approaches

to data I/O, storage and processing allowing Big Data analytics techniques and the newest HPC architectures to leverage each other clearly appears as a key catalyst factor for the convergence process.

Activities in 2017 are described on the web site of the Associate Team.

8.3.2. *Inria International Partners*

8.3.2.1. *Declared Inria International Partners*

8.3.2.2. *DataCloud@Work*

Title: DataCloud@Work.

International Partner:

- Polytechnic University of Bucharest (Romania), Computer Science Department, Nicolae Tapus and Valentin Cristea.

Duration: 5 years.

Start year: 2013. The status of IIP was established right after the end of our former *DataCloud@work* Associate Team (2010–2012).

URL: https://www.irisa.fr/kerdata/doku.php?id=cloud_at_work:start.

Description: Our research topics address the area of distributed data management for cloud services, focusing on autonomic storage. The goal is explore how to build an efficient, secure and reliable storage IaaS for data-intensive distributed applications running in cloud environments by enabling an autonomic behavior.

8.3.2.3. *Informal International Partners*

Instituto Politécnico Nacional, IPN, Ciudad de México: We continued our informal collaboration in the area of stream processing. A PhD student from IPN (José Aguilar Canepa) was hosted by the KerData team for a 1-month internship, during which he identified optimization problems that can be subject to joint work (see Internships section below).

National University of Singapore (NUS): We collaborate on resource management for workflows in the cloud and optimizing graph processing in geo-distributed data-centers.

8.3.3. *Participation in Other International Programs*

8.3.3.1. *International Initiatives*

8.3.3.1.1. BDEC: Big Data and Extreme Computing

Since 2015, Gabriel Antoniu has been invited to participate to the yearly workshops of the international **Big Data and Extreme-scale Computing** (BDEC) working group, focused on the convergence of Extreme Computing (the latest incarnation of High-Performance Computing - HPC) and Big Data. BDEC is organized as an yearly series of invitation-based international workshops. In 2017 Gabriel Antoniu was solicited to co-lead the BDEC working group dedicated to exploring convergence-related challenges for hybrid architectures combining HPC systems, clouds and fog/edge computing infrastructures with **Geoffrey Fox** and **Ewa Deelman**. The contributions are reflected in the final report on convergence available on the BDEC web page.

8.4. *International Research Visitors*

8.4.1. *Visits of International Scientists*

José Aguilar Canepa (Instituto Politécnico Nacional, IPN, Mexico) visited the KerData team for one month (November 2017) in order to setup a common topic of research for the future proposal of an Associate Team Kerdata-IPN.

8.4.1.1. *Internships*

Mukrram Rahman (M1, University of Rennes 1) has done a 3-month internship within the team, working with Ovidiu Marcu and Alexandru Costan on HDFS extensions for dedicated stream storage.

8.4.2. *Visits to International Teams*

8.4.2.1. *Research Stays Abroad*

Pierre Matri has done a 3-month internship at Argonne National Lab, to work on extreme-scale logging through application-defined storage under the supervision of Phil Carns and Rob Ross. See Section *New Results* for details.

LACODAM Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *SePaDec: Declarative approaches for Sequential Pattern mining*

Participants: Benjamin Negrevergne, Thomas Guyet, Ahmed Samet, Alexandre Termier.

The SEPADEC project is funded by the Region Bretagne. During the execution of this project we explored the application of declarative pattern mining (specifically ASP) in the field of care pathway analysis. The goal was to model domain knowledge to enrich raw data with medical expert knowledge and to develop a toolbox that smoothly integrates both expert knowledge and declarative pattern mining.

We developed a new approach for mining rare sequential mining with ASP [20] and we also proposed a general framework based on ASP for flexibly mine care pathways [12].

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. *#DigitAg: Digital agriculture*

Participants: Alexandre Termier, Véronique Masson, Christine Largouët, Anne-Isabelle Graux.

#DigitAg is a “Convergence Institute” dedicated to the increasing importance of digital techniques in agriculture. Its goal is twofold: First, make innovative research on the use of digital techniques in agriculture in order to improve competitiveness, preserve the environment, and offer correct living conditions to farmers. Second, prepare future farmers and agricultural policy makers to successfully exploit such technologies.

While #DigitAg is based on Montpellier, Rennes is a satellite of the institute focused on cattle farming. LACODAM is involved in the “data mining” challenge of the institute, that A. Termier co-leads. He is also the representative of Inria in the steering committee of the institute.

The interest for the team is to design novel methods to analyze and represent agricultural data, which are challenging because they are both heterogeneous and multi-scale (both spatial and temporal).

9.2.2. National Platforms

9.2.2.1. *PEPS: Pharmaco-epidemiology for Health Products*

Participants: Yann Dauxais, Thomas Guyet, Véronique Masson, René Quiniou, Ahmed Samet.

The PEPS project (Pharmaco-epidemiology des Produits de Santé) is funded by the ANSM (National Agency for Health Security). The project leader is E. Oger from the clinical investigation center CIC-1414 INSERM/CHU Rennes. The other partners located in Rennes are the Institute of Research and Technology (IRT), B<>Com, EHESP and the LTSI. The project started in January 2015 and is funded for 4 years.

The PEPS project consists of two parts: a set of clinical studies and a research program dedicated to the development of innovative tools for pharmaco-epidemiological studies with medico-administrative databases.

Our contribution to this project will be to propose pattern mining algorithms and reasoning techniques to analyse the typical care pathways of specific groups of insured patients. This year we worked on the design and development of the DCM algorithm [8], [7] to mine patterns on care pathways.

9.3. International Research Visitors

9.3.1. Internships

This year, we hosted Scarlett Kelly, a student of Dalhousie University (Canada) from May to the end of August. Her internship was funded by a joint Mitacs Globalink (Canada) / Inria grant. Scarlett Kelly is a student of social sciences, thus she has a different profile than the computer science students who usually do internships at LACODAM. We were interested in such profile in order to gain a critical view on the current approaches of *interactive data mining*. Scarlett quickly picked up the literature of the domain, and could write a report and make interesting propositions that were unexpected from a computer science point of view, i.e., introduce a specially trained "data liaison" person between practitioners and data scientists. Her proposition led to a paper [14] accepted at the HICSS conference (an IT conference ranked "A" at CORE2017).

LAGADIC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *ARED DeSweep*

Participants: Lesley-Ann Duflot, Alexandre Krupa.

no Inria Rennes 8033, duration: 36 months.

This project funded by the Brittany council started in October 2014. It supports in part Lesley-Ann Duflot's Ph.D. about visual servoing based on the shearlet transform (see Section 7.3.1).

9.1.2. *ARED Locoflot*

Participants: Ide Flore Kenmogne Fokam, Vincent Drevelle, Eric Marchand.

no Inria Rennes 9944, duration: 36 months.

This project funded by the Brittany council started in October 2015. It supports in part Ide Flore Kenmogne Fokam's Ph.D. about cooperative localization in multi-robot fleets using interval analysis (see Section 7.6.2).

9.1.3. *ARED Mod4Nav*

Participants: Aline Baudry, Marie Babel.

no INSA Rennes 2016/01, duration: 36 months.

This project funded by the Brittany council started in October 2016. It supports in part Aline Baudry's Ph.D. about wheelchair modeling.

9.1.4. *“Equipement mi-lourd Rennes Métropole”*

Participant: Paolo Robuffo Giordano.

no CNRS Rennes 14C0481, duration: 36 months.

This grant from “Rennes Métropole” has been obtained in June 2014 and supported the activities related to the use of drones (quadrotor UAVs). The platform described in Section 6.8.5 has been purchased in part thanks to this grant.

9.1.5. *“Allocation d'installation scientifique”*

Participant: Claudio Pacchierotti.

no CNRS Rennes 17C0487, duration: 36 months.

This grant from “Rennes Métropole” has been obtained in July 2017 and supported the activities related to the teleoperation of drones (quadrotor UAVs) using wearable haptics interfaces.

9.1.6. *IRT Jules Verne Mascot*

Participant: François Chaumette.

no Inria Rennes 10361, duration: 36 months.

This project started in October 2015. It is managed by IRT Jules Verne in Nantes and achieved in cooperation with LS2N, Airbus, Renault, Faurecia and Alstom. Its goal is to perform screwing for various industrial applications.

9.1.7. *IRT b<>com NeedleWare*

Participants: Hadrien Gurnel, Alexandre Krupa.

no Inria Rennes 9072, duration: 36 months.

This project started in October 2016. It supports Hadrien Gurnel's Ph.D. about the study of a shared control strategy fusing haptic and ultrasound visual control for assisting manual steering of needles for biopsy or therapy purposes in a synergetic way (see Section 7.3.4).

9.1.8. *Prisme*

Participants: Solenne Fortun, Marie Babel.

no Insa Rennes 9072, duration: 24 months.

This project started in January 2017 and is supported by Brittany region/BPI. This project aims at designing a fall prevention strategy based on the sensing collaboration of a smart wheelchair and a smart medical bed. Fall detection and automatic positioning of the wheelchair next to the bed issues are planned to be addressed (see Section 7.5.5).

9.2. National Initiatives

9.2.1. *France Life Imaging WP3-FLI ANFEET*

Participant: Alexandre Krupa.

duration: 24 months.

This project started in January 2016. Its objective is to initiate collaborative research with the ICube laboratory (Strasbourg) on the control and supervision of flexible endoscopes in the digestive tube using ultrasound images.

9.2.2. *ANR Contint Visioland*

Participants: Noël Mériaux, Pierre-Marie Kerzerho, Patrick Rives, François Chaumette.

no Inria Rennes 8304, duration: 48 months.

This project ended in October 2017. It involved a consortium managed by Onera in Toulouse with Airbus, Spikenet Technology, LS2N, and Lagadic. Its aim was to develop vision-based localization and navigation techniques for autonomous landing on a runway (see Section 7.1.4).

9.2.3. *ANR Contint Entracte*

Participant: Julien Pettré.

no Inria Rennes 8013, duration: 42 months.

This project ended in April 2017. It was realized in collaboration with the Gepetto group at Laas, Toulouse, and the Mimetic group at Irisa and Inria Rennes Bretagne Atlantique. It addressed the problem of motion planning for anthropomorphic systems, and more generally, the problem of manipulation path planning. Entracte proposed to study in parallel both the mathematical foundations of artificial motion and the neurocognitive structures used by humans to quickly solve motion problems.

9.2.4. *ANR JCJC Percolation*

Participant: Julien Pettré.

no Inria Rennes 7991, duration: 42 months.

The ANR "Jeune Chercheur" Percolation project ended on June 2017. It aimed at designing perception-based crowd simulation algorithms. We developed agents able of perceiving their virtual environment through virtual sensors, and able to navigate in it, as well as to interact with the other agents.

9.2.5. *ANR JCJC SenseFly*

Participants: Thomas Bellavoit, Muhammad Usman, Paolo Robuffo Giordano.

no Irisa CNRS 50476, duration: 36 months.

The ANR “Jeune Chercheur” SenseFly project started in August 2015. Its goal is to advance the state-of-the-art in multi-UAV in the design and implementation of fully decentralized and sensor-based group behaviors by only resorting to onboard sensing (mainly cameras and IMU) and local communication (e.g., Bluetooth communication, wireless networks). Topics such as individual flight control, formation control robust against sensor limitations (e.g., limited field of view, occlusions), distributed estimation of relative positions/bearings from local sensing, maintenance of architectural properties of a multi-UAV formation are studied in the project. Part of the platforms described in Section 6.8.5 has been purchased thanks to this grant.

9.2.6. ANR PLaTINUM

Participants: Eduardo Fernandez Moral, Vincent Drevelle, Patrick Rives.

no Inria Sophia 10204, duration: 42 months.

This project started in November 2015. It involves a consortium managed by Litis in Rouen with IGN Matis (Paris), Le2i (Le Creusot) and Lagadic group. It aims at proposing novel solutions to robust long-term mapping of urban environments.

9.2.7. BPI Romeo 2

Participants: Giovanni Claudio, Fabien Spindler, François Chaumette.

no Inria Rennes 7114, duration: 60 months.

This project ended in October 2017. It involved a large consortium managed by Softbank Robotics (ex Aldebaran Robotics) with Laas in Toulouse, Isir in Paris, Lirmm in Montpellier, Inria groups Lagadic, Bipop (Pierre-Brice Wieber), Flowers (Pierre-Yves Oudeyer), etc. It aimed at developing advanced control and perception functionalities to a humanoid robot. In this project, we developed visual manipulation and navigation tasks with Romeo and Pepper.

9.2.8. Equipex Robotex

Participants: Fabien Spindler, François Chaumette.

no Inria Rennes 6388, duration: 9 years.

Lagadic is one of the 15 French academic partners involved in the Equipex Robotex network that started in February 2011. It is devoted to get and manage significant equipment in the main robotics labs in France. In the scope of this project, we have got the humanoid robot Romeo (see Section 6.8.4).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. FP7 Space RemoveDEBRIS

Participants: Eric Marchand, François Chaumette.

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2018

Coordinator: University of Surrey (United Kingdom)

Partners: Surrey Satellite Technology (United Kingdom), Airbus (Toulouse, France and Bremen, Germany), Isis (Delft, The Netherlands), CSEM (Neuchâtel, Switzerland), Stellenbosch University (South Africa).

Inria contact: François Chaumette

Abstract: The goal of this project is to validate model-based tracking algorithms on images acquired during an actual space debris removal mission [22], [47].

9.3.1.2. H2020 ICT Comanoid

Participants: Giovanni Claudio, Souriya Trinh, Fabien Spindler, François Chaumette.

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programme: H2020

Duration: January 2015 - December 2018

Coordinator: CNRS (Lirmm)

Partners: Airbus Group (France), DLR (Germany), Università Degli Studi di Roma La Sapienza (Italy), CNRS (I3S)

Inria contact: Francois Chaumette

Comanoid investigates the deployment of robotic solutions in well-identified Airbus airliner assembly operations that are laborious or tedious for human workers and for which access is impossible for wheeled or rail-ported robotic platforms. As a solution to these constraints a humanoid robot is proposed to achieve the described tasks in real-use cases provided by Airbus Group. At a first glance, a humanoid robotic solution appears extremely risky, since the operations to be conducted are in highly constrained aircraft cavities with non-uniform (cargo) structures. Furthermore, these tight spaces are to be shared with human workers. Recent developments, however, in multi-contact planning and control suggest that this is a much more plausible solution than current alternatives such as a manipulator mounted on multi-legged base. Indeed, if humanoid robots can efficiently exploit their surroundings in order to support themselves during motion and manipulation, they can ensure balance and stability, move in non-gaited (acyclic) ways through narrow passages, and also increase operational forces by creating closed-kinematic chains. Bipedal robots are well suited to narrow environments specifically because they are able to perform manipulation using only small support areas. Moreover, the stability benefits of multi-legged robots that have larger support areas are largely lost when the manipulator must be brought close, or even beyond, the support borders. COMANOID aims at assessing clearly how far the state-of-the-art stands from such novel technologies. In particular the project focuses on implementing a real-world humanoid robotics solution using the best of research and innovation. The main challenge are to integrate current scientific and technological advances including multi-contact planning and control; advanced visual-haptic servoing; perception and localization; human-robot safety, and the operational efficiency of cobotics solutions in airliner manufacturing.

9.3.1.3. H2020 ICT Romans

Participants: Firas Abi Farraj, Fabien Spindler, François Chaumette, Claudio Pacchierotti, Paolo Robuffo Giordano.

Title: Robotic Manipulation for Nuclear Sort and Segregation

Programme: H2020

Duration: May 2015 - April 2018

Coordinator: University of Birmingham

Partners: NLL (UK), CEA (France), Univ. Darmstadt (Germany)

CNRS contact: Paolo Robuffo Giordano

The RoMaNS (Robotic Manipulation for Nuclear Sort and Segregation) project will advance the state of the art in mixed autonomy for tele-manipulation, to solve a challenging and safety-critical “sort and segregate” industrial problem, driven by urgent market and societal needs. Cleaning up the past half century of nuclear waste, in the UK alone (mostly at the Sellafield site), represents the largest environmental remediation project in the whole of Europe. Most EU countries face related challenges. Nuclear waste must be “sorted and segregated”, so that low-level waste is placed in low-level storage containers, rather than occupying extremely expensive and resource intensive high-level storage containers and facilities. Many older nuclear sites (>60 years in UK) contain large

numbers of legacy storage containers, some of which have contents of mixed contamination levels, and sometimes unknown contents. Several million of these legacy waste containers must now be cut open, investigated, and their contents sorted. This can only be done remotely using robots, because of the high levels of radioactive material. Current state-of-the-art practice in the industry, consists of simple tele-operation (e.g. by joystick or teach-pendant). Such an approach is not viable in the long-term, because it is prohibitively slow for processing the vast quantity of material required. The project aims at: 1) Develop novel hardware and software solutions for advanced bi-lateral master-slave tele-operation. 2) Develop advanced autonomy methods for highly adaptive automatic grasping and manipulation actions. 3) Combine autonomy and tele-operation methods using state-of-the-art understanding of mixed initiative planning, variable autonomy and shared control approaches. 4) Deliver a TRL 6 demonstration in an industrial plant-representative environment at the UK National Nuclear Lab Workington test facility.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. Interreg Adapt

Participants: Nicolas Le Borgne, Marie Babel.

Programme: Interreg VA France (Channel) England

Project acronym: Adapt

Project title: Assistive Devices for empowering disAbled People through robotic Technologies

Duration: 01/2017 - 06/2021

Coordinator: ESIGELEC/IRSEEM Rouen

Other partners: INSA Rennes - IRISA, LGCGM, IETR (France), Université de Picardie Jules Verne - MIS (France), Pôle Saint Hélier (France), CHU Rouen (France), Réseau Breizh PC (France), Ergovie (France), Pôle TES (France), University College of London - Aspire CREATE (UK), University of Kent (UK), East Kent Hospitals Univ NHS Found. Trust (UK), Health and Europe Centre (UK), Plymouth Hospitals NHS Trust (UK), Canterbury Christ Church University (UK), Kent Surrey Sussex Academic Health Science Network (UK), Cornwall Mobility Center (UK).

Abstract: This project aims to develop innovative assistive technologies in order to support the autonomy and to enhance the mobility of power wheelchair users with severe physical/cognitive disabilities. In particular, the objective is to design and evaluate a power wheelchair simulator as well as to design a multi-layer driving assistance system.

9.3.3. Collaborations with European Partners

9.3.3.1. ANR Opmops

Participants: Florian Berton, Julien Pettré.

Programme: ANR

Project acronym: Opmops

Project title: Organized Pedestrian Movement in Public Spaces: Preparation and Crisis Management of Urban Parades and Demonstration Marches with High Conflict Potential

Duration: June 2017 - June 2020

Coordinator: Université de Haute Alsace (for France), Technische Universität Kaiserslautern (for Germany)

Other partners: Gendarmerie Nationale, Hochschule München, ONHYS S.A.S, Polizei Rheinland-Pfalz, Universität Koblenz-Landau, VdS GmbH

Abstract: This project is about parades of highly controversial groups or of political demonstration marches are considered as a major threat to urban security. Due to the movement of the urban parades and demonstration marches (in the following abbreviated by UPM) through large parts of cities and the resulting space and time dynamics, it is particularly difficult for forces of civil security (abbreviated in the following by FCS) to guarantee safety at these types of urban events without endangering one of the most important indicators of a free society. In this proposal, partners representing the FCS (police and industry) will cooperate with researchers from academic institutions to develop a decision support tool which can help them both in the preparation phase and crisis management situations of UPMs. Specific technical issues which the French-German consortium will have to tackle include the following: Optimization methods to plan UPM routes, transportation to and from the UPM, location and personnel planning of FCS, control of UPMs using stationary and moving cameras, and simulation methods, including their visualization, with specific emphasis on social behavior.

9.3.3.2. *iProcess*

Participants: Agniva Sengupta, Fabien Spindler, Eric Marchand, Alexandre Krupa, François Chaumette.

Project acronym: i-Process

Project title: Innovative and Flexible Food Processing Technology in Norway

Duration: January 2016 - December 2019

Coordinator: Sintef (Norway)

Other partners: Nofima, Univ. of Stavanger, NMBU, NTNU (Norway), DTU (Denmark), KU Leuven (Belgium), and about 10 Norwegian companies.

Abstract: This project is granted by the Norwegian Government. Its main objective is to develop novel concepts and methods for flexible and sustainable food processing in Norway. In the scope of this project, the Lagadic group is involved for visual tracking and visual servoing of generic and potentially deformable objects (see Section 7.1.2). Prof. Ekrem Misimi from Sintef spent a 4-month visit from May 2017 and a 1-week visit in November 2017. François Chaumette and Alexandre Krupa spent a short period at Sintef in Trondheim in February and June 2017 respectively.

9.4. International Initiatives

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

9.4.1.1. *SIMS*

Title: Realistic and Efficient Simulation of Complex Systems

International Partners:

University of North Carolina at Chapel Hill (USA) - GAMMA Group - Ming C. Lin, Dinesh Manocha

University of Minnesota (USA) - Motion Lab - Stephen Guy

Brown University (USA) - VenLab - William Warren

Start year: 2012

See <http://people.rennes.inria.fr/Julien.Pettre/EASIMS/easims.html>

The general goal of SIMS is to make significant progress toward realistic and efficient simulation of highly complex systems, which raise combinatory explosive problems. This proposal is focused on human motion and interaction, and covers 3 active topics with wide application range:

1. Crowd simulation: virtual human interacting with other virtual humans,
2. Autonomous virtual humans interacting with their environment,
3. Physical simulation: real humans interacting with virtual environments.

SIMS is orthogonally structured by transversal questions: the evaluation of the level of realism reached by a simulation (which is a problem by itself in the considered topics), considering complex systems at various scales (micro, meso and macroscopic ones), and facing combinatory explosion of simulation algorithms.

9.4.1.2. ISI4NAVE

Title: Innovative Sensors and adapted Interfaces for assistive NAVigation and pathology Evaluation
International Partner (Institution - Laboratory - Researcher):

University College London (United Kingdom) - Aspire CREATE - Tom Carlson

Start year: 2016

See also: <http://www.irisa.fr/lagadic/team/MarieBabel/ISI4NAVE/ISI4NAVE.html>

The global ageing population, along with disability compensation constitutes major challenging societal and economic issues. In particular, achieving autonomy remains a fundamental need that contributes to the individual's wellness and well-being. In this context, innovative and smart technologies are designed to achieve independence while matching user's individual needs and desires.

Hence, designing a robotic assistive solution related to wheelchair navigation remains of major importance as soon as it compensates partial incapacities. This project then addresses the following two issues. First, the idea is to design an indoor / outdoor efficient obstacle avoidance system that respects the user intention, and does not alter user perception. This involves embedding innovative sensors to tackle the outdoor wheelchair navigation problem. The second objective is to take advantage of the proposed assistive tool to enhance the user Quality of Experience by means of biofeedback. Indeed, adapted interfaces should improve the understanding of people that suffer from cognitive and/or visual impairments.

The originality of the project is to continuously integrate medical validation as well as clinical trials during the scientific research work in order to match user needs and acceptance.

9.4.2. Participation in International Programs

9.4.2.1. ACRV

The Lagadic group is one of the five external partners of the Australian Center for Robotic Vision (see <http://roboticvision.org>). This center groups QUT in Brisbane, ANU in Canberra, Monash University and Adelaide University. In the scope of this project, Quentin Bateux received a grant to participate to the 2017 Robotic Vision Summer School in Kioloa (New South Wales) and spent a 1-week visit at QUT in March 2017.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Denis Wolf, Associate Professor at Univ. Sao Paulo, Brazil, spent a sabbatical year in Sophia Antipolis from July 2016 to August 2017. He worked on semantic learning applied to intelligent vehicles.
- Prof. Dan Zelazo (Technion) and Prof. Antonio Bicchi (Univ. Pisa) spent a short visit in the group in Rennes in 2017.

9.5.1.1. Internships

- Giuseppe Sirignano (Univ. Salerno), from October 2017 to March 2018
- Mario Selvaggio (Univ. Naples), from November 2017 till end of December 2017

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Jason Chevie spent a 3-month visit in Sarthak Misra's lab at the Surgical Robotics Laboratory (SRL) of University of Twente (Netherlands) where he performed robotic experiments in the scope of his Ph.D (see Section 7.3.2).
- François Chaumette was invited for a 1-week visit at Zhejiang University in November 2017.

LARSEN Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. SATELOR

Title: SATELOR

Program: AME Region Lorraine

Duration: September 2013 - September 2017

Coordinator: Diatelic

PI for Inria: François Charpillet

The Economic Mobilisation Agency in Lorraine has launched a new project Satelor providing it with 2.5 million Euros of funding over 3 years, out of an estimated total of 4.7 million. The leader of the project is Pharmagest-Diatelic. Pharmagest, in Nancy, is the French leader in computer systems for pharmacies, with a 43.5 % share of the market, 9,800 clients and more than 700 employees. Recently, the Pharmagest Group expanded its activities into e-health and the development of telemedicine applications. The Satelor project will accompany the partners of the project in developing services for maintaining safely elderly people with loss of autonomy at home or people with a chronic illness. Larsen team will play an important role for bringing some research results such as:

- developing a low cost environmental sensor for monitoring the daily activities of elderly people at home
- developing a low cost sensor for fall detection
- developing a low cost companion robot able to interact with people and monitoring their activities while detecting emergency situations.
- developing a general toolbox for data-fusion: Bayesian approach.

Publications: [16], [18]

9.1.2. Project *PsyPhIne: Cogitamus ergo sumus*

Title: Cogitamus ergo sumus

Program: PEPS CNRS

Duration: January 2016 - January 2018

Coordinator: MSH Lorraine (USR3261)

Larsen member: Amine Boumaza

This project gathers researchers from the following institutes: InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Inria Bordeaux Sud-Ouest, Loria (UMR7503). Refer to sec. 7.2.2.2 for the goals of the project.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. RESIBOTS

Title: Robots with animal-like resilience

Program: H2020

Type: ERC

Duration: May 2015 - April 2020

Coordinator: Inria

Inria contact: Jean Baptiste Mouret

Despite over 50 years of research in robotics, most existing robots are far from being as resilient as the simplest animals: they are fragile machines that easily stop functioning in difficult conditions. The goal of this proposal is to radically change this situation by providing the algorithmic foundations for low-cost robots that can autonomously recover from unforeseen damages in a few minutes. The current approach to fault tolerance is inherited from safety-critical systems (e.g. spaceships or nuclear plants). It is inappropriate for low-cost autonomous robots because it relies on diagnostic procedures, which require expensive proprioceptive sensors, and contingency plans, which cannot cover all the possible situations that an autonomous robot can encounter. It is here contended that trial-and-error learning algorithms provide an alternate approach that does not require diagnostic, nor pre-defined contingency plans. In this project, we will develop and study a novel family of such learning algorithms that make it possible for autonomous robots to quickly discover compensatory behaviors. We will thus shed a new light on one of the most fundamental questions of robotics: how can a robot be as adaptive as an animal? The techniques developed in this project will substantially increase the lifespan of robots without increasing their cost and open new research avenues for adaptive machines.

9.2.1.2. CODYCO

Title: Whole-body Compliant Dynamical Contacts for Humanoids

Programme: FP7

Type: ICT STREP (No. 600716)

Duration: March 2013 - February 2017

Coordinator: IIT

PI for Inria: Serena Ivaldi

The aim of CoDyCo was to improve the current control and cognitive understanding about robust, goal-directed whole-body motion interaction with multiple contacts. CoDyCo went beyond traditional approaches: proposing methodologies for performing coordinated interaction tasks with complex systems; combining planning and compliance to deal with predictable and unpredictable events and contacts; validating theoretical progresses in real-world interaction scenarios. CoDyCo advanced the state-of-the-art in the way robots coordinate physical interaction and physical mobility.

9.2.1.3. ANDY

Title: Advancing Anticipatory Behaviors in Dyadic Human-Robot Collaboration

Programme: H2020

Type: ICT RIA (No. 731540)

Duration: January 2017 - December 2020

Coordinator: IIT

PI for Inria: Serena Ivaldi

Recent technological progress permits robots to actively and safely share a common workspace with humans. Europe currently leads the robotic market for safety-certified robots, by enabling robots to react to unintentional contacts. AnDy leverages these technologies and strengthens European leadership by endowing robots with the ability to control physical collaboration through intentional interaction.

To achieve this interaction, AnDy relies on three technological and scientific breakthroughs. First, AnDy will innovate the way of measuring human whole-body motions by developing the wearable AnDySuit, which tracks motions and records forces. Second, AnDy will develop the AnDyModel, which combines ergonomic models with cognitive predictive models of human dynamic behavior

in collaborative tasks, which are learned from data acquired with the AnDySuit. Third, AnDy will propose the AnDyControl, an innovative technology for assisting humans through predictive physical control, based on AnDyModel.

By measuring and modeling human whole-body dynamics, AnDy provides robots with an entirely new level of awareness about human intentions and ergonomics. By incorporating this awareness online in the robot's controllers, AnDy paves the way for novel applications of physical human-robot collaboration in manufacturing, health-care, and assisted living.

AnDy will accelerate take-up and deployment in these domains by validating its progress in several realistic scenarios. In the first validation scenario, the robot is an industrial collaborative robot, which tailors its controllers to individual workers to improve ergonomics. In the second scenario, the robot is an assistive exoskeleton which optimizes human comfort by reducing physical stress. In the third validation scenario, the robot is a humanoid, which offers assistance to a human while maintaining the balance of both.

Partners: Italian Institute of Technology (IIT, Italy, coordinator), Josef Stefan Institute (JSI, Slovenia), DLR (Germany), IMK Automotive GmbH (Germany), XSens (Netherlands), AnyBody Technologies (Denmark)

9.3. International Research Visitors

9.3.1. Visits of International Scientists

9.3.1.1. Internships

- Waldez Azevedo Gomes Junior (Brazil) – from May 2017 to November 2017
- Kazuya Otani (USA, Carnegie Mellon) – from May 2017 to November 2017
- Kapil Sawant (India, BITS Pilani) – from July to December 2017
- Luigi Penco (Italy, La Sapienza University) – from October 2017 to February 2018

LEMON Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Cart'Eaux project (European Regional Development Fund (ERDF)): in partnership with colleagues of LIRMM and HSM (Montpellier) and with Berger-Levrault company, Carole DELENNE and Benjamin COMMANDRE are developing a methodology that will collect and merge multi-sources data in the aim of mapping urban drainage networks for hydraulic modeling purpose. This chain of treatment includes: i) detection of manhole covers from remote sensing data (aerial images, numerical elevation models...), 2) development of an algorithm to retrieve the network from the detected points and other information such as roads or topography, 3) data manning to extract useful characteristics for the hydraulic model, from various databases available or from documents automatically gathered from the web. A confidence index will be given to each characteristic assessed and a sensitivity analysis will enable the software to propose a hydraulic model together with an associated uncertainty.

The GeRIMU project (Gestion du Risque d'Inondation en Milieu Urbain) will be based on the SW2D computational code. The purpose is to optimize and implement the commercial version of the code into a complete software chain for the forecasting and scenario appraisal for rainfall-generated urban floods on the scale of the urban area. The test and application site is the entire urban area of Montpellier.

7.2. National Initiatives

7.2.1. ANR

Antoine ROUSSEAU is member of the ANR project ANSWER (PI Céline Casenave), 2016-2019

7.2.2. LEFE-INSU

Gwladys TOULEMONDE is head of a project (2016-2018) funded by INSU via the action MANU (Mathematical and NUMerical methods) of the LEFE program. This project, called Cerise, aims to propose methods for simulating scenarii integrating spatio-temporal extremes fields with eventual asymptotic independence for impact studies in environmental sciences.

7.3. International Initiatives

7.3.1. Inria International Labs

Antoine ROUSSEAU collaborates with Inria Chile through the partnership with **MERIC** in Chile. Two visits every year.

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

7.3.2.1. NEMOLOCO

Title: NEw MOdeLing tOols for Coastal Oceanography

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (Chile) - CIGIDEN - Rodrigo Cienfuegos

Start year: 2017

See also: <https://team.inria.fr/lemon/en/>

The NEMOLOCO project targets the improvement of models in the coastal zone. Expected contributions concern: - design and implementation of domain decomposition and coupling techniques for coastal modeling - high resolution ocean simulation (including nesting) thanks to the software ROMS-CROCO, applied to biological tracers tracking.

7.3.3. Inria International Partners

7.3.3.1. Declared Inria International Partners

In 2015, the *Marine Energies Research International Center* (MERIC) was launched in Chile by CORFO. Antoine ROUSSEAU is the scientific coordinator for Inria, and several members of LEMON, CARDAMOM and TOSCA research teams will be involved in this 8 years project driven by DCNS. Antoine ROUSSEAU and Fabien MARCHE are involved in the research line *advanced modeling for marine energy*.

7.3.3.2. Informal International Partners

Vincent GUINOT collaborates with B.F. Sanders (Irvine University, Californie, USA)

Carole DELENNE and Vincent GUINOT collaborates with S. Soares-Fraza (Unité de Génie Civil, Université catholique de Louvain, Belgium)

7.3.4. Participation in Other International Programs

Antoine ROUSSEAU was member of a successful application to the REDES (Conicyt, Chile) program with H. Ramirez (CMM, Santiago) and P. Gajardo (UTFSM, Valparaiso).

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Andres Sepulveda (Univ Concepcion, Chile) visited the team in the framework of the CROCO summer school organized in Toulouse by the AIRSEA project-team.

José Galaz (PUC Santiago, Chile) visited Montpellier for one week.

7.4.1.1. Internships

Joao CALDAS (Ecole des Ponts, Ecole Polytechnique de Sao Paulo) was intern at Inria Chile / MERIC, advised by A. Rousseau.

LFANT Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Alambic – AppLicAtions of MalleaBIlity in Cryptography

Participant: Guilhem Castagnos.

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

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

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

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

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

Title: OpenDreamKit

Program: H2020

Duration: January 2016 - December 2020

Coordinator: Nicolas Thiéry

Inria contact: Karim Belabas

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

OpenDreamKit is a Horizon 2020 European Research Infrastructure project (#676541) that will run for four years, starting from September 2015. It provides substantial funding to the open source computational mathematics ecosystem, and in particular popular tools such as LinBox, MPIR, SageMath, GAP, Pari/GP, LMFDB, Singular, MathHub, and the IPython/Jupyter interactive computing environment.

7.3. International Initiatives

7.3.1. Inria International Labs

7.3.1.1. FAST

Title: (Harder Better) FAster STronger cryptography

International Partner

Université des Sciences et Techniques de Masuku (Gabon) - Tony Ezome and the PRMAIS project

Start year: 2017

See also: <https://www.inria.fr/en/associate-team/fast>

The project aims to develop better algorithms for elliptic curve cryptography with prospect of the two challenges ahead: - securing the internet of things - preparing towards quantum computers.

Elliptic curves are currently the fastest public-key cryptosystem (with a key size that can fit on embedded devices) while still through a different mode of operation being (possibly) able to resist quantum based computers.

Activities for this year involved the funding of Luca De Feo to speak at the EMA “Mathématiques pour la Cryptographie Post-quantique et Mathématiques pour le Traitement du Signal”, organised by Djiby Sow and Abdoul Asiz Ciss organised an EMA at the École Polytechnique de Thiès (Sénégal) from May 10 to May 23, about “Cryptographie à base d’isogénies”; the visit of Abdoulaye Maiga to the LFANT team where he worked with Damien Robert to find absolute invariants of good reduction modulo 2 for abelian surfaces; and the organisation by Damien Robert of a workshop in Bordeaux with most of the team members from September 04 to September 08. The slides or proceedings are available at <https://lfant.math.u-bordeaux.fr/index.php?category=seminar&page=2017>.

7.3.2. Inria International Partners**7.3.2.1. Informal International Partners**

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

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

7.4. International Research Visitors**7.4.1. Visits of International Scientists**

Researchers visiting the team to give a talk to the team seminar include Damien Stehlé (ENS Lyon), Cécile Pierrot (Centrum Wiskunde and Informatica, Amsterdam), Christophe Petit (Oxford), Benjamin Wesolowski (EPFL), Bernhard Schmidt (Nanyang Technological University, Singapore), Mohamadou Sall (Université Cheikh Anta Diop, Dakar, Sénégal), Emmanuel Fouotsa (The University of Bamenda, Cameroon), Abdoulaye Maiga (Université Cheikh Anta Diop, Dakar, Sénégal), Tony Ezome (Université des Sciences et Techniques de Masuku (USTM), Franceville, Gabon), Abdoul Aziz Ciss (Université Cheikh Anta Diop, Dakar, Sénégal), José Manuel Rodriguez Caballero (Labri), Jean Kieffer (ENS Paris), Christian Klein (Institut de Mathématiques de Bourgogne), Frank Vallentin (Mathematisches Institut, Universität zu Köln).

7.4.2. Visits to International Teams

Jared Asuncion went to the Autumn school: Topics in arithmetic and algebraic geometry last 9 - 13 October 2017 at the University of Mainz in Mainz, Germany.

Jared Asuncion went to see his cosupervisor, Marco String last 6 - 10 November 2017 at the Universiteit Leiden in Leiden, The Netherlands. It is planned to stay in Leiden for a period of six months while working on his PhD.

Jared Asuncion went to the 21st Workshop on Elliptic Curve Cryptography last 13 - 15 November 2017 at the Radboud University in Nijmegen, The Netherlands.

A. Page visited C. Maire in Cornell University (Ithaca, US) from November 27th to December 4th and gave a research talk there on December 1st. He then visited Michael Lipnowski in the Institute for Advanced Studies (Princeton, US) from December 4th to December 14th.

A. Enge visited Bernhard Schmidt in Nanyang Technological University, Singapore for three weeks.

Fredrik Johansson participated in the OSCAR: Antic workshop at TU Kaiserslautern, Germany and gave an invited talk on "Fundamental algorithms in Arb".

Fredrik Johansson participated in the workshop on Elliptic Integrals, Elliptic Functions and Modular Forms in Quantum Field Theory at DESY, Zeuthen, Germany, and gave an invited talk on "Numerics of classical elliptic functions, elliptic integrals and modular forms".

LIFEWARE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

- ANR-MOST **BIOPSY** (2016-2020) on “Biochemical Programming System”, coordinated by F. Molina (CNRS, Sys2diag, Montpellier) and J.H. Jiang (National Taiwan University), with F. Fages.
- ANR **MEMIP** (2016-2020) on “Mixed-Effects Models of Intracellular Processes”, coordinated by G. Batt, with P. Hersen, (CNRS/Paris7), E. Cinquemani (Inria EPI IBIS) and M. Lavielle (Inria/CNRS/Polytechnique, EPI XPOP).
- ANR **COGEX** (2016-2019) on “Computer Aided Control of Gene Expression” coordinated by P. Hersen (MSC lab, CNRS/Paris7), with G. Batt and G. Truan (LISBP, CNRS/INSA).
- ANR Blanc **HYCLOCK** (2014-2018) on “Hybrid modeling of time for Circadian Clock Biology and Chronopharmacology”, coordinated by F. Delaunay (CNRS, Nice), with F. Lévi (INSERM Paris-Sud), G. Bernot (CNRS I3S, Nice), O. Roux (Ecole Centrale Nantes), F. Fages and S. Soliman.
- ANR Blanc **STOCH-MC** (2014-2018) on “Stochastic Models: Scalable Model Checking”, coordinated by Blaise Genest (Inria Rennes), with Grégory Batt, Wieslaw Zielonka (LIAFA), and Hugo Gimbert (LaBRI).
- ANR Investissement Avenir **ICEBERG** project (2011-2017) “From population models to model populations”, coordinated by Grégory Batt, with Pascal Hersen (MSC lab, Paris Diderot Univ./CNRS), Reiner Veitia (Institut Jacques Monod, Paris Diderot Univ./CNRS), Olivier Gandrillon (BM2A lab, Lyon Univ./CNRS), Cédric Lhoussaine (LIFL/CNRS), and Jean Krivine (PPS lab, Paris Diderot Univ./CNRS).

8.1.2. Inria Project Lab

- IPL **COSY** (2017-2021) “real-time control of synthetic microbial communities”, coordinated by Eugenio Cinquemani (Ibis, Inria), with Jean-Luc Gouzé (Biocore, Inria), Gregory Batt, Frédéric Bonnans (Commands, Inria), Efimov Denis (Non-A, Inria), and Hans Geiselmann (BIOP, Université Grenoble-Alpes), Beatrice Laroche (Maiaage, Inra Jouy-en-Josas), and Hyun Youk (Youk lab, TU Delft).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- H2020 FET-OPEN **COSY-BIO** (2017-2020), “Control Engineering of Biological Systems for Reliable Synthetic Biology Applications”, coordinated by Diego di Bernardo (Tigem), with Filippo Menolascina (Edinburgh U), Mario di Bernardo (Naples U), Pascal Hersen (Paris7 U), Mustafa Khammash (ETHZ), Gregory Batt, Guy-Bart Stan (Imperial College), and Lucia Marucci (Bristol U).

8.3. International Initiatives

8.3.1. Participation in International Programs

- French-German PROCOPE (2015-2017) grant on “Réduction de modèle et analyse de grands réseaux biochimiques par des méthodes stoechiométriques et tropicales”, coord. Prof. Andreas Weber, University of Bonn, Germany, and Prof. Ovidiu Radulescu, Univ. Montpellier, France.

LINKMEDIA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CominLabs Project Linking Media in Acceptable Hypergraphs (LIMAH)

Participants: Rémi Bois, Vincent Claveau, Guillaume Gravier, Pascale Sébillot, Arnaud Touboullic.

Duration: 4 years, started in April 2014

Partners: Telecom Bretagne (IODE), Univ. Rennes II (CRPCC, PREFics), Univ. Nantes (LINA/TAL)

URL: <http://limah.irisa.fr>

LIMAH aims at exploring hypergraph structures for multimedia collections, instantiating actual links reflecting particular content-based proximity—similar content, thematic proximity, opinion expressed, answer to a question, etc. Exploiting and developing further techniques targeting pairwise comparison of multimedia contents from an NLP perspective, LIMAH addresses two key issues: How to automatically build from a collection of documents an hypergraph, i.e., a graph combining edges of different natures, which provides exploitable links in selected use cases? How collections with explicit links modify usage of multimedia data in all aspects, from a technology point of view as well as from a user point of view? LIMAH studies hypergraph authoring and acceptability taking a multidisciplinary approach mixing ICT, law, information and communication science as well as cognitive and ergonomics psychology.

9.1.2. CominLabs Project BigCLIN

Participants: Vincent Claveau, Ewa Kijak, Clément Dalloux.

Duration: 3 years, started in September 2016

Partners: STL-CNRS, Inserm/CHU Rennes, Inria

URL: <http://www.bigclin.cominlabs.ueb.eu>

Data collected or produced during clinical care process can be exploited at different levels and across different domains. Yet, a well-known challenge for secondary use of health big data is that much of detailed patient information is embedded in narrative text, mostly stored as unstructured data. The project proposes to address the essential needs when reusing unstructured clinical data at a large scale. We propose to develop new clinical records representation relying on fine-grained semantic annotation thanks to new NLP tools dedicated to French clinical narratives. To efficiently map this added semantic information to existing structured data for further analysis at big scale, the project also addresses distributed systems issues: scalability, management of uncertain data and privacy, stream processing at runtime, etc.

9.2. National Initiatives

9.2.1. ANR Project IDFRAud

Participant: Teddy Furon.

Duration: 3 years, started in Feb. 2015

Partners: AriadNext, IRCGN, École Nationale Supérieure de Police

The IDFRAud project consists in proposing an automatic solution for ID analysis and integrity verification. Our ID analysis goes through three processes: classification, text extraction and ID verification. The three processes rely on a set of rules that are externalized in formal manner in order to allow easy management and evolving capabilities. This leads us to the ID knowledge management module. Finally, IDFRAud addresses the forensic link detection problem and to propose an automatic analysis engine that can be continuously applied on the detected fraud ID database. Cluster analysis methods are used to discover relations between false IDs in their multidimensional feature space. This pattern extraction module will be coupled with a suitable visualization mechanism in order to facilitate the comprehension and the analysis of extracted groups of inter-linked fraud cases.

9.2.2. *FUI 19 NexGenTV*

Participants: Vincent Claveau, Guillaume Gravier, Ewa Kijak, Gabriel Sargent, Ronan Sicre.

Duration: 2.5 years, started in May 2015

Partners: Eurecom, Avisto Telecom, Wildmoka, Envivio-Ericsson

Television is undergoing a revolution, moving from the TV screen to multiple screens. Today's user watches TV and, at the same time, browses the web on a tablet, sends SMS, posts comments on social networks, searches for complementary information on the program, etc. Facing this situation, NexGen-TV aims at developing a generic solution for the enrichment, the linking and the retrieval of video content targeting the cost-cutting edition of second screen and multiscreen applications for broadcast TV. The main outcome of the project will be a software platform to aggregate and distribute video content via a second-screen edition interface connected to social media. The curation interface will primarily make use of multimedia and social media content segmentation, description, linking and retrieval. Multiscreen applications will be developed on various domains, e.g., sports, news.

9.2.3. *Inria Project Lab Knowledge-driven data and content collaborative analytics (iCODA)*

Participants: Laurent Amsaleg, Vincent Claveau, Cheikh Brahim El Vaigh, Guillaume Gravier, Pascale Sébillot.

Duration: 4.5 years, started in April 2017

Partners: Inria project-teams Linkmedia, CEDAR, GraphIK and ILDA, with Ouest France, Le Monde and AFP

One of today's major issues in data science is the design of algorithms that allow analysts to efficiently infer useful information and knowledge by collaboratively inspecting heterogeneous information sources, from structured data to unstructured content. Taking data journalism as an emblematic use-case, the goal of the project is to develop the scientific and technological foundations for knowledge-mediated user-in-the-loop collaborative data analytics on heterogeneous information sources, and to demonstrate the effectiveness of the approach in realistic, high-visibility use-cases. The project stands at the crossroad of multiple research fields—content analysis, data management, knowledge representation, visualization—that span multiple Inria themes, and counts on a club of major press partners to define usage scenarios, provide data and demonstrate achievements.

9.3. European Initiatives

9.3.1. *CHIST ERA ID_IOT*

Participant: Teddy Furon.

Duration: 3 years, started in Oct. 2016

Partners: Eindhoven Univ. of Technology, Univ. of Geneva

The IoT will contain a huge number of devices and objects that have very low or nonexistent processing and communication resources, coupled to a small number of high-power devices. The weakest devices, which are most ubiquitous, will not be able to authenticate themselves using cryptographic methods. This project addresses these issues using physical unclonable functions (PUFs). PUFs, and especially quantum readout PUFs, are ideally suited to the IoT setting because they allow for the authentication and identification of physical objects without requiring any crypto or storage of secret information.

Furthermore, we foresee that back-end systems will not be able to provide security and privacy via cryptographic primitives due to the sheer number of IoT devices. Our plan is to address these problems using privacy-preserving database structures and algorithms with good scaling behaviour. Approximate nearest neighbour (ANN) search algorithms, which have remarkably good scaling behaviour, have recently become highly efficient, but do not yet have the right security properties and have not yet been applied to PUF data. Summarised in a nutshell, the project aims to improve the theory and practice of technologies such as PUFs and ANN search in the context of generic IoT authentication and identification scenarios.

9.3.2. Collaborations with Major European Organizations

Big Data Value Association (BDVA): LINKMEDIA is a co-founder and co-leader of the media group (TF7) within BDVA

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- National Institute for Informatics, Japan
- University of Amsterdam, The Netherlands
- Czech Technical University, Czech Republic
- Katholieke Universiteit Leuven, Belgium

9.4.2. Participation in Other International Programs

- CNRS – CONFAP FIGTEM
 - Title: Fine-grained text-mining for clinical trials
 - International Partner (Institution - Laboratory - Researcher): Pontifícia Universidade Católica do Paraná - Health Informatics dept, Claudia Moro

FIGTEM aims at developing natural language processing methods, including information extraction and indexing, dedicated to the clinical trial domain. The goal is to populate a formal representation of patients (via their electronic patient records) and clinical trial data in different languages (French, English, Portuguese).
 - Jan. 2016 – Dec. 2018

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Giorgos Tolias

Date: Sept. 2017 (1 week)

Institution: Czech Technical University, Czech Republic

Vincent Oria

Date: July 2017 (2 weeks)

Institution: New Jersey Institute of Technology, Newark, USA

Michael Houle

Date: July 2017 (2 weeks)

Institution: National Institute of Informatics, Tokyo, Japan

9.5.1.1. Internships

Gabriel B. de Fonseca

Date: Nov. 2016 - Jan. 2017

Institution: PUC Minas, Brazil

9.5.2. Visits to International Teams

Laurent Amsaleg

Date: Oct. 2017 (2 days)

Institution: New Jersey Institute of Technology, Newark, USA

Laurent Amsaleg

Date: May. 2017 (1 week)

Institution: East China Normal University, Shanghai, PRC

Clément Dalloux

Date: Nov.-Dec 2017 (1 month)

Institution: Pontifícia Universidade Católica do Paraná, Brazil

Guillaume Gravier

Date: Nov. 2017 (1 week)

Institution: Universidad de Chile, Santiago, Chile

Guillaume Gravier

Date: May. 2017 (1 week)

Institution: East China Normal University, Shanghai, PRC

LINKS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

ANR Aggreg (2014-19): Aggregated Queries.

- Participants: J. Niehren [correspondent], P. Bourhis, A. Lemay, A. Boiret
- The coordinator is J. Niehren and the partners are the University Paris 7 (A. Durand) including members of the Inria project DAHU (L. Ségoufin), the University of Marseille (N. Creignou) and University of Caen (E. Grandjean).
- Objective: the main goal of the Aggreg project is to develop efficient algorithms and to study the complexity of answering aggregate queries for databases and data streams of various kinds.

ANR Colis (2015-20): Correctness of Linux Scripts.

- Participants: J. Niehren [correspondent], A. Lemay, S. Tison, A. Boiret, V. Hugot, N. Bacquey, P. Gallot, S. Salvati.
- The coordinator is R. Treinen from the University of Paris 7 and the other partner is the Tocata project of Inria Saclay (C. Marché).
- Objective: This project aims at verifying the correctness of transformations on data trees defined by shell scripts for Linux software installation. The data trees here are the instance of the file system which are changed by installation scripts.

ANR DataCert (2015-20):

- Participants: I. Boneva [correspondent], S. Tison, J. Lozano.
- Partners: The coordinator is E. Contejean from the University of Paris Sud and the other partner is the University of Lyon.
- Objective: the main goals of the Datacert project are to provide deep specification in Coq of algorithms for data integration and exchange and of algorithms for enforcing security policies, as well as to design data integration methods for data models beyond the relational data model.

ANR Headwork (2016-21):

- Participants: P. Bourhis [correspondant], J. Niehren, M. Sakho.
- Scientific partners: The coordinateur is D. Gross-Amblard from the Druid Team (Rennes 1). Other partners include the Dahu team (Inria Saclay) and Sumo (Inria Bretagne)
- Industrial partners: Spipoll, and Foulefactory.
- Objective: The main object is to develop data-centric workflows for programming crowd sourcing systems in flexible declarative manner. The problem of crowd sourcing systems is to fill a database with knowledge gathered by thousands or more human participants. A particular focus is to be put on the aspects of data uncertainty and for the representation of user expertise.

ANR Delta (2016-21):

- Participants: J. Niehren, P. Bourhis [correspondent], S. Salvati, N. Bacquey, D. Gallois.
- Partners: The coordinator is M. Zeitoun from LaBRI, other partners are LIF (Marseille) and IRIF (Paris-Diderot).
- Objective: Delta is focused on the study of logic, transducers and automata. In particular, it aims at extending classical framework to handle input/output, quantities and data.

ANR Bravas (2017-22):

- Participants: S. Salvati [correspondent]
- Scientific Partners: The coordinator is Jérôme Leroux from LaBRI, University of Bordeaux. The other partner is LSV, ENS Cachan.
- Objective: The goal of the BraVAS project is to develop a new and powerful approach to decide the reachability problems for Vector Addition Systems (VAS) extensions and to analyze their complexity. The ambition here is to crack with a single hammer (ideals over well-orders) several long-lasting open problems that have all been identified as a barrier in different areas, but that are in fact closely related when seen as reachability.

8.2. European Initiatives

Edinburgh-Links exchange projet funded by the University of Lille. The coordiator is Slawek Staworko.

Lille-Oxford cooperation project funded by the University of Lille. Links' contact is Pierre Bourhis.

8.3. International Initiatives

8.3.1. Inria International Partners

Niehren and Bourhis continue to cooperate with Domagoy Vrgoc from the University of Satiago di Chile, also after the end of the AMSud project.

M3DISIM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

ANR METIS(ANR-13-BS09-0004-02). Title: “Mechanics of Tissues: multiscale structural approach of Ehlers-Danlos Syndrome”. Involved research groups: LMS (Ecole Polytechnique, CNRS, Mines ParisTech, PI: Jean-Marc ALLAIN), LOB - Optics and Biosciences Laboratory (Ecole Polytechnique, CNRS, INSERM), IGFL - Institut de Génétique Fonctionnelle de Lyon (ENS Lyon, Université Lyon 1, CNRS, INRA). Total amount of the grant: 200k€ for the team. The METIS project is dedicated to the study of the biomechanics of connective tissues. Soft connective tissues such as skin, tendon or cornea are made of more than 90% of extracellular matrix proteins, fibrillar collagens being by far the predominant component. The rationale of this project is to understand the link between the microstructure of connective tissues and their macroscopic mechanical properties. To achieve this, observations of the fibrillar collagen will be done at different levels of stretch, while recording the mechanical properties. The consequences of change in the microstructure will also be explored through mutants mimicking the Ehler-Danlos syndrome, but also aging or wound-healing experiments. The project was completed on September 30th 2017 (4 years project).

9.1.2. Other funding

IPM-MS project (for Imagerie Polarimétrique de Mueller pour la réalisation d’un système original de caractérisation des propriétés mécaniques des Matériaux Structurés). 50k€ funded by the LABEX Lasips. This project, which involves the LPICM laboratory (Ecole Polytechnique, CNRS), the LMS (Ecole Polytechnique, CNRS, Mines ParisTech) and the Centre des Matériaux (Mines ParisTech), aims at developing an optical tool to study the link between the mechanical properties of a material and its hierarchical organization. Despite the development of new methods to observe the microstructure, one of the limitations is the number of observations that can be obtained on a given sample in a realistic experimental time. To overcome this difficulty, we are planning to use the Mueller polarimetry to obtain at a fast rate (a few frames per second, compared to a few frames per half-hour) relevant information on the local anisotropy of biological (heart, skin) and composite (short fibers composite) samples.

G. Bureau, software engineer in the team, is funded by an Inria Reo industrial contract with Kephalios, a startup working on innovative artificial valves devices.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. VP2HF

Title: Computer model derived indices for optimal patient-specific treatment selection and planning in Heart Failure

Programm: FP7

Duration: October 2013 - March 2017

Coordinator: King’s College London (UK)

Inria contact: Dominique Chapelle

Abstract: Heart failure (HF) is one of the major health issues in Europe affecting 6 million patients and growing substantially because of the aging population and improving survival following myocardial infarction. The poor short to medium term prognosis of these patients means that treatments such as cardiac re-synchronisation therapy and mitral valve repair can have substantial impact. However, these therapies are ineffective in up to 50% of the treated patients and involve significant morbidity and substantial cost. The primary aim of VP2HF is to bring together image and data processing tools with statistical and integrated biophysical models mainly developed in previous VPH projects, into a single clinical workflow to improve therapy selection and treatment optimisation in HF.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

We have started a collaboration with the University of Texas Southwestern Medical Center in Dallas. A joint PhD student based at Inria and funded by UTSW is starting in October 2017. An associated team proposal has been submitted in October 2017.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. PhD exchange program

J. Albella, PhD student at University of Santiago de Compostela, has spent 3 months in M3DISIM, working with S. Imperiale on numerical methods for elastodynamics wave propagation.

E. Bertoberoglu, PhD Student at ETH Zurich, has spent multiple weeks in M3DISIM to work with M. Genet on computational models of growth and remodeling of the heart, validated on MRI data acquired at ETH Zurich.

MADYNES Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. 6PO Research Region Lorraine and UL project

Participants: Emmanuel Nataf, Ye-Qiong Song, Laurent Ciarletta [contact].

Funded by Region Lorraine and Université de Lorraine since 2013. Adel Belkadi (CRAN & LORIA) is co-directed by L. Ciarletta and Didier Theilliol (CRAN correspondant).

6PO (“Systèmes Cyber-Physiques et Commande Coopérative Sûre de Fonctionnement pour une Flotte de Véhicules sans Pilote”) is a joint research project between the Loria and CRAN laboratories. As a part of the Aetournos ecosystem, it also aims at researching solutions for safe formation flying of collaborative UAVs seen as part of a collection of Cyber Physical Systems mixing computer science and automation solutions.

It is reinforced by a PhD grant from this federation that started in october 2014 (*Conception de méthodes de diagnostic et de tolérance aux fautes des systèmes multi-agents: Application à une flotte de véhicules autonomes*, Adel Belkadi) and has been successfully defended in october 2017.

This led to common publications, notably on the subjects of the robust control of a fleet or flock of UAVs (with or without leader, using agents paradigms and particle swarm optimisation [10] and [31]).

The project provides common use cases and scientific challenges that serve as catalysts for collaboration between teams from different research topics :

- Cyber Physical Systems, Real Time, Quality of service, Performance and Energy in Wireless Sensors and Activator Networks
- Collaborative, communicating autonomous systems and Unmanned Vehicles
- Safety, Dependability, Reliability, Diagnosis, Fault-Tolerance

9.1.2. Hydradrone FEDER Région Lorraine project

Participants: Zhixiang Liu, Laurent Ciarletta [contact].

Feder funding

The Madynes team has been working on the Hydradrone project since July 2014. It started as a collaborative R&D initiative funded by *Région Lorraine* and is now FEDER funded. This project started as a joint work between Madynes and PEMA (*Pedon Environnement et Milieux Aquatiques*), an SME/VSE (small and medium size Entreprise, PME/TPE). The consortium now includes Alerion another VSE, a spinoff from Loria/UL.

It consists in developing a new solution for the surveillance of aquatic environment, the Hydradrone:

- starting with an actual need for automated and remote operation of environmental sensing expressed by PEMA
- based on an hybrid UxV (Unmanned Air, Surface... Vehicle),
- some Cyber Physical bricks in coherence with the Alerion’s concepts (ease of use, safety, autonomy)
- and an integration in the Information System of the company

PEMA, as an environmental company, provides the use cases and terrain (and business) validation, while Alerion is working on the integration and engineering of the solution.

This third year has been dedicated to the development of the surface controller for the Hydradrones along with the development of a new small version, and the integration of environmental sensors. The project has been extended towards the summer 2018 in order to finish the integration and tests.

9.1.3. Satelor AME Lorraine regional project

Participants: François Despaux, Bernardetta Addis, Evangelia Tsiontsiou, Ye-Qiong Song [contact].

The Madynes team is involved in Satelor, a regional research and development project funded by the AME (Agence de Mobilisation Economique) of Lorraine (October 2013 – September 2017). The consortium includes academic (Univ. of Lorraine, Inria), medical (OHS) and industrial (Diatelic-Pharmagest (lead), ACS, Kapelse, Salendra, Neolinks) partners. It aims at developing innovative and easily deployable ambient assisted living solutions for their effective use in the tele-homecare systems. The Madynes team is mainly involved in the data collection system development based on wireless sensors networks and IoT technology. The first topic consists in defining the basic functions of the future SATEBOX – a gateway box for interconnecting in-home sensors to the medical datacenter, based on our previously developed MPIGate software. A beta-version prototype of the future Satebox gateway has been achieved. It now includes Zigbee wireless sensors, EnOcean battery-free sensors and Bluetooth Low Energy sensors. It provides a low-cost and easily deployable solution for the daily activity monitoring. After its first real-world deployment at a OHS hospital room, a second prototype testbed has been realized at one EHPAD including several rooms. The second topic is related to improve the data transfer reliability while still keep minimum energy consumption. This has led us to focus on the multi-hop mesh network topology with multi-constrained QoS routing problem (PhD thesis of Evangelia Tsiontsiou). The third topic is UWB-based indoor localization and its use for tracking and detecting falls of the elderlies. Experiments have shown a great benefice of multi-sensor fusion (e.g. localization + accelerometer) for increasing the detection accuracy.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR BottleNet

Participants: Isabelle Chrisment [contact], Thibault Cholez, Vassili Rivron.

The Quality of Experience (QoE) when accessing the Internet, on which more and more human activities depend on, is a key factor for today's society. The complexity of Internet services and of user's local connectivity has grown dramatically in the last years with the proliferation of proxies and caches at the core and access technologies at the edge (home wireless and 3G/4G access), making it difficult to diagnose the root cause of performance bottlenecks. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure end-to-end Internet QoE and to diagnose the cause of experienced issues. The result can then be used by users, network and service operators or regulators to improve the QoE.

The ANR BottleNet project (<https://project.inria.fr/bottlenet>) started in February 2016. It involves many partners in the field of computer networks and QoE: Inria Muse and Diana teams, Lille1 University, Telecom Sud-Paris, Orange, IP-Label. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet QoE and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users' devices. We plan to collect network and application performance metrics directly at users' devices and correlate them with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

9.2.1.2. ANR Doctor

Participants: Thibault Cholez [contact], Xavier Marchal, Daishi Kondo, Olivier Festor.

The DOCTOR project <http://www.doctor-project.org> is an applied research project funded by the French National Research Agency (ANR), grant <ANR-14-CE28-000>, and supported by the French Systematic cluster. The project started on December 2014 for three years plus one year of extension (2018) to align the scientific production with the budget consumption. It involves five partners specialized in network monitoring and security: Orange Labs (lead), Thales, Montimage, Université de technologie de Troyes and LORIA/CNRS. The DOCTOR project advocates the use of virtualized network equipment (Network Functions Virtualization), to enable the co-existence of new Information-Centric Networking stacks (e.g.: Named-Data Networking) with IP, and the progressive migration of traffic from one stack to the other while guaranteeing the good security and manageability of the network. Therefore in DOCTOR, the main goals of the project are: (1) the efficient deployment of NDN as a virtualized networking environment; (2) the monitoring and security of this virtualized NDN stack.

This year, we focused on the second workpackage dedicated to security. We did a joint work with UTT investigating the impact on the Content Poisoning Attack on the NDN architecture [21]. We also wrote a book chapter about our use of NDN and NFV technologies to deploy an NDN network while providing advanced monitoring and security functions [35].

We also improved our HTTP/NDN gateway that will be soon released for the community and which design and evaluation will be submitted in a journal.

The next (and last) year of the project will be dedicated to the orchestration of our virtualized NDN architecture to manage its performance and security, and to the deployment of a testbed carrying real user traffic.

9.2.1.3. FUI HUMA (01/09/2015-31/08/2018)

Participants: Giulia de Santis, Soline Blanc, Sofiane Lagraa, Jérôme François [contact], Abdelkader Lahmadi, Isabelle Chrisment.

The HUMA project (*L'HUmain au cœur de l'analyse de données MAssives pour la sécurité*) is funded under the national FUI Framework (Fonds Unique Interministeriel) jointly by the BPI (Banque Publique d'Investissement) and the Région Lorraine. It has been approved by two competitive clusters: Systematic and Imaginove. The consortium is composed of three academic (ICube, Citi, Inria) and five industrial (Airbus Defence and Space, Intrinsec, Oberthur, Wallix, Sydo) partners. The leader is Intrinsec.

This project targets the analysis of Advanced Persistent Threat. APT are long and complex attacks which thus cannot be captured with standard techniques focused on short time windows and few data sources. Indeed, APTs may last for several months and involve multiple steps with different types of attacks and approaches. The project will address such an issue by leveraging data analytics and visualization techniques to guide human experts, which are the only one able to analyze APT today, rather than targeting a fully automated approach.

In 2017, our contribution focused on defining a graph-mining technique to discover dependencies among security events clustering techniques in order to group individual events into a common one. We applied our technique to darknet data as shown in section 7.2.1. In addition, we also start the modeling of an attacker process by considering the first phase of APT, *i.e.* the reconnaissance phase by analyzing scanning activities using Hidden Markov Model (7.2.1). We also technically contribute to the definition of APT scenarios by providing a very stealthy scanning approach (Wiscan described in 7.1.2). Finally, from a project management point of view, Inria is in charge of leading the work-package related to data analytics technique for analyzing security probe events.

9.2.1.4. Inria-Orange Joint Lab

Participants: Jérôme François [contact], Rémi Badonnel, Olivier Festor, Maxime Compastie, Paul Chaignon.

The challenges addressed by the Inria-Orange joint lab relate to the virtualization of communication networks, the convergence between cloud computing and communication networks, and the underlying software-defined infrastructures. This lab aims at specifying and developing a GlobalOS (Global Operating System) approach as a platform or a software infrastructure for all the network and computing resources required by the Orange network operator. Our work, started in November 2015, concerns in particular monitoring methods for

software-defined infrastructures, and management strategies for supporting software-defined security in multi-tenant cloud environments. We have specified a management framework dedicated to cloud software-defined security. It relies on on-the-fly generation and execution of unikernels in order to build highly-constrained configurations. The solution has been evaluated through extensive series of experiments, based on a proof-of-concept prototype using MirageOS. Results show that the costs induced by security mechanisms integration are relatively limited, and unikernels are well suited to minimize risk exposure.

9.2.1.5. ANR FLIRT

Participants: Olivier Festor [contact], Rémi Badonnel, Thibault Cholez, Jérôme François, Abdelkader Lahmadi, Laurent Andrey.

FLIRT (Formations Libres et Innovantes Réseaux & Télécom) is an applied research project led by the Institut Mines-Télécom, for a duration of 4 years. It includes 14 academic partners (engineering schools including Telecom Nancy), 3 industrial partners (Airbus, Nokia Group and Orange), 2 innovative startups (the MOOC agency, and Isograd), as well as 3 professional or scientific societies (Syntec Numérique, Unetel, SEE). The project objective is to build a collection of 10 MOOCs (Massive Open Online Courses) in the area of networks and telecommunications, 3 training programmes based on this collection, as well as several innovations related to pedagogical efficiency (such as virtualization of practical labs, management of student cohorts, and adaptive assessment). The Madynes team is leading a working group dedicated to the building of a MOOC on network and service management. This MOOC, whose first session will open end of 2018, covers the fundamental concepts, architectures and protocols of the domain, as well as their evolution in the context of future Internet, and includes practical labs and exercises using widely-used tools and technologies.

9.2.2. Technological Development Action (ADT)

9.2.2.1. ADT UASS

The goal of this ADT provides assistance in developing the Aetournos platform to help in the UAV Challenge Medical Express. Through this ADT, funded by Inria, Raphaël Cherfan has coordinated students work on the platform and tutored the Aetournos team for the 2016 Outback Joe Search and Rescue / Medical Express Challenge, and help in the design and building of a novel Hybrid UAV.

9.2.2.2. ADT VERTEX

This ADT started in 2016 and will end on 2018. The Madynes project is a major partner funded at the level of 120k€. ADT VERTEX built upon the foundations of the Grid'5000 testbed aims to reinforce and extend it towards new use cases and scientific challenges. Several directions are being explored: networks and Software Defined Networking, Big Data, HPC, and production computation needs. Previously developed prototypes are also being consolidated, and the necessary improvements to user management and tracking are also being performed.

9.2.2.3. ADT SDT

Built on the Distem emulator, that enables the creation of virtual experimental environments from clusters of homogeneous machines, this project aims at enlarging the scope of use of Distem to additional fields: *Software Defined Networking, Named Data Networking, Big Data*. In addition, we will explore *temporal dilation* as a technique to study future infrastructures.

The project started in 2017 and will end in 2019.

9.2.2.4. ADT RIOT

RIOT ADT is a multi-site project with Infine and Madynes teams, which started in December 2016 for a duration of two years. The high-level objective is to (1) contribute open source code, upstream, to the RIOT code base, (2) coordinate RIOT development within Inria, with other engineers and researchers using/developing RIOT, (3) coordinate RIOT development outside Inria, help maintain the RIOT community at large (see <http://www.riot-os.org> and <http://www.github.com/RIOT-OS/RIOT>) which aims to become the equivalent of Linux for IoT devices that cannot run Linux because of resource constraints.

This year MADYNES team has mainly contributed to the efficient MAC layer protocol implementation issues. We have built a general MAC protocol module (gnrc mac module) for providing critical development tools for MAC protocol developers in the RIOT community. Based on these generic functions, we have developed two duty-cycled MAC protocols lw-MAC and GoMacH which are above IEEE802.15.4. lw-MAC is a single channel MAC protocol that has similar principle of X-MAC and ContikiMAC. GoMacH [26] is a traffic-adaptive multi-channel MAC protocol for IoT which exhibits low power consumption and high throughput performance. Both are integrated into the RIOT IoT protocol stack and merged into RIOT master branch. They are publically available in RIOT open source github.

9.2.2.5. ATT AMICS

The ATT AMICS is run in cooperation with the High Security Lab (HSL). The goal is to develop a customizable security analytics stack as a service. The added value of the HSL is to cross-correlate customer data with Internet probes hosted at HSL collecting tons of security data. Indeed, the basic service provided to potential customer is a VPN on top of which custom modules can be added. In 2017, we setup the VPN elements and also developed a flexible framework for security analysis. Different moddules have already been defined and implemented: blacklists aggregators to gather continuously information from third parties providing blacklists, real-time verification of traffic going through the VPN using blacklists, real-time detection of IP spoofing by correlating user traffic with HSL darknet traffic and real-time detection of customer hosts infected by a malware.

9.2.3. Inria Project Lab

9.2.3.1. IPL BetterNet

Participants: Isabelle Chrisment [contact], Thibault Cholez, Vassili Rivron, Lakhdar Meftah [University of Lille].

The Inria Project Lab BetterNet (<https://project.inria.fr/betternet>) has been launched in October 2016. Its goal is to build and deliver a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. We will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Tools, models and algorithms will be provided to collect data that will be shared and analyzed to offer a valuable service to scientists, stakeholders and civil society.

The Madynes team leads this IPL and in particular Isabelle Chrisment who coordinates the project.

In 2017, the main activities of the project focused on federating Inria's monitoring tools (APISENSE, Fathom, Hostview, ACQUA) and building our open measurement platform for acquiring data.

Lakhdar Meftah, a shared PhD student with the SPIRALS team (Inria/University of Lille) has worked on a privacy preservation scheme using data dissemination that introduces an a priori data anonymization and improves user privacy without compromising the overall quality of the crowdsourced dataset.

9.2.3.2. IPL Discovery

Participant: Lucas Nussbaum [contact].

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 (also referred as Fog/Edge Computing) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote a new kind of Cloud Operating System (OS) that will enable the management of such a large-scale and widely distributed infrastructure in an unified and friendly manner.

The consortium is composed of experts in the following research areas: large-scale infrastructure management systems, networking and P2P algorithms. Moreover, two key network operators, namely Orange and RENATER, are involved in the project.

By deploying and using a Fog/Edge OS on backbones, our ultimate vision is to enable large parts of the Internet to be hosted and operated by its internal structure itself: a scalable set of resources delivered by any computing facilities forming the Internet, starting from the larger hubs operated by ISPs, governments and academic institutions, to any idle resources that may be provided by end users.

MADYNES contributes to the DISCOVERY IPL on the networking axis. A CIFRE PhD with Orange is expected to start at the beginning of 2018.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Fed4Fire+ (2017-2022)

Title: Federation for FIRE Plus

Program: H2020

Duration: January 2017 - December 2021

Coordinator: Interuniversitair Micro-Electronicacentrum Imec VZW

Partners:

Universidad de Malaga

National Technical University of Athens - NTUA

The Provost, Fellows, Foundation Scholars & the other members of board of the College of the Holy & Undivided Trinity of Queen Elizabeth Near Dublin

Ethniko Kentro Erevnas Kai Technologikis Anaptyxis

GEANT Limited

Institut Jozef Stefan

Mandat International Alias Fondation Pour la Cooperation Internationale

Universite Pierre et Marie Curie - Paris 6

Universidad De Cantabria

Fundacio Privada I2CAT, Internet I Innovacio Digital A Catalunya

EURESCOM-European Institute For Research And Strategic Studies in Telecommunications GMBH

Nordunet A/S

Technische Universitaet Berlin

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk

Fraunhofer Gesellschaft zur Foerderung Der Angewandten Forschung E.V.

Universiteit Van Amsterdam

University of Southampton

Martel GMBH

Atos Spain SA

Institut National de Recherche en Informatique et automatique

Inria contact: David Margery (for MADYNES: Lucas Nussbaum)

Fed4FIRE+ is a successor project to Fed4FIRE. In Fed4FIRE+, we more directly integrate Grid'5000 into the wider eco-system of experimental platforms in Europe and beyond using results we developed in Fed4FIRE. We will also provide a generalised proxy mechanisms to allow users with Fed4FIRE identities to interact with services giving access to different testbeds but not designed to support Fed4FIRE identities. Finally, we will work on orchestration of experiments in a federation context. Fed4FIRE+ was prepared in 2016, and has started January 1st, 2017.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. RETINA

Program: Eurosatrs-2

Project acronym: RETINA

Project title: Real-Time support for heterogenous networks in automotive applications

Duration: April 2016 - March 2018

Coordinator: TCN (Time critical networks)

Other partners: TCN (Sweden), Alkit (Sweden), Viktoria (Sweden), TNO (Netherlands), Scuola Superiore Sant'Anna (Italy), Evidence (Italy), University of Lorraine (France)

Abstract: The project will develop integrated software tools to predict, simulate, test and support real-time communication in heterogeneous vehicular networks. The tool set will allow SMEs and larger industry to design, develop and evaluate time-critical applications such as advanced safety systems and autonomous vehicles. This will put high requirements on both in-vehicle infrastructure, as well as vehicle-to-vehicle and vehicle-to infrastructure utilizing the next generation of mobile networks for ITS.

9.4. International Initiatives

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

9.4.1.1. IoT4D

Title: Internet of Things for Developing countries

International Partner (Institution - Laboratory - Researcher):

UY (Cameroon) - MASECNeSS - Thomas DJOTIO NDIE

Start year: 2016

See also: <https://team.inria.fr/iot4dc/>

Our goal is to connect wireless sensors networks (WSN) to the Internet through gateways. WSN should have several accessible gateways (depending on the size and quality of service needed) and gateways should be used by several wireless sensors networks. This is an optimization problem in a peculiar context featuring unreliable communications and equipments that are easily disturbed by environment .

9.4.1.2. Masdin

Title: MAnagement of Software-Defined INfrastructure

International Partner (Institution - Laboratory - Researcher):

University of Luxembourg (Luxembourg) - SnT (Interdisciplinary Centre for Security, Reliability and Trust) - Radu State

Joint publications: [25], [12], [16]

Start year: 2016

See also: <https://project.inria.fr/masdin>

Networking is deeply evolving with the advent of new paradigms making the network more configurable and more dynamic. In particular, SDN (Software-Defined Network) consists in splitting the control plane and the data plane. A SDN-enabled switch is so only viewed as a specialized device in forwarding data traffic while a logically centralized controller exposes interfaces to services and applications strengthening their coupling. Hence, network is not only a medium of communication but a software component. In the same context, NFV (Network Function Virtualization) promotes the virtualization of all kinds of network functions (router, load-balancer, firewall. . .) on commodity server, a server in a cloud. These technologies are deeply changing networking principle by allowing a high flexibility in network management. The new features provided by these concepts will thus allow to reinvent the network management in all its areas, especially for network monitoring and provisioning. In addition, even more recent propositions argue for a finer granularity applying the programmability idea of SDN (working at flow level) to packet processing level by promoting the definition of a common language like P4 to reconfigure any switch at low level (vendor independent). The original goal of the associate team is to explore co-jointly this research area through four directions: Monitoring of NFV- and SDN-enabled networks, investigating the integration of data analytics as virtualized functions in virtual networks, security of SDN networks, service chain composition, programming packet processing with P4 and other equivalents. ICN (Information Centric Networking) is also an important topic which is addressed in the team, especially regarding performance (with SDN) and security.

Furthermore, management of blockchain has been set as a new research topic to be focused in the team at the end of 2016. In the scope of network management, our objective is to design monitoring and orchestration methods for blockchain. In particular, we want to assess the relationships and impact between blockchain and network performance. We will have to define proper metrics to catch meaningful data to be analyzed. Moreover, a blockchain technology is by nature without authority (except in the private case), configuration requires thus to enforce some collaboration between nodes.

MAGIQUE-3D Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Partnership with I2M in Bordeaux supported by Conseil Régional d'Aquitaine

Title: Imaging complex materials.

Coordinator: Hélène Barucq

Other partners: I2M CNRS Université Bordeaux I

The detection, localization and monitoring of the defect evolution in composite materials, concrete and more generally heterogeneous materials is a challenging problem for Aeronautics and energy production. It is already possible to localize defects in homogeneous materials by using methods based on ultrasonic inspection and sometimes, they are usable in particular heterogeneous materials, most of the time in 2D. Classical methods rely on the correspondence between the distance and the propagation time of the wave traveling between the defect and the receivers. In complex media, such a correspondence may be lapsed, for instance when the velocity depends on the frequency (dispersion) or of the propagation direction (anisotropy). The defect signature can also be embedded in the acoustic field sent by the structure (multiple reflections). The complexity of the propagation in heterogeneous materials makes then difficult the accurate localization of the defect, in particular in 3D.

Topological imaging techniques can be applied to heterogeneous media. They can find the positions of defects from two simulations performed in a safe experimental medium. They have been developed at I2M laboratory to carry on 2D single/multi mode inspection in isotropic and anisotropic waveguides. They have also been applied to a highly reflecting medium observed with a single sensor. The objective of this work is to extend the technique to 3D problems. In particular, we are going to handle detection in composite plates and in highly heterogeneous media including a collection of small scatterers.

This project is supported by the Conseil Régional d'Aquitaine, for a duration of 2 years.

8.2. National Initiatives

8.2.1. Depth Imaging Partnership

Magique-3D maintains active collaborations with Total. In the context of Depth Imaging, Magique-3D coordinates research activities dealing with the development of high-performance numerical methods for solving wave equations in complex media. This project has involved 2 other Inria Team-Projects (Hiepac and Nachos) which have complementary skills in mathematics, computing and in geophysics. DIP is fully funded by Total by the way of an outline agreement with Inria .

In 2014, the second phase of DIP has begun. Lionel Boillot has been hired as engineer to work on the DIP platform. Six PhD students have defended their PhD since 2014 and they are now post-doctoral researchers or engineers in Europe. DIP is currently employing 2 PhD students and one post-doctoral researcher.

8.2.2. ANR Num4Sun

The ANR has launched a specific program for supporting and promoting applications to European or more generally International projects. Magique-3D has been selected in 2016 after proposing a project to be applied as a FET project on the occasion of a call that will open in 2017 April. This project will gather researchers of the MPS (<https://www.mps.mpg.de/en>), of the BSC (<https://www.bsc.es/>), of the BCAM (<http://www.bcamath.org/en/>), of Heriot-Watt University (<https://www.hw.ac.uk/>) and Inria teams.

A kick-off meeting has been held in November 2016 in Strasbourg and a second one in Paris in July 2017. Thanks to this support, we have submitted a ETPHPC proposal in September 2017. The project is funded for 18 months starting from August 2016. The funding amounts 30000€.

8.2.3. ANR NonLocalDD

Magique 3-D is a partner of the ANR project entitled "Non Local Domain Decomposition Methods in Electromagnetics" that begins in October 2015. The aim of this project is to develop domain decomposition methods for the efficient solution of acoustics and Maxwell's equation either with boundary integral equations or finite element volume method. To obtain an exponential convergence of the iterative solution, non-local operators are studied and optimized to achieve a faster convergence. A post-doctoral student Marcella Bonazzoli has been hired by Magique 3-D in 2017 to study multi-domain integral equations for wave propagation. This student is supervised by Xavier Claeys, a partner of the NonLocalDD ANR project.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. GEAGAM

Title: Geophysical Exploration using Advanced GALerkin Methods

Program: H2020

Duration: January 2015 - December 2017

Coordinator: Universidad Del Pais Vasco (EHU UPV)

Partners:

Beam - Basque Center for Applied Mathematics Asociacion (Spain)

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Total S.A. (France)

Universidad Del Pais Vasco Ehu Upv (Spain)

Pontificia Universidad Catolica de Valparaiso (Chile)

Universidad de Chile (Chile)

Universidad Tecnica Federico Santa Maria (Chile)

University of Texas at Austin (USA)

Inria contact: Hélène BARUCQ

The main objective of this Marie Curie RISE action is to improve and exchange interdisciplinary knowledge on applied mathematics, high performance computing, and geophysics to be able to better simulate and understand the materials composing the Earth's subsurface. This is essential for a variety of applications such as CO₂ storage, hydrocarbon extraction, mining, and geothermal energy production, among others. All these problems have in common the need to obtain an accurate characterization of the Earth's subsurface, and to achieve this goal, several complementary areas will be studied, including the mathematical foundations of various high-order Galerkin multiphysics simulation methods, the efficient computer implementation of these methods in large parallel machines and GPUs, and some crucial geophysical aspects such as the design of measurement acquisition systems in different scenarios. Results will be widely disseminated through publications, workshops, post-graduate courses to train new researchers, a dedicated webpage, and visits to companies working in the area. In that way, we will perform an important role in technology transfer between the most advanced numerical methods and mathematics of the moment and the area of applied geophysics.

8.3.1.2. HPC4E

Title: HPC for Energy

Program: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partners:

Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)

Iberdrola Renovables Energia (Spain)

Repsol (Spain)

Lancaster University (United Kingdom)

Total S.A. (France)

Fundação Coordenação de Projetos, Pesquisas e Estudos Tecnológicos, (Brazil)

National Laboratory for Scientific Computation, (Brazil)

Instituto Tecnológico de Aeronáutica, (Brazil)

Petrobras, (Brazil)

Universidade Federal do Rio Grande do Sul, (Brazil)

Universidade Federal de Pernambuco, (Brazil)

Inria contact: Stéphane Lanteri

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO₂ emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

8.4.1.1.1. MAGIC2

Title: Advance Modeling in Geophysics

International Partner (Institution - Laboratory - Researcher):

California State University at Northridge (United States) - Department of Mathematics -
Djellouli Rabia

The Associated Team MAGIC was created in January 2006 and renewed in January 2009. At the end of the program in December 2011, the two partners, MAGIQUE-3D and the California State University at Northridge (CSUN) decided to continue their collaboration and obtained the “Inria International Partner” label in 2013.

See also: <https://project.inria.fr/magic/>

The ultimate objective of this research collaboration is to develop efficient solution methodologies for solving inverse problems arising in various applications such as geophysical exploration, underwater acoustics, and electromagnetics. To this end, the research program will be based upon the following three pillars that are the key ingredients for successfully solving inverse obstacle problems. 1) The design of efficient methods for solving high-frequency wave problems. 2) The sensitivity analysis of the scattered field to the shape and parameters of heterogeneities/scatterers. 3) The construction of higher-order Absorbing Boundary Conditions.

In the framework of Magic2, Izar Azpiroz visited CSUN in May 2017 and Rabia Djellouli (CSUN) visited Magique 3D in December 2017

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Rabia Djellouli (CSUN) visited Magique 3D in December 2017.
- Damien Fournier (MPS) visited Magique 3D in October 2017.
- Morgane Bergot (Univ Lyon) visited Magique 3D in November 2017.

8.5.2. Visits to International Teams

8.5.2.1. Research Stays Abroad

- In the framework of the European project Geagam, Izar Azpiroz and Justine Labat visited Ignacio Muga, PUCV, Chile, in April 2017.
- In the framework of the International Partnership Magic2, Izar Azpiroz visited Rabia Djellouli, CSUN (California State University at Northridge), USA, in May 2017.

MAGNET Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

We strengthen our partnership with the linguistic laboratory STL in Lille university. We welcome Bert Cappelle for a stay (delegation) in the group. The topic of this collaboration is to study modal verbs and the translation of the notion of compositionality when applied to vectorial representation of words.

We also participate to the *Data Advanced data science and technologies* project (CPER Data). This project is organized following three axes: internet of things, data science, high performance computing. MAGNET is involved in the data science axis to develop machine learning algorithms for big data, structured data and heterogeneous data. The project MyLocalInfo is an open API for privacy-friendly collaborative computing in the internet of things.

9.2. National Initiatives

9.2.1. ANR Pamela (2016-2020)

Participants: MARC TOMMASI [correspondent], AURÉLIEN BELLET, RÉMI GILLERON, FABIO VITALE

The Pamela project aims at developing machine learning theories and algorithms in order to learn local and personalized models from data distributed over networked infrastructures. Our project seeks to provide first answers to modern information systems built by interconnecting many personal devices holding private user data in the search of personalized suggestions and recommendations. More precisely, we will focus on learning in a collaborative way with the help of neighbors in a network. We aim to lay the first blocks of a scientific foundation for these new types of systems, in effect moving from graphs of data to graphs of data and learned models. We argue that this shift is necessary in order to address the new constraints arising from the decentralization of information that is inherent to the emergence of big data. We will in particular focus on the question of learning under communication and privacy constraints. A significant asset of the project is the quality of its industrial partners, Snips and Mediego, who bring in their expertise in privacy protection and distributed computing as well as use cases and datasets. They will contribute to translate this fundamental research effort into concrete outcomes by developing personalized and privacy-aware assistants able to provide contextualized recommendations on small devices and smartphones. <https://project.inria.fr/pamela/>.

9.2.2. ANR JCJC GRASP (2016-2020)

Participants: PASCAL DENIS [correspondent], AURÉLIEN BELLET, RÉMI GILLERON, MIKAELA KELLER, MARC TOMMASI

The GRASP project aims at designing new graph-based Machine Learning algorithms that are better tailored to Natural Language Processing structured output problems. Focusing on semi-supervised learning scenarios, we will extend current graph-based learning approaches along two main directions: (i) the use of structured outputs during inference, and (ii) a graph construction mechanism that is more dependent on the task objective and more closely related to label inference. Combined, these two research strands will provide an important step towards delivering more adaptive (to new domains and languages), more accurate, and ultimately more useful language technologies. We will target semantic and pragmatic tasks such as coreference resolution, temporal chronology prediction, and discourse parsing for which proper Machine Learning solutions are still lacking. <https://project.inria.fr/grasp/>.

9.2.3. ANR-NFS REM (2016-2020)

With colleagues from the linguistics departments at Lille 3 and Neuchâtel (Switzerland), PASCAL DENIS is a member of another ANR project (REM), funded through the bilateral ANR-NFS Scheme. This project, co-headed by I. Depreatere (Lille 3) and M. Hilpert (Neufchâtel), proposes to reconsider the analysis of English modal constructions from a multidisciplinary perspective, combining insights from theoretical, psycho-linguistic, and computational approaches.

9.2.4. EFL (2010-2020)

PASCAL DENIS is an associate member of the Laboratoire d'Excellence *Empirical Foundations of Linguistics* (EFL), <http://www.labex-efl.org/>.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

ERC-PoC 713626 SOM “Statistical modeling for Optimization Mobility”: This project aims at bringing to practice results from the project ERC-StG 240186 MiGrANT in the domain of mobility and mobile devices. In particular, a proof of concept will be made of graph mining approaches to learn predictive models and/or recommendation systems from collections of data distributed over a large number of devices (cars, smartphones, ...) while caring about privacy-friendliness.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. Sci-GENERATION (2013-2017)

Program: COST

Project acronym: Sci-GENERATION

Project title: Next Generation of Young Scientist: Towards a Contemporary Spirit of R&I.

Duration: 2013-2017

Coordinator: JAN RAMON is an MC member for Belgium and a core group member

Other partners: More information on <http://scigeneration.eu/en/participants.html>

Abstract: Sci-Generation is a COST targeted network that addresses the challenges faced by next generation of researchers in Europe. We aim to improve the visibility, inclusion and success of excellent young researchers and research teams in European science and policy-making. We study and deliberate how changes in research funding opportunities and career perspectives can facilitate these improvements. We wish to promote new and emergent research topics, methods and management organizations. We are developing recommendations for EU science policy that will foster transformations at national and regional levels to promote scientific excellence and to establish a true European research area. (See <http://scigeneration.eu>).

9.3.2.2. TextLink (2014-2018)

Program: COST Action

Project acronym: TextLink

Project title: Structuring Discourse in Multilingual Europe

Duration: Apr. 2014 - Apr. 2018

Coordinator: Prof. Liesbeth Degand, Université Catholique de Louvain, Belgium. PASCAL DENIS is member of the Tools group.

Other partners: 26 EU countries and 3 international partner countries (Argentina, Brazil, Canada)

Abstract: Effective discourse in any language is characterized by clear relations between sentences and coherent structure. But languages vary in how relations and structure are signaled. While monolingual dictionaries and grammars can characterize the words and sentences of a language and bilingual dictionaries can do the same between languages, there is nothing similar for discourse. For discourse, however, discourse-annotated corpora are becoming available in individual languages. The Action will facilitate European multilingualism by (1) identifying and creating a portal into such resources within Europe - including annotation tools, search tools, and discourse-annotated corpora; (2) delineating the dimensions and properties of discourse annotation across corpora; (3) organizing these properties into a sharable taxonomy; (4) encouraging the use of this taxonomy in subsequent discourse annotation and in cross-lingual search and studies of devices that relate and structure discourse; and (5) promoting use of the portal, its resources and sharable taxonomy. With partners from across Europe, TextLink will unify numerous but scattered linguistic resources on discourse structure. With its resources searchable by form and/or meaning and a source of valuable correspondences, TextLink will enhance the experience and performance of human translators, lexicographers, language technology and language learners alike.

9.4. International Initiatives

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

9.4.1.1. *RSS*

Program: Inria North-European Labs

Project title: Rankings and Similarities in Signed graphs

Duration: late 2015 to late 2017

Partners: Aristides Gionis (Data Mining Group, Aalto University, Finland) and Mark Herbster (Centre for Computational Statistics and Machine Learning, University College London, UK)

Abstract: The project focuses on predictive analysis of networked data represented as signed graphs, where connections can carry either a positive or a negative semantic. The goal of this associate team is to devise novel formal methods and machine learning algorithms towards link classification and link ranking in signed graphs and assess their performance in both theoretical and practical terms.

9.4.1.2. *LEGO*

Title: LEarning GOod representations for natural language processing

International Partner (Institution - Laboratory - Researcher):

University of Southern California (United States) - Department of Computer Science - Fei Sha

Start year: 2016

See also: <https://team.inria.fr/lego/>

LEGO lies in the intersection of Machine Learning and Natural Language Processing (NLP). Its goal is to address the following challenges: what are the right representations for structured data and how to learn them automatically, and how to apply such representations to complex and structured prediction tasks in NLP? In recent years, continuous vectorial embeddings learned from massive unannotated corpora have been increasingly popular, but they remain far too limited to capture the complexity of text data as they are task-agnostic and fall short of modeling complex structures in languages. LEGO strongly relies on the complementary expertise of the two partners in areas such as representation/similarity learning, structured prediction, graph-based learning, and statistical NLP to offer a novel alternative to existing techniques. Specifically, we will investigate the following three research directions: (a) optimize the embeddings based on annotations so as to minimize structured prediction errors, (b) generate embeddings from rich language contexts represented as graphs, and (c) automatically adapt the context graph to the task/dataset of interest by learning a similarity between nodes to appropriately weigh the edges of the graph. By exploring these complementary research strands, we intend to push the state-of-the-art in several core NLP problems, such as dependency parsing, coreference resolution and discourse parsing.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

PETER KLING The objective of the visit of PETER KLING was centered around Learning in Distributed Environments. This initiative contributes to the recent effort of Magnet towards decentralized learning also supported for instance by the Pamela project (Personalized and decentralIzed MachinE Learning under constrAints). Peter Kling's background in distributed computing, combinatorial optimization, online algorithms, and stochastic processes is a good opportunity to investigate new machine learning approaches in this area. In this first of one month, we have started to study Population and Spreading Processes. Two other topics on distributed load balancing and energy-aware algorithms will be the investigated in a second visit in 2018.

VALENTINA ZANTEDESCHI During her one month stay, VALENTINA ZANTEDESCHI has collaborated with AURÉLIEN BELLET and MARC TOMMASI on decentralized learning. A paper on collaborative and decentralized boosting will be submitted in 2018.

ISABEL VALERA visited MAGNET for 3 days to collaborate with AURÉLIEN BELLET on fairness in machine learning.

CLEMENT WEISBECKER visited MAGNET for 1 week to collaborate with AURÉLIEN BELLET on large-scale kernel methods using block low-rank approximations.

WILHELMINA HAMALAINEN visited MAGNET for 2 weeks to collaborate with JAN RAMON. In particular, they worked on multiple hypothesis tests for regression and discretization problems.

BERT CAPPELLE visited MAGNET for a semester, as part of his "delegation", to collaborate with PASCAL DENIS and MIKAELA KELLER on compositional distributional semantics, and more specifically on the distributional analysis of so-called privative adjectives. A collaborative paper on this work will be submitted in 2018.

Several international researchers have also been invited to give a talk at the MAGNET seminar:

- R. Babbar (Max Planck Institute): Algorithms for Extreme Multi-Class and Multi-Label Classification
- M. Chehreghani (Xerox Research): Unsupervised Learning over Graphs: Distances, Algorithms, and an Information-Theoretic Model Validation Principle
- G. Boleda (University Pompeu Fabra): Instances and Concepts in Distributional Space
- M. Blondel (NTT): A Regularized Framework for Sparse and Structured Neural Attention
- L. Wehenkel (University of Liège): Probabilistic Reliability Management of the European Electric Power System
- A. Herbelot (University Pompeu Fabra): A Formal Distributional Semantics for Cognitively-Plausible Reference Acts
- H. Ivey-Law (Data61/CSIRO): Private Federated Learning on Vertically Partitioned Data via Entity Resolution and Additively Homomorphic Encryption

9.5.1.1. Internships

Juhi Tandon worked on developing re-ranking parsing models that exploit and compare various tree kernels in the context of semi-supervised graph-based multilingual dependency parsing.

Quentin Tremouille worked on applications of the Hypernode graphs model [39] in the context of (movie) recommendation based on reviews in natural language.

Hippolyte Bourel worked on the application of the decentralized learning algorithms [15] for mobility data.

Rumei Li worked on a Yanakakis style algorithm for computing the effective sample size of a set of dependent training examples.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

MATHIEU DEHOUCK visited USC during one month. He worked with pairs of 8 main and auxiliary NLP tasks. More specifically, he looked at transfer learning from low-level tasks (such as part-of-speech tagging, named entity recognition, chunking, word polarity classification) to high-level tasks (e.g., semantic relatedness, textual entailment, sentiment analysis). In contrast to a common belief in the NLP community that transfer learning between these tasks should be possible, we discovered that the widely-used technique in which word representations act as a medium of transfer only leads to limited improvements. These results were presented by Fei Sha at the Inria SiliconValley workshop (BIS'2017), and a paper is in preparation for 2018.

AURÉLIEN BELLET visited École Polytechnique Fédérale de Lausanne (EPFL) during 1 week. He worked with the distributed computing group of Rachid Guerraoui on decentralized and privacy-preserving machine learning, leading to some joint papers [18], [16].

AURÉLIEN BELLET and PASCAL DENIS visited USC during two weeks in December 2017. In collaboration with MELISSA AILEM, recently recruited as a post-doc on the LEGO project, they worked on developing a new algorithm for joint learning of word and image embeddings inspired on the Skip-Gram word2vec model. In addition, they furthered the work initiated with MATHIEU DEHOUCK along with USC colleagues on multi-task learning by proposing a new encoder-decoder model that integrates task and domain embeddings.

MAGRIT Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The MAGRIT and the MIMESIS teams have been working for several years on the use of augmented reality for deformable organs and especially on liver surgery. The PhD of Jaime Garcia Guevara started in October 2015 and is funded by the Région Lorraine. It is co-supervised by M.-O. Berger and S. Cotin (MILESIS, Strasbourg). It follows on from our past works and aims at improving the reliability and the robustness of AR-based clinical procedures.

A one year post-doc position was granted by the Region Lorraine and the Université de Lorraine. Cong Yang started this position in November 2016 and ended in October 2017. He developed algorithms for object recognition in large-scale industrial environments (factories, vessels, ...), with the aim to enrich the operator's field of view with digital information and media. The main issues concerned the size of the environment, the nature of the objects (often non textured, highly specular, ...) and the presence of repeated patterns.

9.2. National Initiatives

9.2.1. *Projet RAPID EVORA*

Participants: M.-O. Berger, V. Gaudillière, G. Simon, C. Yang.

This 3-year project is supported by DGA/DGE and led by the SBS-Interactive company. The objective is to develop a prototype for location and object recognition in large-scale industrial environments (factories, ships...), with the aim to enrich the operator's field of view with digital information and media. The main issues concern the size of the environment, the nature of the objects (often non textured, highly specular...) and the presence of repeated patterns. Use cases will be provided by industrial partners such as DCNS and Areva. A class of officer cadets and professors of the Merchant Marine School will also be associated to judge the pedagogical interest of such a tool. A PhD student, Vincent Gaudillière, has been recruited to work on this project and his contract started in December 2016.

9.2.2. *Project funded by GDR ISIS in collaboration with Institut Pascal*

Participant: F. Sur.

Between September 2014 and September 2017, we have been engaged in a collaboration with Institut Pascal funded by GDR ISIS. The aim of this project was the investigation of image processing tools for enhancing the metrological performance of contactless measurement systems in experimental mechanics.

9.2.3. *AEN Inria SOFA-InterMedS*

Participants: R. Anxionnat (CHU Nancy), M.-O. Berger, E. Kerrien.

The SOFA-InterMedS large-scale Inria initiative is a research-oriented collaboration across several Inria project-teams, international research groups and clinical partners. Its main objective is to leverage specific competences available in each team to further develop the multidisciplinary field of Medical Simulation research. Our action within the initiative takes place in close collaboration with both the MIMESIS team and the Department of diagnostic and therapeutic interventional neuroradiology of Nancy University Hospital. Two PhD students - R. Trivisonne and J. Guarica Guevara- are currently co-supervised by the Magrit and the MIMESIS teams.

9.3. International Initiatives

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

9.3.1.1. CURATIVE

Title: CompUteR-based simulAtion Tool for mItral Valve rEpair

International Partner (Institution - Laboratory - Researcher):

Harvard University (United States) - Harvard Biorobotics Lab (HBL) - Robert Howe

Start year: 2017

See also: <https://team.inria.fr/curative/>

The mitral valve of the heart ensures one-way flow of oxygenated blood from the left atrium to the left ventricle. However, many pathologies damage the valve anatomy producing undesired backflow, or regurgitation, decreasing cardiac efficiency and potentially leading to heart failure if left untreated. Such cases could be treated by surgical repair of the valve. However, it is technically difficult and outcomes are highly dependent upon the experience of the surgeon.

One way to facilitate the repair is to simulate the mechanical behavior of the pathological valve with subject-specific data. Our main goal is to provide surgeons with a tool to study solutions of mitral valve repairs. This tool would be a computer-based model that can simulate a potential surgical repair procedure in order to evaluate its success. The surgeons would be able to customize the simulation to a patient and to a technique of valve repair. Our methodology will be to realistically simulate valve closure based on segmentation methods faithful enough to capture subject-specific anatomy and based on a biomechanical model that can accurately model the range of properties exhibited by pathological valves.

During the first year, we worked on three aspects of this project: i) developing a fast image-based mitral valve simulation, ii) extracting the mitral valve chordae from a CT scan (see section New Results) and iii) developing a Cosserat model for catheter robot for heart surgical procedures. The work on fast image-based mitral valve simulation has been accepted to the The International Journal of Medical Robotics and Computer Assisted Surgery [17].

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Douglas Perrin, a senior researcher at Harvard University (<http://people.seas.harvard.edu/~dperrin>), visited the MAGRIT team from 05/29/17 to 06/02/17. He gave a talk to the Department 1 in Loria, he helped out with scientific understanding of the mitral valve anatomy and he provided advice to Daryna Panicheva supervision during one week.

Thomas Waite, an undergrad student at Harvard University, visited the MAGRIT team from 06/05/17 to 06/09/17. He gave a talk to the Department 1 in Loria, he worked with Pierre-Frédéric Villard on modeling a heart surgical catheter robot with Cosserat model and started writing a journal paper on this subject.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Pierre-Frederic Villard spent one month (August 2017) at Uppsala University working on the INVIVE project http://www.it.uu.se/research/scientific_computing/project/rbf/biomech. His work there includes supervising PhD student Igor Tominec, meeting with a physiologist expert in respiration muscles and working on both the mesh and the boundary conditions in the case of a passive diaphragm.

MAMBA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR Blanc 2014-2018 “Kibord”

This project gathers several members of the MAMBA team together with the ENS Cachan and Université Paris-Dauphine on the mathematical study of PDE models with application to biology.

8.1.1.2. ANR 2014-2017 IFLOW

Eric Vibert, Hopital Paul Brousse (coordinator). Partners: Inria REO, Hopital Toulouse, Dirk Drasdo. Objectives are simulation of liver perfusion after partial hepatectomy with and without therapeutic manipulations to improve patients survival after PHx.

8.1.1.3. ANR iLITE 2016 - 2020

Jean-Charles Duclos-Vallée, Paul Brousse Hospital, Villejuif. Partners are several departments in Paul Brousse Hospital, ENS Cachan, University of Compiègne and several companies all over France, and REO team, Inria Paris. The pursued objective is the bioengineering design of an artificial liver intended for liver replacement.

8.1.1.4. ANR InTelo 2017-2020

Telomere dynamics, headed by Teresa Teixeira (IBPC, Paris).

8.1.2. ITMO Cancer 2016 - 2020, HTE call (heterogeneity of tumours in their ecosystems)

8.1.2.1. ITMO Cancer EcoAML

Early leukaemogenesis in Acute Myelogenous Leukaemia (AML), 8 teams headed by François Delhommeau (CDR St Antoine, Paris).

8.1.2.2. ITMO Cancer MoGIImaging

Treatment-induced treatment resistance and heterogeneity in glioblastoma, 8 teams headed by Elizabeth Moyal (INSERM, Toulouse).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Research axis 1 (population dynamics): The ERC Starting Grant SKIPPER^{AD} (Marie Doumic, 2014-2018) supported and was the guideline for the study of nucleation, growth and fragmentation equations.

Benoît Perthame has obtained in April 2017 the ERC Advanced Grant ADORA (Asymptotic approach to spatial and dynamical organisations)

8.2.2. Collaborations with Major European Organisations

German BMBF: LiverSimulator (Dirk Drasdo, 2014 - 2017)

8.3. International Initiatives

8.3.1. Participation in International Programs

CAPES/COFECUB project “Modelling innovative control methods for dengue fever” (Bliman)

STIC AmSud project “MOSTICAW- MOdelling the Spread and (opTimal) Control of Arboviroses by Wolbachia” (2016-2017) (Bliman)..

ECOS-Nord project “New methods for controlling epidemics of dengue fever and arboviroses” (2017-2019) (Bliman)

(See below)

8.3.1.1. *International Initiatives*

MOSTICAW

Title: MOdelling the Spread and (opTimal) Control of Arboviroses by Wolbachia

International Partners (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (Argentina) - Hernán G. Solari

Universidad de Chile (Chile) - Carlos Conca

Universidade Federal Fluminense (Brazil) - Max Souza

Duration: 2016 - 2017

Start year: 2016

The spread of certain strains of the intracellular parasitic bacterium Wolbachia in populations of mosquitoes *Aedes aegypti* drastically reduces their competence as vector of dengue and other severe mosquito-borne viral diseases known as arboviral infections. In absence of vaccine, or of preventive or curative treatment, the release of mosquitoes infected by the bacterium has been recently considered a promising tool to control these diseases, and experimental introductions in wild populations are currently under way in Brazil and Colombia. A key question about this method concerns the effective strategies of release of the infected mosquitoes in the field that can be applied with limited cost to reach the desired state of complete exclusion of Wolbachia-free mosquitoes. The mathematical study of central topics is the core of this project. The scientific questions to be addressed during this project are related to the study of the dynamic and control of the key invasion mechanism on finite-dimensional compartmental models; and to specific focus on the spatial aspects, achieved through more elaborate models (PDE, models on interaction graphs, stochastic models). We further propose to elaborate on the risks involved in the spreading of Wolbachia, implementing in mathematical models critical analysis, complex systems (R. García) and a complexity aware epistemology (E. Morin) in contrast with the instrumental reason (Horkheimer).

8.3.1.2. *International Initiatives*

C17M01

Title: New methods for the control of epidemics of dengue and arboviroses

International Partner (Institution - Laboratory - Researcher):

Universidad del Valle (Colombia) - Olga Vasilieva

Duration: 2017 - 2019

Start year: 2017

8.4. International Research Visitors

8.4.1. Internships

September 2016-January 2017: Julie Favre, M1 student at EPFL (Zürich), research internship report [39]

8.4.2. Visits to International Teams

8.4.2.1. *Sabbatical programme*

Doumic Marie

Date: Sep 2016 - Jul 2018

Institution: Wolfgang Pauli Institute, Vienna (Austria)

8.4.2.2. *Research Stays Abroad*

P.-A. Bliman is still a professor at Funadação Getulio Vargas, Rio de Janeiro, Brazil, and makes frequent stays there.

MANAO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Carer xD: "Caractérisation et restitution du réel xD"

Currently, the characterization and display of the real world are limited to techniques focusing on a subset of the necessary physical phenomena. A lot of work has been done to acquire geometric properties. However, the acquisition of a geometry on an object with complex reflection property or dynamic behavior is still a challenge. Similarly, the characterization of a material is limited to a uniform object for complex material or a diffuse material when one is interested in its spatial variations.

To reach full interaction between real and virtual worlds (augmented reality, mixed reality), it is necessary to acquire the real world in all its aspects (spatial, spectral, temporal) and to return it as in all these dimensions. To achieve this goal, a number of theoretical and practical tools will be developed around the development of mixed reality solutions and the development of some theoretical framework that supports the entire project.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. "Young Researcher" VIDA (2017-2021)

LP2N-CNRS-IOGS Inria

Leader R. Pacanowski (LP2N-CNRS-IOGS)

Participant P. Barla (Inria)

9.2.1.2. Context.

Since the beginning of the industrial era, prototyping has been an important stage for manufacturers as a preliminary step before mass production. With the rise of Computer Science and the recent advances of intensive computation, the industry is progressively shifting from a tangible prototype to a fully numerical and virtual prototype with the goal of reducing costs during the R&D phase. During the past few years, the emergence of 3D printers has enabled virtual prototyping methods to take into account, at an early stage, some degree of fabricability, especially regarding the shape of the manufactured object. Beyond the shape of an object, predicting the final appearance of a virtual prototype remains a challenge of high potential for many domains (e.g., furniture, textile, architecture). The challenge is mainly due to the fact that the final appearance of an object is dependent on its shape, the material(s) applied on it as well as the viewing and lighting conditions. As shown in Figure 13, solving the inverse problem that goes from Pictorial Design [A] to the Operational Design [D], where a specialist controls the fabrication process, is very hard and ill-posed.

9.2.1.3. Scientific Objectives.

The VIDA project aims at removing the several scientific locks by establishing a framework for direct and inverse design of material appearance for objects of complex shape. Since the manufacturing processes are always changing and evolving, our goal is to establish a framework that is not tied to a fabrication stage. To provide a rich variety of possible appearances, we will target multi-layered materials. We will ensure that every step of our framework is **validated** by either predictive simulation and/or measurements of the appearance. To illustrate the fabricability of our results, material samples as well as object samples will be fabricated locally or out-sourced to *Ecole des Mines de Saint-Etienne* (<http://www.mines-stetienne.fr/en/EMSE>) or <http://www.saint-gobain-recherche.fr> Saint-Gobain Recherche and their appearance will also be validated with specific devices developed at the <https://www.institutoptique.fr/en> Institut d'Optique-<http://www.lp2n.fr> LP2N.

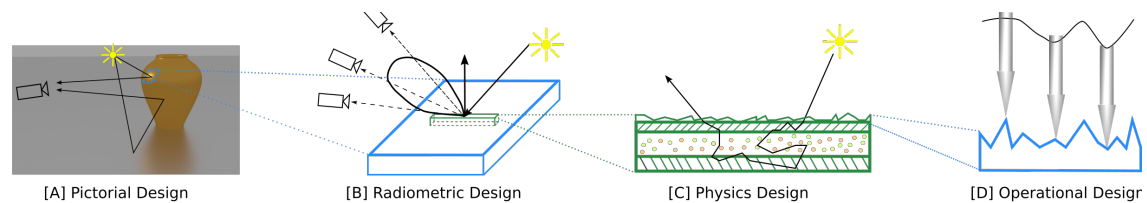


Figure 13. The different scales involved in the design of object appearance. [A] Pictorial scale: the object is seen as a whole. [B] Radiometric scale: represents the behaviour of a material when light interacts with it. [C] Microscopic scale: the material is described by physical parameters (e.g., index of refraction, absorption coefficient). [D] Operational scale: the parameters control the machine-dependent fabrication process.

9.2.1.4. “Young Researcher” RichShape (2014-2018)

MANAO

Leader G. Guennebaud

This project aims at the development of novel representations for the efficient rendering and manipulation of highly detailed shapes in a multi-resolution context.

9.2.1.5. ISAR (2014-2018)

POTIOC, MANAO, LIG-CNRS-UJF, Diatasoft

Leader M. Hachet (POTIOC)

The ISAR project focuses on the design, implementation and evaluation of new interaction paradigms for spatial augmented reality, and to systematically explore the design space.

9.2.1.6. MATERIALS (2015-2019)

MAVERICK, LP2N-CNRS (MANAO), Musée d’Ethnographie de Bordeaux, OCÉ-Print

Leader N. Holzschuch (MAVERICK)

Local Leader R. Pacanowski (LP2N-CNRS)

Museums are operating under conflicting constraints: they have to preserve the artifacts they are storing, while making them available to the public and to researchers. Cultural artifacts are so fragile that simply exposing them to light degrades them. 3D scanning, combined with virtual reality and 3D printing has been used for the preservation and study of sculptures. The approach is limited: it acquires the geometry and the color, but not complex material properties. Current 3D printers are also limited in the range of colors they can reproduce. Our goal in this project is to address the entire chain of material acquisition and restitution. Our idea is to scan complex cultural artifacts, such as silk cloths, capturing all the geometry of their materials at the microscopic level, then reproduce them for study by public and researchers. Reproduction can be either done through 2.5D printing or virtual reality displays.

9.2.1.7. FOLD-Dyn (2017-2021)

IRIT, IMAGINE, MANAO, TeamTo, Mercenaries

Leader L. Barthe (IRIT)

Local Leader G. Guennebaud (Inria)

The FOLD-Dyn project proposes the study of new theoretical approaches for the effective generation of virtual characters deformations, when they are animated. These deformations are two-folds: character skin deformations (skinning) and garment simulations. We propose to explore the possibilities offered by a novel theoretical way of addressing character deformations: the implicit skinning. This method jointly uses meshes and volumetric scalar functions. By improving the theoretical properties of scalar functions, the study of their joint use with meshes, and the introduction of a new approach and its formalism - called multi-layer 3D scalar functions - we aim at finding effective solutions allowing production studios to easily integrate in their pipeline plausible character deformations together with garment simulations.

9.2.2. Competitiveness Clusters

9.2.2.1. LabEx CPU

IMB (UPR 5251), LABRI (UMR 5800), Inria (CENTRE BORDEAUX SUD-OUEST), I2M (NEW UMR FROM 2011), IMS (UMR 5218), CEA/DAM

Some members of *MANAO* participate in the local initiative CPU. As it includes many thematics, from fluid mechanics computation to structure safety but also management of timetable, safety of networks and protocols, management of energy consumption, etc., numerical technology can impact a whole industrial sector. In order to address problems in the domain of certification or qualification, we want to develop numerical sciences at such a level that it can be used as a certification tool.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Invited professor: Pierre Poulin, professor at Université de Montréal, Visiting scholar program of IdEx Bordeaux

MARELLE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

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

- TECAP "Analyse de protocoles, Unir les outils existants", starting on October 1st, 2011, for 60 months, with a grant of 89 kEuros. Other partners are Inria teams PESTO (Inria Nancy grand-est), Ecole Polytechnique, ENS Cachan, IRISA Rennes, and CNRS. The corresponding researcher for this contract is Benjamin Grégoire.
- SafeTLS "La sécurisation de l'Internet du futur avec TLS 1.3" started on October 1st, 2016, for 60 months, with a grant of 147kEuros. Other partners are Université de Rennes 1, and secrétariat Général de la Défense et de la Sécurité Nationale. The corresponding researcher for this contract is Benjamin Grégoire.
- BRUTUS "Chiffrements authentifiés et résistants aux attaques par canaux auxiliaires", started on October 1st, 2014, for 60 months, with a grant of 41 kEuros for Marelle. Other partners are Université de Rennes 1, CNRS, secrétariat Général de la défense et de la sécurité nationale, and Université des Sciences et Technologies de Lille 1. The corresponding researcher for this contract is Benjamin Grégoire.
- FastRelax, "Fast and Reliable Approximations", started on October 1st, 2014, for 60 months, with a grant of 75 kEuros for Marelle. Other partners are Inria Grenoble (ARIC project-team), LAAS-CNRS (Toulouse), Inria Saclay (Toccata and Specfun project-teams), and LIP6-CNRS (Paris). The corresponding researcher for this contract is Laurence Rideau.

7.2. European Initiatives

7.2.1. Collaborations with Major European Organizations

We have sustained collaborations with the team of Thierry Coquand at Chalmers and the University of Göteborg in Sweden and with the team of Gilles Barthe at IMDEA in Spain.

7.3. International Initiatives

7.3.1. Informal International Partners

In September, we organized a meeting on formal proofs for cryptography, with the following attendants: Manuel Barbosa (Portugal), Gilles Barthe (Spain), Vincent Laporte (Spain), Jose Carlos Bacelar Almeida (Portugal), Pierre-Yves Strub (France), Ko Stoffelen (the Netherlands), Benoit Viguier (the Netherlands), Chitchanok Chuengsatiansup (France).

We have frequent visits by Gilles Barthe, François Dupressoir (IMDEA, Madrid) and visits of Benjamin Grégoire at IMDEA Madrid.

Benjamin Grégoire visited University of Minho in May to work on the Jasmin compiler with Manuel Barbosa.

In our activity to setup the Coq consortium, we have frequent interaction with A. Appel (U. Princeton), B. Pierce (U. Penn), Zhong Shao (Yale University), A. Chlipala (MIT), and G. Morrisett (Cornell University).

We received Reynald Affeldt from AIST for a 10-days visit in November.

MATHERIALS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

The project-team is involved in several ANR projects:

- S. Boyaval is the PI of the ANR JCJC project SEDIFLO (2016-2020) to investigate new numerical models of solid transport in rivers.
- G. Stoltz is the PI of the ANR project COSMOS (2014-2018) which focuses on the development of efficient numerical techniques to simulate high-dimensional systems in molecular dynamics and computational statistics. It includes research teams from Institut Mines-Telecom, Inria Rennes and IBPC Paris.
- E. Cancès is a member of the ANR project BECASIM (2013-2017), PI: I. Danaila (Université de Rouen). This project is concerned with the numerical simulation of Bose-Einstein condensates.
- F. Legoll is a member of the ANR project CINE-PARA (2015-2019), PI: Y. Maday, UPMC. This project is concerned with parallel-in-time algorithms.

Members of the project-team are participating in the following GdR:

- CORREL (correlated methods in electronic structure computations),
- EGRIN (gravity flows),
- MANU (Mathematics for NUclear applications)
- MASCOT-NUM (stochastic methods for the analysis of numerical codes),
- MEPHY (multiphase flows)
- DYNQUA (time evolution of quantum systems, with applications to transport problems, nonequilibrium systems, etc.),
- REST (theoretical spectroscopy),
- CHOCOLAS (experimental and numerical study of shock waves).

The project-team is involved in two Labex, namely the Labex Bezout (started in 2011) and the Labex MMCD (started in 2012).

9.2. European Initiatives

The ERC consolidator Grant MSMATH (ERC Grant Agreement number 614492, PI T. Lelièvre) is running (it started in June 2014).

9.3. International Initiatives

The *Germaine de Staël* grant awarded to S. Boyaval (from CampusFrance Hubert-Curien program) has been used in 2017 to pursue the collaboration with A. Caboussat (Lausanne) about 3D numerical simulations of free-surface flows.

T. Lelièvre, G. Stoltz and F. Legoll participate in the Laboratoire International Associé (LIA) CNRS / University of Illinois at Urbana-Champaign on complex biological systems and their simulation by high performance computers. This LIA involves French research teams from Université de Nancy, Université de Lyon and Université Aix-Marseille. The LIA is renewed for 4 years, starting January 1st, 2018.

MATHNEURO Team

5. Partnerships and Cooperations

5.1. European Initiatives

5.1.1. FP7 & H2020 Projects

5.1.1.1. HBP

Title: The Human Brain Project

Programm: FP7

Duration: October 2013 - March 2016 (first part) and then : April 2016 - March 2018 (second part)

Coordinator: EPFL

Partners:

see the [webpage](#) of the project.

Inria contact: Olivier Faugeras (first part) and then : Romain Veltz (second part)

Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases.

This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics, Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity.

A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

5.2. International Research Visitors

5.2.1. Visits of International Scientists

Invitation of Antoni Guillamon (as part of a sabbatical semester), Polytechnic University of Catalonia (Spain), March-April 2017

Invitation of Vivien Kirk, University of Auckland (New Zealand), April 2017

Invitation of Jeff Moehlis, University of California Santa Barbara (USA), April 2017

Invitation of Martin Wechselberger, University of Sydney (Australia), August 2017

Invitation of Cian O'Donnell, University of Bristol (UK), September 2017

MATHRISK Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- ANR Cosmos 2015-2018, Participant: B. Jourdain ; Partners : Ecole des Ponts, Telecom, Inria Rennes and IBPC

8.1.2. Competitvity Clusters

Pôle Finance Innovation.

8.2. International Initiatives

8.2.1. Informal International Partners

- Center of Excellence program in Mathematics and Life Sciences at the Department of Mathematics, University of Oslo, Norway, (B. Øksendal).
- Kings College, London (R. Dumitrescu)
- Department of Mathematics, University of Manchester (Tusheng Zhang, currently in charge of an EU-ITN program on BSDEs and Applications).
- Kensas University (Yaozhong Hu)
- Cornell University, ORIE department (Andreea Minca)
- Mannheim University (Alexander Schied, Chair of Mathematics in Business and Economics, Department of Mathematics)
- Roma Tor Vergata University (Lucia Caramellino)
- Ritsumeikan University (A. Kohatsu-Higa).

8.3. International Research Visitors

- Oleg Kudryavtsev, Rostov University (Russia)
- Martino Grasselli, Padova University,

8.3.1. Visits of International Scientists

8.3.1.1. Internships

- Adel Cherchali (June to August 2017): Multilevel Monte-Carlo methods for nested expectations. Supervisor: A. Alfonsi.
- Zeqi Chen (ENSTA), May -July , Supervisor: A. Zanette
- Mohamed Homed, April-September, Supervisor: A. Zanette
- Xinglong Tian (ENSTA), May-July 2017, Supervisor: A. Zanette
- Sebastien Villette, April-October, Supervisor: A. Zanette

MAVERICK Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

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

Maverick is part of the GPU Research Center labeled by nVIDIA at Inria Grenoble. Team contact: Fabrice Neyret.

8.2. National Initiatives

8.2.1. ANR CONTINT: MAPSTYLE

Participants: Joëlle Thollot [contact], Hugo Loi.

The MAPSTYLE project aims at exploring the possibilities offered by cartography and expressive rendering to propose original and new cartographic representations. Through this project, we target two types of needs. On the one hand, mapping agencies produce series paper maps with some renderings that are still derived from drawings made by hand 50 years ago: for example, rocky areas in the series TOP25 (to 1/25000) of the French Institut Géographique National (IGN). The rendering of these rocky areas must be automated and its effectiveness retained to meet the requirements of hikers safety. On the other hand, Internet mapping tools allow any user to become a cartographer. However, they provide default styles that cannot be changed (GeoPortal, Google Maps) or they are editable but without any assistance or expertise (CloudMade). In such cases, as in the case of mobile applications, we identify the need to offer users means to design map styles more personalised and more attractive to meet their expectations (decision-making, recreation, etc.) and their tastes. The grant started on October 2012, for 48 months.

8.2.2. 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.

8.2.3. 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.

8.2.4. 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.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

Title: “MAIS”: Mathematical Analysis of Image Synthesis

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada) - Département d'Informatique et Recherche Opérationnelle - Derek Nowrouzezahrai

Duration: 2015 - 2019

Start year: 2015

See also: <http://diro.umontreal.ca/accueil/>

8.3.1.2. Indo-French Center of Applied Mathematics

Topology-driven Visualization of Scientific Data

Title: Topology-driven Visualization of Scientific Data

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Department of Science and Automation - Vijay Natarajan

Duration: Sept 2016 - Sept 2017

One of the greatest scientific challenges of the 21st century is how to master, organize, and extract useful knowledge from the overwhelming flow of information made available by today's data acquisition systems and computing resources. Visualization is the premium means of taking up this challenge. Topological analysis has recently emerged as a powerful class of methods for visualizing data. From the input data, these methods derive combinatorial structures capturing the essential features of the data. The goal of this project is to design new topological structures, study their properties, and develop efficient algorithms to compute them. In order to solve this challenge, we will combine our expertise in Topology for the Indian partner and in Geometric Modeling for the French partner. We plan to develop new geometric models that accurately and intuitively depict the topological combinatorial structures.

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

- Alexandre Bléron has made a 3 months internship to work with Hock Soon Seah on 3D stylization in the MAGIC group of Nanyang Technological University of Singapore.
- Alban Fichet is making a 12 months stay at Charles University in Prague, to work with Alexander Wilkie and Jaroslav Krivanek on material models.
- Guillaume Loubet has made a 3 months internship in the Hyperion group at Disney, Los Angeles.

MCTAO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Weak KAM beyond Hamilton-Jacobi (WKBHJ). Started 2013 (decision ANR-12-BS01-0020 of December 19, 2012), duration: 4 years. L. Rifford is in the scientific committee.

Sub-Riemannian Geometry and Interactions (SRGI). Started 2015 (decision ANR-15-CE40-0018), duration: 4 years. L. Rifford is a member.

Intéractions Systèmes Dynamiques Équations d'Évolution et Contrôle (ISDEEC). Started 2016 (decision ANR-16-CE40-0013), duration: 4 years. L. Rifford is a member.

Maximic: optimal control of microbial cells by natural and synthetic strategies. Started 2017, duration: 4 years. J.-B. Caillaud, L. Giraldi, J.-B. Pomet are members.

8.1.2. Others

The McTAO team participates in the **GdR MOA**, a CNRS network on Mathematics of Optimization and Applications.

PGMO grant (2016-2017) on "Metric approximation of minimizing trajectories and applications" (PI J.-B. Caillaud). This project involves colleagues from Université Paris Dauphine and has funding for one year, including one intership (M2 level).

PGMO grant (2017-2019) on "Algebro-geometric techniques with applications to global optimal control for Magnetic Resonance Imaging (MRI)". B. Bonnard, A. Nolut and J. Rouot participate in this project, the PI is O. Cots, from ENSEIHT, Toulouse.

J.-B. Caillaud is associate researcher of the team of the CNRS team **Parallel Algorithms & Optimization team** at ENSEIHT, Univ. Toulouse.

Défi InfIniti CNRS project, Control and Optimality of Magnetic Microrobot, (PI L. Giraldi). Started 2017, duration: 1 years. This project involves colleagues from Université Paris 6, from University of York (UK) and University of Padova (Italie). Y. El Alaoui Faris, C. Moreau, L. Giraldi, J.-B. Pomet are members.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: FCT (Fundação para a Ciência e a Tecnologia, Portugal)

Project acronym: None

Project title: Extremal spectral quantities and related problems

Duration: 2016-2019

Coordinator: P. Freitas

Other partners: Inria, Univ. Luxembourg, Univ. Lisbon, Prague Czech Technical Univ., Univ. Bern

Abstract: The purpose of this project is to combine analytic, geometric and computational techniques to study extremal values of different spectral quantities, such as individual eigenvalues, functions of these eigenvalues and some global spectral quantities. More specifically, some of the objects under consideration are the possible extremal sets of the first eigenvalue of the Laplacian with Robin boundary conditions, for which team members have recently shown that the ball is no longer an optimiser for large negative values of the boundary parameter, thus providing a counter-example to a 1977 conjecture, finite combinations of eigenvalues of the Laplace and Schrödinger operators, the functional determinant associated with these operators and the spectral abscissa of the (non self-adjoint) operator associated with the damped wave equation. To handle these problems a wide range of methods is required, including those from geometric analysis, functional analysis, control theory, numerical analysis, etc.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Hermes Gadhêla (Univ. of York), November, 2017. Collaboration on PDE vs ODE models for elastic swimmers.

Izhar Or (Technion), September, 2017. Collaboration on magnetic micro-swimmers.

Sorin Sabau (Tokai Univ.), November, 2017. Collaboration on Finsler geometry.

Romain Serra (Univ. of Strathclyde, Glasgow), October, 2017. Collaboration on space mechanics.

Martha Zoppello (University of Padova), February, 2017. Collaboration on magnetic micro-swimmers.

MEMPHIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Leading team of the regional project "Investigation and Modeling of Suspensions" with the LOMA and LOF labs in Bordeaux

9.2. National Initiatives

We belong to the GDR AMORE on ROMs.

9.2.1. Starting grants

NEMO (A Numerical Enabler for MultiPhysics Simulations on Octrees) is an action to improve and merge all the main MEMPHIS numerical codes. To achieve this goal we have a 12 months financial support (Inria BSO FRM) for a young engineer. This work will be done with strong interaction with the local Inria BSO SED as well as Philippe Depouilly from the IMB "SED".

SMecH is a start-up project in software edition, carried on by Florian Bernard, research engineer in the MEMPHIS team. The project aims at porting to an industrial level the numerical codes developed by the MEMPHIS team. The different collaboration with industrial partners have highlighted the need of new numerical tools to simulate high complexity phenomena such as atmospheric reentries, multi-material flows or fluid-structure interactions, but also to highly automatize the numerical simulation workflow to save engineer time. The research codes developed in the MEMPHIS team could match perfectly to this need thanks to:

- the various innovative multi-physics models implemented
- the use of Hierarchical Cartesian schemes that automatize the treatment of moving geometry with accuracy
- the development of schemes suitable for High Parallel Computing.

This year, the project has been submitted to the DGD, the Inria department in charge of technological transfert, and has been granted an engineer for 6 months as well as the support of IT-Translation.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

EU research projects were and will be a privileged instrument of diffusion and transfer of our results. The AEROGUST H2020 project involves aeronautical industry (Airbus, Dassault, Piaggio...) and research labs (University of Bristol, DLR, NLR, University of Cape Town) and is dedicated to modeling of aerodynamic gust response for applications. We take part in this project by developing simulation models for unsteady aeroelastic problems and data-driven reduced-order models. We played a similar role for the past in the FP7 project FFAST with the same partners.

9.3.1.1. AEROGUST

Title: Aeroelastic Gust Modelling

Programm: H2020

Duration: May 2015 - April 2018

Coordinator: University of Bristol

Partners:

Airbus Defence and Space (Germany)

University of Cape Town (South Africa)

Dassault Aviation (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Stichting Nationaal Lucht- en Ruimtevaartlaboratorium (Netherlands)

Numerical Mechanics Applications International (Belgium)

Optimad Engineering S.R.L. (Italy)

Piaggio Aero Industries Spa (Italy)

The University of Liverpool (United Kingdom)

University of Bristol (United Kingdom)

Valeol (France)

Inria contact: Angelo IOLLO and Michel Bergmann

Encounters with atmospheric turbulence are a vitally important in the design and certification of many manmade structures such as aircraft and wind turbines. Gusts cause rapid changes in the flow about the structures which leads to rigid and flexible unsteady responses. Knowledge of aircraft/gust interactions is therefore vital for loads estimation during aircraft design as it impacts on control systems and often defines the maximum loads that these structures will experience in service. At present industry typically uses the linear doublet lattice method with static loads corrections from expensive wind tunnel data. The wind tunnel data is created using the final aerodynamic surface in the predicted cruise shape. This means that gust loads come relatively late when the design options have been narrowed. Increased competition and environmental concerns are likely to lead to the adoption of more flexible materials and the consideration of novel configurations, in which case the linear assumptions of the current gust loads process will become unacceptable. To introduce non-linearity into the gust loads process without significantly increasing the cost and time, this project has three main objectives: to carry out investigations using CFD so that the non-linearities in gust interactions are understood; to create a gust loads process that does not require wind tunnel data and hence reduces the need for wind tunnel testing; to develop updated reduced order models for gust prediction that account for non-linearity at an acceptable cost. These investigations will reduce the need for expensive wind tunnel testing and hence lead to time and cost savings at the design stage therefore ensuring that the European aerospace and defense industry remain competitive in the future. The wind turbine industry has similar concerns, with gusts and wind shear restricting the locations available for wind farms. The project will also address these issues using common methodology.

9.3.2. Collaborations with Major European Organizations

Partner 1: Chalmers University (Sweden)

This activity is complemented by several international interactions, in particular with Chalmers University in order to converge towards the real implementation of new control technologies on cars, buses and trucks.

Partner 2: Optimad Engineering , Torino (Italy)

We have a crucial partnership with Optimad Engineering, a spin-off of the Politecnico di Torino. This society has implemented in industrial codes several schemes that we have developed for the past. In exchange, we have access to these codes. One example is Pablo, an octree managing parallel library (<http://www.optimad.it/products/pablo/>). Three former PhD students at Inria are presently employed in Optimad and several others have spent or will spend a research period in this company in order to get acquainted with code architecture and massive parallelism. This company represents for us an ideal partner for the actual industrial feedback on our methods. As mentioned, we plan to create a local start-up in close collaboration with Optimad. This start-up will respond to actual industrial needs by specific software packages built starting from open source tools that are made available to the applied research community via a consortium. Florian Bernard has been recruited in Memphis for two years with the objective of bringing to a higher maturity level a set of modules developed within the team. He plans to fully invest himself in the creation of the start-up. As for the consortium, we are discussing with several partners including Cineca (Italy HPC center) and Optimad about how to structure such a mutual effort. The Storm Inria team is included in the discussions as a possible partner.

Partner 3: W4E (Wave for Energy) (Italy)

One project is the design of an ISWEC (Inertial Sea Wave Energy Converter) in collaboration with W4E (Wave for Energy), Optimad and others. The ISWEC is a floater prototype that can extract energy from the sea waves. The mechanism is based on a gyroscope that is rotating due to the passive motion of the floater. This prototype is actually tested in the Mediterranean sea in Italy. We will develop the numerical simulation as well as the shape optimization of the ISWEC.

Partner 4: MRGM (Maladies Rares : Génétique et Métabolisme), Bordeaux University (France)

We develop a collaboration with the MRGM lab. They are interested in the swimming of a zebrafish larvae under genetic modifications. One aim is to quantify the power spent by such fishes to swim after a stimuli reaction. The numerical simulation we develop can help computing integral quantities such as the power. This simulation is challenging due to the coupling several methods like image treatment (from movies given by MRGM), optimal transport and numerical simulations.

Partner 5: CRPP (Centre de recherche Paul Pascal), LOF (Laboratoire du Futur) and LOMA (Laboratoire Ondes et Matière d'Aquitaine) labs, Bordeaux University, France.

We established collaborations with physics and chemistry labs in Bordeaux, namely the CRPP, the LOF and the LOMA. They are concerned with the behavior of many passive (CRPP and LOF) and active (LOMA) particles in an incompressible flow. With these partners, we intend to use a combined experimental and computational approach to calibrate models in the case of dilute and concentrated suspensions. The numerical simulations of such particles can help to understand some underlying phenomena at the particles scale and thus to develop mesoscopic models for the whole system (PhD of Baptiste Lambert, oct. 2015).

9.4. International Research Visitors

9.4.1. Visits to International Teams

We have obtained a grant from the Idex Bordeaux of 10*keuro* to start a collaboration with Charbel Farhat of Stanford University on ROMs.

MEPHYSTO Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. ANR BECASIM

G. Dujardin is a member of the ANR BECASIM project (<http://becasim.math.cnrs.fr/>). This ANR project gathers mathematicians with theoretical and numerical backgrounds together with engineers. The objective is to develop numerical methods to accurately simulate the behavior of Bose-Einstein condensates.

Title: Simulation numérique avancée pour les condensats de Bose-Einstein.

Type: Modèles Numériques - 2012.

ANR reference: ANR-12-MONU-0007.

Coordinator: Ionut DANAILA, Université de Rouen.

Duration: January 2013 - December 2017.

Partners: Université Lille 1, UPMC, Ecole des Ponts ParisTech, Inria-Nancy Grand-Est, Université Montpellier 2, Université Toulouse 3.

5.1.2. ANR EDNHS

M. Simon is a member of the ANR EDNHS project.

Title: Diffusion de l'énergie dans des système hamiltoniens bruités.

Type: Défi de tous les savoirs (DS10) 2014.

ANR reference: ANR-14-CE25-0011.

Coordinator: Cédric Bernardin, Université de Nice.

Duration: October 2014 - October 2019.

5.1.3. Labex CEMPI

Title: Centre Européen pour les Mathématiques, la Physique et leurs Interactions.

Coordinator: Stephan De Bièvre.

Duration: January 2012 - December 2019.

Partners: Laboratoire Paul Painlevé and Laser physics department (PhLAM), Université Lille 1.

The "Laboratoire d'Excellence" Centre Européen pour les Mathématiques, la Physique et leurs interactions (CEMPI), a project of the Laboratoire de Mathématiques Paul Painlevé and the Laboratoire de Physique des Lasers, Atomes et Molécules (PhLAM), was created in the context of the "Programme d'Investissements d'Avenir" in February 2012.

The association Painlevé-PhLAM creates in Lille a research unit for fundamental and applied research and for training and technological development that covers a wide spectrum of knowledge stretching from pure and applied mathematics to experimental and applied physics.

One of the three focus areas of CEMPI research is the interface between mathematics and physics. This focus area encompasses three themes. The first is concerned with key problems of a mathematical, physical and technological nature coming from the study of complex behavior in cold atoms physics and non-linear optics, in particular fibre optics. The two other themes deal with fields of mathematics such as algebraic geometry, modular forms, operator algebras, harmonic analysis and quantum groups that have promising interactions with several branches of theoretical physics.

5.1.4. PEPS “Jeunes Chercheurs”

M. Simon obtained a CNRS grant "PEPS Jeunes Chercheurs" for a project in collaboration with Oriane Blondel (Université Lyon 1), Clément Erignoux (IMPA, Rio de Janeiro) and Makiko Sasada (Tokyo University).

5.1.5. MIS

Incentive Grant for Scientific Research (MIS) of the Fonds National de la Recherche Scientifique (Belgium).

Title: Patterns, Phase Transitions, 4NLS & BIon.

Coordinator: D. Bonheure.

Duration: January 2014 - December 2016.

Partner: Université libre de Bruxelles.

5.1.6. PDR

Research Project (PDR) of the Fonds National de la Recherche Scientifique (Belgium).

D. Bonheure is co-investigator of this PDR.

Title: Asymptotic properties of semilinear systems.

Coordinator: Christophe Troestler (UMons).

Duration: July 2014 - June 2018.

Partner: Université de Mons, Université catholique de Louvain, Université libre de Bruxelles.

5.2. European Initiatives

5.2.1. FP7 & H2020 Projects

5.2.1.1. QUANTHOM

Title: Quantitative methods in stochastic homogenization.

Program: FP7.

Duration: February 2014 - August 2017.

Coordinator: Inria.

Partner: Département de mathématique, Université Libre de Bruxelles (Belgium).

Inria contact: Antoine Gloria.

This proposal deals with the development of quantitative tools in stochastic homogenization, and their applications to materials science. Three main challenges will be addressed. First, a complete quantitative theory of stochastic homogenization of linear elliptic equations will be developed starting from results we recently obtained on the subject combining tools originally introduced for statistical physics, such as spectral gap and logarithmic Sobolev inequalities, with elliptic regularity theory. The ultimate goal is to prove a central limit theorem for solutions to elliptic PDEs with random coefficients. The second challenge consists in developing an adaptive multiscale numerical method for diffusion in inhomogeneous media. Many powerful numerical methods were introduced in the last few years, and analyzed in the case of periodic coefficients. Relying on my recent results on quantitative stochastic homogenization, we have made a sharp numerical analysis of these methods, and introduced more efficient variants, so that the three academic examples of periodic, quasi-periodic, and random stationary diffusion coefficients can be dealt with efficiently. The emphasis of this challenge is put on the adaptivity with respect to the local structure of the diffusion coefficients, in order to deal with more complex examples of interest to practitioners. The last and larger objective is to make a rigorous connection between the continuum theory of nonlinear elastic materials and polymer-chain physics through stochastic homogenization of nonlinear problems and random graphs. Analytic and numerical preliminary results show the potential of this approach. We plan to derive explicit constitutive laws for rubber from polymer chain properties, using the insight of the first two challenges. This requires a good understanding of polymer physics in addition to qualitative and quantitative stochastic homogenization.

5.2.2. HyLEF

M. Simon is a collaborator of the ERC HyLEF project.

- Title: Hydrodynamic Limits and Equilibrium Fluctuations: universality from stochastic systems.
- Duration: May 2017 - April 2022.
- Coordinator: P. Gonçalves, Instituto Superior Técnico, Lisbon.
- A classical problem in the field of interacting particle systems (IPS) is to derive the macroscopic laws of the thermodynamical quantities of a physical system by considering an underlying microscopic dynamics which is composed of particles that move according to some prescribed stochastic, or deterministic, law. The macroscopic laws can be partial differential equations (PDE) or stochastic PDE (SPDE) depending on whether one is looking at the convergence to the mean or to the fluctuations around that mean.

One of the purposes of this research project is to give a mathematically rigorous description of the derivation of SPDE from different IPS. We will focus on the derivation of the stochastic Burgers equation (SBE) and its integrated counterpart, namely, the KPZ equation, as well as their fractional versions. The KPZ equation is conjectured to be a universal SPDE describing the fluctuations of randomly growing interfaces of 1d stochastic dynamics close to a stationary state. With this study we want to characterize what is known as the KPZ universality class: the weak and strong conjectures. The latter states that there exists a universal process, namely the KPZ fixed point, which is a fixed point of the renormalization group operator of spacetime scaling 1:2:3, for which the KPZ is also invariant. The former states that the fluctuations of a large class of 1d conservative microscopic dynamics are ruled by stationary solutions of the KPZ.

Our goal is threefold: first, to derive the KPZ equation from general weakly asymmetric systems, showing its universality; second, to derive new SPDE, which are less studied in the literature, as the fractional KPZ from IPS which allow long jumps, the KPZ with boundary conditions from IPS in contact with reservoirs or with defects, and coupled KPZ from IPS with more than one conserved quantity. Finally, we will analyze the fluctuations of purely strong asymmetric systems, which are conjectured to be given by the KPZ fixed point.

5.3. International Initiatives

5.3.1. Inria International Partners

5.3.1.1. Informal International Partners

Max Planck Institute for Mathematics in the Sciences: long-term collaboration with Felix Otto on stochastic homogenization.

University of Umea: long-time collaboration with David Cohen on numerical methods for the numerical integration of stochastic evolution problems.

5.4. International Research Visitors

5.4.1. Research Stays Abroad

M. Simon spent three weeks in Berkeley University, visiting Pr. Alan Hammond (July 2017).

M. Simon spent two weeks at Braga University, as a guest of P. Gonçalves (September 2017).

MEXICO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- Thomas Chatain, Stefan Haar , Serge Haddad and Stefan Schwoon are participating in the ANR Project **ALGORECELL**.
- Matthias Függer participates in the ANR project FREDDA.

8.2. International Initiatives

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

8.2.1.1. LifeForm

Title: Life Sciences need formal Methods !

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2016

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

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

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Joost-Pieter Katoen, Aachen, spent two weeks with MEXICO.

8.3.1.1. Internships

Aalok Thakkar, 2nd year student from CMI (India), did a two-month research internship on 'Semantics of Mutation Dynamics' under the supervision of Stefan Haar, from May 2nd to July 21st, 2017.

8.3.2. Visits to International Teams

MIMESIS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Institute of Image-Guided Surgery (IHU) Strasbourg

The Institute of Image-Guided Surgery of Strasbourg develops innovative surgery to deliver personalized patient care, combining the most advanced minimally invasive techniques and the latest medical imaging methods.

Project *CIOS Alpha Fusion* funded by IHU Strasbourg has started at the beginning of 2017. The goal of the project is to develop a solution for real-time, accurate, image fusion between 3D anatomical data and 2D X-ray images. This requires to spatially align these two imaging datasets with each other, knowing that a deformation has occurred between the 2 acquisitions. We consider two different cases, of increasing scientific complexity: static image fusion using 2 fluoroscopic images taken at 2 different angles, and dynamic image fusion using a single fluoroscopic image. We also consider two additional scenarios: in the first one, a 3D image or a 3D model has been obtained from a preoperative CTA or MRA while in the second scenario it has been acquired using an intra-operative contrast-enhanced CBCT. In the second case, tissue deformation between the 2D and 3D data is significantly reduced.

The project team involves scientists from the MIMESIS team at Inria, engineers from Siemens as industrial partner, and clinicians from the NHC hospital and IHU.

9.1.2. Research and Clinical Partners

At the regional level, the MIMESIS team collaborates with

ICube Automatique Vision et Robotique (AVR): We have been collaborating with the medical robotics team on percutaneous procedures, in particular robotized needle insertion (with Prof. Bernard Bayle), and needle tracking in medical images (with Elodie Breton). We are also collaborating with Jonathan Vappou on elastography.

ICube Informatique Géométrique et Graphique (IGG): MIMESIS joined the IGG team and develops collaboration in the domain of dynamic topologies, mainly through the use of the CGoGN framework. CGoGN is a C++ library for the manipulation of meshes. It implements combinatorial maps and their multiresolution extensions and has been used in various high level application like the simulation of crowds of autonomous agents and the simulation of cuts, tears and fractures in the context of surgical simulations.

Nouvel Hôpital Civil, Strasbourg: since 2014 we have been working with Prof. David Gaucher, an ophthalmologist and expert in retina surgery. This led to the submission of the ANR project RESET which started in March 2015. We also collaborate with Prof. Patrick Pessaux, a surgeon who helps us in the context of the SOFA-OR project.

9.2. National Initiatives

9.2.1. ADT (*Action de Développement Technologique*)

Team MIMESIS received a support for the development of the SOFA framework through two ADTs:

DynMesh (Sep 2015 – Aug 2017): The objectives of the ADT was the coupling of SOFA, the physical simulation platform supported by Inria, and CGoGN, the mesh management library developed within the ICube lab at Strasbourg. The goal is to extend the physical engine SOFA with the topological kernel of CGoGN that supports a wide variety of mesh and many local remeshing operations. The coupling of both software libraries will provide users of physical engines with new tools for the development of simulations involving topological changes like cutting, fracturing, adaptation of the resolution or improving contact management or collision detection. The impacts are numerous and will be operated directly within the MIMESIS Team, with our partners or through the establishment of new collaborations.

ASNAP (*Accélération des Simulations Numériques pour l'Assistance Peropératoire*, Jan 2017 – Dec 2018). We are partners of ADT ASNAP with principal investigator being Inria team CAMUS. The goal of the project is a significant acceleration of physics-based simulations developed by MIMESIS. The technologies such as Apollo, XFOR, ORWL, developed by team CAMUS are used to optimize the execution of different components of framework SOFA, taking into account the possibilities provided by modern CPUs and GPGPUs. Since team CAMUS is also located in Strasbourg, the project benefits from the geographical location: an engineer Maxim Mogé was recruited, starting from 01/01/2017 and he shares his time between the two teams.

9.2.2. ANR (*Agence Nationale de la Recherche*)

MIMESIS participates in the following ANR projects:

RESET: This project started in March 2015 and will end in May 2017. Its objective is to develop a high-fidelity training system for retinal surgery. Retinal surgery is an increasingly performed procedure for the treatment of a wide spectrum of retinal pathologies. Yet, as most micro-surgical techniques, it requires long training periods before being mastered. This simulator is built upon our scientific expertise in the field of real-time simulation, and our success story for technology transfer in the field of cataract surgery simulation (MSICS simulation developed for the HelpMeSee foundation).

Coordinator: MIMESIS

Partners: the InSimo company, the AVR team of the ICube lab.

EVEREST: The overall objective of the EVEREST project is thus to bring a leap forward in factorization of large sparse tensors in order to improve the accessibility, completeness and reliability of real-world KBs. This line of research could have a huge impact in industry (Semantic Web, biomedical applications, etc.). For that reason, Xerox Research Center Europe is supporting this project and will supply data, provide expertise and ease industrial transfer. This proposal is also consistent with the long-term research direction of its principal partner, Heudiasyc, since it contributes in several aspects of the 10 years LabEx program on *Technological Systems of Systems* started in 2011.

Coordinator: IHU Strasbourg

Partners: Inria, IRCAD, University of Strasbourg, Siemens Healthcare, Karl Storz GmbH., University of Twente

9.2.3. Inria Collaborations

MIMESIS is closely connected to the SOFA Consortium, created by Inria in November 2015 with the objective to support the SOFA community and encourage contributions from new SOFA users. The Consortium should also be a way to better answer to the needs of academic or industrial partners. MIMESIS actively participates at the development of SOFA and contributed to the evolution of the framework. Moreover, MIMESIS also participates in an initiative aiming at verification and validation of codes and algorithms of SOFA.

Further, MIMESIS actively collaborates with the following Inria teams:

MAGRIT: The team at Inria Grand Est focuses on research in computer vision and is also actively involved in computer-based solutions for the planning or the simulation of interventional radiology procedures, with a strong collaboration with the CHU in Nancy. We collaborate with MAGRIT in the area of interventional radiology and augmented reality. Currently, two PhD thesis are co-supervised by researcher from Magrit: the PhD thesis of Jaime Garcia Guevara and Raffaella Trivisonne.

CAMUS: The team focuses on developing, adapting and extending automatic parallelizing and optimizing techniques, as well as proof and certification methods, for the efficient use of current and future multi-core processors. Currently, we collaborate with team CAMUS on parallelization of framework SOFA in ADT project ASNAP.

DEFROST: The team conducts research in soft robotics. We continue mutual interaction with DEFROST mainly in the context of contact modeling.

9.2.4. National Collaborations

At the national level, the MIMESIS team collaborates with:

The TIMC laboratory(*Techniques de l'Ingénierie Médicale et de la Complexité*) in Grenoble: this large research group has a strong background in computer-aided surgery, medical imaging, registration, statistical and bio-mechanical modeling. We have regular interactions with various members of this group. We are collaborating with Yohan Payan (DR CNRS) on the modeling and simulation of the brain shift. A common PhD thesis started on that topic in late 2014. Other areas of interest are in the field of advanced soft tissue modeling and computer aided surgery.

The LML laboratory(*Laboratoire de Mécanique de Lille*): a French research laboratory (UMR CNRS 8107) part of the Carnot institute ARTS. With more than two hundred researchers, LML focuses on the following research areas: mechanical reliability and Tribology, fluid mechanics, civil engineering and soil mechanics.

Hôpital Paul-Brousse: a hospital in South Paris. We collaborate with *Centre Hépato-Biliaire* via the co-supervision of the Ph.D. thesis of Nicolas Golse, MD, who is a surgeon at the center.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: H2020, Innovative Training Network, MSCA

Project acronym: HiPerNav

Project title: High performance soft tissue navigation

Coordinator: Oslo University Hospital

Other partners: SINTEF Trondheim, University of Bern

Abstract: HiPerNav is an Innovative Training Network (ITN) funded through a Marie Skłodowska-Curie grant. There will be 14 fully funded and 2 partially funded PhD's working on the project. The project aims to improve soft tissue navigation through research and development, to improve several bottleneck areas:

- Creating effective pre-operative model(s) and planning
- Faster and more accurate intra-operative model updates
- Faster and more accurate model-to-patient registration
- More intuitive user-interaction and effective work flow
- Usage of high performance computing (e.g. GPU)

9.3.2. Informal Collaborations

University of Twente: Thanks to our clinical partner IHU, we collaborate with Prof. Stefano Stramigioli, head of a group at Robotics and Mechatronics laboratory.

Faculty of Informatics, Masaryk University, Czech Republic: We collaborate on simulation of living cells in fluorescent microscopy. The collaboration resulted in a presentation at an international conference [29] and a journal paper [18].

Team Legato, University of Luxembourg: we have an active collaboration with Prof. Stéphane Bordas on error estimation in real-time simulations of deformable objects. The collaboration resulted in a common publication [16].

9.4. International Initiatives

The MIMESIS team actively collaborates with following international partners:

CIMIT & Harvard Medical School, Boston, USA: We collaborate on a project REBOASim in the context of interventional radiology, in particular the design and development of a hardware interface for tracking catheters and guidewires. The common DoD project REBOASim focuses on development of the physics-based models for catheter and guidewire motion, blood flow and graphical rendering towards a novel simulator for REBOA that will include physical vascular access, simulated passage of the IR instruments into the aorta with accompanying training/educational content, device withdrawal and closure: Duration of the project: Feb 2017 – Feb 2019.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

From Feb 2017 to July 2017, **Prof. Adam Wittek** joined team MIMESIS as a visiting scientist. Prof. Wittek is with Intelligent Systems for Medicine Laboratory, School of Mechanical and Chemical Engineering at the University of Western Australia, Perth. His research focuses on patient-specific biomechanical modeling and he has published an important number of high-quality publications on this topic with more than 2,000 citations.

During his stay, Prof. Wittek provided his highly valuable expertise in various domains of patient-specific simulations and advanced techniques of modeling of deformations in soft tissues such as meshless methods. He was also involved in projects related to insertions of flexible needles into soft tissues.

9.5.1.1. Internships

From Jul 2017 to Dec 2017, Vincent Magnoux, a Canadian PhD student from École polytechnique de Montréal, joined MIMESIS as an international intern. During his stay, he has worked on implementing and validating a meshless method for computing organ deformation. This work also involved exploring methods to accelerate these computations on multi-core systems for an interactive simulation.

MIMETIC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- SATT "Ouest valorisation" grant for the maturation of the Kimea software and projet (Franck Multon and Pierre Plantard). 12 months of three full-time people 300K€. Creation of the start-up company planned beginning of 2018.
- SATT "Ouest valorisation" grant for the maturation of the Populate software (Fabrice Lamarche). One full-time engineer (2017-2018).

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. Cineviz

Participants: Marc Christie [contact], Christophe Lino, Quentin Galvane, Hui-Yin Wu.

Cineviz is a 3-year ANR LabCom project (2016-2019). Amount: 300k€. Parnters: SolidAnim, UR1.

The project is a bilateral collaboration with the SolidAnim company. The objective is to jointly progress on the design and implementation of novel tools for the preproduction in the film industry. The project will address the challenges related to (i) proposing expressive framing tools, (ii) integrating the technical aspects of shooting (how to place the cameras, lights, green sets) directly at the design stage), and (iii) novel interaction metaphors for designing and controlling the staging of lights in preproduction, using an example-based approach.

9.2.1.2. Entracte

Participants: Charles Pontonnier [contact], Georges Dumont, Franck Multon, Pierre Plantard, Ana Lucia Cruz Ruiz, Antoine Muller, Anthony Sorel, Nicolas Bideau, Richard Kulpa.

The ANR project ENTRACTE is a collaboration between the Gepetto team in LAAS, Toulouse (head of the project) and the Inria/MimeTIC team. The project started in November 2013 and ended in August 2017. The purpose of the ENTRACTE project is to address the action planning problem, crucial for robots as well as for virtual human avatars, in analyzing human motion at a biomechanical level [16] and in defining from this analysis bio-inspired motor control laws and bio-inspired paradigms for action planning. The project is launched since november 2013 and Ana Lucia Cruz Ruiz, who has been recruited as a PhD student since this date, defended her thesis on muscle-based control based on synergies last year.

9.2.2. National scientific collaborations

9.2.2.1. Cavaletic

Participant: Franck Multon [contact].

The Cavaletic collaborative project is leaded by University Bretagne Sud and also involves University Rennes2 (CREAD Lab.). It has been funded by the National IFCE (Institut Français du Cheval et de l'Equitation) in order to develop and evaluate technological assistance in horse riding learning, thanks to a user-centered approach. MimeTIC is involved in measuring expert and non-expert horse riders' motions in standardized situations in order to develop metrics to measure riders' performance. It will be used to develop a technological system embedded on users to evaluate their performance and provide them with real-time feedback to correct potential errors.

9.2.2.2. FFT

Participants: Richard Kulpa [contact], Benoit Bideau, Pierre Touzard.

An exclusive contract has been signed between the M2S laboratory and the French Federation of Tennis for three years. The goal is to perform biomechanical analyses of 3D tennis serves on a population of 40 players of the Pôle France. The objective is to determine the link between injuries and biomechanical constraints on joints and muscles depending on the age and gender of the players. At the end, the goal is to evaluate their load training.

9.2.2.3. *gDGA*

Participants: Antonio Mucherino [contact], Ludovic Hoyet, Franck Multon.

gDGA (generalization of the Distance Geometry and its Applications) is a INS2I/CNRS PEPS project involving local and national partners. Distance geometry can nowadays be seen as a classical problem in operational research, having a wide range of applications. The main aim of this interdisciplinary project is to extend the definition and the range of applicability of distance geometry. In particular, our main interest is on dynamical problems, motivated by a certain number of applications of interest, including interaction motion adaptation, the simulation of crowd behaviours, and the conception of modern recommender systems. The classical application of distance geometry arising in the biological field is also taken into consideration. The necessity of a strong computational power for the considered applications motivates the need of implementing our algorithms in environments capable of exploiting the resources on GPU cards.

9.2.2.4. *IRMA*

Participants: Ronan Gaugne [contact], Georges Dumont.

The IRMA project is an Imag'In project funded by CNRS which aims at developing innovative methodologies for research in the field of cultural heritage based on the combination of medical imaging technologies and interactive 3D technologies (virtual reality, augmented reality, haptics, additive manufacturing). It relies on close collaborations with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET. The developed tools are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. We focus on a large number of archeological artefacts of different nature, and various time periods (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We can notably mention the oldest human bones found in Brittany (clavicle Beg Er Vil), a funeral urn from Trebeurden (22), or a Bronze Cauldron from a burial of the Merovingian necropolis "Crassés Saint-Dizier" (51). This project involves a strong collaboration with members of the team Hybrid (Valérie Gouranton, Bruno Arnaldi and Jean-Baptiste Barreau), Théophane Nicolas (Inrap/UMR Trajectoires), Quentin Petit (SED Inria Rennes), and Grégor Marchand (CNRS/UMR CReAAH).

9.2.3. *ADT: Immerstar*

Participants: Franck Multon, Georges Dumont [contact], Ronan Gaugne.

The ADT-Immerstar is driven by the SED and aims at developing new tools and facilities for the scientific community in order to develop demos and use the two immersive rooms in Rennes: Immersia and Immermove. The engineer (Quentin Petit, SED) has the responsibility of homogenizing the software modules and development facilities in each platform, of installing new upgrades and of developing collaborative applications between the two sites.

9.2.4. *PRE*

Participants: Franck Multon [contact], Ludovic Hoyet, Antonio Mucherino.

The Inria PRE project entitled "Smart sensors and novel motion representation breakthrough for human performance analysis" aims at designing a new description for human motion in order to automatically capture, measure and transfer the intrinsic constraints of human motion. Current approach consisted in manually editing the constraints associated with a motion, to use classical skeleton representation with joint angles based on direct or indirect measurements, and then perform inverse kinematics to fulfill these constraints. We aim at designing a new representation to simplify this process pipeline and make it automatic, together with relevant motion sensors that could provide enough information to automatically extract these intrinsic

constraints. To this end, this project has been jointly proposed with the Inria CAIRN team, which develops sensors based on joint orientations and distances between sensors. We aim at extending this type of device to measure new types of information that would help to simplify the above mentioned pipeline. A postdoc arrived in November 2016 to jointly work with CAIRN. We also involved Hubert Shum from Northumbria University to link this project with the long-term collaboration with Dr. Shum about this type of problem. type of problems.

9.3. International Initiatives

9.3.1. FORMOSA

Title: Fostering Research on Models for Storytelling Applications

International Partner (Institution - Laboratory - Researcher):

NCCU (Taiwan) - Intelligent Media Lab (IML) - Tsai-Yen Li

Start year: 2016

See also: <http://www.irisa.fr/mimetic/GENS/mchristi/EA-FORMOSA/>

Interactive Storytelling is a new media which allows users to alter the content and outcome of narratives through role-playing and specific actions. With the quality, the availability and reasonable costs of display technologies and 3D interaction devices on one side, and the accessibility of 3D content creation tools on the other, this media is taking a significant share in entertainment (as demonstrated by the success of cinematographic games such as Heavy Rain or Beyond: two souls). These advances push us to re-think the way narratives are traditionally structured, explore new interactive modalities and provide new interactive cinematographic experiences. As a sequel of the first associate team FORMOSA 1, we propose to address new challenges pertained to interactive storytelling such as the use of temporal structures in narratives, interaction modalities and their impact in terms of immersion, and the adaptation of cinematographic real data to 3D environments. To achieve these objectives, the associate team will rely on the complementary skills of its partners and on the co-supervision of students.

9.3.2. SIMS

Title: REal data against crowd SIMulation AlgorithMS

International Partner (Institution - Laboratory - Researcher):

University of North Carolina at Chapel Hill (United States) - GAMMA Research Group (GAMMA) - Ming LIN

Start year: 2015

See also: <http://www.irisa.fr/mimetic/GENS/jpettre/EASIMS/easims.html>

RE-SIMS aims at gathering the best international research teams working on crowd simulation to allow significant progresses on the level of realism achieved by crowd simulators. To this end, RE-SIMS aims at improving methods for capturing crowd motion data that describe real crowd behaviors, as well as by improving data assimilation techniques.

In this renewal, RE-SIMS extends the previous SIMS partnership and follows a multidisciplinary direction.

9.3.3. Inria International Partners

9.3.3.1. Informal International Partners

- Dr. Edouard Auvinet, Imperial College London, UK (collaboration with Franck Multon)
- Dr. Huber Shum, Northumbria University, Newcastle, UK (collaboration with Franck Multon and Ludovic Hoyet, with joint papers and supervision)

- Dr. Rachel McDonnell, Trinity College Dublin, Ireland (on-going collaboration with Ludovic Hoyet, including a 6-month internship from one of her PhD student in Rennes)
- Prof. Carol O’Sullivan, Trinity College Dublin, Ireland (on-going collaboration with Ludovic Hoyet)
- Prof. Carlile Lavor, UNICAMP, Campinas, Sao Paulo, Brazil (collaboration with Antonio Mucherino)
- Dr. Douglas S. Gonçalves, Federal University of Santa Catarina, Florianópolis, Brazil (collaboration with Antonio Mucherino)
- Jung-Hsin Lin, Academia Sinica, Taipei, Taiwan (collaboration with Antonio Mucherino)

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Professors and associate professors

- Victoria Interrante, Professor, Department of Computer Science and Engineering, University of Minnesota USA, December 8th, 2017
- Michael Cinelli, Associate Professor, Kinesiology and Physical Education, Wilfrid Laurier University, Canada, June 2017

9.4.1.2. Internships

- Emma Carrigan, Trinity College Dublin, Ireland (PhD supervisor: Dr. Rachel McDonnell), 6-month internship in collaboration with Technicolor (Quentin Avril), Jan. to June 2017.

MIMOVE Team

9. Partnerships and Cooperations

9.1. National Initiatives

“BottleNet: Understanding and Diagnosing End-to-end Communication Bottlenecks of the Internet”, project funded by the French research agency (ANR), from Feb 2016 to Sep 2020.

9.1.1. Inria Support

9.1.1.1. Inria IPL CityLab@Inria

Participants: Valérie Issarny [correspondent], Fadwa Rebhi.

- **Name:** CityLab@Inria – *Overcoming the Smart City Challenge – Toward Environmental and Social Sustainability*
- **Period:** [January 2014 – November 2018]
- **Inria teams:** CLIME/ANGE, DICE, FUN, MIMOVE, MYRIADS, SMIS, URBANET, WILLOW
- **URL:** <http://citylab.inria.fr>

The Inria Project Lab (IPL) CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. Obviously, running experiments is a central concern of the Lab, so that we are able to confront proposed approaches to actual settings.

9.1.1.2. Inria IPL BetterNet

Participants: Renata Teixeira, Vassilis Christophides, Francesco Bronzino.

- **Name:** BetterNet – *An observatory to measure and improve Internet service access from user experience*
- **Period:** [2016 – 2019]
- **Inria teams:** Diana, Dionysos, Inria Chile, Madynes, MiMove, Spirals
- **URL:** <https://project.inria.fr/betternet/>

BetterNet aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where:

1. tools, models and algorithms/heuristics will be provided to collect data,
2. acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society,
3. and new value-added services will be proposed to end-users.

9.1.1.3. Inria ADT MOSQUITO

Participants: Renata Teixeira, Francesco Bronzino, Romain Rouvoy.

- **Name:** MOSQUITO – *A mobile platform to measure the quality of Internet connectivity*
- **Period:** [November 2016 – October 2018]
- **Partners:** Inria MiMove, Inria SPIRALS.

The ADT MOSQUITO is part of the Inria Project Lab (IPL) initiative BetterNet. This ADT project focuses on the design and the development of a measurement platform for the quality of mobile Internet access by federating the existing mobile platforms identified in the BetterNet IPL. Beyond the priceless value of such a measurement platform for the research community, this ADT also aims to publish live reports on the quality of mobile Internet access through the BetterNet initiative.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. H2020 ICT CHOReVOLUTION

Participants: Nikolaos Georgantas [correspondent], Valérie Issarny [correspondent].

Name: CHOReVOLUTION – *Automated Synthesis of Dynamic and Secured Choreographies for the Future Internet*

URL: <http://www.chorevolution.eu>

Type: Research & Innovation Action (ICT)

Topic: Tools and Methods for Software Development

Period: [January 2015 - December 2017]

Partners: CEFRIEL (Italy), Inria MiMove, OW2 Consortium (France), Thales Communications S.A. (France) [**coordinator**], Università degli Studi dell'Aquila (Italy) [**scientific leader**], Softeco Sismat Srl (Italy), Tirasa (Italy), Viktoria Swedish ICT (Sweden).

The Future Internet (FI) represents an age of unprecedented opportunities for social, economic, and business growth thanks to the global scale connectivity of the virtual as well as of the physical world. This indeed opens up a wealth of innovative and revolutionary real-life scenarios, as for instance illustrated by the smarter cities perspectives where envisioned scenarios significantly ease daily human activities and give support for the growth of new markets and employment opportunities. However, leveraging the FI for the development of innovative software applications remain a challenging task even though major enablers are readily available by ways of service-oriented and cloud computing. It is in particular our vision that enabling the choreography of FI services shall play a significant role in the provisioning of innovative applications. However, existing choreography-based service composition approaches are rather static and are poorly suited to the need of the FI that is a highly dynamic networking environment, further bringing together highly heterogeneous services ranging from Thing- to Business-based services that span different security domains. As a result, the technology is not mature enough for market take-up. CHOReVOLUTION elevates the Readiness Level of existing choreography technologies in order to drop the dynamism and cross-organization security barriers via the automated synthesis of dynamic and secured choreographies in the FI. To meet its objectives, CHOReVOLUTION undertakes both research and innovation tasks. The former concentrates on choreography modelling, synthesis, adaptation, service bus, security, and cloud; the latter focus on industrial validation, development support and integration platform, and the establishment of a CHOReVOLUTION community and market take-up. Last but not least CHOReVOLUTION outcomes are assessed by experimenting with new applications in the field of Intelligent Transportation Systems.

9.2.1.2. H2020 ICT FIESTA-IoT

Participants: Valérie Issarny [correspondent], Nikolaos Georgantas [correspondent].

Name: FIESTA-IoT – *Federated Interoperable Semantic IoT/cloud Testbeds and Applications*

URL: <http://fiesta-iot.eu>

Type: Research & Innovation Action (ICT)

Topic: FIRE+ (Future Internet Research & Experimentation)

Period: [February 2015 - January 2018]

Partners: Fraunhofer FOKUS (Germany) [**coordinator**], INSIGHT @ National University of Galway (Ireland) [**co-coordinator**], University of Southampton IT Innovation Centre (UK), Inria MiMove, University of Surrey (UK), Unparallel Innovation Lda (Portugal), Easy Global Market (France), NEC Europe Ltd (UK), University of Cantabria (Spain), Com4innov (France), Athens Information Technology (Greece), SOCIEDAD PARA EL DESARROLLO REGIONAL DE CANTABRIA (Spain), Ayuntamiento de Santander (Spain), Korea Electronics Technology Institute (Korea).

Despite the proliferation of IoT and smart cities testbeds, there is still no easy way to conduct large scale experiments that leverage data and resources from multiple geographically and administratively distributed IoT platforms. Recent advances in IoT semantic interoperability provide a sound basis for implementing novel cloud-based infrastructures that could allow testbed-agnostic access to IoT data and resources. FIESTA will open new horizons in IoT experimentation at a global scale, based on the interconnection and interoperability of diverse IoT testbeds. FIESTA will produce a first-of-a-kind blueprint experimental infrastructure (tools, techniques and best practices) enabling testbed operators to interconnect their facilities in an interoperable way, while at the same time facilitating researchers in deploying integrated experiments, which seamlessly transcend the boundaries of multiple IoT platforms. FIESTA will be validated and evaluated based on the interconnection of four testbeds (in Spain, UK, France and Korea), as well as based on the execution of novel experiments in the areas of mobile crowd-sensing, IoT applications portability, and dynamic intelligent discovery of IoT resources. In order to achieve global outreach and maximum impact, FIESTA will integrate an additional testbed and experiments from Korea, while it will also collaborate with IoT experts from USA. The participation of a Korean partner (based its own funding) will maximize FIESTA's value for EC money. Moreover, the project will take advantage of open calls processes towards attracting third-parties that will engage in the integration of their platforms within FIESTA or in the conduction of added-value experiments. As part of its sustainability strategy, FIESTA will establish a global market confidence programme for IoT interoperability, which will enable innovative platform providers and solution integrators to ensure/certify the openness and interoperability of their developments.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

9.2.2.1. EIT Digital Env&You

Participant: Valérie Issarny [correspondent].

Name: Env&You – *Personalizing environmental science for your home, your neighborhood and your life*

URL: <http://ambiciti.io>

Period: [January 2017 - December 2017]

Partners: Ambiciti (F), Forum Virium Helsinki (FI), Inria CLIME/ANGE, Inria MIMOVE [**coordinator**], NumTech (F), TheCivicEngine (USA).

There is a clear, and probably increasing, desire from the citizens to better know their individual exposure to pollution. Partial solutions exist to the exposure data problem but each focuses on one or another domain of information – crowdsourcing exposure, translating government open data to usable consumer information, harnessing social media information, harnessing biometrics – what is unique about Env&You is that we assimilate a multi-dimensional picture of exposure and provide the integrated information to citizen, government, and business use (spanning: B2G, B2B and B2C business cases).

9.2.2.2. EIT Digital CivicBudget

Participants: Valérie Issarny [correspondent], Nikolaos Georgantas [correspondent].

Name: CivicBudget – *Software platform supporting Internet-based participatory budgeting campaigns*

Period: [January 2017 - December 2017]

Partners: CITRIS@UCB (USA), Inria MIMOVE, MissionsPubliques (F) [**coordinator**], Nexus (DE), and TU Berlin (DE).

Many cities in Europe and the U.S.A, and around the world, commit a percentage of their annual budget (often 5%) to implement citizen-proposed projects through a process called Participatory Budgeting (PB). However, supporting urban-scale participatory budgeting campaigns is greatly challenged as it still principally relies on physical meetings. CivicBudget addresses this challenge by leveraging latest ICT so as to promote urban-scale inclusion. CivicBudget fosters a new and inclusive urban public sphere of citizenship. It is especially designed for community groups and activists who want to participate in the PB process. City governments will also be able to promote its use. CivicBudget will facilitate the mobilization of residents both to promote their proposals and to monitor their progress through the PB process to implementation.

9.3. International Initiatives

9.3.1. Inria International Labs

Valérie Issarny acts as scientific manager of the Inria@Silicon Valley program (<https://project.inria.fr/inria-siliconvalley/>) since summer 2013; she is visiting scholar at the EECS Department of University of California, Berkeley, and hosted by CITRIS.

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

9.3.2.1. HOMENET

Title: *Home network diagnosis and security*

International Partner: Princeton (United States) - Nick Feamster

Start year: 2017

Website: <https://team.inria.fr/homenet/>

Modern households connect a multitude of networked devices (ranging from laptops and smartphones to a number of Internet of Things devices) via a home network. Most home networks, however, do not have a technically skilled network administrator for managing the network, for example to identify faulty equipment or take steps to secure end hosts such as applying security patches. Home networks represent a particularly challenging environment due to the diversity of devices, applications, and services users may connect. The goal of HOMENET is to assist users in diagnosing and securing their home networks. Our approach is based on developing new algorithms and mechanisms that will run on the home router (or in-collaboration with the router). The router connects the home network to the rest of the Internet; it is hence the ideal place to secure home devices and to distinguish problems that happen in the home from those happening elsewhere. We will address a number of research challenges for example in device discovery and fingerprinting, anomaly detection in the Internet of Things, home network diagnosis (including wireless diagnosis). HOMENET will bring together two leading research teams in the network measurement arena with successful prior collaboration. Moreover, Princeton brings an existing home router platform and expertise in security, wireless, and software-defined networks; and MiMove brings an existing Web-based measurement platform, and expertise in traffic-based profiling and anomaly detection.

9.3.2.2. ACHOR

Participant: Nikolaos Georgantas [correspondent].

Title: *Adaptive enactment of service choreographies*

International Partner: Universidade Federal de Goiás (UFG), Brazil - Fabio Costa

Start year: 2016

Website: <http://www.inf.ufg.br/projects/achor>

Service choreographies are distributed compositions of services (e.g., Web services) that coordinate their execution and interactions without centralized control. Due to this decentralized coordination and the ability to compose third-party services, choreographies have shown great potential as an approach to automate the construction of large-scale, on-demand, distributed applications. Technologies to enable this approach are reaching maturity level, such as modeling languages for choreography specification and engines that operate the deployment of services and enactment of choreographies at Future Internet scales. Nevertheless, a number of problems remain open on the way to fully realize the approach, among them: (i) Deployment of multiple choreographies on top of a collection of shared services (considering service sharing as an effective way to increase the utilization of resources); (ii) Dynamic adaptation of functional and non-functional properties due to runtime changes in the environment and user requirements (adapting the set of services and/or the resources used to run the services in order to add/remove/change functions and maintain QoS properties, respectively); and (iii) Seamless and dynamic integration of mobile services (e.g., smartphone apps, sensors and actuators on handhelds and wearables) and cloud-based services (including the need to consider: mobility of both devices and services, resource constraints of mobile devices, temporary disconnection, interoperability between different interaction paradigms (message-passing, event-based, data-sharing) at the middleware layer, and effect of these paradigms on end-to-end QoS). The overall goal of the project is to design an architecture for adaptive middleware to support service choreographies in large-scale scenarios that involve dynamicity and diversity in terms of application requirements, service interaction protocols, and the use of shared local, mobile and cloud resources.

9.3.3. Inria International Partners

9.3.3.1. Informal International Partners

Northeastern University (Prof. David Choffnes and his student Arash Molavi): we are working on monitoring and diagnosing Internet QoE.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

Kushagra Singh (from Jun 2017 until Jul 2017)

Internship funded by H2020 CHOReVOLUTION project.

Subject: *Towards correction of outliers in spatial dataset*

Institution: Indraprastha Institute of Information Technology (IIIT) Delhi (India)

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Valérie Issarny is visiting scholar at the EECS Department at UC Berkeley; she is hosted by CITRIS in the context of which she carries out collaborative research in the area of smart cities and acts as scientific coordinator of the Inria@SiliconValley program.
- Rachit Agarwal was visiting professor at Fundacao Getulio Vargas (FGV), Rio De Janeiro, Brazil (from Jun 2017 until Aug 2017). He was hosted at EMaP (Escola de Matematica Aplicada) department within FGV. He taught a Network Science course to Master's students.

MINT2 Team

8. Partnerships and Cooperations

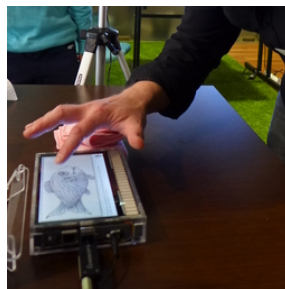
8.1. Regional Initiatives

8.1.1. *StimTac*, 2015-2017

Participants: Frédéric Giraud [correspondant], Patricia Plénacoste, Laurent Grisoni, Michel Amberg, Nicolas Bremmard.

The aim of this project is to create the first digital book, enhanced with haptic feedback, in order to anticipate the integration of this technology into everyday products. This project addresses technological issues, like programming haptic content in a multimedia software, and design issues to understand how the haptic feedback is perceived by the users.

Stimtac is a book, and could thus be presented to non-specialists users and to a wide public during presentations, demos and forums. The scenario and the illustrations were made by Dominique Maes, a Belgium artist, who did the digital book "Bleu de toi" among other things. The Public Library of Lille is a partner of this project and allows us to meet the public.



(a)



(b)

Figure 1. Demo session at "La nuit des Bibliothèques (Lille, October 2016), and a page of Stimtac; the ellipse highlights the tactile feedback on E-Vita.

This project has been granted 8Keuros from IRCICA.

8.1.2. *MATRICE* (sept 2015-sept. 2017)

Participant: Laurent Grisoni [correspondant].

This regional project, funded by ERDF, led by Lille School of Architecture, aims at understanding in which way 3D printing may be interesting for the building economy. partners: Ecole d'architecture de Lille, Inria, Ecole Centrale de Lille, Télécom Lille 1, Ecole des Mines de Douai.

8.2. National Initiatives

8.2.1. *Equipex IRDIVE* (ANR project 2012-2020)

3 Meuros project, co-funded by ERDF for the development of a pluri-disciplinary project on ICT-based tools for understanding human perception of visual contents. Laurent Grisoni is member of the lead group of this project, and animates an axis devoted to art-sciences and technologies collaborations.

8.2.2. MAUVE CPER ("Contrat de Plan État-Région") 2016-2020 project

Funds: 4 Meuros (validated at national level, funded by Region), and 1 Meuro additional funding provided by ERDF.

Subject: ICT tools for mediation and access to knowledge.

Lead: University of Lille, University of Artois. Laurent Grisoni is co-lead of this project.

8.2.3. InriaRT

Participants: Laurent Grisoni [correspondant], Samuel Degrande, Francesco de Comité.

Art/science Inria internal network gathering projects interested in collaborating with artists.

Inria teams involved: MuTANT (Paris), Imagine (Grenoble), Flowers, Potioc (Bordeaux), Hybrid, MimeTic (Rennes). This initiative will take advantage of an agreement between Inria and French Ministry of Culture, signed early December 2016.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, Except FP7 & H2020

MINT participates to the VR4REHAB (2018-2020) project, funded by ENO Interreg. This project gathers rehabilitation structures and provides animation of hackathons for prototyping VR systems for rehabilitation. MINT role is to provide technical support and help mature relevant approaches for getting closer to using VR for personnel, lightweight rehabilitation systems. Funds for the team: 430 Keuros. Contact for the team: Laurent Grisoni.

8.3.2. Collaborations with Major European Organizations

we collaborate with INESC-ID (through exchange of students, join publications).

MISTIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Grenoble Idex projects

MISTIS is involved in a newly accepted transdisciplinary project **NeuroCoG**.

F. Forbes is also responsible for a work package in another project entitled **Grenoble Alpes Data Institute**.

MISTIS is also involved in a newly accepted cross-disciplinary project (CDP) RISK@UGA.

- 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 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, two 2-years multi-disciplinary projects were granted in November 2017 to Mistis in collaboration respectively with Team Necs from Inria and Gipsa-lab (DATASAFE project: understanding Data Accidents for TrAffic SAFETy) and with IPAG and Univ. Paris Sud Orsay (Regression techniques for Massive Mars hyperspectral image analysis from physical model inversion), 9 keuros each.
- Also in the context of the Grenoble Alpes Data Institute, Julyan Arbel and Stéphane Girard were awarded a funding from IRS (Initiatives de Recherche Stratégique) for a research project dedicated to extreme and Bayesian statistics, 8 keuros.

9.1.2. Competitvity 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.

9.1.3. CNRS fundings

- **Defi Mastodons, La qualité des données dans le Big Data (2015-17).** S. Girard is involved in a 2-year project entitled “Classification de Données Hétérogènes avec valeurs manquantes appliquée au Traitement des Données Satellitaires en écologie et Cartographie du Paysage” [53], the other partners being members of Modal (Inria Lille Nord-Europe) or ENSAT-Toulouse. The total funding is 17,5 keuros.
- Stéphane Girard and Julyan Arbel were awarded a funding from TelluS-Insmi (with IPAG and Univ. Paris-Descartes), for a 1-year project entitled “unsupervised classification in high dimension”, 7000 euros.
- **Defi Imag’IN MultiPlanNet (2015-2017).** This is a 2-year project to build a network for the analysis and fusion of multimodal data from planetology. There are 8 partners: IRCCYN Nantes, GIPSA-lab Grenoble, IPAG Grenoble, CEA Saclay, UPS Toulouse, LGL Lyon1, GEOPS University Orsay and Inria Mistis. F. Forbes is in charge of one work package entitled *Massive inversion of multimodal data*. Our contribution will be based on our previous work in the VAHINE project on hyperspectral images and recent developments on inverse regression methods. The CNRS support for the network is of 20 keuros. A 2-day **workshop** was organized in November 2017 in Grenoble, on the analysis of multimodal data for planets observation and exploration.

9.1.4. GDR Madics

Apprentissage, optimisation à Large-échelle et calcul distribué (ATLAS). Mistis is participating to this action supported by the GDR in 2016 (3 keuros).

9.1.5. Networks

MSTGA and AIGM INRA (French National Institute for Agricultural Research) networks: F. Forbes is a member of the INRA network called AIGM (ex MSTGA) network since 2006, <http://carlit.toulouse.inra.fr/AIGM>, on Algorithmic issues for Inference in Graphical Models. It is funded by INRA MIA and RNSC/ISC Paris. This network gathers researchers from different disciplines. F. Forbes co-organized and hosted 2 of the network meetings in 2008 and 2015 in Grenoble.

9.2. International Initiatives

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

9.2.1.1. SIMERGE

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

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LERSTAD - Abdou Ka Diongue

Starting year: 2015

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

Entered in the LIRIMA in January 2015, this team federates researchers from LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger), on the one part, and MISTIS (Inria Grenoble Rhône-Alpes) on the other part. This project consolidates the existing collaborations between these two Laboratories.

The team also involves statisticians from EQUIPPE laboratory (Economie QUantitative Intégration Politiques Publiques Econométrie, Université de Lille) and associated members of Modal (Inria Lille Nord-Europe) as well as an epidemiologist from IRD (Institut de Recherche pour le Développement) at Dakar.

The following two research themes are developed : (1) Spatial extremes with application to management of extreme risks ; (2) Classification with application to global epidemiology.

9.2.2. Inria International Partners

9.2.2.1. Informal International Partners

The context of our research is also the collaboration between MISTIS and a number of international partners such as the statistics department of University of 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 active international collaborations in 2017 are with:

- F. Durante, Free University of Bozen-Bolzano, Italy.
- K. Qin, H. Nguyen and D. Wraith resp. from Swinburne University and La Trobe university in Melbourne, Australia and Queensland University of Technology in Brisbane, Australia.
- E. Deme and S. Sylla from Gaston Berger university and IRD in Senegal.
- M. Stehlik from Johannes Kepler Universitat Linz, Austria and Universidad de Valparaiso, Chile.
- M. Houle from National Institute of Informatics, Tokyo, Japan.
- N. Wang and C-C. Tu from University of Michigan, Ann Arbor, USA.
- R. Steele, from McGill university, Montreal, Canada.
- Guillaume Kon Kam King, Stefano Favaro, Igor Prünster, University of Turin, Italy.
- Bernardo Nipoti, Trinity College Dublin, Ireland.
- Yeh Whye Teh, Oxford University, UK.
- Stephen Walker, University of Texas at Austin, USA.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Seydou Nourou Sylla (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for two months.
- Aboubacrène Ahmad (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for two months.
- Hien Nguyen from La Trobe university, Melbourne Australia, has been hosted for 2 days.

9.3.2. Visits to International Teams

9.3.2.1. Research Stays Abroad

- F. Forbes spent 2 weeks in April 2017 in Australia, visiting Brisbane and Melbourne universities.
- J. Arbel spent 3 months at the University of Texas at Austin.

Mjolnir Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Mjolnir/UCLIC associate team (Inria Lille, 2015-2017)

Participants: Sylvain Malacria [correspondent], Nicolas Roussel.

The goal of this project, whose funding ends 2017, is the design and implementation of novel cross-device systems and interaction techniques. Thanks to this funding, the Mjolnir group and UCLIC are currently working on two scientific research projects. The first one investigates the design of notification systems for smart watches, smartphones, and in distributed computing environments based on device proximity, location, and time. A group of three Computer Science students from UCL is currently designing and implementing the first prototype of this system. The second project studies the influence of the shape and color of icons on visual search, on smartphones and smartwatches. In addition, UCLIC and the Mjolnir group also collaborate on the design and implementation of a software tool for helping HCI researchers to create non-photorealistic figures aimed at illustrating interaction techniques.

Partner: University College London Interaction Centre (United Kingdom).

9.2. National Initiatives

9.2.1. Turbotouch (ANR, 2014-2019)

Participants: G ry Casiez [correspondent], Sylvain Malacria, Mathieu Nancel, Thomas Pietrzak, S bastien Poulmane, Nicolas Roussel.

Touch-based interactions with computing systems are greatly affected by two interrelated factors: the transfer functions applied on finger movements, and latency. This project aims at transforming the design of touch transfer functions from black art to science to support high-performance interactions. We are working on the precise characterization of the functions used and the latency observed in current touch systems. We are developing a testbed environment to support multidisciplinary research on touch transfer functions and will use this testbed to design latency reduction and compensation techniques, and new transfer functions.

Partners: Inria Lille's NON-A team and the "Perceptual-motor behavior group" from the Institute of Movement Sciences.

Web site: <http://mjolnir.lille.inria.fr/turbotouch/>

Related publications: [21], [17], [12], [18]

9.2.2. ParkEvolution (Carnot Inria - Carnot STAR, 2015-2018)

Participants: G ry Casiez [correspondent], S bastien Poulmane.

This project studies the fine motor control of patients with Parkinson disease in an ecological environment, at home, without the presence of experimenters. Through longitudinal studies, we collect raw information from pointing devices to create a large database of pointing behavior data. From the analysis of this big dataset, the project aims at inferring the individual's disease progression and influence of treatments.

Partners: the "Perceptual-motor behavior group" from the Institute of Movement Sciences and H pital de la Timone.

Web site: <http://parkevolution.org/>

9.2.3. BCI-LIFT (Inria Project Lab, 2015-2019)

Participants: G ry Casiez [correspondent], Nicolas Roussel.

The goal of this large-scale initiative is to design a new generation of non-invasive Brain-Computer Interfaces (BCI) that are easier to appropriate, more efficient, and suited for a larger number of people.

Partners: Inria's ATHENA, NEUROSYS, POTIOC, HYBRID & DEMAR teams, *Centre de Recherche en Neurosciences de Lyon* (INSERM) and INSA Rouen.

Web site: <https://bci-lift.inria.fr/>

Related publications: [22], [33]

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Happiness (H2020-ICT-2014-1/ICT-03-2014/RIA, 2015-2018)

Participants: Julien Decaudin, Christian Frisson, Thomas Pietrzak [correspondent], Nicolas Roussel.

The main objective of this project is to develop and evaluate new types of haptic actuators printed on advanced Thin, Organic and Large Area Electronics (TOLAE) technologies for use in car dashboards. These actuators are embedded in plastic molded dashboard parts. The expected outcome is a marketable solution for haptic feedback on curved interactive surfaces.

In this project, Inria is responsible for WP2: Human Factors and Interaction Design, as well as the software development of the project main demo. A first version of this demo was showcased at the Geneva Motor Show 2017. We developed the dashboard software of the Mojave concept car, built by the Sbarro school.

Partners: CEA (coordinator), Inria Rennes' HYBRID team, Arkema, Bosch, Glasgow University, ISD, Walter Pack, Fundacion Gaiker.

Web site: <http://happiness-project.eu/>

Related publications: [26], [36]

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Andy Cockburn, University of Canterbury, Christchurch, NZ [12]

Daniel Vogel, University of Waterloo, Waterloo, CA [14]

Nathalie Henry Riche, Microsoft Research, Seattle, USA [16]

Audrey Girouard, Carleton University, Ottawa, CA [23]

Daniel Wigdor, University of Toronto, Toronto, CA [25]

Ravin Balakrishnan, University of Toronto, Toronto, CA [26]

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Ed Lank, Associate Professor at the University of Waterloo, has already spent one year in our team until Aug. 2017 (funded by Région Hauts-de-France and Université Lille 1). His stay was extended until Feb. 2018, funded by Inria.

Marcelo Wanderley, Professor at McGill University, who has been awarded an Inria International Chair in our team in 2016, spent 2 months in our group this year (June to July).

9.5.1.1. Internships

Shaishav Siddhpuria, Master student, Univ of Waterloo, from Feb. to Apr. 2017

Keiko Katsuragawa, Postdoc, Univ of Waterloo, Mar. 2017

Rina Wehbe, PhD student, Univ of Waterloo, Mar. 2017

Jeff Avery, PhD student, Univ of Waterloo, from Jun. to Aug. 2017

MNEMOSYNE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *PsyPhiNe*

Participant: Nicolas Rougier.

Project gathering researchers from: MSH Lorraine (USR3261), InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Loria (UMR7503) & Mnemosyne.

PsyPhiNe is a pluridisciplinary and exploratory project between philosophers, psychologists, neuroscientists and computer scientists. The goal of the project is to explore cognition and behavior from different perspectives. The project aims at exploring the idea of assignments of intelligence or intentionality, assuming that our intersubjectivity and our natural tendency to anthropomorphize play a central role: we project onto others parts of our own cognition. To test these hypotheses, we ran a series of experiments with human subject confronted to a motorized lamp that can or cannot interact with them while they're doing a specific task. We've organized our third national conference in Nancy gathering speakers from philosophy, robotics, art and psychology and closed a three years cycle. The group now aims at publishing a book gathering text from all the invited speakers.

9.2. National Initiatives

9.2.1. *FUI Sumatra*

Participants: Frédéric Alexandre, Thalita Firmo Drumond, Xavier Hinaut, Randa Kassab, Nicolas Rougier, Thierry Viéville.

This FUI project, supported by the Aerospace Valley Innovation Pole, gathers two industrial groups (Safran Helicopter and SPIE), three research labs and four SME. Its goal is to provide contextualized information to maintenance operators by the online analysis of the operating scene. We are concerned in this project with the analysis of visual scenes, in industrial contexts, and the extraction of visual primitives, categories and pertinent features, best describing the scenes, with biologically inspired neuronal models.

Firstly, this is an opportunity for us to revisit the principles of deep network architectures by adapting principles that we will elaborate from the context of the hierarchical architecture of the temporal visual cortex. Secondly, we intend to exploit and adapt our model of hippocampus to extract more heterogenous features. This project is an excellent opportunity to associate and combine our models and also to evaluate the robustness of our models in real-world applications.

9.2.2. *ANR SOMA (PRCI)*

Participant: Nicolas Rougier.

This new project is a convergence point between past research approaches toward new computational paradigms: adaptive reconfigurable architecture, cellular computing, computational neuroscience, and neuromorphic hardware:

1. SOMA is an adaptive reconfigurable architecture to the extent that it will dynamically re-organize both its computation and its communication by adapting itself to the data to process.
2. SOMA is based on cellular computing since it targets a massively parallel, distributed and decentralized neuromorphic architecture.
3. SOMA is based on computational neuroscience since its self-organization capabilities are inspired from neural mechanisms.
4. SOMA is a neuromorphic hardware system since its organization emerges from the interactions between neural maps transposed into hardware from brain observation.

This project represents a significant step toward the definition of a true fine-grained distributed, adaptive and decentralized neural computation framework. Using self-organized neural populations onto a cellular machine where local routing resources are not separated from computational resources, it will ensure natural scalability and adaptability as well as a better performance/power consumption tradeoff compared to other conventional embedded solutions.

9.2.3. *ANR MACAQUE40*

Participant: Nicolas Rougier.

Most of the theoretical models in economics proposed so far to describe money emergence are based on three intangible assumptions: the omniscience of economic agents, an infinite time and an extremely large number of agents (not bounded). The goal of this interdisciplinary study is to investigate the condition of apparition of a monetary economy in a more ecological framework provided with the assumption that the market is made up of a finite number of agents having a bounded rationality and facing a time constraint.

In this study, we propose a generic model and environment of monetary prospecting. Our first objective is to artificially identify structural (trading organisation, agents specialisation) and cognitive conditions (learning skills, memory and strategic anticipation abilities, tradeoff exploration/exploitation) that allowed money emergence. This will provide relevant environmental constraints that we will use during our manipulations in the laboratory. The agents that will be involved in these manipulations will be of two types: non-human primates (rhesus macaques) and humans.

9.2.4. *Project Motus of the ANSES*

Participant: André Garenne.

The MOTUS project (MODulaTion dU Signal RF et effets sur le cerveau : approche in vivo et in vitro) is financed by the ANSES (the french national agency for health security). This 3 years project is studying the effects of GSM-RF on living matter and especially neuronal activity and development. Our main involvement concerns electrophysiological data and spike trains analysis as well as the development of pharmacological protocols to test GSM-RF effects hypotheses.

This year, we have designed and realised new experiments in order to better characterize the effect of 1800 Mz RF field of GSM on the spontaneous activity of in-vitro cortical cell cultures. In the current study, our aim was to highlight a dose-response relationship for this effect. To do this, we have recorded the spontaneous bursting activity of cortical neurons cultures on multi-electrodes arrays. We have thus shown that at SAR (Specific Absorption Rate) ranging from 0.01 to 9.2 W/kg the signal elicited a clear decrease in bursting rate during the RF exposure phase that lasted even after the end of the exposure. Moreover, the effect grew larger with increasing SAR, and the amplitude of the change was greater with a GSM signal than with a continuous wave RF field of the same energy level. These experimental findings provide evidence for clear effects of RF signals on the bursting rate of neuronal cultures.

9.3. International Initiatives

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

9.3.1.1. *Braincraft*

Title: Braincraft

International Partner (Institution - Laboratory - Researcher):

University of Colorado, Boulder (United States) - Computational Cognitive Neuroscience
- Randall O'Reilly

What are the processes by which animals and humans select their actions based on their motivations and on the consequences of past actions? This is a fundamental question in neurosciences, with implications to ethology, psychology, economics, sociology and computer science. Through a unique combination of expertise in cognitive psychology, neurosciences and computer science, this associate team will foster a collaboration for developing a computationally-based understanding of the neural circuits involved in decision making, namely basal ganglia and prefrontal cortex. One of the key question is to know the overall contribution of these structures and their function in the decision process.

9.3.2. Participation in Other International Programs

9.3.2.1. Project LingoRob with Germany

LingoRob - Learning Language in Developmental Robots - is a project of the Programme Hubert Curien PHC Procope with Germany (University of Hamburg). The scientific objective of the collaboration is to better understand the mechanisms underlying language acquisition and enable more natural interaction between humans and robots in different languages, while modelling how the brain processes sentences and integrates semantic information of scenes. Models developed in both labs involve artificial neural networks, and in particular Echo State Networks (ESN), also known as pertaining to the Reservoir Computing framework. These neural models allow insights on high-level processes of the human brain, and at the same time are well suited as robot control platform, because they can be trained and executed online with low computational resources. The collaborators will also combine Deep Learning networks to the reservoir models already used in order to benefit from their very good feature extraction abilities.

9.3.2.2. Project BGaL with India

In the 3-years project “Basal Ganglia at Large (BGaL)”, funded by the CNRS and the CEFIPRA, we collaborate with the computer science department of IIIT Hyderabad and the biomedical department of IIT Madras, for the design of models of basal ganglia and for their implementation at large scale as well as for their relation with other brain structures. This year we have worked on a model of a dopaminergic region, VTA, central for reinforcement learning in the basal ganglia.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Prof. Chakravarthy Srinivasa

Date: Nov-Dec 2017

Institution: IIT Madras, Chennai (India)

Johannes Twiefel

Date: 10 days, Sep 2017; 1 week, Nov 2017.

Institution: University of Hamburg, Germany.

Luiza Mici

Date: 10 days, Sep 2017.

Institution: University of Hamburg, Germany.

9.4.1.1. Internships

Remya Sankar

Date: June 2017 - Dec 2017

Institution: IIIT Hyderabad (India)

MODAL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Main partners of bilille

Participant: Guillemette Marot.

Bilille, the bioinformatics platform of Lille, officially gathers from Nov. 2015 a few bioinformaticians, biostatisticians and bioanalysts from the following teams:

EA2694 (Univ. Lille, CHRU, Inria)
FRABIO, FR3688 (Univ. Lille, CNRS)
CBP / GFS (Univ. Lille, CHRU)
TAG (Univ. Lille, CNRS, INSERM, Institut Pasteur de Lille)
U1167 (Univ. Lille, CHRU, INSERM et Institut Pasteur de Lille)
U1011 (Univ. Lille, INSERM)
UMR8198 (Univ. Lille, CNRS)
LIGAN PM (Univ. Lille, CNRS)
BONSAI (Inria, Univ. Lille, CNRS).

These last teams are thus the main partners of Modal concerning biostatistics for bioinformatics. Guillemette Marot is the co-head of the platform and works in close collaboration with the following people for the leadership of the scientific strategy related to the platform:

H. Touzet, BONSAI, UMR 9189 (co-head of bilille)
P. Touzet, UMR 8198 (deputy head of bilille)
V. Chouraki, U1167
M. Figeac, CBP / GFS
D. Hot, TAG
V. Leclère, Institut Charles Viollette
M. Lensink, UMR 8576.

9.1.2. Collaborations of the year linked to bilille, the bioinformatics and bioanalysis platform

Participants: Guillemette Marot, Vincent Vandewalle.

Guillemette Marot and Vincent Vandewalle have supervised the data analysis part or support in biostatistics tools testing for the following research projects involving engineers from bilille (only the names of the principal investigators of the project are given even if several partners are sometimes involved in the project):

UMR 8576, E. Goulas, FLAM project
JPARC, M.H. David, AGI-HOX project
JPARC, M.C. Chartier-Harlin, RNA-Seq meta-analysis
U1003, D. Gkika, TRP canals screening
UMR 1167, F. Pinet, INCA-Network project.

9.1.3. Coordinator of the regional (Haut-De-France) project

Participant: Sophie Dabo-Niang.

Sophie Dabo-Niang is the coordinator of the regional (Haut-De-France) project “Bridging cell biomechanical phenotype and their biological expressions for Cancer diagnosis (STATE-CELL)”. It is a project in partnership with Modal-Inria, LIMMS UMI 2820, LEM UMR 9221, Yncrea Hauts de France, INSERM U908. This project is submitted to I-SITE ULNE, SUSTAIN proposals 2017.

9.2. National Initiatives

9.2.1. Programme of Investments for the Future (PIA)

Bilille is a member of two PIA “Infrastructures en biologie-santé”:

France Génomique (<https://www.france-genomique.org/spip/?lang=en>)

IFB, French Institute of Bioinformatics (<https://www.france-bioinformatique.fr/en>)

As leader of the platform, Guillemette Marot is thus involved in these networks.

9.2.2. RHU PreciNASH

Participant: Guillemette Marot.

Acronym: PreciNASH

Project title: Non-alcoholic steato-hepatitis (NASH) from disease stratification to novel therapeutic approaches

Coordinator: F. Pattou

Duration: 5 years

Partners: FHU Integra and Sanofi

PreciNASH, project coordinated by Pr. F. Pattou (UMR 859, EGID), aims at better understanding non alcoholic stratohepatitis (NASH) and improving its diagnosis and care. In this RHU, Guillemette Marot supervises a 2 years post-doc, as her team EA 2694 is member of the FHU Integra. EA 2694 is involved in the WP1 for the development of a clinical-biological model for the prediction of NASH. Other partners of the FHU are UMR 859, UMR 1011 and UMR 8199, these last three teams being part of the labex EGID (European Genomic Institute for Diabetes). Sanofi is the main industrial partner of the RHU PreciNASH. The whole project will last 5 years (2016-2021).

9.2.3. ANR

9.2.3.1. ANR ClinMine

Participants: Cristian Preda, Vincent Vandewalle.

ClinMine Project-2014-2017

ANR project (ANR TECSAN - Technologie de la santé)

Main coordinator of the project: Clarisse Dhaenens, CRISAL, USTL

7 partners - EA 1046 (Maladie d’Alzheimer et pathologies vasculaires, Faculté de Médecine, Lille), EA 2694 (Centre d’Etudes et de Recherche en Informatique Médicale - Faculté de Médecine, Lille), MODAL (Inria LNE), Alicante (Entreprise), CHRU de Montpellier, GHICL (Groupe Hospitalier de l’Institut Catholique de Lille), CRISAL, USTL.

9.2.3.2. ANR TheraSCUD2022

Participant: Guillemette Marot.

Acronym: TheraSCUD2022

Project title: Targeting the IL-20/IL-22 balance to restore pulmonary, intestinal and metabolic homeostasis after cigarette smoking and unhealthy diet

Coordinator: P. Gosset

Duration: 3 years

Partners: CIIL Institut Pasteur de Lille and UMR 1019 INRA Clermont-Ferrand

TheraSCUD2022, project coordinated by P. Gosset (Institut Pasteur de Lille), studies inflammatory disorders associated with cigarette smoking and unhealthy diet (SCUD). Guillemette Marot is involved in this ANR project as head of bilille platform, and will supervise 1 year engineer on integration of omic data. The duration of this project is 3 years (2017-2020).

9.2.4. Working groups

Sophie Dabo-Niang belongs to the following working groups:

- STAFAV (STatistiques pour l'Afrique Francophone et Applications au Vivant)
- ERCIM Working Group on computational and Methodological Statistics, Nonparametric Statistics Team
- Ameriska

Benjamin Guedj belongs to the following working groups (GdR) of CNRS:

- ISIS (local referee for Inria Lille - Nord Europe)
- MaDICS
- MASCOT-NUM (local referee for Inria Lille - Nord Europe).

Guillemette Marot belongs to the [StatOmique working group](#).

9.2.5. Other initiatives

Participants: Serge Iovleff, Cristian Preda, Vincent Vandewalle.

Serge Iovleff is the head of the project CloHe granted in 2016 by the [Mastodons CNRS challenge](#) “Big data and data quality”. The project is axed on the design of classification and clustering algorithms for mixed data with missing values with applications to high spatial resolution multispectral satellite image time-series. [Website](#). Cristian Preda and Vincent Vandewalle are also members of the CloHe project.

9.3. International Initiatives

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

9.3.1.1. Equipes associées nord-européennes

Participants: Christophe Biernacki, Benjamin Guedj.

Benjamin Guedj and Christophe Biernacki pursue a two years collaboration as “Equipes associées nord-européennes” with the Irish team “INSIGHT”. The Centre for Data Analytics INSIGHT is about the size of Inria Lille - Nord Europe and is the main Irish research facility in Statistics and Machine Learning. It is focused on the next generation of machine learning (ML) and statistics (Stat) algorithms that can operate on large-scale dynamic data. Nial FRIEL (NF) is the leader of the ML/Stat axis of INSIGHT, Brendan MURPHY (BM) is a professor. The topic of this project is to manage statistical models inflation by the mean of model clustering.

Benjamin Guedj and Christophe Biernacki visited NF and BM in Dublin once in 2017 to progress in the current collaboration.

9.3.1.2. EMC and CIMPA

Participant: Sophie Dabo-Niang.

EMS (European Mathematical Society): Sophie Dabo-Niang is a nominated member of EMS-CDC (Committee of Developing countries). She will be vice-chair of this committee in 2018.

CIMPA (International Center of Pure and Applied Mathematics): Sophie Dabo-Niang is a nominated member of CIMPA.

9.3.1.3. SIMERGE

Participants: Sophie Dabo-Niang, Serge Iovleff.

Sophie Dabo-Niang and Serge Iovleff are members of SIMERGE, a LIRIMA project-team (January 2015-December 2017). It includes researchers from Mistis (Inria Grenoble - Rhône-Alpes, France) and Inria-MODAL (Lille Nord de France), LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger, Sénégal), IRD (Institut de Recherche pour le Développement, Unité de Recherche sur les Maladies Infectieuses et Tropicales Emergentes, Dakar, Sénégal) and LEM lab (Lille Economie et Management, University of Lille). This project is submitted for renewal with a new partner (Institut Pasteur of Dakar, Senegal).

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Participant: Benjamin Guedj.

Benjamin Guedj collaborates with Wouter Koolen (CWI, Netherlands), Peter Grünwald (CWI & Leiden University, Netherlands).

Benjamin Guedj collaborates with Olivier Wintenberger (KU, Denmark).

9.4. International Research Visitors

9.4.1. Visits to International Teams

Participant: Pascal Germain.

Pascal Germain will visit to “Groupe de recherche en apprentissage automatique de l’Université Laval” (Québec, Canada) to work with Professor François Laviolette from 11/12/2017 to 20/12/2017.

MOEX Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. ANR Elker

Program: ANR-PRC

Project acronym: ELKER

Project title: Extending link keys: extraction and reasoning

Duration: October 2017 - September 2021

Coordinator: LIG/Manuel Atencia

Participants: Manuel Atencia Arcas, Jérôme David, Jérôme Euzenat

Other partners: Inria Lorraine, Université de Vincennes

Abstract: The goal of ELKER is to extend the foundations and algorithms of link keys (see §3.3) in two complementary ways: extracting link keys automatically from datasets and reasoning with link keys.

5.1.2. Framework agreement Ministère de la culture et de la communication

Program: Framework agreement Inria-Ministère de la culture et de la communication

Project acronym: GINCO V3

Project title: Outil d'aide à l'alignement pour l'élaboration du graphe culture

Duration: November 2017 - December 2018

Coordinator: Jérôme David

Participants: Jérôme David, Jérôme Euzenat, Manuel Atencia Arcas

Abstract: The GINCO V3 project aims at extending the GINCO tool with ontology alignment capabilities.

Program: Framework agreement Inria-Ministère de la culture et de la communication

Project acronym: FNE

Project title: Algorithmes d'aide à la définition de clés de liage et d'alignement d'autorités

Duration: November 2017 - December 2018

Coordinator: Jérôme David

Participants: Jérôme David, Manuel Atencia Arcas, Jérôme Euzenat

Other partners: Bibliothèque nationale de France

Abstract: The goal of the FNE cooperation is to evaluate the suitability of link key extraction algorithms to matching authorities from BnF, ABES and the ministry of Culture and to improve such algorithms if necessary.

5.2. International Initiatives

5.2.1. Participation in Other International Programs

Jérôme Euzenat has benefited from a special visiting researcher grant from the Brazilian Ciência sem Fronteiras program on “Methodology and algorithms for ontology refinement and matching” (2015-2017). He works with the team of Fernanda Baião and Kate Revoredo at the Universidade Federal do Estado do Rio de Janeiro (UNIRIO). Together, they investigate methods for evolving ontologies and alignments which involve users and agents. The goal of the project is to design methods and algorithms using theory revision to deal with knowledge evolution in a reliable manner and obtaining better quality alignments.

5.3. International Research Visitors

5.3.1. Visits of International Scientists

- Kate Revoredo (UNIRIO) visited mOeX in May 2017.

5.3.2. Visits to International Teams

- Jérôme Euzenat visited the Universidade Federal do Estado do Rio de Janeiro (UNIRIO) for one month in November-December 2017 (see §[5.2.1](#)).

MOKAPLAN Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

J-D. Benamou is the coordinator of the ANR ISOTACE (Interacting Systems and Optimal Transportation, Applications to Computational Economics) ANR-12-MONU-0013 (2012-2016). The consortium explores new numerical methods in Optimal Transportation AND Mean Field Game theory with applications in Economics and congested crowd motion. Check <https://project.inria.fr/isotace/>.

J-D. Benamou and G. Carlier are members of the ANR MFG (ANR-16-CE40-0015-01). Scientific topics of the project: Mean field analysis Analysis of the MFG systems and of the Master equation Numerical analysis Models and applications

J-D. Benamou G. Carlier F-X. Vialard and T. Gallouët are members of ANR MAGA (ANR-13-JS01-0007-01). The Monge-Ampère equation is a fully nonlinear elliptic equation, which plays a central role in geometry and in the theory of optimal transport. However, the singular and non-linear nature of the equation is a serious obstruction to its efficient numerical resolution. The first aim of the MAGA project is to study and to implement discretizations of optimal transport and Monge-Ampère equations which rely on tools from computational geometry (Laguerre diagrams). In a second step, these solvers will be applied to concrete problems from various fields involving optimal transport or Monge-Ampère equations such as computational physics: early universe reconstruction problem, congestion/incompressibility constraints economics: principal agent problems, geometry: variational problems over convex bodies, reflector and refractor design for non-imaging optics

T. Gallouët is member of the ANR GEOPOR Scientific topic: geometrical approach, based on Wasserstein gradient flow, for multiphase flows in porous media. Theory and Numerics.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- J-D. Benamou is a member of the ITN ROMSOC (Nov. 2017-Nov.2021).
- Andrea Natale has a PRESTIGE Post-Doc Fellowship.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

The following people visited MOKAPLAN during 2016.

- Alfred Galichon (Courant), Teresa Radice (Naples), Gaoyue Guo (Oxford) visited G. Carlier at inria in 2017
- Simone di Marino (Pisa)

MONC Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Plan Cancer

8.1.1.1. NUMEP

Plan Cancer NUMEP: 2016–2019. Numerics for Clinical Electroporation Funding: 460 k€ Partners: Inria Team MONC, Institut de Pharmacologie de Toulouse, CHU J. Verdier de Bondy Duration: Octobre 2016—Septembre 2019 Project leader: C. Poignard Co-PI: M-P. Rols (IPBS), O. Séror (CHU J. Verdier)

8.1.1.2. Dynamo

Plan Cancer DYNAMO: 2015–2018. Dynamical Models for Tissue Electroporation Funding: 370 k€ Partners: Laboratoire Ampère, Lab. Vectorology and Anticancerous Therapies (IGR), Inria Team MONC Duration: Octobre 2015—Septembre 2018 Project leader: R. Scorretti (Laboratoire Ampère) Co-PI: L.M. Mir (IGR), C. Poignard (Inria Team MONC)

8.1.1.3. Moglimaging

- Project acronym - Moglimaging: Modeling of Glioblastoma treatment-induced resistance and heterogeneity by multi-modal imaging.
- Partners -
- Duration - from Nov. 2016 to Nov 2019.
- Coordinator - E. Cohen-Jonathan Moyal, Institut Universitaire du Cancer Toulouse / Local coordinator - O. Saut.
- Team participants - S. Benzekry, A. Collin, C. Poignard, O. Saut.

8.1.1.4. MIMOSA

- Project acronym - Plan Cancer MIMOSA (Physique, Mathématiques et Sciences de l'ingénieur appliqués au Cancer)
- Partner - ITAV, Toulouse
- Duration - from 2014 to 2017
- Coordinator - Th. Colin
- Team participants - Th. Colin, C. Poignard, O. Saut
- Title - Mathematical modeling for exploration of the impact of mechanical constraints on tumor growth

8.1.2. Systems Biology of Renal Carcinoma using a Mouse RCC model

- Title: Plan Cancer Systems Biology of Renal Carcinoma using a Mouse RCC model
- Partners : LAMC, INSERM-Univ. Bordeaux.
- Team participants: O. Saut, S. Benzekry (co-PI)
- 116.64k€

8.1.3. Transnation call: INCA/ARC

- Title: Minimally and non-invasive methods for early detection and/or progression of cancer
- Acronym: TRANSCAN
- Team participants: A. Collin, C. Poignard, O. Saut (local PI)
- Total funds: 1M150, Monc's share 275k€.

8.1.4. Competitivity Clusters

- Labex TRAIL (<http://trail.labex.u-bordeaux.fr>): MOD Project Consolidation. 1 2-years post-doc position (100k€), led by A. Collin, 1 PhD funding (100k€) led by O. Saut.

8.2. European Initiatives

MONC is partner of the European Lab EBAM devoted to electroporation. C.Poignard is member of the steering committee.

8.3. International Initiatives

MONC is partner of the Japanese Core-to-Core project « Establishing networks in mathematical medicine » coordinated by T. Suzuki (Osaka University) with Vanderbilt Univ, and St Andrews Univ. Local PIs are V. Quaranta (Vanderbilt), M. Chaplain (St Andrews) and C. Poignard (MONC).

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

8.3.1.1. METAMATS

Title: Modeling ExperimentAl MetAsTasiS

International Partner (Institution - Laboratory - Researcher):

Roswell Park Cancer Institute (United States) - Department of Cancer Genetics Department of Medicine Department of Pharmacology and Therapeutics (Graduate Program) - John Ebos

Start year: 2017

See also: <http://metamats.bordeaux.inria.fr/>

The aim of the METAMATS associate team is to bring together a cancer biology experimental laboratory led by John ML Ebos (Roswell Park Cancer Institute) and the inria MONC team composed of applied mathematicians. The Ebos laboratory is specialized in the study of anti-cancer therapeutics (in particular, novel biologically targeted therapeutics such as anti-angiogenics and immunotherapies) on the development of metastases and produces unique, hard-to-obtain data sets on this process' dynamics. The MONC team is specialized in mathematical models in oncology, with a dedicated axis about modeling support and methodological development for analysis of data from preclinical studies. In particular, the work of S. Benzekry puts emphasis on proposing, studying and validating mathematical models of metastatic development under the action of various therapeutic modalities. Indeed, metastatic expansion remains the main challenge in the treatment of cancer and integrative studies combining experiments, mathematical models and clinical data have the potential to yield predictive computational tools of help to assist both the design of clinical trials and clinical oncologists in therapeutic decisions such as the control of the toxicity/efficacy balance or the optimal combination of treatment modalities.

8.3.1.2. Num4SEP

Title: Numerics for Spherical Electroporation

International Partner (Institution - Laboratory - Researcher):

University of California, Santa Barbara (United States) - ____Mechanical Engineering____
- Frederic Gibou

Start year: 2017

See also: <http://num4sep.bordeaux.inria.fr/>

Electroporation-based therapies (EPTs) consist in applying high voltage short pulses to cells in order to create defects in the plasma membrane. They provide interesting alternatives to standard ablative techniques, for instance for deep seated badly located tumors. However their use is still limited due to a lack of knowledge of tissue electroporation. The goal of the associate team is to focus on the multiscale numerical modeling of spheroid electroporation, in order to provide new insights in electroporation at the mesoscopic scales (spheroids provide interesting tumor-like biological models). Benefiting from the expertise of F. Gibou's team in HPC for multiphysics, and the expertise of the team MONC in tumor growth and cell electroporation modeling, the goal of the associate team Num4SEP is to obtain accurate and efficient numerical tools for the quantitative evaluation of the EPTs at the mesoscopic scale.

MORPHEME Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Labex Signallife*

The MORPHEME team is member of the SIGNALIFE Laboratory of Excellence.

Florence Besse and Xavier Descombes are members of the Scientific Committee.

Florence Besse and Xavier Descombes participated in the selection committee for LabeX PhD program students.

7.1.2. *Idex UCA Jedi*

Four projects leading by team members were funded.

7.2. National Initiatives

7.2.1. *ANR RNAGRIMP*

Participants: Florence Besse [PI], Xavier Descombes, Eric Debreuve, Djampa Kozlowski.

Here, we propose to study the molecular bases underlying the assembly and regulation of RNA granules, using the highly conserved IMP-containing granules as a paradigm. Specifically, we propose to perform an unbiased genome-wide RNAi screen on *Drosophila* cultured cells to identify mutant conditions in which the organization and/or distribution of IMP-containing granules is altered. To quantitatively and statistically analyze mutant conditions, and to define precise and coherent classes of mutants, we will combine high throughput microscopy with the development of a computational pipeline optimized for automatic analysis and classification of images. The function of positive hits isolated in the screen will then be validated in vivo in *Drosophila* neurons using fly genetics and imaging techniques, and characterized at the molecular and cellular levels using biochemical assays, in vitro phase transition experiments and live-imaging. Finally, the functional conservation of identified regulators will be tested in zebrafish embryos combining gene inactivation and live-imaging techniques. This integrative study will provide the first comprehensive analysis of the functional network that regulates the properties of the conserved IMP RNA granules. Our characterization of the identified regulators in vivo in neuronal cells will be of particular significance in the light of recent evidence linking the progression of several degenerative human diseases to the accumulation of non-functional RNA/protein aggregates.

This 4-years project started january, 2016 and is leaded by F. Besse (iBV, Nice). Participants are iBV, institut de biologie Paris Seine (IBPS, Paris), and Morpheme.

7.2.2. *ANR HMOVE*

Participants: Xavier Descombes, Eric Debreuve, Christelle Requena.

Among the signaling molecules involved in animal morphogenesis are the Hedgehog (Hh) family proteins which act at distance to direct cell fate decisions in invertebrate and vertebrate tissues. To study the underlying process we will develop accurate tracking algorithm to compare trajectories of different Hh pools transportation in live animals. This will allow us to analyze the contribution of the different carriers in the establishment of the Hh gradient. Moreover, we will develop new methods to modify the spatio-temporal and dynamical properties of the extra-cellular Hh gradient and separate the contribution of the apical versus basal Hh pools. We will complete this study with a genome-wide screen to identify genes and related cellular processes responsible for Hh release. The particular interest of this collaboration lies in the combination of development of tracking algorithm to analyze Hh distribution and trajectories with extremely powerful genetics, ease of in vivo manipulation and lack of genetic redundancy of *Drosophila*.

This 4-years project started january, 2016 and is leaded by P. Théron (iBV, Nice). Participants are iBV and Morpheme.

7.2.3. ANR DIG-EM

Participants: Grégoire Malandain, Xavier Descombes, Gaël Michelin.

Morphogenesis controls the proper spatial organization of the various cell types. While the comparatively simple process of patterning and cell differentiation has received considerable attention, the genetic and evolutionary drivers of morphogenesis are much less understood. In particular, we very poorly understand why some morphogenetic processes evolve very rapidly, while others show remarkable evolutionary stability.

This research program aims at developing a high-throughput computational framework to analyze and formalize high-throughput 4D imaging data, in order to quantify and formally represent with cellular resolution the average development of an organism and its variations within and between species. In addition to its biological interest, a major output of the project will thus be the development of robust general computational methods for the analysis, visualization and representation of massive high-throughput light-sheet data sets.

This 4-years project started october the 1st, 2014 and is leaded by P. Lemaire (CRBM, Montpellier). Participants are the CRBM, and two Inria project-team, Morpheme and Virtual Plants.

7.2.4. ANR PhaseQuant

Participants: Grégoire Malandain, Eric Debreuve.

The PhaseQuantHD project aims at developing a high-content imaging system using quadriwave lateral shearing interferometry as a quantitative phase imaging modality. Automated analysis methods will be developed and optimized for this modality. Finally an open biological study question will be treated with the system.

This 3-years project started october the 1st, 2014 and is leaded by B. Wattelier (Phasics, Palaiseau). Participants are Phasics, and three academic teams TIRO (UNS/CEA/CAL), Nice, Mediacoding (I3S, Sophia-Antipolis), and Morpheme.

7.2.5. Inria Large-scale initiative Morphogenetics

Participants: Grégoire Malandain, Xavier Descombes, Gaël Michelin.

This action gathers the expertise of three Inria research teams (Virtual Plants, Morpheme, and Evasion) and other groups (RDP (ENS-CNRS-INRA, Lyon), RFD (CEA-INRA-CNRS, Grenoble)) and aimed at understanding how shape and architecture in plants are controlled by genes during development. To do so, we will study the spatio-temporal relationship between genetic regulation and plant shape utilizing recently developed imaging techniques together with molecular genetics and computational modeling. Rather than concentrating on the molecular networks, the project will study plant development across scales. In this context we will focus on the Arabidopsis flower, currently one of the best-characterized plant systems.

7.2.6. Octopus Project

Participant: Eric Debreuve.

The Octopus project deals with automatic classification of images of zooplankton. It is conducted in collaboration with the Laboratoire d'Océanographie de Villefranche-sur-mer (LOV) et l'ENSTA Paris. The kickoff meeting took place in May 2015 and a 3-day *brainstorming* meeting on Deep Learning took place in December 2015. Participants are I3S (Frédéric Precioso and Mélanie Ducoffe), LOV (Marc Picheral and Jean-Olivier Irisson), and ENSTA Paris (Antoine Manzanera).

7.3. International Initiatives

7.3.1. Participation in Other International Programs

ECOS-Nord France - Colombie 2015-2017: visit of the Pr Arturo Plata from the University Industrial of Santander, Bucaramanga, Columbia, in June 2017.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

Nilgoon Zarei: University of British Columbia, Vancouver, Canada, Jul 2017 - Dec 2017

A Novel approach for Renal Cell Carcinoma Classification Using Vascular, Morphological and Spatial Information

Mohammed Lamine Benomar: PhD, Université Abou Bekr Belkaid Tlemcen, Algérie, from October 2016 until April 2017.

Combinaison adaptative des informations texture et couleur pour la segmentation d'images médicales

Vanna Lisa Coli: PhD, University of Modena and Reggio Emilia, Bologna Italy., from January to April 2017.

TV regularization for the reconstruction of microwave tomographic imagery, with application to the detection of cerebrovascular accidents.

MORPHEO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Persyval-Lab exploratory project Carambole

The Carambole projects initiates a new collaboration between the Morpheo team and biophysicists from University Paris Diderot. The objectives are to develop hardware and software to help tracking feature points on a leaf of *Averrhoa Carambola* during its growth with a multi-camera system and to measure their 3D motion. *Averrhoa carambola* is of special interest because of the distinctive nutation balancing motion of a leaf during its growth.

This exploratory project was funded for 18 months in 2016 and 2017 by the Persyval-Lab LabEx.

9.1.2. ANR

9.1.2.1. 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 industrials : CTC Lyon (shoe conception and manufacturing) and Sporaltec (dissemination). The project has effectively started in October 2017 with Claude Goubet's recruitment as a PhD candidate.

9.1.2.2. ANR project Achmov – Accurate Human Modeling in Videos

The technological advancements made over the past decade now allow the acquisition of vast amounts of visual information through the use of image capturing devices like digital cameras or camcorders. A central subject of interest in video are the humans, their motions, actions or expressions, the way they collaborate and communicate. The goal of ACHMOV is to extract detailed representations of multiple interacting humans in real-world environments in an integrated fashion through a synergy between detection, figure-ground segmentation and body part labeling, accurate 3D geometric methods for kinematic and shape modeling, and large-scale statistical learning techniques. By integrating the complementary expertise of two teams (one French, MORPHEO and one Romanian, CLVP), with solid prior track records in the field, there are considerable opportunities to move towards processing complex real world scenes of multiple interacting people, and be able to extract rich semantic representations with high fidelity. This would enable interpretation, recognition and synthesis at unprecedented levels of accuracy and in considerably more realistic setups than currently considered. This project is currently ongoing with 2 PhDs on the Inria side: Vincent Leroy and Jinlong Yang.

9.1.3. Competitvity Clusters

9.1.3.1. FUI project Creamove

Creamove is a collaboration between the Morpheo team of the Inria Grenoble Rhône-Alpes, the 4D View Solution company specialized in multi-camera acquisition systems, the SIP company specialized in multimedia and interactive applications and a choreographer. The objective is to develop new interactive and artistic applications where humans can interact in 3D with virtual characters built from real videos. Dancer performances will be pre-recorded in 3D and used on-line to design new movement sequences based on inputs coming from human bodies captured in real time. Website: <http://www.creamove.fr>.

9.1.3.2. FUI24 SPINE PDCA – SPINE Plan-Do-Check-Act

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 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.

MULTISPEECH Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CPER LCHN

Project acronym: CPER LCHN

Project title: CPER “Langues, Connaissances et Humanités Numériques”

Duration: 2015-2020

Coordinator: Bruno Guillaume (LORIA) & Alain Polguère (ATILF)

Participants: Dominique Fohr, Denis Jouvét, Odile Mella, Yves Laprie

Abstract: The main goal of the project is related to experimental platforms for supporting research activities in the domain of languages, knowledge and numeric humanities engineering.

MULTISPEECH contributes to automatic speech recognition, speech-text alignment and prosody aspects. This year we have also developed a complete system for the transcription of English broadcast TV shows to participate to the MGB challenge.

9.1.2. CPER IT2MP

Project acronym: CPER IT2MP

Project title: CPER “Innovation Technologique Modélisation et Médecine Personnalisée”

Duration: 2015-2020

Coordinator: Faiez Zannad (Inserm-CHU-UL)

Participants: Romain Serizel, Vishnu Varanasi, Emmanuel Vincent

Abstract: The goal of the project is to develop innovative technologies for health, and tools and strategies for personalized medicine.

MULTISPEECH will investigate acoustic monitoring using an array of microphones.

9.1.3. Dynalips

Project title: Control of the movements of the lips in the context of facial animation for an intelligible lipsync.

Duration: February 2017 - January 2018

Coordinator: Slim Ouni

Participants: Valerian Girard, Slim Ouni

Funding: SATT

Abstract: We propose in this project the development of tools of lipsync which from recorded speech will provide realistic mechanisms of animating the lips. These tools will be available to be integrated into existing 3D animation software and existing game engines. One objective is that these lipsync tools fit easily into the production pipeline in the field of 3D animation and video games. The goal of this maturation is to propose a product ready to be exploited in the industry whether by the creation of a start-up or by the distribution of licenses.

9.2. National Initiatives

9.2.1. E-FRAN METAL

Project acronym: E-FRAN METAL

Project title: Modèles Et Traces au service de l'Apprentissage des Langues

Duration: October 2016 - September 2020

Coordinator: Anne Boyer (LORIA)

Other partners: Interpsy, LISEC, ESPE de Lorraine, D@NTE (Univ. Versailles Saint Quentin), Sailendra SAS, ITOP Education, Rectorat.

Participants: Theo Biasutto-Lervat, Anne Bonneau, Vincent Colotte, Dominique Fohr, Denis Juvet, Odile Mella, Slim Ouni

Abstract: METAL aims at improving the learning of languages (both written and oral components) through the development of new tools and the analysis of numeric traces associated with students' learning, in order to adapt to the needs and rhythm of each learner.

MULTISPEECH is concerned by oral language learning aspects.

9.2.2. PIA2 ISITE LUE

Project acronym: ISITE LUE

Project title: Lorraine Université d'Excellence

Duration: starting in 2016

Coordinator: Univ. Lorraine

Participants: Ioannis Douros, Yves Laprie

Abstract: The initiative aims at developing and densifying the initial perimeter of excellence, within the scope of the social and economic challenges, so as to build an original model for a leading global engineering university, with a strong emphasis on technological research and education through research. For this, we have designed LUE as an "engine" for the development of excellence, by stimulating an original dialogue between knowledge fields.

MULTISPEECH is mainly concerned with challenge number 6: "Knowledge engineering", i.e., engineering applied to the field of knowledge and language, which represent our immaterial wealth while being a critical factor for the consistency of future choices. In 2016, this project has funded a new PhD thesis.

9.2.3. ANR ContNomina

Project acronym: ContNomina

Project title: Exploitation of context for proper names recognition in diachronic audio documents

Duration: February 2013 - March 2017

Coordinator: Irina Illina

Other partners: LIA, Synalp

Participants: Dominique Fohr, Irina Illina, Denis Juvet, Odile Mella, Imran Sheikh

Abstract: The ContNomina project was focus on the problem of proper names in automatic audio processing systems by exploiting in the most efficient way the context of the processed documents. To do this, the project has addressed the statistical modeling of contexts and of relationships between contexts and proper names; the contextualization of the recognition module (through the dynamic adjustment of the lexicon and of the language model in order to make them more accurate and certainly more relevant in terms of lexical coverage, particularly with respect to proper names); and the detection of proper names (on the one hand, in text documents for building lists of proper names, and on the other hand, in the output of the recognition system to identify spoken proper names in the audio/video data).

MULTISPEECH contributes to speech recognition and proper names handling (prediction, introduction in models, ...)

9.2.4. ANR DYCI2

Project acronym: DYCI2 (<http://repmus.ircam.fr/dyci2/>)

Project title: Creative Dynamics of Improvised Interaction

Duration: March 2015 - February 2018

Coordinator: Ircam (Paris)

Other partners: Inria (Nancy), University of La Rochelle

Participants: Ken Deguernel, Nathan Libermann, Emmanuel Vincent

Abstract: The goal of this project is to design a music improvisation system which will be able to listen to the other musicians, improvise in their style, and modify its improvisation according to their feedback in real time.

MULTISPEECH is responsible for designing a system able to improvise on multiple musical dimensions (melody, harmony) across multiple time scales.

9.2.5. ANR JCJC KAMoulox

Project acronym: KAMoulox

Project title: Kernel additive modelling for the unmixing of large audio archives

Duration: January 2016 - January 2019

Coordinator: Antoine Liutkus

Participants: Mathieu Fontaine, Antoine Liutkus

Abstract: The objective is to develop the theoretical and applied tools required to embed audio denoising and separation tools in web-based audio archives. The applicative scenario is to deal with large audio archives, and more precisely with the notorious “Archives du CNRS — Musée de l’homme”, gathering about 50,000 recordings dating back to the early 1900s.

9.2.6. ANR ArtSpeech

Project acronym: ArtSpeech

Project title: Synthèse articulatoire phonétique

Duration: October 2015 - March 2019

Coordinator: Yves Laprie

Other partners: Gipsa-Lab (Grenoble), IADI (Nancy), LPP (Paris)

Participants: Ioannis Douros, Benjamin Elie, Yves Laprie, Anastasiia Tsukanova

Abstract: The objective is to synthesize speech from text via the numerical simulation of the human speech production processes, i.e. the articulatory, aerodynamic and acoustic aspects. Corpus based approaches have taken a hegemonic place in text to speech synthesis. They exploit very good acoustic quality speech databases while covering a high number of expressions and of phonetic contexts. This is sufficient to produce intelligible speech. However, these approaches face almost insurmountable obstacles as soon as parameters intimately related to the physical process of speech production have to be modified. On the contrary, an approach which rests on the simulation of the physical speech production process makes explicitly use of source parameters, anatomy and geometry of the vocal tract, and of a temporal supervision strategy. It thus offers direct control on the nature of the synthetic speech.

Acquisition and processing of cineMRI, new developments of acoustic simulations concerning the production of fricatives and trills, and first works in the implementation of coarticulation in articulatory synthesis are the main activities of this year.

9.2.7. ANR VOCADOM

Project acronym: VOCADOM (<http://vacadom.imag.fr/>)

Project title: Robust voice command adapted to the user and to the context for AAL

Duration: January 2017 - December 2020

Coordinator: CNRS - LIG (Grenoble)

Other partners: Inria (Nancy), Univ. Lyon 2 - GREPS, THEORIS (Paris)

Participants: Dominique Fohr, Sunit Sivasankaran, Emmanuel Vincent

Abstract: The goal of this project is to design a robust voice control system for smart home applications. We are responsible for the speech enhancement and robust automatic speech recognition bricks.

MULTISPEECH is responsible for wake-up word detection, overlapping speech separation, and speaker recognition.

9.2.8. FUI VoiceHome

Project acronym: VoiceHome

Duration: February 2015 - July 2017

Coordinator: VoiceBox Technologies France

Other partners: Orange, Delta Dore, Technicolor Connected Home, eSoftThings, Inria (Nancy), IRISA, LOUSTIC

Participants: Irina Illina, Karan Nathwani, Emmanuel Vincent

Abstract: The goal of this project was to design a robust voice control system for smart home and multimedia applications. We were responsible for the robust automatic speech recognition brick.

MULTISPEECH was responsible for robust automatic speech recognition by means of speech enhancement and uncertainty propagation.

9.2.9. MODALISA

Project acronym: MODALISA

Project title: Multimodality during Language Acquisition: Interaction between Speech Signal and gestures

Duration: January 2017 - December 2017

Coordinator: Christelle Dodane (Praxiling, UMR 5267, Montpellier)

Other partners: Slim Ouni

Participants: Slim Ouni

Funding: CNRS DEFI Instrumentation aux limites

Abstract: The objective of this project was to setup a multimodal platform allowing simultaneous visualization of gestural (motion capture system) and prosodic data during speech and more specifically during language acquisition.

Les contributions de MULTISPEECH concernent l'acquisition et le traitement des données multimodales grâce à la plateforme multimodale MultiMod.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

9.3.1.1. AMIS

Program: CHIST-ERA

Project acronym: AMIS

Project title: Access Multilingual Information opinionS

Duration: Dec 2015- Nov 2018

Coordinator: Kamel Smaïli

Other partners: University of Avignon, University of Science and Technology Krakow, University of DEUSTO (Bilbao)

Participants: Dominique Fohr, Denis Jouvét, Odile Mella

Abstract: The idea of the project is to develop a multilingual help system of understanding without any human being intervention. What the project would like to do, is to help people understanding broadcasting news, presented in a foreign language and to compare it to the corresponding one available in the mother tongue of the user.

MULTISPEECH contributions concern mainly the speech recognition in French, English and Arabic videos.

9.3.2. Collaborations with Major European Organizations

Jon Barker: University of Sheffield (UK)

Robust speech recognition [22], [10], [9], [70]

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Shinji Watanabe, Johns Hopkins University (USA)

Robust speech recognition [22], [10], [9], [70]

9.4.2. Participation in Other International Programs

9.4.2.1. PHC UTIQUE - Arabic speech synthesis

PHC UTIQUE - Arabic speech synthesis, with ENIT (École Nationale d'Ingénieurs de Tunis, Tunisia)

Duration: 2015 - 2018.

Coordinators: Vincent Colotte (France) and Zied LACHIRI (Tunisia).

Participants: Vincent Colotte, Amal Houdhek, Denis Jouvét

Abstract: Modeling of a speech synthesis system for the Arabic language. This includes the use of an Arabic speech corpus, the selection of linguistic features relevant to an Arabic speech synthesis, as well as improving the quality of the speech signal generated by the system (prosodic and acoustic features).

MULTISPEECH co-supervises PhD students.

9.4.2.2. FIRA - La famille face au handicap

Program: FIRA, International Foundation of Applied Disability Research

Project title: La famille face au handicap : la gestion du stress parental des parents d'enfants souffrant du syndrome de Dravet

Duration: Jan 2017- Dec 2019

Coordinator: T. Leonova, University of Lorraine (Perseus)

Other partners: MHS-USR 3261 CNRS, Université de Lorraine, Associations Alliance Syndrome de Dravet (France) and Alliance Syndrome de Dravet (Suisse), Hopital de Hautepierre - Strasbourg University (France), Hopital Necker enfants malades - Paris Descartes University - INSERM U1129, Hôpital Robert Debré - Paris Diderot University- INSERM U1141, Hôpitaux Universitaires de Genève - Université de Genève (Suisse), Université catholique du Sacré Cœur - Rome (Italie), Quebec University (Canada), McMaster Children's Hospital - McMaster University - Hamilton (Canada), MIA518-AgroParisTech/INRA.

Participant: Agnès Piquard-Kipffer

Abstract: the aims of the project are, in a first step, to explore parental stress with Children with Dravet syndrome which combine infant epilepsy and autism and in a second step to create a training program for professionals of Education [68], [69]

In this project, MULTISPEECH is involved in finding the best ways to maximize the communication efficiency between the children and their families, using the methodology or the tools created by the Handicom project.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Ziteng Wang

Date: Sep 2016 – Sep 2017

Institution: Institute of Acoustics, Chinese Academy of Sciences (China)

Vishnuvardhan Varanasi

Date: Feb – Aug 2017

Institution: Indian Institute of Science, Kanpur (India)

Md Sahidullah

Date: Aug – Oct 2017

Institution: University of Eastern Finland (Finland)

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Antoine Liutkus was invited by Kazuyoshi Yoshii (RIKEN, Kyoto University) to work on multichannel extensions to his tensor-factorization methods, that would also allow for much easier inference. This led to a joint publication [47] about the resulting method.

MYCENAE Project-Team

8. Partnerships and Cooperations

8.1. European Initiatives

Together with our BIOS INRA partner, we have participated in a synergistic way in the proposal EVE (*In-Silico Safety and Efficacy Assessment of Reproductive Endocrinology Treatments*) submitted to the H2020-SC1-2016-2017 call (Personalised Medicine), whose PI was Enrico Tronci (Sapienza, Roma).

8.2. National Initiatives

8.2.1. ANR

Jonathan Touboul is member of the **Kibord** (KInetic models in Biology Or Related Domains) project obtained in 2014.

He is also PI of the projects “Mathematical modeling of synaptic plasticity” (with Laurent Venance, CIRB) funded as an interdisciplinary structuring project of INSB (Institut des Sciences Biologiques in CNRS) and “Altering Fear Memory” (with Sidney Wiener, CIRB and Karim Benchenane, ESPCI) funded by the PSL Labex **MemoLife**.

8.2.2. National Networks

- **GdR REPRO** (F. Clément is member of the direction board)
- **MIA REM network**: Réduction de modèles (PI Béatrice Laroche, INRA Jouy)

8.2.3. National Collaborations

- **UMR Physiologie de la Reproduction et des Comportements**, INRA Centre- Val de Loire (Bios and Bingo teams)
- Université Pierre & Marie Curie (UPMC)
 - **Jacques-Louis Lions Laboratory**, Pierre & Marie Curie University (Jean-Pierre François, Marie Postel)
 - **Developmental Biology Laboratory**, Institut de Biologie Paris Seine (IBPS), Pierre & Marie Curie University (Alice Karam, Sylvie Schneider Maunoury), in the framework of the NeuroMathMod, Sorbonne-Universités Émergence call
- **Center for Interdisciplinary Research in Biology** (CIRB), Collège de France (Alain Prochiantz, Marie Manceau, Laurent Venance)

MYRIADS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CominLabs EPOC project (2013-2017)

Participants: Sabbir Hasan Rochi, Yunbo Li, Anne-Cécile Orgerie, Jean-Louis Pazat.

In this project, partners aim at focusing on energy-aware task execution from the hardware to application's components in the context of a mono-site data center (all resources are in the same physical location) which is connected to the regular electric Grid and to renewable energy sources (such as windmills or solar cells). In this context, we tackle three major challenges:

- Optimizing the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services.
- Designing a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed systems.
- Investigating energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

Sabbir Hasan Rochi has defended his PhD on SLA driven Cloud autoscaling for optimizing energy footprint on May 3rd, 2017. Yunbo Li has defended his PhD on Resource allocation in a Cloud partially powered by renewable sources on June 12th, 2017.

9.1.2. INDIC - Cybersecurity Pole of Excellence (2014-2020)

Participants: Anna Giannakou, Christine Morin, Jean-Louis Pazat, Louis Rilling, Amir Teshome Wonjiga, Clément El Baz.

Our study carried out in the framework of a collaboration with DGA-MI aims at defining and enforcing SLA for security monitoring of virtualized information systems. To this aim we study three topics:

- defining relevant SLA terms for security monitoring,
- enforcing and evaluating SLA terms,
- making the SLA terms enforcement mechanisms self-adaptable to cope with the dynamic nature of clouds.

The considered enforcement and evaluation mechanisms should have a minimal impact on performance. The funding from DGA funds two PhD students: Anna Giannakou and Amir Teshome Wonjiga. Clément El Baz is partially funded by the Brittany Regional Council in the PEC framework.

9.2. National Initiatives

9.2.1. ADEME RennesGrid

Participants: Benjamin Camus, Anne-Cécile Orgerie, Martin Quinson.

The aim of the RennesGrid project is to design and implement a large-scale preindustrial microgrid demonstrator in the territory of Rennes Metropole to organize the shared self-consumption of a group of photovoltaic panels coupled to stationary storage devices. Traditional approaches to power grid management tend to overlook the costs, both energy and economic, of using computers to ensure optimal electricity network management. However, these costs can be significant. It is therefore necessary to take them into account along with the design of IT tools during studies of optimal energy management of smart grids. In addition, telecommunication networks are generally considered to have an ideal functioning, that is to say they can not negatively affect the performance of the electricity network. However, this is not realistic and it is necessary to analyze the impact of phenomena such as congestion, latency, failures related to computer equipment or impact on the batteries of sensors, etc. on strategies for optimal management of the electricity network. In this project, we will closely collaborate with Anne Blavette (CR CNRS in electrical engineering, SATIE, Rennes) and co-supervise a post-doc on evaluating the impact of the IT infrastructure in the management of smart grids.

9.2.2. *Inria ADT SaaP (2016-2018)*

Participants: Toufik Boubehziz, Martin Quinson.

The SaaP technological development action (SimGrid As A Platform) funded by INRIA targets the refactoring of SimGrid to make it ready to use in production and teaching contexts. Our ultimate goal is to sustain the development of the framework by involving 5 to 10 companies that are using it internally. Our target of the teaching context is thus an intermediate goal, as we think that the best solution to ensure the adoption of our tool by the industrial engineers is that they discover the tool during their studies.

The technical actions envisioned for this ADT are the complete re-factoring of the software (to make it easier to script a new model within the tool kernel) and a reorganization of the interfaces (for a better integration in the Java and python language). This work is lead by Toufik Boubehziz in collaboration with the whole SimGrid community, which provide valuable feedback.

9.2.3. *Inria ADT DiFFuSE (2017-2018)*

Participants: Nikos Parlavantzas, Christine Morin, Manh Linh Pham.

The DiFFuSE technological development action (Distributed framework for cloud-based epidemic simulations) funded by INRIA focuses on the DiFFuSE framework developed by Myriads in the context of MIHMES (2012-2017). MIHMES was a 5-year collaborative multidisciplinary project funded by ANR under the Investments for the Future Program, and led by BIOEPAR, INRA, ONIRIS. DiFFuSE is a framework that provides design support, reusable code, and tools for building and executing epidemic simulations in the cloud. The main objectives of this ADT are to improve the usability and robustness of DiFFuSE, to provide support to scientists for applying the framework to a new epidemic simulations as well as to provide a thorough evaluation of the framework using multiple case studies.

9.2.4. *Inria IPL Discovery (2015-2019)*

Participants: Ehsan Ahvar, Anne-Cécile Orgerie, Matthieu Simonin, Genc Tato, Cédric Tedeschi.

The Inria IPL Discovery officially started in September 2015. It targets the design, development and deployment of a distributed Cloud infrastructure within the network's backbone. It will be based upon a set of building blocks whose design will take locality as a primary constraint, so as to minimize distant communications and consequently achieve better network traffic, partition management and improved availability.

Its developments are planned to get integrated within the OpenStack framework. Myriads is involved in the design of new overlay networks for such environments so as to support efficient messaging and routing. Myriads is also involved in the energy/cost benefit analysis of distributed edge-cloud architectures.

9.2.5. *Inria IPL CityLab (2015-2018)*

Participants: Subarna Chatterjee, Christine Morin.

The Inria Project Lab (IPL) CityLab@Inria (<http://citylab.inria.fr>) studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. City-scale experiments of the proposed platforms and services are planned in cities in California and France, thereby learning lessons from diverse setups.

Myriads investigates advanced cloud solutions for the Future Internet, which are critical for the processing of urban data. It leverages its experience in cloud computing and Internet of services while expanding its research activities to the design and implementation of cloud services to support crowd-Xing applications and mobile social applications.

In 2017, Christine Morin was involved in the preparation of a SPOC entitled "Technological challenges of participatory smart cities", which is proposed in the framework of the EIT Digital professional school. She prepared seven sequences on cloud-based urban data management. This SPOC is the English version of the MOOC entitled "*Défis technologiques des villes intelligentes participatives*" run on the FUN platform in Spring and Fall 2017.

In 2017, we also conducted a comparative experimental evaluation of data stream processing environments executed on clusters and clouds. We compared the performance and energy consumption of Heron, Storm and Flink frameworks with three data streaming representative applications.

9.2.6. Inria IPL Hac Specis (2016-2020)

Participants: Anne-Cécile Orgerie, Martin Quinson, The Anh Pham.

The goal of the HAC SPECIS (High-performance Application and Computers: Studying PERformance and Correctness In Simulation) project (<http://hacspecis.gforge.inria.fr/>) is to answer methodological needs of HPC application and runtime developers and to allow to study real HPC systems both from the correctness and performance point of view. To this end, we gather experts from the HPC, formal verification and performance evaluation community.

During his first year of PhD thesis, The Anh Pham conducted an analysis of the formal methods and algorithms used in SimGrid. This work, co-advised by Martin Quinson with Thierry Jéron (team SUMO, formal methods), was important to bridge the gap between the involved communities. The resulting work has been published in a workshop gathering the intersection between the communities of formal methods and HPC [44].

Another PhD thesis will start in December 2017, co-advised by Laurent Lefèvre (Avalon team, Lyon), Martin Quinson and Anne-Cécile Orgerie. This thesis will focus on simulating the energy consumption of continuum computing between heterogeneous numerical infrastructures for HPC.

9.2.7. COSMIC PRE (2016 - 2018)

Participants: Benjamin Camus, Anne-Cécile Orgerie, Martin Quinson.

The distributed nature of Cloud infrastructures involves that their components are spread across wide areas, interconnected through different networks, and powered by diverse energy sources and providers, making overall energy monitoring and optimization challenging. The COSMIC project aims at taking advantage of the opportunity brought by the Smart Grids to exploit renewable energy availability and to optimize energy management in distributed Clouds. This PRE, led by Anne-Cécile Orgerie also involves Fanny Dufossé from Dolphin team (Inria Lille), Anne Blavette from SATIE laboratory (electrical engineering, Rennes), and Benjamin Camus, who has started a 18 months post-doc in October 2016 in the context of this project. A paper on this project has been presented at SMARTGREENS 2017 and two others are currently under submission.

9.2.8. MIHMES ANR Investissements d'Avenir (2012 - 2017)

Participants: Christine Morin, Manh Linh Pham, Nikos Parlavantzas.

The MIMHES project (<http://www.inra.fr/mihmes>) led by INRA/BioEpAR aimed at producing scientific knowledge and methods for the management of endemic infectious animal diseases and veterinary public health risks. The role of Myriads was to help MIMHES researchers improve the performance of their simulation applications and take advantage of computing resources provided by clouds. To that end, Myriads developed a framework, named DiFFuSE, that provides design support, reusable code, and tools for building and executing epidemic simulations in the cloud.

In 2017, we further developed DiFFuSE and extended the framework to make use of the PaaSage open-source platform, the main outcome of a European FP7 IP project in which Myriads participated (2012-2016). Thanks to PaaSage, DiFFuSE allows deploying and managing services in multi-cloud environments. We applied DiFFuSE to restructure an application that simulates the spread of the bovine viral diarrhoea virus (BVDV) and conducted experiments to evaluate DiFFuSE [45].

9.2.9. *SESAME ASTRID project (2016-2019)*

Participants: Pascal Morillon, Christine Morin, Matthieu Simonin, Cédric Tedeschi, Mehdi Belkhiria.

The Sesame project (<http://www.agence-nationale-recherche.fr/Project-ANR-16-ASTR-0026>) led by IMT Atlantique aims at develop efficient infrastructures and tools for the maritime traffic surveillance. The role of Myriads is to define a robust and scalable infrastructure for the real-time and batch processing of vessel tracking information.

9.2.10. *PIA ELCI (2015-2018)*

Participant: Anne-Cécile Orgerie.

The PIA ELCI project deals with software environment for computation-intensive applications. It is leaded by BULL. In the context of this project, we collaborate with ROMA and Avalon teams from Lyon: we co-supervise a PhD student (Issam Rais) funded by this project with these teams on multi-criteria scheduling for large-scale HPC environments. This collaboration has led to two publications in 2017: a journal article published in IJHPCA and a conference paper presented at EuroPar.

9.2.11. *CNRS GDS EcoInfo*

Participant: Anne-Cécile Orgerie.

The EcoInfo group deals with reducing environmental and societal impacts of Information and Communications Technologies from hardware to software aspects. This group aims at providing critical studies, lifecycle analyses and best practices in order to improve the energy efficiency of printers, servers, data centers, and any ICT equipment in use in public research organizations. In particular, it has led in December 2016 to the publication of an ADEME report jointly with Deloitte Développement Durable, Futuribles, CREDOC and ADEME on the potential contribution of digital to the reduction of environmental impacts: state of play and challenges for the prospective.

9.3. European Initiatives

9.3.1. *FP7 & H2020 Projects*

9.3.1.1. *FogGuru*

Participant: Guillaume Pierre.

Title: MSCA ITN EID

Programm: H2020

Duration: September 2017 - August 2021

Coordinator: Guillaume Pierre

Participants:

University of Rennes 1, France (coordinator)

Technisch Universität Berliun, Germany

Elastisys AB, Sweden

U-Hopper srl, Italy

EIT Digital Rennes, France

Las Naves, Spain

FogGuru is a doctoral training project which aims to to train eight talented PhD students with an innovative and inter-sectoral research program to constitute the next generation of European Cloud and Fog computing experts. Besides their scientific and technical education, FogGuru's PhD students will receive extensive training in technological innovation and entrepreneurship as well as soft skills. These combined skills will enable them to fully master the innovation process stemming from fundamental research towards invention and development of innovative products and services, and to real-life deployment, experimentation and engagement with beta-testers.

9.3.1.2. *Fed4Fire+* (2017-2022)

Participants: David Margery, Yue Li.

Title: Federation for FIRE Plus

Programm: H2020

Duration: January 2017 - December 2021

Coordinator: Interuniversitair Micro-Electronicacentrum Imec VZW

Partners:

Universidad de Malaga

National Technical University of Athens - NTUA

The Provost, Fellows, Foundation Scholars & the other members of board of the College of the Holy & Undivided Trinity of Queen Elizabeth Near Dublin

Ethniko Kentro Erevnas Kai Technologikis Anaptyxis

GEANT Limited

Institut Jozef Stefan

Mandat International Alias Fondation Pour la Cooperation Internationale

Université Pierre et Marie Curie - Paris 6

Universidad De Cantabria

Fundacio Privada I2CAT, Internet I Innovacio Digital A Catalunya

EUROSCOM-European Institute For Research And Strategic Studies in Telecommunications GMBH

Nordunet A/S

Technische Universitaet Berlin

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk

Fraunhofer Gesellschaft zur Foerderung Der Angewandten Forschung E.V.

Universiteit Van Amsterdam

University of Southampton

Martel GMBH

Atos Spain SA

Institut National de Recherche en Informatique et automatique

Inria contact: David Margery

Fed4FIRE+ is a successor project to Fed4FIRE. In Fed4FIRE+, we more directly integrate Grid'5000 into the wider eco-system of experimental platforms in Europe and beyond using results we developed in Fed4FIRE. We have developed a generalized proxy mechanisms to allow users with Fed4FIRE identities to interact with services giving access to different testbeds but not designed to support Fed4FIRE identities. Fed4FIRE+ has started January 1st, 2017.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. NESUS

Participant: Anne-Cécile Orgerie.

Program: ICT COST

Project acronym: NESUS

Project title: Network for Sustainable Ultrascale Computing (ICT COST Action IC1305)

Duration: 2014 - 2018

Coordinator: Prof. Jesus Carretero, University Carlos III of Madrid, Spain, <http://www.nesus.eu>

Other partners: 33 COST countries and 11 non-COST countries

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger than today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to gluing disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society. Anne-Cécile Orgerie is co-responsible of the focus group on metrics, monitoring, instrumentation and profiling in the Working Group 5 on Energy Efficiency. A joint paper has been accepted in 2017 on this topic at the Elsevier journal on Sustainable Computing.

9.3.3. Collaborations with Major European Organizations

Partner 1: EPFL, Network architecture lab (Switzerland)

We collaborate with Katerina Argyraki's research group on the integration of networking and cloud computing technologies in order to support placement constraints between cloud resources.

Partner 2: University of Neuchâtel, dept. of Computer Science (Switzerland)

We collaborate with Pascal Felber's research group on energy efficiency in Clouds and in particular on the design of energy cost models for virtual machines. A joint journal paper has been accepted in 2017 for publication in Sustainable Computing: Informatics and Systems, Elsevier.

Partner 3: Catholic University of Louvain (Belgium)

We collaborate with Etienne Riviere's research group on the efficient service placement and discovery in a SaaS context.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. DALHIS

Participants: Christine Morin, Deborah Agarwal, Anna Giannakou, Amir Teshome Wonjiga, Subarna Chatterjee.

Title: Data Analysis on Large Heterogeneous Infrastructures for Science

International Partner (Institution - Laboratory - Researcher):

Lawrence Berkeley National Laboratory (United States) - Data Science and Technology department - Deb Agarwal

Start year: 2016

See also: <https://project.inria.fr/dalhis/>

Data produced by scientific instruments (large facilities like telescopes or field data), large-scale experiments, and high-fidelity simulations are increasing in magnitude and complexity. Existing data analysis methods, tools and infrastructure are often difficult to use and unable to provide the complete data management, collaboration, and curation environment needed to manage these complex, dynamic, and large-scale data analysis environments. The goal of the Inria-LBL DALHIS associate team involving the Myriads (PI) and Avalon Inria project-teams and the Data Science and Technology (DST) department at Lawrence Berkeley National Laboratory (LBL) is to create a collaborative distributed software ecosystem to manage data lifecycle and enable data analytics on distributed data sets and resources. Specifically, our goal is to build a dynamic software stack that is user-friendly, scalable, energy-efficient and fault tolerant. Our research will determine appropriate execution environments that allow users to seamlessly execute their end-to-end dynamic data analysis workflows in various resource environments and scales while meeting energy-efficiency, performance and fault tolerance goals. We will engage in deep partnerships with scientific teams (Fluxnet in environmental science and SNFactory and LSST experiences in cosmology) and use a mix of user research with system software R&D to address specific challenges that these communities face. In 2017, we worked on evaluating data streaming environments (see Section 7.1.4) and on producing tools to help users (scientist in the climate and environment community) to explore the carbon flux datasets from AmeriFlux (Americas) and FLUXNET (global) (see Section 7.4.2.2). We also worked on two facets of security in the context of HPC distributed computing infrastructures: (i) building a workflow for data analysis for anomaly detection and (ii) using the block-chain technology to leverage data integrity at the network and some portion of computation levels.

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

9.4.2.1. SUSTAM associated team

Participants: Anne-Cécile Orgerie, Yunbo Li.

Anne-Cécile Orgerie participates in the associated team named SUSTAM (Sustainable Ultra Scale compuTing, dAta and energy Management) led by Laurent Lefèvre (Avalon team, Lyon) with Prof. Manish Parashar (RDI2, Rutgers University, NJ, USA). The SUSTAM associate team will focus on the joint design of a multi-criteria orchestration framework dealing with resources, data and energy management in a sustainable way.

9.4.3. Inria International Partners

9.4.3.1. Informal International Partners

Partner: Rutgers University, dept. of Computer Science (New Jersey, United States)

We collaborate with Manish Parashar's research group on energy efficiency in edge Clouds and in particular on the design of energy cost models for such environments involving renewable energy. A joint paper has been presented at IEEE/ACM CCGrid 2017.

Partner: Northeastern University, dept. of Computer Science (Massachusetts, United States)

We collaborate with Gene Cooperman's research group on the study of large-scale distributed systems. More specifically, we actively collaborate on virtualization technologies and system snapshotting (we obtained a postdoc funding on that topic from the Brittany Regional Council, but all applicants declined in the last minute). We plan to reinforce and extend our collaboration to formal methods for distributed systems in the next year.

Partner: University of Guadalajara (Mexico)

We collaborate with the team of Prof. Hector Duran-Limon on application and resource management in the cloud. In 2017, we produced a joint publication [46]. Nikos Parlavantzas is co-advising a PhD student enrolled in the University of Guadalajara (Carlos Ruiz Diaz).

Partner: Tlemcen University (Algeria)

We collaborate with Djawida Dib on energy-efficient fault-tolerant resource and application management in containerized clouds. Christine Morin and Nikos Parlavantzas have been co-advising Yasmina Bouizem, a PhD student enrolled in the University of Tlemcen from December 2016.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Deb Agarwal, senior scientist at Lawrence Berkeley National Laboratory, who has been awarded an Inria International Chair for the 2015-2019 period, visited Myriads team during two months from August 1st to October 15th, 2017.

Professor Gene Cooperman, Northeastern University, Boston, USA, visited the Myriads team for one week in July to reinforce our collaboration on the virtualization of large-scale distributed systems.

9.5.1.1. Internships

Betsegaw Lemma Amersho

Date: Feb-June 2017

Institution: University of Rennes 1 & Aalto University (Finland)

Supervisors: Anne-Cécile Orgerie and Martin Quinson

Vinothkumar Nagasayanan

Date: May-August 2017

Institution: University of Rennes 1 & TU Berlin (Germany)

Supervisor: Guillaume Pierre

Salsabil Amri

Date: May-August 2017

Institution: University of Rennes 1

Supervisor: Guillaume Pierre

Bérenger Nguyen Nhon

Date: July-August 2017

Institution: University of Rennes 1

Supervisor: Guillaume Pierre

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Genc Tato started a 6-month research visit at the Catholic University of Louvain in November 2017 to work with Etienne Riviere on service placement and discovery in a SaaS context.
- Amir Teshome Wonjiga did a 3-month research internship in the Data Science and Technology department of the Lawrence Berkeley National Laboratory from April to June 2017. He worked with Sean Peisert, staff scientist, on ensuring data integrity in the workflow of high performance applications.
- Anne-Cécile Orgerie visited for 1 week the team of Prof. Manish Parashar in the RDI2 laboratory at Rutgers University in October 2017.

NACHOS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Inria Project Lab

7.1.1.1. C2S@Exa (*Computer and Computational Sciences at Exascale*)

Participants: Olivier Aumage [STORM project-team, Inria Bordeaux - Sud-Ouest], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri [Coordinator of the project], Jean-François Méhaut [CORSE project-team, Inria Grenoble - Rhône-Alpes], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is coordinating the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

7.1.2. ANR project

7.1.2.1. TECSER

Participants: Emmanuel Agullo [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Xavier Antoine [CORIDA project-team, Inria Nancy - Grand-Est], Patrick Breuil [Nucléudes, Les Ulis], Thomas Frachon, Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri, Ludovic Moya, Guillaume Sylvand [Airbus Group Innovations].

Type: ANR ASTRID

Duration: May 2014 - April 2017

Coordinator: Inria

Partner: Airbus Group Innovations, Inria, Nucléudes

Inria contact: Stéphane Lanteri

Abstract: the objective of the TECSER project is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. DEEP-ER

Title: Dynamic Exascale Entry Platform - Extended Reach

Program: FP7

Duration: October 2013 - September 2016

Coordinator: Forschungszentrum Juelich GmbH (Germany)

Partner: Intel GmbH (Germany), Bayerische Akademie der Wissenschaften (Germany), Ruprecht-Karls-Universität Heidelberg (Germany), Universität Regensburg (Germany), Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung E.V (Germany), Eurotech SpA (Italy), Consorzio Interuniversitario Cineca (Italy), Barcelona Supercomputing Center - Centro Nacional de Supercomputación (Spain), Xyratex Technology Limited (United Kingdom), Katholieke Universiteit Leuven (Belgium), Stichting Astronomisch Onderzoek in Nederland (The Netherlands) and Inria (France).

Inria contact: Stéphane Lanteri

Abstract: the DEEP-ER project aims at extending the Cluster-Booster Architecture that has been developed within the DEEP project with a highly scalable, efficient, easy-to-use parallel I/O system and resiliency mechanisms. A Prototype will be constructed leveraging advances in hardware components and integrate new storage technologies. They will be the basis to develop a highly scalable, efficient and user-friendly parallel I/O system tailored to HPC applications. Building on this I/O functionality a unified user-level checkpointing system with reduced overhead will be developed, exploiting multiple levels of storage. The DEEP programming model will be extended to introduce easy-to-use annotations to control checkpointing, and to combine automatic re-execution of failed tasks and recovery of long-running tasks from multi-level checkpoint. The requirements of HPC codes with regards to I/O and resiliency will guide the design of the DEEP-ER hardware and software components. Seven applications will be optimised for the DEEP-ER Prototype to demonstrate and validate the benefits of the DEEP-ER extensions to the Cluster-Booster Architecture.

7.2.1.2. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputación (Spain)

Commissariat A L Energie Atomique et Aux Energies Alternatives (France)

Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)

Consiglio Nazionale Delle Ricerche (Italy)

The Cyprus Institute (Cyprus)

Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)

Fraunhofer Gesellschaft Zur Förderung Der Angewandten Forschung Ev (Germany)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Forschungszentrum Jülich (Germany)

Max Planck Gesellschaft Zur Förderung Der Wissenschaften E.V. (Germany)

University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

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

7.2.1.3. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partner: Barcelona Supercomputing Center (Spain), Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas - CIEMAT (Spain), REPSOL SA (Spain), Iberdrola Renovables Energia SA (Spain), Lancaster University (United Kingdom), COPPE/UFRJ - Universidade Federal do Rio de Janeiro (Brazil), LNCC (Brazil), INF/UFRGS - Universidade Federal do Rio Grande do Sul (Brazil), CER/UFPE - Universidade Federal de Pernambuco (Brazil), PETROBRAS (Brazil), TOTAL SA (France), and Inria (France).

Inria contact: Stéphane Lanteri

Abstract: This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO₂ emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial

applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

7.3. International Initiatives

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

7.3.1.1. HOMAR

Title: High performance Multiscale Algorithms for wave pRopagation problems

International Partner (Institution - Laboratory - Researcher):

Laboratório Nacional de Computação Científica (Brazil) - Coordenação de Matemática Aplicada e Computacional - Frédéric Valentin

Start year: 2015

See also: <http://www-sop.inria.fr/nachos/index.php/Main/HOMAR>

The general scientific context of the collaboration proposed in the HOMAR project is the study of time dependent wave propagation problems presenting multiscale features (in space and time). The general goal is the design, analysis and implementation of a family of innovative high performance numerical methods particularly well suited to the simulation of such multiscale wave propagation problems. Mathematical models based on partial differential equations (PDE) embedding multiscale features occur in a wide range of scientific and technological applications involving wave propagation in heterogeneous media. Electromagnetic wave propagation and seismic wave propagation are two relevant physical settings that will be considered in the project. Indeed, the present collaborative project will focus on two particular application contexts: the interaction of light (i.e. optical wave) with nanometer scale structure (i.e. nanophotonics) and, the interaction of seismic wave propagation with geological media for quantitative and non destructive evaluation of imperfect interfaces.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

Prof. Kurt Busch, Humboldt-Universität zu Berlin, Institut für Physik, Theoretical Optics & Photonics

Prof. Martijn Wubs, Technical University of Denmark (DTU), Structured Electromagnetic Materials Theory group

Dr. Urs Aeberhard and Dr. Markus Ermes, Theory and Multiscale Simulation, IEK-5 Photovoltaik, Forschungszentrum Jülich, Germany

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Prof. Liang Li, School of Mathematical Sciences, University of Electronic Science and Technology of China, Chengdu. From March 2016 to February 2017.

Dr. Antonio Tadeu Gomez and Dr. Frédéric Valentin, LNCC, Petropolis, Brazil. From December 15, 2016 to February 15, 2017.

7.4.2. Visits to International Teams

Claire Scheid, guest researcher's stays, KIT, Karlsruhe, financed by the CRC 1173 "Wave phenomena: analysis and numerics": 3 weeks from 12 June to 6 July 2017, and 5 weeks from 19 November to 23 December 2017.

NANO-D Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

In 2015, NANO-D had funding from one ANR program:

- **ANR Modeles Numeriques (MN):** 180,000 Euros over four years (2011-2015). This project, coordinated by NANO-D (S. Grudinin), gathers biologists and computer scientists from three research groups: Dave Ritchie at LORIA, Valentin Gordeliy at IBS (total grant: 360,000 Euros).

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

6.2.1.1. ADAPT

Title: Theory and Algorithms for Adaptive Particle Simulation

Programm: FP7

Duration: September 2012 - August 2017

Coordinator: Inria

Inria contact: Stephane Redon

'During the twentieth century, the development of macroscopic engineering has been largely stimulated by progress in digital prototyping: cars, planes, boats, etc. are nowadays designed and tested on computers. Digital prototypes have progressively replaced actual ones, and effective computer-aided engineering tools have helped cut costs and reduce production cycles of these macroscopic systems. The twenty-first century is most likely to see a similar development at the atomic scale. Indeed, the recent years have seen tremendous progress in nanotechnology - in particular in the ability to control matter at the atomic scale. Similar to what has happened with macroscopic engineering, powerful and generic computational tools will be needed to engineer complex nanosystems, through modeling and simulation. As a result, a major challenge is to develop efficient simulation methods and algorithms. NANO-D, the Inria research group I started in January 2008 in Grenoble, France, aims at developing efficient computational methods for modeling and simulating complex nanosystems, both natural and artificial. In particular, NANO-D develops SAMSON, a software application which gathers all algorithms designed by the group and its collaborators (SAMSON: Software for Adaptive Modeling and Simulation Of Nanosystems). In this project, I propose to develop a unified theory, and associated algorithms, for adaptive particle simulation. The proposed theory will avoid problems that plague current popular multi-scale or hybrid simulation approaches by simulating a single potential throughout the system, while allowing users to finely trade precision for computational speed. I believe the full development of the adaptive particle simulation theory will have an important impact on current modeling and simulation practices, and will enable practical design of complex nanosystems on desktop computers, which should significantly boost the emergence of generic nano-engineering.'

6.2.2. Collaborations with Major European Organizations

Partner 1: Institut Laue-Langevin, SANS platform (France)

Partner 2: European Synchrotron Radiation Facility, SAXS platform (France)

The topic of collaboration is the development and validation of novel computational methods for small-angle scattering experiments.

6.3. International Initiatives

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

6.3.1.1. PPI-3D

Title: Structure Meets Genomics

International Partner (Institution - Laboratory - Researcher):

Stony Brook University (United States) - Dima Kozakov

Start year: 2015

See also: <https://team.inria.fr/nano-d/research/ppi-3d-structure-meets-genomics/>

Protein–protein interactions are integral to many mechanisms of cellular control, and therefore their characterization has become an important task for both experimental and computational approaches in systems biology. Genome-wide proteomics studies provide a growing list of putative protein-protein interactions, and demonstrate that most if not all proteins have interacting partners in the cell. A fraction of these interaction has been reliably established, however, one can only identify whether two proteins interact and, in the best cases, which are the individual domains mediating the interaction. A full comprehension of how proteins bind and form complexes can only come from high-resolution three-dimensional structures. While the most complete structural characterization of a complex is provided by X-ray crystallography, protein-protein hetero-complexes constitute less than 6% of protein structures in the Protein Data Bank. Thus, it is important to develop computational methods that, starting from the structures of component proteins, can determine the structure of their complexes.

The basic problem of predictive protein docking is to start with the structures (or sequences) of unbound component proteins A and B, and to obtain computationally a model of the bound complex AB, as detailed structural knowledge of the interactions facilitates understanding of protein function and mechanism. Our current docking approaches performs ab initio docking of the two structures without the use of any additional information. The goal of this proposal is to speed up docking approaches to tackle genome-scale problems, and utilize additional information on interactions, sequences, and structures that is available for virtually any protein.

This project includes several methodological and application research directions: 1) Developing fast sampling approaches; 2) Development of new scoring functions; 3) Integrative approaches for structure determination.

Overall, during the course of the project we will (i) jointly develop new methodology and algorithms in the field of genomic-scale protein complex prediction; (ii) provide server-based applications built upon services of the Boston team; (iii) and finally develop modular applications coded inside the SAMSON software platform created by the Inria team.

6.3.2. Participation in Other International Programs

6.3.2.1. International Initiatives

BIOTOOLS

Title: Novel Computational Tools for Structural Bioinformatics

International Partner (Institution - Laboratory - Researcher):

MIPT (Russia (Russian Federation)) - Vadim Strijov

Duration: 2016 - 2020

Start year: 2016

6.4. International Research Visitors

6.4.1. Visits of International Scientists

- Dima Kozakov, Professor at the University of Stony Brook, visited Nano-D for 2 weeks in July 2017.
- Dzmitry Padhorny, PhD candidate at the University of Stony Brook, visited Nano-D for 2 weeks in July 2017.
- Mikhail Ignatov, PhD candidate at the University of Stony Brook, visited Nano-D for 2 weeks in June 2017.

6.4.1.1. Internships

Mikhail Karasikov

Date: 1/08/2016 - 30/01/2017

Institution: Skolkovo Research Center / MIPT Moscow (Russia (Russian Federation))

Supervisor: Sergei Grudinin

NECS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ProCyPhyS

ProCyPhyS is a one year project funded by University Grenoble Alps, MSTIC department, with the aim to study privacy in cyberphysical system. A post-doc (H. Nouasse) has been hired to perform analysis of privacy protection through system-theoretic measures. We are interested with cyber-physical systems that can be viewed as systems of interconnected entities which are locally governed by difference equations of partial differential equations, namely intelligent transportation systems and indoor navigation. A first approach to analyze privacy preservation is to study observability of the overall system, see [8] where a large family of non-observable networks have been characterized for homogeneous systems of consensus type. In this approach, the network structure immunizes the overall system. A second approach, consists in adding information (noise) to the sensitive one: that is the differential privacy concept that leads to differential filtering where the aim is to develop an estimator that is robust enough according to the added noise [46]. In ProCyPhyS the main goal is to make the system partially nonobservable. The idea is to compress the state space while adding noise to the sensitive information in a smarter way.

8.1.2. Control of Cyber-Social Systems (C2S2)

C2C2 is a two year project funded by the University Grenoble Alpes, MSTIC department. Evolving from recent research on network systems, this exploratory project has the objective to concentrate on “cyber-social” systems, that is, complex systems with interacting social and technological components. A strong motivation for this novel research direction comes from the need for innovative tools for the management of vehicular traffic. In this application, state-of-the-art approaches concentrate on hard control actions, like traffic lights: instead, future management methods should exploit soft control actions aimed at controlling the traffic demand, that is, the aggregated behaviors of the drivers.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. SPEEDD (Scalable Proactive Event-Driven Decision making)

Type: STREP

Objective: ICT-2013.4.2a – Scalable data analytics – Scalable Algorithms, software frameworks and visualisation

Duration: Feb. 2014 to Jan. 2017.

Coordinator: National Centre of Scientific Research ‘Demokritos’ (Greece)

Partners: IBM Israel, ETH Zurich (CH), Technion (Israel), Univ. of Birmingham (UK), NECS CNRS (France), FeedZai (Portugal)

Inria contact: C. Canudas de Wit

Abstract: SPEEDD is developing a prototype for robust forecasting and proactive event-driven decision-making, with on-the-fly processing of Big Data, and resilient to the inherent data uncertainties. NECS leads the intelligent traffic-management use and show case.

See also: <http://speedd-project.eu>

8.2.1.2. Scale-FreeBack

Type: ERC Advanced Grant

Duration: Sep. 2016 to Aug. 2021

Coordinator: C. Canudas de Wit

Inria contact: C. Canudas de Wit

Abstract: The overall aim of Scale-FreeBack is to develop holistic scale-free control methods of controlling complex network systems in the widest sense, and to set the foundations for a new control theory dealing with complex physical networks with an arbitrary size. Scale-FreeBack envisions devising a complete, coherent design approach ensuring the scalability of the whole chain (modelling, observation, and control). It is also expected to find specific breakthrough solutions to the problems involved in managing and monitoring large-scale road traffic networks. Field tests and other realistic simulations to validate the theory will be performed using the equipment available at the Grenoble Traffic Lab center (see GTL), and a microscopic traffic simulator replicating the full complexity of the Grenoble urban network.

See also: <http://scale-freeback.eu>

8.3. International Initiatives

8.3.1. Participation in Other International Programs

8.3.1.1. TICO-MED

TicoMed (Traitement du signal Traitement numérique multidimensionnel de l'Information avec applications aux Télécommunications et au génie Biomédical) is a French-Brazilian project funded by CAPES-COFECUB. It started in February 2015 with University of Nice Sophia Antipolis (I3S Laboratory), CNAM, SUPELEC, University of Grenoble Alpes (Gipsa-Lab), Universidade Federal do Ceara, Universidade Federal do Rio de Janeiro, and Universidade Federal do Santa Catarina as partners.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Dr. Walter Musakwa from Univ. of Johannesburg (South Africa) visited the team in August 2017 for working with A. Kibangou on analysis on cycling data collected in Johannesburg and setting up a MoA between UGA and UJ.

Prof. Olga Quintero Montoya, from Universidad EAFIT (Colombia) visited the team from May 2017 until June 2017 to work with C. Canudas de Wit on traffic flow problems.

Pr. Marcello L.R. de Campos (Federal Univ. of Rio de Janeiro, Brazil) visited the team in October 2017 in the framework of the TICO-MED project.

Dr. Paola Goatin (Inria Sophia Antipolis) visited the team in September to work with M. L. Delle Monache on traffic flow modeling and control using conservation laws.

F. Acciani (U. Twente, Netherlands) visited the team in November 2017 to work with P. Frasca.

W. S. Rossi (U. Twente, Netherlands) visited the team in November 2017 to work with P. Frasca.

Professor Per-Olof Gutman visited the team on February 9th and 10th 2017. He gave two talks on "Modelling of and Controller Design for a Virtual Skydiver" and "Dynamic model for estimating the Macroscopic Fundamental Diagram" to the NeCS team. He exchanged ideas with Carlos Canudas de Wit, Paolo Frasca and Giacomo Casadei.

Professor Ioannis Paschalidis visited the team on September 2017. He gave a talk "Inverse Equilibrium Problems and Price-of-Anarchy Estimation in Transportation Networks". He exchanged ideas with Carlos Canudas De Wit, Paolo Frasca and Stephane Mollier.

8.4.1.1. Research Stays Abroad

A. Kibangou visited the University of Johannesburg (UJ) in March and October 2017. During his stay, he gave lectures to students of Department of Town and Regional Planning of UJ on Mobility and traffic management.

A. Kibangou visited University of Cape Town (UCT) in October 2017. During his stay, he gave a lecture to students and researchers of Control department of UCT.

Federica Garin spent three weeks in Lund, Sweden, in June, for the LCCC Focus Period on Large-Scale and Distributed Optimization (<http://www.lccc.lth.se/index.php?page=june-2017-optimization>)

Paolo Frasca visited the University of Cagliari, Cagliari, Italy in April–May 2017.

M. L. Delle Monache visited Rutgers University (USA) in June 2017. During her stay they worked on control of traffic with conservation laws.

NEO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Marmote

Participants: Alain Jean-Marie, Eleni Vatamidou.

ANR Program: Modèles Numériques (MN) 2012, number ANR-12-MONU-0019

Project title: MARKovian MOdeling Tools and Environments

Duration: January 2013 - June 2017

Coordinator: Alain Jean Marie (Inria)

Partners: Inria (project-teams DYOGENE, NEO and POLARIS), Univ. Versailles-Saint-Quentin (DAVID lab.), Telecom SudParis (SAMOVAR lab.), Univ. Paris-Est Créteil (LACL), and Univ. Pierre-et-Marie-Curie (LIP6)

Abstract: ANRMARMOTE aimed, among other goals, at realizing the prototype of a software environment dedicated to modeling with Markov chains. It brought together seven partner teams, expert in Markovian analysis, who developed advanced solution algorithms and applications in different scientific domains: reliability, distributed systems, physics and economics. See Section 6.1, Section 7.1.2 . Related publications: [26],[33],[37].

<https://wiki.inria.fr/MARMOTE/Welcome>

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Participant: Konstantin Avrachenkov.

Program: EU COST

Project acronym: **ACROSS**

Project title: Autonomous Control for a Reliable Internet of Services

Duration: November 2013 - November 2017

Coordinator: Rob Van Der Mei (CWI) and J.L. Van Den Berg (TNO), The Netherlands

Other partners: see <http://www.cost-across.nl/>

Abstract: Currently, we are witnessing a paradigm shift from the traditional information-oriented Internet into an Internet of Services (IoS). This transition opens up virtually unbounded possibilities for creating and deploying new services. Eventually, the ICT landscape will migrate into a global system where new services are essentially large-scale service chains, combining and integrating the functionality of (possibly huge) numbers of other services offered by third parties, including cloud services. At the same time, as our modern society is becoming more and more dependent on ICT, these developments raise the need for effective means to ensure quality and reliability of the services running in such a complex environment. Motivated by this, the aim of this Action is to create a European network of experts, from both academia and industry, aiming at the development of autonomous control methods and algorithms for a reliable and quality-aware IoS.

Program: EU COST

Project acronym: **COSTNET**

Project title: European Cooperation for Statistics of Network Data Science

Duration: May 2016 - April 2020

Coordinator: Ernst Wit (NL), Gesine Reinert (UK)

Other partners: see http://www.cost.eu/COST_Actions/ca/CA15109

Abstract: A major challenge in many modern economic, epidemiological, ecological and biological questions is to understand the randomness in the network structure of the entities they study: for example, the SARS epidemic showed how preventing epidemics relies on a keen understanding of random interactions in social networks, whereas progress in curing complex diseases is aided by a robust data-driven network approach to biology.

Although analysis of data on networks goes back to at least the 1930s, the importance of statistical network modelling for many areas of substantial science has only been recognized in the past decade. The USA is at the forefront of institutionalizing this field of science through various interdisciplinary projects and networks. Also in Europe there are excellent statistical network scientists, but until now cross-disciplinary collaboration has been slow.

This Action aims to facilitate interaction and collaboration between diverse groups of statistical network modellers, establishing a large and vibrant interconnected and inclusive community of network scientists. The aim of this interdisciplinary Action is two-fold. On the scientific level, the aim is to critically assess commonalities and opportunities for cross-fertilization of statistical network models in various applications, with a particular attention to scalability in the face of Big Data. On a meta-level, the aim is to create a broad community which includes researchers across the whole of Europe and at every stage in their scientific career and to facilitate contact with stakeholders.

9.3. International Initiatives

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

9.3.1.1. MALENA

Title: Machine Learning for Network Analytics

International Partner (Institution - Laboratory - Researcher):

Indian Institute of Technology Bombay (India) - Electrical Communication Engineering - Vivek Borkar

Start year: 2017

See also: <http://www-sop.inria.fr/members/Konstantin.Avratchenkov/MALENA.html>

In the past couple of decades network science has seen an explosive growth, enough to be identified as a discipline of its own, overlapping with engineering, physics, biology, economics and social sciences. Much effort has gone into modelling, performance measures, classification of emergent features and phenomena, etc, particularly in natural and social sciences. The algorithmic side, all important to engineers, has been recognised as a thrust area (e.g., two recent Nevanlinna Prize (J. Kleinberg 2006 and D. Spielman 2010) went to prominent researchers in the area of network analytics). Still, in our opinion the area is yet to mature and has a lot of uncharted territory. This is because networks provide a highly varied landscape, each flavour demanding different considerations (e.g., sparse vs dense graphs, Erdős-Rényi vs planted partition graphs, standard graphs vs hypergraphs, etc). Even adopting existing methodologies to these novel situations is often a nontrivial exercise, not to mention many problems that cry out for entirely new algorithmic paradigms. It is in this context that we propose this project of developing algorithmic tools, drawing not only upon established as well as novel methodologies in machine learning and big data analytics, but going well beyond, e.g., into statistical physics tools.

9.3.1.2. THANES

Title: THEory and Application of NEtwork Science

International Partner (Institution - Laboratory - Researcher):

Universidade Federal do Rio de Janeiro (Brazil) - Department of Computer and Systems Engineering - Daniel Ratton Figueiredo

Purdue University (USA) - Department of Computer Science - Bruno Ribeiro

Start year: 2017

See also: <https://team.inria.fr/thanes/>

During the 3-year lifetime of this joint team we plan to move beyond the study of a single network and focus on multiplex networks, i.e. multiple interacting networks. Multiplex networks have recently raised as “one of the newest and hottest themes in the statistical physics of complex networks.” They originate from the observation that many complex systems, ranging from living organisms to critical infrastructures, operate through multiple layers of distinct interactions among their constituents. In particular work on the co-evolution of the different layers of a multiplex network and on how epidemics spread in such setting.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

NEO has continued collaborations with researchers from GERAD, Univ. Montreal (Canada), Flinders Univ. (Australia), National Univ. of Rosario (Argentina), Technion - Israel Institute of Technology (Israel), Univ. of Arizona (USA), Univ. of Illinois at Urbana-Champaign (USA), Univ. of Liverpool (UK), Univ. of Massachusetts at Amherst (USA), Univ. of Florence (Italy), Univ. of Palermo (Italy), Univ. of Twente (The Netherlands), Petrozavodsk State Univ. (Russia) and Ghent Univ. (Belgium).

9.3.3. Participation in Other International Programs

9.3.3.1. SticAmSud project DyGaMe

Title: Dynamic Games Methods: theory, algorithmics and application

International Partners (Institution - Laboratory - Researcher):

Univ. de Chile (Chile) - Department of Industrial Engineering - Fernando Ordóñez

Univ. Nacional de Rosario (Argentina) - Facultad de Ciencias Exactas, Ingeniería y Agrimensura - Eugenio Della Vecchia

CNRS (France) - LIP6 - Emmanuel Hyon

Duration: 2016 - 2017

Start year: 2016

See also: <https://project.inria.fr/dygame>

Stochastic Dynamic Game Theory is developing in Engineering sciences and is in need of more theoretical results, algorithms and applications. This project brings together researchers from Applied Mathematics, Operations Research and Economics, with the objective of contributing to these aspects. It will more specifically concentrate on agent rationality and the game structure, look for efficient solution algorithms by crossing Applied Mathematics and Operations Research techniques, and apply the results to problems originating from, on the one hand, security/conservation concerns, and on the other hand, sustainable development problems.

9.3.3.2. CEFIPRA Grant Monte Carlo, no.5100-ITI

Title: Monte Carlo and Learning Schemes for Network Analytics

International Partners (Institution - Laboratory - Researcher):

IIT Bombay (India) - Department of Electrical Engineering - Prof. V.S. Borkar;

IIS Bangalore (India) - Department of Electrical Engineering - Prof. R. Sundaresan.

Duration: 2014 - 2017

Start year: 2014

The project aims to approach various computation problems in network analytics by means of Markov Chain Monte Carlo (MCMC) and related simulation techniques as well as machine learning algorithms such as reinforcement learning, ant colony optimization, etc. This will include network diagnostics such as ranking, centrality measures, computation on networks using local message passing algorithms, resource allocation issues pertaining to networks and network-based systems such as the internet, peer-to-peer networks, social networks. The work will involve both development of analytical tools and extensive validation thereof using simulation studies. The research will draw upon techniques from graph theory, probability, optimization, and distributed computation.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Professors / Researchers

Damiano Carra

Date: 6-8 December 2017

Institution: Univ. of Verona (Italy)

Koen de Turck

Date: 13-17 November 2017

Institution: CentraleSupélec (France)

Eugene Feinberg

Date: 1 June 2017

Institution: Stony Brook Univ. (USA)

Daniel Figueiredo

Date: 17-21 July 2017

Institution: UFRJ (Brazil)

Giulio Iacobelli

Date: 21-25 August 2017

Institution: UFRJ (Brazil)

Emilio Leonardi

Date: 21 February 2017 - 3 March 2017

Date: 9-20 October 2017

Institution: Politecnico di Torino (Italy)

Nelly Litvak

Date: 23 May 2017 - 2 June 2017

Institution: Twente Univ. (The Netherlands)

Vladimir Mazalov

Date: 19-17 March 2017

Institution: Karelian Institute of Applied Mathematical Research (Russia)

Fernando Ordóñez

Date: 15-19 May 2017

Institution: Univ. of Chile (Chile)

Pawel Pralat

Date: 2 July 2017 - 4 August 2017

Institution: Ryerson Univ. (Canada)

Bruno Ribeiro

Date: 17-21 July 2017

Institution: Purdue Univ. (USA)

Isaac Sonin

Date: 1-13 April 2017

Institution: Dept. of Mathematics and Statistics, UNC Charlotte (USA)

Rajesh Sundaresan

Date: 13-25 February 2017

Institution: IIS Bangalore (India)

Uri Yechiali

Date: 24 April 2017 - 5 May 2017

Institution: Tel Aviv Univ. (Israel)

9.4.1.2. Post-doc / Ph.D. students

Víctor Bucarey López

Date: 15-19 May 2017

Institution: Univ. of Chile (Chile)

Akhil Padinhare Thalasseryveetil

Date: 20 February 2017 - 20 August 2017

Institution: IIT Bangalore (India)

Berksan Serbetci

Date: 20 September 2017 - 20 December 2017

Institution: Univ. of Twente (The Netherlands)

Ranbir Singh

Date: 18 September 2017 - 26 October 2017

Institution: IIT Mumbai (India)

Gayane Vardoyan

Date: 16 May 2017 - 10 August 2017

Institution: Univ. of Massachusetts (USA)

Geetika Verma

Date: 20-30 June 2017

Institution: Univ. of South Australia (Australia)

9.4.1.3. Internships

Ilya Bogdanov

Date: 3 July 2017 - 18 September 2017

Institution: Moscow High School of Economics (Russia)

Supervisor: Konstantin Avrachenkov

Konstantinos Dermentzis

Date: 20 November 2017 - 19 May 2018

Institution: National Technical Univ. of Athens (Greece)

Supervisor: Giovanni Neglia

Srishti Jain

Date: 9 May 2017 - 26 Jul 2017

Institution: IIT Kampur (India)

Supervisor: Eitan Altman

Sarath Pattathil

Date: 3 May 2017 - 3 July 2017

Institution: IIT Bombay (India)

Supervisor: Konstantin Avrachenkov

Dmytro Rubanov

Date: 1 March 2017 - 31 August 2017

Institution: Master IFI Ubinet, UNS

Supervisor: Konstantin Avrachenkov

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Konstantin Avrachenkov

Date: 1 - 9 February 2017

Institution: IIT Bombay and IIS Bangalore (India)

Date: 11 - 19 March 2017

Institution: Novosibirsk State Univ. (Russia)

Date: 18 - 25 April 2017

Institution: Univ. of Liverpool (UK)

Date: 18 - 19 September 2017

Institution: Univ. of Warsaw (Poland)

Date: 30 October - 4 November 2017

Institution: IIT Bombay (India)

Alain Jean-Marie

Date: 2 - 20 November 2017

Institution: Univ. of Montreal (Canada)

Date: 28 October - 27 November 2017

Institution: National Univ. of Rosario (Argentina)

Giovanni Neglia

Date: 8 - 11 November 2017

Institution: Northeastern Univ., Boston and Univ. of Massachusetts, Amherst (USA)

Date: 13 - 18 November 2017

Institution: Purdue Univ. (USA)

Date: 14 - 15 December 2017

Institution: Florence Univ. (Italy)

NEUROSYS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Within the *Contrat de Projet État Région (CPER) IT2MP 2015-2020 on Technological innovations, modeling and Personalized Medicine*, we are contributing on platform SCIARAT (*cognitive stimulation, Ambient Intelligence, Robotic assistance" and Telemedicine*) observing electroencephalographic activity of humans during motor tasks. Contact in Neurosys is Laurent Bougrain.

8.2. National Initiatives

Inria project-Lab BCI-LIFT, Brain-Computer Interfaces: Learning, Interaction, Feedback, Training, Maureen Clerc, 2015-2018, 7 Inria project-teams (Aramis, Athena, Demar, Hybrid, Mjolnir, Neurosys, Potioc), university of Rouen, Dycog team at Centre de Recherche en Neurosciences de Lyon.

BCI-LIFT is a research initiative to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. With this concern of usability as our driving objective, we build non-invasive systems that benefit from advanced signal processing and machine learning methods, from smart interface design, and where the user immediately receives supportive feedback. What drives this project is the concern that a substantial proportion of human participants is currently categorized "BCI-illiterate" because of their apparent inability to communicate through BCI. Through this project we aim at making it easier for people to learn to use BCI, by implementing appropriate machine learning methods and developing user training scenarios.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- We have an ongoing collaboration with Prof. Motoharu Yoshida at Ruhr university Bochum, Germany, aiming to study the role of persistent firing neurons in memory and more specifically in neural network synchronization. M. Yoshida provides us with biological data that we combine with simulations to test hypotheses on memory formation (L. Buhry).
- We also collaborate with Prof. LieJune Shiau (university of Houston, Texas, USA) on more theoretical approaches concerning the role of intrinsic neuronal dynamics in network synchronization and brain oscillations (L. Buhry).
- We also collaborate with Anton Popov (Kiev Polytechnic Institute, Ukraine) on feature extraction of brain signal and deep learning (L. Bougrain).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Anton Popov, Ass. Prof, Kiev Polytechnic Institute, Ukraine, 5 weeks (May 2017)
- Yevgeniy Karplyuk, Ass. Prof, Kiev Polytechnic Institute, Ukraine, 3 weeks (May 2017)
- Widodo Budiharto, Full Prof, university of Binus, Indonesia, 1 week (Jan 2017)

8.4.1.1. Internships

- Oleksii Avilov, Erasmus+, Kiev Polytechnic Institute, Ukraine, Jan-Jul 2017
- Ivan Kotiuchi, Erasmus+, Kiev Polytechnic Institute, Ukraine, Jan-Jul 2017

NON-A Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Project ARCIR ESTIREZ “Estimation distribuée de systèmes dynamiques en réseaux”, coordinators: D. Efimov, M. Petreczky, 2013-2017.
- CPER DATA 2016-2020 (involved in two projects: “FIT” related to the wireless robots and sensors network and “DATA”, related to platform). FIT includes our robotic activity and DATA corresponds to our computation need in fluid mechanics as well as possible security issues in the ControlHub development platform.
- ELSAT20202 (Ecomobilité, Logistique, Sécurité, Adaptabilité dans les Transports) is a Regional consortium gathering aeronautics (ONERA), micro/nano technologies (IEMN), control sciences (Non-A) and fluid mechanics (LAMIH, LML) and working on technologies and methods for the active control of separated flows.

9.2. National Initiatives

- ANR project Finite4SoS (Finite time control and estimation for Systems of Systems), coordinator: W. Perruquetti, 2015-2020.
- ANR project WaQMoS (Coastal waters quality surveillance using bivalve mollusk-based sensors), coordinator: D. Efimov, 2015-2019.
- ANR project TurboTouch (High-performance touch interactions), coordinator: G. Casiez (MJOL-NIR team, Inria), 2014-2018.
- ANR project ROCC-SYS (Robust Control of Cyber-Physical Systems), coordinator: L. Hetel (CNRS, EC de Lille), 2013-2018.
- ANR project MSDOS (Multidimensional System: Digression on Stability), coordinator: Nima Yeganefar (Poitiers University), 2014-2018.
- We are also involved in several technical groups of the GDR MACS (CNRS, "Modélisation, Analyse de Conduite des Systèmes dynamiques", see <http://www.univ-valenciennes.fr/GDR-MACS>), in particular: Technical Groups "Identification", "Time Delay Systems", "Hybrid Systems", "Complex Systems, Biological Systems and Automatic Control," and "Control in Electrical Engineering".
- Model-free control: collaborations with the startup ALIEN SAS (created by C. Join and M. Fließ).

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

Partner 1: KULeuven, labo 1 (Belgium)
 Supervisor: W. Michiels
 Partner 2: TU/Eindhoven, labo 1 (The Netherlands)
 Supervisor: H. Nijmeijer
 Partner 3: Centrale Lille, labo 1 (France)
 Supervisor: J.-P. Richard

H2020 project UCoCoS (“Understanding and Controlling of Complex Systems”, 2016-2020) is a European Joint Doctorate aiming at creating a framework for complex systems, and at defining a common language, common methods, tools and software for the complexity scientist. It strongly relies on a control theory point of view. Six ESR (early stage researchers) perform a cutting-edge project, strongly relying on the complementary expertise of the 3 academic beneficiaries and benefiting from training by 4 non-academic partners from different sectors. ESR1: Analytical and numerical bifurcation analysis of delay-coupled systems; ESR2: Estimation in complex systems; ESR3: Grip on partial synchronization in delay-coupled networks; ESR4: Reduced modelling of large-scale networks ; ESR5: Network design for decentralized control ; ESR6: Networks with event triggered computing. Non-A is firstly invested on ESR 2 (Haik Silm), 4 (Quentin Voortman), 5 (Deesh Dileep), 6 (Jijju Thomas).

9.4. International Initiatives

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

9.4.1.1. HoTSMoCE

Title: Homogeneity Tools for Sliding Mode Control and Estimation

International Partner (Institution - Laboratory - Researcher):

UNAM (Mexico), Departamento de Ingeniería de Control y Robótica, Leonid Fridman

Start year: 2016

See also: <https://team.inria.fr/non-a/asso-team-hotsmoce/>

The team Non-A is developing an estimation theory, built around differential algebra and operational calculation on the one hand, and high gain algorithms (such as sliding mode) on the other hand. The Mexican partner team comes from "Sliding Mode Control" laboratory of UNAM. There exists a strong intersection of interests of both teams (application of homogeneity for design of sliding mode control and estimation algorithms, and analysis of finite-time stability). That is why there exists a long history of collaboration between these two teams. The goal of the project is development of control and estimation algorithms converging in fixed or in finite time by applying the last generation sliding mode techniques and the homogeneity theory. The project realization is planned in the form of short-time visits of permanent staff and visits of PhD students for a long period of stay. Such visits are very important for young scientists, and also help Non-A team to prepare and find good PhDs/post-docs for future.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- Emilia Fridman, Tel Aviv University, Israel
- Leonid Fridman, UNAM, Mexico
- Jaime Moreno, UNAM, Mexico
- Johannes Schiffer, Leeds University, UK
- ITMO University, Saint-Petersburg, Russia
- Eva Zerz, Aachen University, Germany

9.4.3. Participation in Other International Programs

PHC Amadeus "Computer Algebra and Functional Equations", 2016-2017, with the University of Limoges (XLIM) and the University of Linz (Austria).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Leonid Fridman, UNAM, Mexico
- Petteri Laakkonen, Tampere University of Technology, Finland, 11–14/12/2017

9.5.2. Visits to International Teams

G. Zheng visited two weeks at Wuhan University (China) in July 2017.

9.5.2.1. Research Stays Abroad

G. Zheng held a visiting professor position in Nanjing University of Science and Technology (China) for one month stay in August 2017.

NUMED Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. ANR

CNRS InFIniti, 2017-2018 (P. Vigneaux): 12ke in 2017 (pending for 2018)

ORPAILLEUR Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Hydreos*

Participant: Jean-François Mari.

Hydreos is a state organization -a so-called “Pôle de compétitivité”– aimed at evaluating the delivering and the quality of water (<http://www.hydreos.fr/fr>). Actually, data about water resources rely on many agronomic variables, including land use successions. The data to be analyzed are obtained by surveys or by satellite images and describe the land use at the level of the agricultural parcel. Then there is a search for detecting changes in land use and for correlating these changes to groundwater quality. Accordingly, one main challenge in our participation in Hydreos is to process and analyze space-time data for reaching a better understanding of the changes in the organization of a territory. The systems ARPEnTAgE and CarottAgE are used in this context, especially by agronomists of INRA (ASTER Mirecourt <http://www6.nancy.inra.fr/sad-aster>).

8.1.2. *The Smart Knowledge Discovery Project*

Participants: Jérémie Nevin, Amedeo Napoli, Chedy Raïssi.

The SKD project for “Smart Knowledge Discovery” aims at analyzing complex industrial data for troubleshooting and decision making, and is funded by “Grand Est Region”. We are working with the Vize company –which is based in Nancy and specialized in visualization-based data mining– on exploratory knowledge discovery. The data which are under study are provided by the Arcelor-Mittal Steel Company and are related to the monitoring of rolling mills. Data are complex time series and the problem can be set as follows: problem statement, data access and preparation, design of adapted knowledge discovery methods based on symbolic and numerical methods, interaction with analysts, tests and validation. For the Orpailleur team, one main objective of SKD is to combine sequence mining and visualization tools for recognizing and then preventing the occurrences of defects in the outputs of the rolling mills.

8.2. National Initiatives

8.2.1. *ANR*

8.2.1.1. *Elker (2017–2020)*

Participants: Miguel Couceiro, Esther Catherine Galbrun, Amedeo Napoli, Chedy Raïssi.

The objectives of the new ELKER ANR Research Project is to study, formalize and implement the search for link keys in RDF data. Link keys generalize database keys in two independent directions, i.e. they deal with RDF data and they apply across two datasets. The goal of ELKER is to study the automatic discovery of link keys and reasoning with link keys, especially in taking an FCA point of view. One main idea is to rely on the competencies of Orpailleur in FCA for solving the problem using FCA and pattern structures algorithms, especially those related to the discovery of functional dependencies. This project involves the EPI Orpailleur at Inria Nancy Grand Est, the EPI MOEX at Inria Rhône Alpes, and LIASD at Université Paris 8.

8.2.1.2. *ISTEX (2014–2017)*

Participant: Yannick Toussaint.

ISTEX is a so-called “Initiative d’excellence” managed by CNRS and DIST (“Direction de l’Information Scientifique et Technique”). ISTEX aims at providing the research and teaching community an on-line access to scientific publications in all domains (<http://www.istex.fr/istex-excellence-initiative-of-scientific-and-technical-information/>). In this way, ISTEX requires a massive acquisition of documents such as journals, proceedings, corpora, and databases. The Orpailleur team was especially involved in the development of facilities for querying full-text documentation, analyzing content and extracting information. The project was carried out in collaboration with the ATILF laboratory and the INIST Institute (both located in Nancy).

8.2.1.3. *PractiKPharma (2016–2020)*

Participants: Adrien Coulet, Joël Legrand, Pierre Monnin, Amedeo Napoli, Malika Smaïl-Tabbone, Yannick Toussaint.

PractiKPharma for “Practice-based evidences for actioning Knowledge in Pharmacogenomics” is an ANR research project (<http://praktikpharma.loria.fr/>) about the validation of domain knowledge in pharmacogenomics. Pharmacogenomics is interested in understanding how genomic variations related to patients have an impact on drug responses. Most of the available knowledge in pharmacogenomics (state of the art) lies in biomedical literature, with various levels of validation. An originality of PractiKPharma is to use Electronic Health Records (EHRs) to constitute cohorts of patients. These cohorts are then mined for extracting potential pharmacogenomics patterns to be then validated w.r.t. literature knowledge for becoming actionable knowledge units. More precisely, firstly we should extract pharmacogenomic patterns from the literature and secondly we should confirm or moderate the interpretation and validation of these units by mining EHRs. Comparing knowledge patterns extracted from the literature with facts extracted from EHRs is a complex task depending on the EHR language –literature is in English whereas EHRs are in French– and on knowledge level, as EHRs represent observations at the patient level whereas literature is related to sets of patients. The PractiKPharma involves three other laboratories, namely LIRMM in Montpellier, SSPIM in St-Etienne and CRC in Paris.

8.2.2. *CNRS PEPS and Mastodons projects*

8.2.2.1. *Mastodons Projects: from HyQual to HyQualiBio (2016–2018)*

Participants: Miguel Couceiro, Esther Catherine Galbrun, Tatiana Makhalova, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

The HyQual project was proposed in 2016 in response to the Mastodons CNRS Call about data quality in data mining (see <http://www.cnrs.fr/mi/spip.php?article819&lang=fr>). This project is interested in the mining of nutritional data for discovering predictive biomarkers of diabetes and metabolic syndrome in elder populations. The considered data mining methods are hybrid, and they combine symbolic and numerical methods for mining complex and noisy metabolic data [80]. Regarding the mining process, we are interested in the quality of the data at hand and in the discovered patterns. In particular, we check the incompleteness of the data, the quality of the extracted rules and the possible existence of redescrptions.

Initially, the project involved researchers from the EPI Orpailleur, with researchers from LIRIS Lyon, ICube Strasbourg, and INRA Clermont-Ferrand. This year, we were merged with another Mastodons project, namely QualiBioConsensus, about the “ranking of biological data using consensus ranking techniques”. The joint Mastodons project is now called “HyQualiBio”. The topics of interest for the participants are the mining of complex biological data, rankings and ties in rankings, and the search of dependencies in the web of data.

8.2.2.2. *PEPS Decade*

Participants: Miguel Couceiro, Esther Catherine Galbrun, Nyoman Juniarta, Amedeo Napoli, Justine Reynaud, Chedy Raïssi.

Decade stands for “Découverte et exploitation des connaissances pour l’aide à la décision en chimie thérapeutique”. The objective of the CNRS PEPS Decade project is to study the basis of knowledge system for analyzing the so-called PAINS (“Pan Assay Interference Compounds”) in chemistry. The system should rely on the knowledge possibly discovered in the data and domain knowledge and expertise. The members of the projects are interested in data mining techniques guided by constraints and preferences, “instant data mining”, subgroup discovery and exceptional model mining. All these topics were already of interest in the PEPS Prefute (2015-2016) which was about interaction and iteration in the knowledge discovery process.

The members of the Decade project are from Greyc Caen, LIFO Orléans LIRIS Lyon, Université de Tours-Blois, EPI Lacodam in Rennes and EPI Orpailleur (in association with chemists based in Caen and Orléans)

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. CrossCult (H2020 Project, 2016-2020)

Participants: Miguel Couceiro, Nyoman Juniarta, Amedeo Napoli, Chedy Raïssi.

CrossCult (<http://www.crosscult.eu/>) aims to make reflective history a reality in the European cultural context, by enabling the re-interpretation of European (hi)stories through cross-border interconnections among cultural digital resources, citizen viewpoints and physical venues. The project has two main goals. The first goal is to lower cultural EU barriers and create unique cross-border perspectives, by connecting existing digital historical resources and by creating new ones through the participation of the public. The second goal is to provide long-lasting experiences of social learning and entertainment that will help for achieving a better understanding and re-interpretation of European history. To achieve these goals, CrossCult will use cutting-edge technology to connect existing digital cultural assets and to combine them with interactive experiences that all together are intended to increase retention, stimulate reflection and help European citizens appreciate their past and present in a holistic manner. CrossCult will be implemented on four real-world flagship pilots involving a total of 8 sites across Europe.

The role of the Orpailleur Team (in conjunction with the LORIA Kiwi Team) is to work on knowledge discovery and recommendation. The focus is on the mining of visitor trajectories for analysis purposes, and on the definition of a visitor profile in connection with domain knowledge for recommendation.

The numerous partners of the Orpailleur team in the CrossCult project are: Luxembourg Institute for Science and Technology and Centre Virtuel de la Connaissance sur l'Europe (Luxembourg, leader of the project), University College London (England), University of Malta (Malta), University of Peloponnese and Technological Educational Institute of Athens (Greece), Università degli Studi di Padova (Italy), University of Vigo (Spain), National Gallery (London, England), and GVAM Guías Interactivas (Spain).

8.4. International Initiatives

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

8.4.1.1. Snowball

Title: Discovering knowledge on drug response variability by mining electronic health records

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Medicine, Stanford Center for Biomedical Informatics Research (BMIR) - Nigam Shah

Start year: 2017

See also: <http://snowball.loria.fr/>

Snowball (2017-2019) is an Inria Associate Team and the continuation of the preceding Associate Team called Snowflake (2014-2016). The objective of Snowball is to study drug response variability through the lens of Electronic Health Records (EHRs) data. This is motivated by the fact that many factors, genetic as well as environmental, imply different responses from people to the same drug. The mining of EHRs can bring substantial elements for understanding and explaining drug response variability.

Accordingly the objectives of Snowball are to identify in EHR repositories groups of patients which are responding differently to similar treatments, and then to characterize these groups and predict patient drug sensitivity. These objectives are complementary to those of the PractiKPharma ANR project. Moreover, it should be noticed that Adrien Coulet has started a one-year sabbatical stay in the lab of Nigam Shah at Stanford University since September 2017.

8.4.2. Participation in International Programs

8.4.2.1. A stay at NASA Frontier Development Lab

In July 2017, Chedy Raïssi visited NASA Ames and SETI Institute as part of the Frontier Development Lab. He worked on mentoring teams and developing meaningful research opportunities, as well as supporting the work of the planetary defense community and showing the potential of this kind of applied research methodology to deliver breakthrough of significant value.

Delay-Doppler radar imaging is a powerful technique to characterize the trajectories, shapes, and spin states of near-Earth asteroids and has yielded detailed models of dozens of objects. Since the 1990s, delay-Doppler data has been analyzed using the SHAPE software developed originally by Steven J. Ostro. SHAPE performs sequential single-parameter fitting, and requires considerable computation runtime and human intervention. Recently, multiple-parameter fitting algorithms have been shown to more efficiently invert delay-Doppler datasets thus decreasing runtime while improving accuracy. However, reconstructing asteroid shapes and spins from delay-Doppler data is, like many inverse problems, computationally intensive and requires extensive human oversight of the shape modeling process.

Thus we have explored two new techniques to better automate delay-Doppler shape modeling: Bayesian optimization and deep generative models. Firstly we have implemented a Bayesian optimization routine that uses SHAPE to autonomously search the space of spin-state parameters. Bayesian optimization yielded similar spin state constraints with computer runtime reduced by a factor of 3. Secondly, the shape modeling process could be further accelerated using a deep “*generative model*” to replace or complete iterative fitting. Accordingly, we have implemented and trained a deep generative model based on different architectures of deep convolutional networks. Results are currently under analysis and future publications are in preparation.

8.4.2.2. LEA STRUCO

Participant: Jean-Sébastien Sereni.

LEA STRUCO is an “Associated International Laboratory” of CNRS between IÚUK, Prague, and LIAFA, Paris. It focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work. Jean-Sébastien Sereni is the founder and previous director of LEA STRUCO, which was initiated when Jean-Sébastien was a member of LIAFA, and he is now a member of its scientific committee.

8.4.2.3. Research Collaboration with HSE Moscow

Participants: Miguel Couceiro, Adrien Coulet, Tatiana Makhalova, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

An on-going collaboration involves the Orpailleur team and Sergei O. Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory several times while Sergei O. Kuznetsov visits Inria Nancy Grand Est every year. The collaboration is materialized by the joint supervision of students (such as the thesis of Aleksey Buzmakov defended in 2015 and the on-going thesis of Tatiana Makhalova), and the organization of scientific events, as the workshop FCA4AI with five editions between 2012 and 2016 (see <http://www.fca4ai.hse.ru>).

This year, we participated in the organization of two main events: a special session about Knowledge Discovery and Formal Concept Analysis at the ISMIS Conference in Warsaw (Poland) in June 2017 (http://ismis2017.ii.pw.edu.pl/s_kd_fca.php), and the chairing of the track “General Topics of Data Analysis” at the AIST Conference in Moscow in July 2017 (6th International Conference on Analysis of Images, Social Networks, and Texts <http://aistconf.org/>). Finally a next edition of the seventh edition of the FCA4AI workshop is planned in July 2018 at the ECAI-IJCAI Conference to be held in Stockholm Sweden.

PACAP Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Britanny region fellowship*

Participants: Niloofar Charmchi, André Seznec.

The Brittany Region is partially funding a Ph.D. fellowship for Niloofar Charmchi on the topic “Hardware prefetching and related issues”.

8.2. National Initiatives

8.2.1. *Capacités: Projet “Investissement d’Avenir”, 1/11/14 to 31/01/2018*

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

The project objective is to develop a hardware and software platform based on manycore architectures, and to demonstrate the relevance of these manycore architectures (and more specifically the Kalray manycore) for several industrial applications. The Kalray MPPA manycore architecture is currently the only one able to meet the needs of embedded systems simultaneously requiring high performance, lower power consumption, and the ability to meet the requirements of critical systems (low latency I/O, deterministic processing times, and dependability).

The project partners are Kalray (lead), Airbus, Open-Wide, Safran Sagem, IS2T, Real Time at Work, Dassault Aviation, Eurocopter, MBDA, ProbaYes, IRT, Onera, Verimag, Inria, Irisa, Tima and Armines.

8.2.2. *Zero Power Computing Systems (ZEP): Inria Project Lab, 2017–2020*

Participant: Erven Rohou.

This proposal addresses the issue of designing tiny wireless, batteryless, computing objects, harvesting energy in the environment. The energy level harvested being very low, very frequent energy shortages are expected. In order for the new system to maintain a consistent state, it will be based on a new architecture embedding non-volatile RAM (NVRAM). In order to benefit from the hardware innovations related to energy harvesting and NVRAM, software mechanisms will be designed. On the one hand, a compilation pass will compute a worst-case energy consumption. On the other hand, dedicated runtime mechanisms will allow:

1. to manage efficiently and correctly the NVRAM-based hardware architecture;
2. to use energy intelligently, by using the worst-case energy consumption.

The ZEP project gathers four Inria teams that have a scientific background in architecture, compilation, operating systems together with the CEA Lialp and Lisan laboratories of CEA LETI & LIST. The main application target is Internet of Things (IoT).

8.2.3. *ANR Continuum 2015–2019*

Participants: Erven Rohou, Rabab Bouziane.

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

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

8.2.4. ANR W-SEPT 2012-2017

Participants: Isabelle Puaut, Erven Rohou.

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

The ANR W-SEPT project partners are Verimag Grenoble, IRIT Toulouse, Inria Rennes. A case study is provided by Continental Toulouse.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ANTAREX

Participants: Erven Rohou, Imane Lasri.

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

Program: H2020

Duration: September 2015 - September 2018

Coordinator: Politecnico di Milano, Italy (POLIMI)

Partners:

Consorzio Interuniversitario Cineca (Italy)

Dompé Farmaceutici Spa (Italy)

Eidgenoessische Technische Hochschule Zürich (Switzerland)

Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)

Politecnico di Milano (Italy)

Sygic As (Slovakia)

Universidade do Porto (Portugal)

Inria contact: Erven Rohou

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

8.3.1.2. *EuroLab-4-HPC*

Participant: André Seznec.

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

Program: H2020

Duration: September 2015 - September 2017

Coordinator: Chalmers Tekniska Högskola AB

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputación (Spain)

Chalmers Tekniska Högskola (Sweden)

École Polytechnique Fédérale de Lausanne (Switzerland)

Foundation for Research and Technology Hellas (Greece)

Universität Stuttgart (Germany)

Rheinisch-Westfälische Technische Hochschule Aachen (Germany)

Technion - Israel Institute of Technology (Israel)

Universität Augsburg (Germany)

The University of Edinburgh (United Kingdom)

Universiteit Gent (Belgium)

The University of Manchester (United Kingdom)

Inria contact: Albert Cohen (Inria Paris)

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

8.3.1.3. *ARGO*

Participants: Isabelle Puaut, Damien Hardy, Imen Fassi.

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

Program: H2020

Type: RIA

Duration: Jan 2016 - Dec 2018

Coordinator: Karlsruher Institut für Technologie (KIT)

Université Rennes I contact: Steven Derrien

Partners:

Karlsruher Institut für Technologie (KIT)

SCILAB enterprises SAS

Recore Systems BV

Université de Rennes I

Technogiko Ekpaideftiko Idryma (TEI) Dytikis Elladas
 Absint GmbH
 Deutsches Zentrum für Luft - und Raumfahrt EV
 Fraunhofer

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

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

8.3.1.4. *HiPEAC4 NoE*

Participants: Pierre Michaud, Erven Rohou, André Seznec.

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

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

8.4. International Initiatives

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

Participants: Nicolas Kiss, Damien Hardy, Erven Rohou.

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

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

8.4.2. *PHC IMHOTEP*

Participant: Erven Rohou.

Title: Thoth – An Automatic Dynamic Binary Parallelisation System

International Partner (Institution - Laboratory - Researcher):

Egypt-Japan University of Science and Technology - Prof. Ahmed ElMahdy.

Dates: 2016–2017

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

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

8.4.3.1. PROSPIEL

Participant: Sylvain Collange.

Title: Profiling and specialization for locality

International Partner (Institution - Laboratory - Researcher):

Universidade Federal de Minas Gerais (Brazil) - DCC - Fernando Magno Quintão Pereira

Start year: 2015

See also: <https://team.inria.fr/pacap/prospiel/>

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

8.5. International Research Visitors

Prof. Ahmed ElMahdy, from the Egypt-Japan University of Science and Technology (E-JUST), Alexandria, Egypt, visited PACAP for two weeks in September, in the context of the project PHC IMHOTEP.

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Stefano Cherubin, PhD student at Politecnico di Milano for one month in Mar 2017, within the context of the ANTAREX H2020 project.

Andrei Rimsa Alvares, PhD at UFMG and Assistant Professor at CEFET-MG, 1 month from January 6 to February 5, 2017, PROSPIEL Associate Team.

PANAMA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. *Labex Comin Labs projects*

CominLabs is a Laboratoire d'Excellence funded by the PIA (Programme Investissements d'Avenir) in the broad area of telecommunications.

9.1.1.1. *HEMISFER*

Participant: Rémi Gribonval.

Acronym: HYBRID (Hybrid Eeg-MrI and Simultaneous neuro-feedback for brain Rehabilitation)

<http://www.hemisfer.cominlabs.ueb.eu/>

Research axis: 3.1

CominLabs partners : VISAGES, HYBRID and PANAMA Inria project-teams;

External partners : EA 4712 team from University of Rennes I; ATHENA Inria project-team, Sophia-Antipolis;

Coordinator: Christian Barillot, VISAGES Inria project-team

Description: The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. We propose to combine advanced instrumental devices (Hybrid EEG and MRI platforms), with new man-machine interface paradigms (Brain computer interface and serious gaming) and new computational models (source separation, sparse representations and machine learning) to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major neurological and psychiatric disorders of the developmental and the aging brain (stroke, attention-deficit disorder, language disorders, treatment-resistant mood disorders, ...).

Contribution of PANAMA: PANAMA, in close cooperation with the VISAGES team, contributes to a coupling model between EEG and fMRI considered as a joint inverse problem addressed with sparse regularization. By combining both modalities, one expects to achieve a good reconstruction both in time and space. This new imaging technique will then be used for improving neurofeedback paradigms in the context of rehabilitation and psychiatric disorders, which is the final purpose of the HEMISFER project.

9.1.1.2. *TEPN*

Participant: Rémi Gribonval.

Acronym: TEPN (Toward Energy Proportional Networks)

<http://www.tepn.cominlabs.ueb.eu/>

Research axis: 3.1

CominLabs partners : IRISA OCIF - Telecom Bretagne; IETR SCN; IETR SCEE; PANAMA Inria project-team

Coordinator: Nicolas Montavont, IRISA OCIF - Telecom Bretagne

Description: As in almost all areas of engineering in the past several decades, the design of computer and network systems has been aimed at delivering maximal performance without regarding to the energy efficiency or the percentage of resource utilization. The only places where this tendency was questioned were battery-operated devices (such as laptops and smartphones) for which the users accept limited (but reasonable) performance in exchange for longer use periods. Even though the end users make such decisions on a daily basis by checking their own devices, they have no way of minimizing their energy footprint (or conversely, optimize the network resource usage) in the supporting infrastructure. Thus, the current way of dimensioning and operating the infrastructure supporting the user services, such as cellular networks and data centers, is to dimension for peak usage. The problem with this approach is that usage is rarely at its peak. The overprovisioned systems are also aimed at delivering maximal performance, with energy efficiency being considered as something desired, but non-essential. This project aims at making the network energy consumption proportional to the actual charge of this network (in terms of number of served users, or requested bandwidth). An energy proportional network can be designed by taking intelligent decisions (based on various constraints and metrics) into the network such as switching on and off network components in order to adapt the energy consumption to the user needs. This concept can be summarized under the general term of Green Cognitive Network Approach.

Contribution of PANAMA: PANAMA, in close cooperation with the SCEE team at IETR (thesis of Marwa Chafii, 2016), focuses on the design of new waveforms for multi carrier systems with reduced Peak to Average Power Ratio (PAPR).

9.1.2. ANR INVATE project with IRT b<>com, Rennes

Participants: Rémi Gribonval, Nancy Bertin, Mohammed Hafsati.

Thesis on 3D audio scene decomposition for interactive navigation

Duration: 3 years (2016-2019)

Research axis: 3.2.2

Partners: IRT b<>com; Inria-Rennes; IRISA

Funding: ANR INVATE project (PIA)

The objective of this thesis is to develop tools to analyze audio scenes in order to identify, locate, and extract the sources present in the scene to re-spatialize them according to the user head orientation and the movement of the user in the targeted virtual scene.

9.1.3. ANR OATMIL project

Participants: Rémi Gribonval, Antoine Chatalic.

Duration: 4 years (2017-2021)

Acronym: OATMIL (Bringing Optimal Transport and Machine Learning Together)

<http://people.irisa.fr/Nicolas.Courty/OATMIL/>

Research Axis 3.1

Partners: Obelix team and PANAMA Inria project-team, IRISA; LITIS, Rouen; Lagrange Laboratory, Nice; Technicolor R&I France, Rennes.

Coordinator: Nicolas Courty (Obelix team)

Description: The OATMIL project will propose novel concepts, methodologies, and new tools for exploiting large data collections. This will result from a cross-fertilization of fundamental tools and ideas from optimal transport (OT) and machine learning (ML). The main objective of OATMIL is to develop new techniques for large-scale machine learning, encompassing adaptability, scalability, and robustness, by a cross-fertilization of ideas coming from OT and ML. This cross-fertilization leads to two complementary scientific challenges : bringing OT to ML and bringing ML to OT.

Contribution of PANAMA: PANAMA will explore the use of dimension-reduction with sketching strategies in the context compressive optimal transport.

Funding: ANR

9.1.4. OSEO-FUI: voiceHome

Participants: Nancy Bertin, Frédéric Bimbot, Romain Lebarbenchon, Ewen Camberlein.

Duration: 3 years (2015-2017)

Research axis: 3.2

Partners: voicebox (formerly known as onMobile), Delta Dore, eSoftThings, Orange, Technicolor R&I France, LOUSTIC, Inria Nancy

Coordinator: voicebox

Description: The goal of the project is to design and implement a multi-channel voice interface for smart home and multimedia (set-top-box) appliances.

Contributions of PANAMA are focused on audio source localization and separation with distant microphones in real environments. In both cases, the issue of energy frugality is central and strongly constrains the available resources. This cooperation, which reached its end in November 2017, allowed us to make progress towards operational low-resource audio source localization and separation schemes, to disseminate software, collected data and scientific results, and to identify new research and development perspectives in adaptive microphone array processing for fast and robust audio scene analysis.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

PANAMA has strong recurrent collaborations with the LTS2 lab at EPFL, the Center for Digital Music at Queen Mary University of London, the Institute for Digital Communications at the University of Edinburgh, and the Institute for Mathematics of the Postdam University.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Flavio Castro Alves Teixeira, in May-June 2017, Post-doc, University of Innsbruck, Austria
- Pierre Vandergheynst, in June-July 2017, Professor of Signal and Image Processing, EPFL (Chaire Internationale Inria), Lausanne, Switzerland
- Gilles Blanchard, in September 2017, Professor, University of Potsdam, Germany
- Mike Davies, in October 2017, Professor, University of Edinburgh, UK
- Jérémy Cohen, in November 2017, Post-doc, University of Mons, Belgium
- Andreas Loukas, in December 2017, Post-doc, EPFL, Lausanne, Switzerland

9.3.1.1. Internships

- Helena Peic Tukuljac, from October to December 2017, PhD Student at EPFL, Lausanne, Switzerland
- Martin Strauss, from October to December 2017, M1 student, Friedrich-Alexander University, Erlangen, Germany

PARIETAL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CoSmic project

Participants: Philippe Ciuciu [Correspondant], Carole Lazarus, Loubna El Gueddari.

This is a collaborative project with Jean-Luc Stark, (CEA) funded by the DRF-impulsion CEA program.

Compressed Sensing is a recent theory in maths that allows the perfect recovery of signals or images from compressive acquisition scenarios. This approach has been popularized in MRI over the last decade as well as in astrophysics (noticeably in radio-astronomy). So far, both of these fields have developed skills in CS separately. The aim of the COSMIC project is to foster collaborations between CEA experts in MRI (Parietal team within NeuroSpin) and in astrophysics (CosmoStat lab within the Astrophysics Department). These interactions will allow us to share different expertise in order to improve image quality, either in MRI or in radio-astronomy (thanks to the interferometry principle). In this field, given the data delivered by radio-telescopes, the goal consists in extracting high temporal resolution information in order to study fast transient events.

9.1.2. BrainAMP project

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Antonio Andre Monteiro Manoel.

This is a collaborative project with Lenka Zdeborová, Theoretical Physics Institute (CEA) funded by the DRF-impulsion CEA program.

In many scientific fields, the data acquisition devices have benefited of hardware improvement to increase the resolution of the observed phenomena, leading to ever larger datasets. While the dimensionality has increased, the number of samples available is often limited, due to physical or financial limits. This is a problem when these data are processed with estimators that have a large sample complexity, such as multivariate statistical models. In that case it is very useful to rely on structured priors, so that the results reflect the state of knowledge on the phenomena of interest. The study of the human brain activity through high-field MRI belongs among these problems, with up to 10^6 features, yet a set of observations limited by cost and participant comfort.

We are missing fast estimators for multivariate models with structured priors, that furthermore provide statistical control on the solution. Approximate message passing methods are designed to work optimally with low-sample-complexity, they accommodate rather generic class of priors and come with an estimation of statistical significance. They are therefore well suited for our purposes.

We want to join forces to design a new generation of inverse problem solvers that can take into account the complex structure of brain images and provide guarantees in the low-sample-complexity regime. To this end, we will first adapt AMP to the brain mapping setting, using first standard sparsity priors (e.g. Gauss-Bernoulli) on the model. We will then consider more complex structured priors that control the variation of the learned image patterns in space. Crucial gains are expected from the use of the EM algorithm for parameter setting, that comes naturally with AMP. We will also examine the estimators provided by AMP for statistical significance. BrainAMP will design a reference inference toolbox released as a generic open source library. We expect a 3- to 10-fold improvement in CPU time, that will benefit to large-scale brain mapping investigations.

9.1.3. iConnectom project

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Elvis Dohmatob.

This is a Digiteo project (2014-2017).

Mapping brain functional connectivity from functional Magnetic Resonance Imaging (MRI) data has become a very active field of research. However, analysis tools are limited and many important tasks, such as the empirical definition of brain networks, remain difficult due to the lack of a good framework for the statistical modeling of these networks. We propose to develop population models of anatomical and functional connectivity data to improve the alignment of subjects brain structures of interest while inferring an average template of these structures. Based on this essential contribution, we will design new statistical inference procedures to compare the functional connections between conditions or populations and improve the sensitivity of connectivity analysis performed on noisy data. Finally, we will test and validate the methods on multiple datasets and distribute them to the brain imaging community.

9.1.4. *MetaCog project*

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Jérôme Dockès.

This is a Digicosme project (2016-2019) and a collaboration with Fabian Suchanek (Telecom Paritech).

Understanding how cognition emerges from the billions of neurons that constitute the human brain is a major open problem in science that could bridge natural science –biology– to humanities –psychology. Psychology studies performed on humans with functional Magnetic Resonance Imaging (fMRI) can be used to probe the full repertoire of high-level cognitive functions. While analyzing the resulting image data for a given experiment is a relatively well-mastered process, the challenges in comparing data across multiple datasets poses serious limitation to the field. Indeed, such comparisons require to pool together brain images acquired under different settings and assess the effect of different *experimental conditions* that correspond to psychological effects studied by neuroscientists.

Such meta-analyses are now becoming possible thanks to the development of public data resources –OpenfMRI <http://openfmri.org> and NeuroVault <http://neurovault.org>. As many others, researchers of the Parietal team understand these data sources well and contribute to them. However, in such open-ended context, the description of experiments in terms of cognitive concepts is very difficult: there is no universal definition of cognitive terms that could be employed consistently by neuroscientists. Hence meta-analytic studies loose power and specificity. On the other hand, <http://brainspell.org> provide a set of curated annotation, albeit on much less data, that can serve as a seed or a ground truth to define a consensual ontology of cognitive concepts. Relating these terms to brain activity poses another challenge, of statistical nature, as brain patterns form high-dimensional data in perspective with the scarcity and the noise of the data.

The purpose of this project is to learn a semantic structure in cognitive terms from their occurrence in brain activation. This structure will simplify massive multi-label statistical-learning problems that arise in brain mapping by providing compact representations of cognitive concepts while capturing the imprecision on the definition these concepts.

9.1.5. *HighDimStat project*

Participants: Bertrand Thirion [Correspondant], Jérôme-Alexis Chevalier, Joseph Salmon.

This is a Digicosme project (2017-2020) and a collaboration with Joseph Salmon (Telecom Paritech).

The HiDimStat project aims at handling uncertainty in the challenging context of high dimensional regression problem. Though sparse models have been popularized in the last twenty years in contexts where many features can explain a phenomenon, it remains a burning issue to attribute confidence to the predictive models that they produce. Such a question is hard both from the statistical modeling point of view, and from a computation perspective. Indeed, in practical settings, the amount of features at stake (possibly up to several millions in high resolution brain imaging) limit the application of current methods and require new algorithms to achieve computational efficiency. We plan to leverage recent developments in sparse convex solvers as well as more efficient reformulations of testing and confidence interval estimates to provide several communities with practical software handling uncertainty quantification. Specific validation experiments will be performed in the field of brain imaging.

9.1.6. AMPHI project

Participants: Bertrand Thirion [Correspondant], Joseph Salmon, Antonio Andre Monteiro Manoel.

This is a Digicosme project (2017-2020) and a collaboration with Joseph Salmon (Telecom Paritech) and Lenka Zdeborova (CEA, IPHT).

In many scientific fields, the data acquisition devices have benefited of hardware improvement to increase the resolution of the observed phenomena, leading to ever larger datasets. While the dimensionality has increased, the number of samples available is often limited, due to physical or financial limits. This is a problem when these data are processed with estimators that have a large sample complexity, such as multivariate statistical models. In that case it is very useful to rely on structured priors, so that the results reflect the state of knowledge on the phenomena of interest. The study of the human brain activity through neuroimaging belongs among these problems, with up to 10^6 features, yet a set of observations limited by cost and participant comfort. We are missing fast estimators for multivariate models with structured priors, that furthermore provide statistical control on the solution. Approximate message passing (AMP) methods are designed to work optimally with low- sample-complexity, they accommodate rather generic class of priors and come with an estimation of statistical significance. They are therefore well suited for our purposes. We want to join forces to design a new generation of inverse problem solvers that can take into account the complex structure of brain images and provide guarantees in the low-sample-complexity regime. To this end, we will first adapt AMP to the brain mapping setting, using first standard sparsity priors (e.g. Gauss-Bernoulli) on the model. We will then consider more complex structured priors that control the variation of the learned image patterns in space. Crucial gains are expected from the use of the EM algorithm for parameter setting, that comes naturally with AMP. We will also examine the estimators provided by AMP for statistical significance. AMPHI will design a reference inference toolbox released as a generic open source library. We expect a 3- to 10-fold improvement in CPU time, that will benefit to large-scale brain mapping investigations.

9.1.7. CDS2

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Guillaume Lemaître, Joris Van Den Bossche.

CDS2 is an "Strategic research initiative" of the Paris Saclay University Idex <http://datascience-paris-saclay.fr>. Although it groups together many partners of the Paris Saclay ecosystem, Parietal has been deeply involved in the project. It currently funds a post-doc for Guillaume Lemaître and an engineer position for Joris van den Bossche.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. MultiFracs project

Participants: Philippe Ciuciu [Correspondant], Daria La Rocca.

The scale-free concept formalizes the intuition that, in many systems, the analysis of temporal dynamics cannot be grounded on specific and characteristic time scales. The scale-free paradigm has permitted the relevant analysis of numerous applications, very different in nature, ranging from natural phenomena (hydrodynamic turbulence, geophysics, body rhythms, brain activity,...) to human activities (Internet traffic, population, finance, art,...).

Yet, most successes of scale-free analysis were obtained in contexts where data are univariate, homogeneous along time (a single stationary time series), and well-characterized by simple-shape local singularities. For such situations, scale-free dynamics translate into global or local power laws, which significantly eases practical analyses. Numerous recent real-world applications (macroscopic spontaneous brain dynamics, the central application in this project, being one paradigm example), however, naturally entail large multivariate data (many signals), whose properties vary along time (non-stationarity) and across components (non-homogeneity), with potentially complex temporal dynamics, thus intricate local singular behaviors.

These three issues call into question the intuitive and founding identification of scale-free to power laws, and thus make uneasy multivariate scale-free and multifractal analyses, precluding the use of univariate methodologies. This explains why the concept of scale-free dynamics is barely used and with limited successes in such settings and highlights the overriding need for a systematic methodological study of multivariate scale-free and multifractal dynamics. The Core Theme of MULTIFRACS consists in laying the theoretical foundations of a practical robust statistical signal processing framework for multivariate non homogeneous scale-free and multifractal analyses, suited to varied types of rich singularities, as well as in performing accurate analyses of scale-free dynamics in spontaneous and task-related macroscopic brain activity, to assess their natures, functional roles and relevance, and their relations to behavioral performance in a timing estimation task using multimodal functional imaging techniques.

This overarching objective is organized into 4 Challenges:

1. Multivariate scale-free and multifractal analysis,
2. Second generation of local singularity indices,
3. Scale-free dynamics, non-stationarity and non-homogeneity,
4. Multivariate scale-free temporal dynamics analysis in macroscopic brain activity.

9.2.1.2. *NiConnect project*

Participants: Bertrand Thirion, Gaël Varoquaux [Correspondant], Kamalaker Reddy Dadi, Darya Chyzyk, Mehdi Rahim.

- **Context:** The NiConnect project (2012-2017) arises from an increasing need of medical imaging tools to diagnose efficiently brain pathologies, such as neuro-degenerative and psychiatric diseases or lesions related to stroke. Brain imaging provides a non-invasive and widespread probe of various features of brain organization, that are then used to make an accurate diagnosis, assess brain rehabilitation, or make a prognostic on the chance of recovery of a patient. Among different measures extracted from brain imaging, functional connectivity is particularly attractive, as it readily probes the integrity of brain networks, considered as providing the most complete view on brain functional organization.
- **Challenges:** To turn methods research into popular tool widely usable by non specialists, the NiConnect project puts specific emphasis on producing high-quality open-source software. NiConnect addresses the many data analysis tasks that extract relevant information from resting-state fMRI datasets. Specifically, the scientific difficulties are *i)* conducting proper validation of the models and tools, and *ii)* providing statistically controlled information to neuroscientists or medical doctors. More importantly, these procedures should be robust enough to perform analysis on limited quality data, as acquiring data on diseased populations is challenging and artifacts can hardly be controlled in clinical settings.
- **Outcome of the project:** In the scope of computer science and statistics, NiConnect pushes forward algorithms and statistical models for brain functional connectivity. In particular, we are investigating structured and multi-task graphical models to learn high-dimensional multi-subject brain connectivity models, as well as spatially-informed sparse decompositions for segmenting structures from brain imaging. With regards to neuroimaging methods development, NiConnect provides systematic comparisons and evaluations of connectivity biomarkers and a software library embedding best-performing state-of-the-art approaches. Finally, with regards to medical applications, the NiConnect project also plays a support role in on going medical studies and clinical trials on neurodegenerative diseases.
- **Consortium**
 - Parietal Inria research team: applied mathematics and computer science to model the brain from MRI
 - LIF INSERM research team: medical image data analysis and modeling for clinical applications

- CATI center: medical image processing center for large scale brain imaging studies
- Henri-Mondor hospital neurosurgery and neuroradiology: clinical teams conducting research on treatments for neurodegenerative diseases, in particular Huntington and Parkinson diseases
- Logilab: consulting in scientific computing

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. HBP

Title: The Human Brain Project

Programm: FP7

Duration: October 2013 - September 2016

Coordinator: EPFL

Partners:

- Inria contact: Olivier Faugeras
- Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases. This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics, Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity. A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

9.4. International Initiatives

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

9.4.1.1. MetaMRI

Title: Machine learning for meta-analysis of functional neuroimaging data

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Psychology - Russ Poldrack

Start year: 2015

See also: <https://team.inria.fr/metamri>

Neuroimaging produces huge amounts of complex data that are used to better understand the relations between brain structure and function. Observing that the neuroimaging community is still largely missing appropriate tools to store and organize the knowledge related to the data, Parietal team and Poldrack's lab, have decided to join forces to set up a framework for functional brain image meta-analysis, i.e. a framework in which several datasets can be jointly analyzed in order to accumulate information on the functional specialization of brain regions. MetaMRI will build upon Poldrack's lab expertise in handling, sharing and analyzing multi-protocol data and Parietal's recent developments of machine learning libraries to develop a new generation of meta-analytic tools.

9.4.1.2. *LargeBrainNets*

Title: Characterizing Large-scale Brain Networks Using Novel Computational Methods for dMRI and fMRI-based Connectivity

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Stanford Cognitive and Systems Neuroscience Laboratory -
Vinod Menon

Start year: 2016

See also: <http://www-sop.inria.fr/members/Demian.Wassermann/large-brain-nets.html>

In the past two decades, brain imaging of neurotypical individuals and clinical populations has primarily focused on localization of function and structures in the brain, revealing activation in specific brain regions during performance of cognitive tasks through modalities such as functional MRI. In parallel, technologies to identify white matter structures have been developed using diffusion MRI. More recently, interest has shifted towards developing a deeper understanding of the brain's intrinsic architecture and its influence on cognitive and affective information processing. Using for this resting state fMRI and diffusion MRI to build the functional and structural networks of the human brain.

The human brain is a complex patchwork of interconnected regions, and graph-theoretical approaches have become increasingly useful for understanding how functionally connected systems engender, and constrain, cognitive functions. The functional nodes of the human brain and their structural inter-connectivity, collectively the "connectome", are, however, poorly understood. Critically, there is a dearth of computational methods for reliably identifying functional nodes of the brain and their structural inter-connectivity in vivo, despite an abundance of high-quality data from the Human Connectome Project (HCP). Devising and validating methods for investigating the human connectome has therefore taken added significance.

The first major goal of this project is to develop and validate appropriate sophisticated computational and mathematical tools for identifying functional nodes at the whole-brain level and measuring structural and functional connectivity between them, using state-of-the-art human brain imaging techniques and open-source HCP data. To this end, we will first develop and validate novel computational tools for (1) identifying stable functional nodes of the human brain using resting-state functional MRI and (2) measuring structural connectivity between functional nodes of the brain using multi-shell high-angular diffusion MRI. Due to the complementarity of the two imaging techniques fMRI and dMRI, our novel computational methods methods, the synergy between the two laboratories of this associate team will allow us to reveal in unprecedented detail the structural and functional connectivity of the human brain.

The second major goal of this project is to use our newly developed computational tools to characterize normal structural and functional brain networks in neurotypical adults.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Parietal has welcome François Meyer, Univ Colorado at Boulder, for a six months visit (Jan-June 2017), funded by a D'Alembert fellowship of Paris Saclay University. The project of François is to assess novel statistical models of functional connectivity based on the generalized resistivity model he has developed within a graph theoretical framework.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

9.5.2.1.1. Denis Engemann

has spent two months in Boston (April-May) with the MEG Core lab, Athinoula A. Martinos Center (MGH/Harvard-MIT) working on functional connectivity methods and population analysis for MEG.

9.5.2.1.2. Arthur Mensch

has spent 3 months in Japan (Sept-Dec) with NTT, working on dynamic time warping problems with Mathieu Blondel.

9.5.2.1.3. Jérôme Dockès

has spent two months with Poldracklab at Stanford, as part of the MetaMRI associated team. He has worked on the statistical relationships between neuroscientific concepts (whether anatomical or cognitive) and brain activation loci.

PARKAS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

ANR/CHIST-ERA DIVIDEND project, 2013-2018.

8.1.2. Investissements d'avenir

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

8.1.3. Others

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

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. EuroLab-4-HPC

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

Programm: H2020

Duration: September 2015 - September 2017

Coordinator: CHALMERS TEKNISKA HOEGSKOLA AB

Inria contact: Albert Cohen

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

8.2.1.2. TETRACOM

Title: Technology Transfer in Computing Systems

Programm: FP7

Duration: September 2013 - August 2016

Coordinator: RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN

Inria contact: Albert Cohen

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

8.2.1.3. EMC2

Title: Embedded Multi-Core Systems for Mixed Criticality Applications in Dynamic and Changeable Real-Time Environments

Programm: FP7

Duration: April 2014 - March 2017

Coordinator: Infineon Technologies

Inria contact: Albert Cohen

'Embedded systems are the key innovation driver to improve almost all mechatronic products with cheaper and even new functionalities. Furthermore, they strongly support today's information society as inter-system communication enabler. Consequently boundaries of application domains are alleviated and ad-hoc connections and interoperability play an increasing role. At the same time, multi-core and many-core computing platforms are becoming available on the market and provide a breakthrough for system (and application) integration. A major industrial challenge arises facing (cost) efficient integration of different applications with different levels of safety and security on a single computing platform in an open context. The objective of the EMC² project (Embedded multi-core systems for mixed criticality applications in dynamic and changeable real-time environments) is to foster these changes through an innovative and sustainable service-oriented architecture approach for mixed criticality applications in dynamic and changeable real-time environments. The EMC2 project focuses on the industrialization of European research outcomes and builds on the results of previous ARTEMIS, European and National projects. It provides the paradigm shift to a new and sustainable system architecture which is suitable to handle open dynamic systems. EMC² is part of the European Embedded Systems industry strategy to maintain its leading edge position by providing solutions for: . Dynamic Adaptability in Open Systems . Utilization of expensive system features only as Service-on-Demand in order to reduce the overall system cost. . Handling of mixed criticality applications under real-time conditions . Scalability and utmost flexibility . Full scale deployment and management of integrated tool chains, through the entire lifecycle Approved by ARTEMIS-JU on 12/12/2013 for EoN. Minor mistakes and typos corrected by the Coordinator, finally approved by ARTEMIS-JU on 24/01/2014. Amendment 1 changes approved by ECSEL-JU on 31/03/2015.'

8.3. International Initiatives

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

8.3.1.1. POLYFLOW

Title: Polyhedral Compilation for Data-Flow Programming Languages

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2016

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

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

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

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

8.3.2. Participation in Other International Programs

- VerticA (Francesco Zappa Nardelli), 2017-2020, joint project with Northeastern University, USA, financed by the ONR (Office of Naval Research), 1.5M\$ (subcontract for 150k\$).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Alex Susu from Polytechnica di Bucarest spent a 3 months internship in the Fall.

8.4.2. Visits to International Teams

8.4.2.1. Sabbatical programme

Francesco Zappa Nardelli, from Feb. 1st, 2017 to July. 29th, 2017 has been on sabbatical leave at Northeastern University, Boston, USA, invited by Prof. Jan Vitek.

PARSIFAL Project-Team

7. Partnerships and Cooperations

7.1. European Initiatives

7.1.1. FISP: ANR blanc International

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

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

Duration: 01/01/2016 – 31/10/2019

Partners:

University Paris VII, PPS (PI: Michel Parigot)

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

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

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

Total funding by the ANR: 316 805 EUR

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

7.1.2. COCA HOLA: ANR JCJC Project

Participant: Beniamino Accattoli.

Title: COst model for Complexity Analyses of Higher-Order programming Languages.

Collaborators: Ugo Dal Lago (University of Bologna & Inria), Delia Kesner (Paris Diderot University), Damiano Mazza (CNRS & Paris 13 University), Claudio Sacerdoti Coen (University of Bologna).

Duration: 01/10/2016 – 31/09/2019

Total funding by the ANR: 155 280 EUR

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

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

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

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

7.2. International Initiatives

7.2.1. Participation in Other International Programs

7.2.1.1. PHC Amadeus: Analytic Calculi for Modal Logics

Participants: Kaustuv Chaudhuri, Sonia Marin, Giselle Reis, Lutz Straßburger.

Title: Analytic Calculi for Modal Logics

Duration: 01/01/2016 – 31/12/2017

Austrian Partner: TU Wien, Institute for Computer Science (Department III)

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

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

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Internships

Riccardo Treglia was an intern funded by COCA HOLA during March, April, and May 2017. He was advised by Accattoli and worked on the complexity analysis of abstract machines for the λ -calculus.

7.3.2. Visits to International Teams

7.3.2.1. Research Stays Abroad

Stéphane Graham-Lengrand spent 8 months, from January 2017 to August 2017, at SRI International, Computer Science Lab. This visit developed a collaboration with N. Shankar, MP Bonacina, and D. Jovanovic, on new algorithms and new architectures for automated and interactive theorem proving, as well as on new programme verification techniques.

PERCEPTION Project-Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. VHIA

Title: Vision and Hearing in Action

EU framework: FP7

Type: ERC Advanced Grant

Duration: February 2014 - January 2019

Coordinator: Inria

Inria contact: Radu Horaud

The objective of VHIA is to elaborate a holistic computational paradigm of perception and of perception-action loops. We plan to develop a completely novel twofold approach: (i) learn from mappings between auditory/visual inputs and structured outputs, and from sensorimotor contingencies, and (ii) execute perception-action interaction cycles in the real world with a humanoid robot. VHIA will achieve a unique fine coupling between methodological findings and proof-of-concept implementations using the consumer humanoid NAO manufactured in Europe. The proposed multi-modal approach is in strong contrast with current computational paradigms influenced by unimodal biological theories. These theories have hypothesized a modular view, postulating quasi-independent and parallel perceptual pathways in the brain. VHIA will also take a radically different view than today's audiovisual fusion models that rely on clean-speech signals and on accurate frontal-images of faces; These models assume that videos and sounds are recorded with hand-held or head-mounted sensors, and hence there is a human in the loop who intentionally supervises perception and interaction. Our approach deeply contradicts the belief that complex and expensive humanoids (often manufactured in Japan) are required to implement research ideas. VHIA's methodological program addresses extremely difficult issues: how to build a joint audiovisual space from heterogeneous, noisy, ambiguous and physically different visual and auditory stimuli, how to model seamless interaction, how to deal with high-dimensional input data, and how to achieve robust and efficient human-humanoid communication tasks through a well-thought tradeoff between offline training and online execution. VHIA bets on the high-risk idea that in the next decades, social robots will have a considerable economical impact, and there will be millions of humanoids, in our homes, schools and offices, which will be able to naturally communicate with us.

Website: <https://team.inria.fr/perception/projects/erc-vhia/>

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

- Bar Ilan University, Israel (prof. Sharon Gannot and his team)
- University of Trento, Italy (prof. Nicu Sebe and prof. Elisa Ricci)
- Dr. Rafael Munoz-Salinas and prof. Manuel Marin-Jimenez, University of Cordoba, Spain,
- Dr. Christine Evers and prof. Patrick Naylor, Imperial College of Science and Medecine, UK.
- Dr. Miriam Redi, Wikimedia Foundation, UK.
- Prof. Shih-Fu Chang, Columbia University, USA.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Prof. Sharon Gannot (Bar Ilan University)
- Oscar David Gomez Lopez (University of Granada)

PERSVASIVE INTERACTION Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Project Involved

Participants: Amr Alyafi, Patrick Reignier.

Other Partners: UMR G-SCOP, UMR LIG (Persuasive Interaction, IIHM, Getalp), CEA Liten, PACTE, Vesta Systems and Elithis.

Dates: Jan 2015 to Dec 2018

The ANR project Involved focuses on bringing solutions to building actors for upcoming challenges in energy management in residential buildings. The project explores a user centric energy management system, where user needs and tacit knowledge drive the search of solutions. These are calculated using a flexible energy model of the living areas. The system is personified by energy consultants with which building actors such as building owners, building managers, technical operators but also occupants, can interact with in order to co-define energy strategies, benefiting of both assets: tacit knowledge of human actors, and measurement with computation capabilities of calculators. Putting actors in the loop, i.e. making energy not only visible but also controllable is the needed step before large deployment of energy management solutions.

The project will develop interactive energy consultants for all the actors, providing energy management aided systems embedding models in order to support the decision making processes. MIRROR (interactive monitoring), WHAT-IF (interactive quantitative simulation), EXPLAIN (interactive qualitative simulation), SUGGEST- AND-ADJUST (interactive management) and RECOMMEND (interactive diagnosis) functionalities will be developed.

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

Participants: James Crowley, Dominique Vaufreydaz, Rafaellea Balzarini

Other Partners: Dept of NeuroCognition, CITEN, Bielefeld University

Dates: Jan 2016 to Dec 2019

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

In this project, we will observe the visual attention, physiological responses and mental states of subject with different levels of expertise solving classic chess problems, and participating in chess matches. We will observe chess players using eye-tracking, sustained and instantaneous face-expressions (micro-expressions), skin conductivity, blood flow (BVP), respiration, posture and other information extracted from audio-visual recordings and sensor readings of players. We will use the recorded information to estimate the mental constructs with which the players understand the game situation. Information from visual attention as well as physiological reactions will be used to determine and model the degree to which a player understands the game situation in terms of abstract configurations of chess pieces. This will provide a structured environment that we will use for experimental evaluation of current theories of mental modeling and emotional response during problem solving and social interaction.

The project is organized in three phases. During the first phase, we will observe individual players of different levels of chess expertise solving known chess problems. We will correlate scan-path from eye tracking and other information about visual attention to established configurations of pieces and known solutions to chess problems. This will allow us to construct a labeled corpus of chess play that can be used to evaluate competing techniques for estimating mental models and physiological responses. In a second phase, we will observe the attention and face expressions of pairs of players of different levels of chess ability during game play. In particular, we will seek to annotate and segment recordings with respect to the difficulty of the game situation as well as situations that elicit particularly strong physiological reactions. In the final phase, we will use these recordings to evaluate the effectiveness of competing techniques for mental modeling and observation of emotions in terms of their abilities to predict the chess abilities of players, game outcomes and individual moves and player self reports. Results of our work will be published in scientific conferences and journals concerned with cognitive science and cognitive neuroscience as well as computer vision, multimodal interaction, affective computing and pervasive computing. Possible applications include construction of systems that can monitor the cognitive abilities and emotional reactions of users of interactive systems to provide assistance that is appropriate but not excessive, companion systems that can aid with active healthy ageing, and tutoring systems that can assist users in developing skills in a variety of domains including chess.

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

Participants: James Crowley, Patrick Reignier, Rafaellea Balzarini 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

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

Participants: Emmanuel Mazer, Raphael Frisch Other Partners: Laurent Girin (TIMA), 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.

8.1.5. 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.

PESTO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. CNRS

- CNRS PEPS INS2I 2016-2018 project ASSI *Analyse de Sécurité de Systèmes Industriels*, duration: 2 years, leader: Pascal Lafourcade (Univ Clermont-Ferrand), participant Pesto: Jannik Dreier, other participants: Marie-Laure Potet, Maxime Puys (Univ Grenoble-Alpes).

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

9.1.2. ANR

- ANR SEQUOIA *Security properties, process equivalences and automated verification*, duration: 4 years, since October 2014, leader: Steve Kremer, other partners: ENS Cachan, Univ Luxembourg. Most protocol analysis tools are restricted to analyzing reachability properties while many security properties need to be expressed in terms of some process equivalences. The increasing use of observational equivalence as a modeling tool shows the need for new tools and techniques that are able to analyze such equivalence properties. The aims of this project are (i) to investigate which process equivalences – among the plethora of existing ones – are appropriate for a given security property, system assumptions and attacker capabilities; (ii) to advance the state-of-the-art of automated verification for process equivalences, allowing for instance support for more cryptographic primitives, relevant for case studies; (iii) to study protocols that use low-entropy secrets expressed using process equivalences; (iv) to apply these results to case studies from electronic voting.
- ANR TECAP *Protocol Analysis — Combining Existing Tools*, duration: 4 years, starting in 2018, leader: Vincent Cheval, other partners: ENS Cachan, Inria Paris, Inria Sophia Antipolis, IRISA, LIX. Despite the large number of automated verification tools, several cryptographic protocols (e.g. stateful protocols) still represent a real challenge for these tools and reveal their limitations. To cope with these limits, each tool focuses on different classes of protocols depending on the primitives, the security properties, etc. Moreover, the tools cannot interact with each other as they evolve in their own model with specific assumptions. The aim of this project is to get the best of all these tools, meaning, to improve the theory and implementations of each individual tool towards the strengths of the others and, to build bridges that allow the cooperations of the methods/tools. We will focus in this project on the tools CryptoVerif, EasyCrypt, Scary, ProVerif, *TAMARIN*, *Akiss* and APTE. In order to validate the results obtained in this project, we will apply our results to several case studies such as the Authentication and Key Agreement protocol from the telecommunication networks, the Scytl and Helios voting protocols, and the low entropy authentication protocols 3D-Secure. These protocols have been chosen to cover many challenges that the current tools are facing.

9.1.3. Fondation MAIF

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

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- SPOOC (2015–2020) ⁰— ERC Consolidator Grant on Automated Security Proofs of Cryptographic Protocols: Privacy, Untrusted Platforms and Applications to E-voting Protocols.

The goals of the SpooC project are to develop solid foundations and practical tools to analyze and formally prove security properties that ensure the privacy of users as well as techniques for executing protocols on untrusted platforms. We will

- develop foundations and practical tools for specifying and formally verifying new security properties, in particular privacy properties;
- develop techniques for the design and automated analysis of protocols that have to be executed on untrusted platforms;
- apply these methods in particular to novel e-voting protocols, which aim at guaranteeing strong security guarantees without need to trust the voter client software.

Steve Kremer is the leader of the project.

9.3. International Initiatives

9.3.1. Inria International Partners

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- David Galindo (Univ Birmingham), June 2017
- Bogdan Warinschi (Univ Bristol), November 2017

⁰<https://members.loria.fr/SKremer/files/spooc/index.html>

PETRUS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR PerSoCloud (Jan 2017 - Jan 2020)

Partners: Orange Labs (coordinator), PETRUS (Inria-UVSQ), Cozy Cloud, U. of Versailles.
PETRUS funding: 170k€. The objective of PerSoCloud is to design, implement and validate a full-fledged Privacy-by-Design Personal Cloud Sharing Platform. One of the major difficulties linked to the concept of personal cloud lies in organizing and enforcing the security of the data sharing while the data is no longer under the control of a central server. We identify three dimensions to this problem. Devices-sharing: assuming that the primary copy of user U1's personal data is hosted in a secure place, how to share and synchronize it with U1's multiple (mobile) devices without compromising security? Peers-sharing: how user U1 could exchange a subset of his-her data with an identified user U2 while providing to U1 tangible guarantees about the usage made by U2 of this data? Community-sharing: how user U1 could exchange a subset of his-her data with a large community of users and contribute to personal big data analytics while providing to U1 tangible guarantees about the preservation of his-her anonymity? In addition to tackling these three scientific and technical issues, a legal analysis will guarantee compliance of this platform with the security and privacy French and UE regulation, which firmly promotes the Privacy by Design principle, including the current reforms of personal data regulation.

8.1.2. PIA - PDP SECSi (May 2016 - Dec 2017)

Partners: Cozy Cloud (coordinator), Qwant, Inria (Inria-UVSQ), FING.
SMIS funding: 149k€. The objective of this PIA-PDP (Programme Investissement d'Avenir - Protection des Données Personnelles) SECSi project is to build a concrete Personal Cloud platform which can support a large scale deployment of Self Data services. Three major difficulties are identified and will be tackled in this project: (1) how to implement and enforce a fine control of the data flow when personal data are exploited by third party applications, (2) how to protect these same applications when processing is delegated to the personal cloud platform itself and (3) how to implement personalized search on the web without hurting user's privacy.

8.1.3. CityLab@Inria, Inria Project Lab (May 2014 -).

Inria Partners: ARLES-MIMOVE, CLIME, DICE, FUN, MYRIADS, OAK, PETRUS, URBANET, WILLOW.
External partners: UC Berkeley.

Funding: not associated to individual project teams. CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. SMIS contributes to Privacy-by-Design architectures for trusted smart objects so as to ensure privacy to citizens, which is critical for ensuring that urbanscale sensing contributes to social sustainability and does not become a threat. The PhD Thesis of Dimitris Tsoulovos, co-directed by MIMOVE and PETRUS, is funded by CityLab. <http://citylab.inria.fr/>

PHOENIX Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Independent living with intellectual disabilities – ANDDI – 2014 - 2017

ANDDI leverages the abilities of individuals with ID and the recent technological advances to develop a variety of assistive services addressing their daily needs. These services draw on our expertise in cognitive science and computer science, dedicated to assisting users with technologies. In particular, we use our platform, named HomeAssist, dedicated to the independently living of older adults. This project is funded by the Region of Aquitaine.

8.1.2. Populational Study of HomeAssist – HomeAssist 500 – 2015 - 2017

We conduct a Randomized Controlled Trial (RCT) of HomeAssist with older adults, ranging from autonomous to mildly cognitively impaired (e.g., Alzheimer disease (AD) in its early stage). The RCT is considered as the gold standard of a true experimental design. Furthermore, it provides strong evidence for causal relationships, as well as the ability to generalize the results to people outside the study's sample. The study design will thus be a single-blinded RCT. It will include up to 500 participants, matched with non-equipped participants. The HomeAssist intervention will involve monitoring as well as compensation services to support independent living in place. The duration of the HomeAssist intervention is of 12 months. This project is funded by the Region of Aquitaine, the Districts of Gironde and Pyrénées Atlantique, CARSAT Aquitaine, UDCCAS, and CNSA.

8.2. National Initiatives

8.2.1. School Inclusion for Children with Autism

The objective of this project is to provide children with assistive technologies dedicated to the school routines. This project is in collaboration with the “Handicap et Système Nerveux” research group (EA 4136, Bordeaux University), the PsyCLÉ research center (EA 3273, Provence Aix-Marseille University) and the “Parole et Langage” research laboratory (CNRS, Provence Aix-Marseille University).

This work is funded by the French Ministry of National Education and Orange Foundation.

8.3. International Initiatives

8.3.1. Participation in Other International Programs

- International exchange program Idex (2016-17) — “Memory, aging, Parkinson disease, and Virtual Reality”, with Pr. Luc Noreau, Centre Interdisciplinaire de Recherche en réadaptation et intégration sociale-University of Laval, Canada. Coordinated by P. Dehail.
- Mobility program Idex UB-University of Waterloo, Canada — “Aging, Neurological conditions, and Assistance technologies” (2016-17). Coordinated by M. Fernandes and H. Sauzéon.

PL.R2 Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

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

Pierre-Louis Curien (coordinator), Yves Guiraud (local coordinator), Philippe Malbos and Samuel Mimram are members of the four-year Cathre ANR project (January 2014 to December 2017). This project investigates the general theory of higher-dimensional rewriting, the development of a general-purpose library for higher-dimensional rewriting, and applications in the fields of combinatorial linear algebra, combinatorial group theory and theoretical computer science. This project is joint with mathematicians and computer scientists from LAGA (Univ. Paris 13), LIX (École Polytechnique), ICJ (Univ. Lyon 1 and Univ. Saint-Étienne), I2M (Univ. Aix-Marseille) and IMT (Univ. Toulouse 3). The project Cathre provided the funding for the PhD of Maxime Lucas.

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

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

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

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

Matthieu Sozeau is a member of the CoqHoTT project led by Nicolas Tabareau (Gallinette team, Inria Nantes & École des Mines de Nantes), funded by an ERC Starting Grant. The post-doctoral grant of Eric Finster is funded by the CoqHoTT ERC and Amin Timany's 2-month visit was funded on the ERC as well.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, Except FP7 & H2020

Hugo Herbelin is a deputy representative of France in the COST action EUTYPES. The full name of the project (whose scientific leader is Herman Geuvers, from the University of Nijmegen) is "European research network on types for programming and verification".

Presentation of EUTYPES: Types are pervasive in programming and information technology. A type defines a formal interface between software components, allowing the automatic verification of their connections, and greatly enhancing the robustness and reliability of computations and communications. In rich dependent type theories, the full functional specification of a program can be expressed as a type. Type systems have rapidly evolved over the past years, becoming more sophisticated, capturing new aspects of the behaviour of programs and the dynamics of their execution. This COST Action will give a strong impetus to research on type theory and its many applications in computer science, by promoting (1) the synergy between theoretical computer scientists, logicians and mathematicians to develop new foundations for type theory, for example as based on the recent development of "homotopy type theory", (2) the joint development of type theoretic tools as proof assistants and integrated programming environments, (3) the study of dependent types for programming and its deployment in software development, (4) the study of dependent types for verification and its deployment in software analysis and verification. The action will also tie together these different areas and promote cross-fertilisation.

7.3. International Initiatives

7.3.1. *Inria International Labs*

7.3.1.1. *Other IIL projects*

Matthieu Sozeau is part of an international collaboration network CSEC "Certified Software Engineering in Coq" funded by Inria Chile, Conicyt and the CoqHoTT ERC, which will officially start in early 2018. The participants include Eric Tanter (primary investigator) and Nicolas Tabareau.

7.3.2. *Inria Associate Teams Not Involved in an Inria International Labs*

7.3.2.1. *Associate team*

Pierre-Louis Curien and Claudia Faggian are members of the CRECOGI associate team, coordinated on one side by Ugo dal Lago (research-team FoCUS, Inria Sophia and Bologna), and on the other side by Ichiro Hasuo (NII, Tokyo). The full name of the project is Concurrent, Resourceful and Effectful Computation, by Geometry of Interaction.

Presentation of CRECOGI: Game semantics and geometry of interaction (GoI) are two closely related frameworks whose strength is to have the characters of both a denotational and an operational semantics. They offer a high-level, mathematical (denotational) interpretation, but are interactive in nature. The formalisation in terms of movements of tokens through which programs communicate with each other can actually be seen as a low-level program. The current limit of GoI is that the vast majority of the literature and of the software tools designed around it have a pure, sequential functional language as their source language. This project aims at investigating the application of GoI to concurrent, resourceful, and effectful computation, thus paving a way to the deployment of GoI-based correct-by-construction compilers in real-world software developments in fields like (massively parallel) high-performance computing, embedded and cyberphysical systems, and big data. The presence of both the Japanese GoI community (whose skills are centered around effects and coalgebras) and the French GoI community (more focused on linear logic and complexity analysis) bring essential, complementary, ingredients.

7.3.2.2. *Joint Inria-CAS project*

Pierre-Louis Curien is principal investigator on the French side for a joint Inria-CAS project (a new programme of Inria with the Chinese Academy of Sciences). The project's title is "Verification, Interaction, and Proofs". The principal investigator on the Chinese side is Ying Jiang, from the Institute of Software (ISCAS) in Beijing. The participants of the project on the French side are Pierre-Louis Curien and Jean-Jacques Lévy, as well as other members of IRIF (Thomas Ehrhard, Jean Krivine, Giovanni Bernardi, Ahmed Bouajjani, Mihaela Sighireanu, Constantin Enea, Gustavo Petri), and Gilles Dowek (Deducteam team of Inria Saclay). On the Chinese side, the participants are Ying Jiang, as well as other members of the ISCAS (Angsheng Li, Xinxin Liu, Yi Lü, Peng Wu, Yan Rongjie, Zhilin Wu, and Wenhui Zhang), and Yuxi Fu (from Shanghai Jiaotong University). The project funds the postdoc of Kailiang Ji at University Paris 7, starting in December 2017.

Presentation of VIP: The line between “verification” and “proofs” is comparable to the one separating satisfiability and provability: in a formal system, a formula can be trusted either if it is satisfied in the intended model (for all of its instances), or if it can be proved formally by using the axioms and inference rules of some logical system. These two directions of work are called model-checking and proof-checking, respectively. One of the aims of the present project is to bring specialists of the two domains together and to tackle problems where model-checking and proof-checking can be combined (the “V” and the “P” of the acronym). Applications in the realm of distributed computation, or concurrency theory (the “T” of the acronym) are particularly targeted.

7.3.3. Inria International Partners

7.3.3.1. Informal International Partners

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

7.3.4. Participation in Other International Programs

Pierre-Louis Curien participates to the ANR International French-Chinese project LOCALI (Logical Approach to Novel Computational Paradigms), coordinated by Gilles Dowek (Deducteam). This project ended in July 2017.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

John Baez (University of California River Side) visited the team for a week in November 2017.

Marcelo Fiore (University of Cambridge) visited the team for two weeks in February 2017.

Jovana Obradović (now a postdoc at Charles University, Prague) visited the team from December 1 to December 10 2017.

Amin Timany (KU Leuven, Belgium) visited the team for two months in March-April 2017 and collaborated with Matthieu Sozeau on the design and implementation of cumulative inductive types in Coq.

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

Pierre-Louis Curien visited East China Normal University for a month in June 2017 (collaborations with Yuxin Deng and Min Zhang). Pierre-Louis Curien and Jovana Obradović visited the Institute of Mathematics of the Serbian Academy of Sciences in Belgrade in July 2017 (collaboration with Zoran Petrić).

Jean-Jacques Lévy visited the Institute of Software of Chinese Academy of Sciences (ISCAS) in December 2017 (project VIP and on-going work with Ran Chen) during 2 weeks. He gave talks at ISCAS hosted by Ying Jiang, and during a third week at ECNU Shanghai hosted by Min Zhang, USTC Suzhou (University of Science and Technology of China) hosted by Xinyu Feng, Nankai University in Tianjin hosted by Chunfu Jia.

PLEIADE Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. COTE – Continental to Coastal Ecosystems

The Labex cluster of excellence COTE (Continental To coastal Ecosystems: evolution, adaptability and governance) develops tools to understand and predict ecosystem responses to human-induced changes as well as methods of adaptive management and governance to ensure their sustainability. The LabEx includes nine laboratories of the University of Bordeaux and major national research institutes involved in research on terrestrial and aquatic ecosystems (INRA, CNRS, IFREMER and IRSTEA). PLEIADE is a partner in one project funded by COTE:

- *Aerobarcoding: détection de pollens allergénisants*. 2017-18.

7.2. National Initiatives

7.2.1. Biocontamination in aircraft reservoirs

ANTICOR is an industrial-academic research and development working group coordinated by Dassault Aviation, investigating the causes of microbial contamination in aircraft reservoirs and aimed at developing mitigating procedures and equipment. Previous results have shown that this contamination forms biofilms at the fuel-water interface and is comprised of complex communities of hundreds of bacterial and fungal species. PLEIADE is particularly interested in measuring and modeling these communities, especially as concerns understanding how they change based on environmental conditions and on reservoir geometry.

This working group continues work started in CAER – Alternative Fuels for Aeronautics, a 6 M-Euro contract with the Civil Aviation Directorate (Direction Générale de l'Aviation Civile, DGAC), coordinated by the French Petroleum Institute (Institut français de pétrole-énergies nouvelles, IFPEN) on behalf of a large consortium of industrial (EADS, Dassault, Snecma, Turbomeca, Airbus, Air France, Total) and academic (CNRS, INRA, Inria) partners to explore different technologies for alternative fuels for aviation.

7.2.2. Agence Française pour la Biodiversité

The AFB is a public law agency of the French Ministry of Ecology that supports public policy in the domains of knowledge, preservation, management, and restoration of biodiversity in terrestrial, aquatic, and marine environments. PLEIADE is a partner in two AFB projects developed with the former ONEMA:

- *Methods for metabarcoding*. 2017-18.
- *Molecular diagnosis of freshwater quality*. 2014-present.

7.2.3. Inria Projet Lab in silico Algae

In 2017 PLEIADE joined the IPL “In silico Algae” coordinated by Olivier Bernard. The IPL addresses challenges in modeling and optimizing microalgae growth for industrial applications. PLEIADE worked this year on comparative genomic analysis of genes implicated in lipid production by the picoalgae *Ostreococcus tauri*, in collaboration with Florence Corellou of the CNRS UMR 5200 (Laboratoire de Biogénèse Membranaire). The goal of this work is the production of long-chain polyunsaturated fatty acids, developed as nutritional additives. Mercia Ngoma Komb's two-month internship in PLEIADE contributed to this work.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, Except FP7 & H2020

Alain Franc has been appointed co-chair of Working Group 4 (Data Analysis and Storage) of COST DNAqua.net ⁰, at the Sarajevo meeting in Fall 2017, with the main task of developing contact with HPC and metabarcoding for serving the whole community. The goal of DNAqua-Net is to nucleate a group of researchers across disciplines with the task to identify gold-standard genomic tools and novel eco-genomic indices and metrics for routine application for biodiversity assessments and biomonitoring of European water bodies.

7.4. International Initiatives

7.4.1. CEBA – Center for the study of biodiversity in Amazonia

The Laboratoire of excellence CEBA promotes innovation in research on tropical biodiversity. It brings together a network of internationally-recognized French research teams, contributes to university education, and encourages scientific collaboration with South American countries. PLEIADE participates in three current international projects funded by CEBA:

- *MicroBIOMES: Microbial Biodiversities*. 2017-19.
- *Neutrophyl: Inferring the drivers of Neotropical diversification*. 2017-19.
- *Phyloguianas: Biogeography and pace of diversification in the Guiana Shield*. 2015-present

⁰<http://dnaqua.net/>

POEMS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The post-doc of Maryna Kachanovska was funded by the Fondation Mathématique Jacques Hadamard (FMJH).

9.2. National Initiatives

9.2.1. ANR

- ANR project *RAFFINE: Robustesse, Automatisation et Fiabilité des Formulations INTégrales en propagation d'ondes : Estimateurs a posteriori et adaptivité*
Partners: EADS, IMACS, ONERA, Thales
Start : January 2013. End : June 2017. Administrator : Inria. Coordinator: Marc Bonnet.
- ANR project *Non-Local Domain Decomposition Methods in Electromagnetism*.
Partners: Inria Alpines, Inria POEMS, Inria Magique 3D.
Start : 2015, End : 2019. Administrator : Inria. Coordinator: Xavier Claeys.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. BATWOMAN

Type: FP7 Marie Curie

Objectif: Basic Acoustics Training - & Workprogram On Methodologies for Acoustics - Network

Duration: September 2013 - August 2017

Coordinator: Martin Wifling, VIRTUAL VEHICLE (AT)

Inria contact: P. Joly

Abstract: The BATWOMAN ITN aims at structuring research training in basic and advanced acoustics and setting up a work program on methodologies for acoustics for skills development in a highly diverse research field offering multiple career options.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Wilkins Aquino (Duke University)
 Juan Pablo Borthagaray (Univ. of Maryland, College Park, USA)
 Fioralba Cakoni (University of Rutgers)
 Maxence Cassier (Columbia University)
 Camille Carvalho (UC Merced, Merced, USA)
 Christophe Geuzaine (Université de Liège)
 Bojan Guzina (University of Minnesota)
 Marcus Grote (Universitaet Basel)
 Sergei Nazarov (Saint-Petersburg University)
 Jeronimo Rodriguez (University of Santiago de Compostela)
 Adrien Semin (BTU Cottbus)
 Ricardo Weder (Universidad Nacional Autonoma, Mexico)
 Shravan Veerapaneni (Univ. of Michigan at Ann Arbor, USA)

POLARIS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Nicolas Gast received a grant from the IDEX UGA that fund a post-doctoral researcher for two years to work on the smart-grid project that focus on distributed optimization in electrical distribution networks.

9.2. National Initiatives

9.2.1. Inria Project Labs

HAC SPECIS: 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. PGM0 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.

9.2.3. ANR

- *GAGA (2014–2017)*
GAGA is an ANR starting grant (JCJC) whose aim is to explore the Geometric Aspects of GAMES. The GAGA team is spread over three different locations in France (Paris, Toulouse and Grenoble), and is coordinated by Vianney Perchet (ENS Cachan). Its aim is to perform a systematic study of the geometric aspects of game theory and, in so doing, to establish new links between application areas that so far appeared unrelated (such as the use of Hessian Riemannian optimization techniques in wireless communication networks).
- *MARMOTE (2013–2017)*
Partners: Inria Sophia (MAESTRO), Inria Rocquencourt (DIOGEN), Université Versailles-Saint-Quentin (PRiSM lab), Telecom SudParis (SAMOVAR), Université Paris-Est Créteil (*Spécification et vérification de systèmes*), Université Pierre-et-Marie-Curie/LIP6.
The project aims at realizing a software prototype dedicated to Markov chain modeling. It gathers seven teams that will develop advanced resolution algorithms and apply them to various domains (reliability, distributed systems, biology, physics, economy).
- *NETLEARN (2013–2017)*
Partners: Université Versailles – Saint-Quentin (PRiSM lab), Université Paris Dauphine, Inria Grenoble (POLARIS), Institut Mines–Telecom (Telecom ParisTech), Alcatel–Lucent Bell Labs (ALBF), and Orange Labs.
The main objective of the project is to propose a novel approach of distributed, scalable, dynamic and energy efficient algorithms for mobile network resource management. This new approach relies on the design of an orchestration mechanism of a portfolio of algorithms. The ultimate goal of the proposed mechanism is to enhance the user experience, while at the same time ensuring the more efficient utilization of the operator's resources.

- *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.
- *ANR SONGS, 2012–2016.* Partners: Inria Nancy (Algorille), Inria Sophia (MASCOTTE), Inria Bordeaux (CEPAGE, HiePACS, RunTime), Inria Lyon (AVALON), University of Strasbourg, University of Nantes.

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently exploit such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the SONGS project (Simulation of Next Generation Systems) is to extend the applicability of the SimGrid simulation framework from grids and peer-to-peer systems to clouds and high performance computation systems. Each type of large-scale computing system will be addressed through a set of use cases and led by researchers recognized as experts in this area. Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management. Such aspects are also addressed in the SONGS project.

9.2.4. National Organizations

- Jean-Marc Vincent is member of the scientific committees of the CIST (Centre International des Sciences du Territoire).
- *REAL.NET (2017)*
REAL.NET is a CNRS PEPS starting grant (JCJC) coordinated by Panayotis Mertikopoulos. Its objective is to provide dynamic control methodologies for nonstationary stochastic optimization problems that arise in wireless communication networks.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. QUANTICOL

Program: The project is a member of Fundamentals of Collective Adaptive Systems (FOCAS), a FET-Proactive Initiative funded by the European Commission under FP7.

Project acronym: QUANTICOL

Project title: A Quantitative Approach to Management and Design of Collective and Adaptive Behaviours

Duration: 04 2013 – 03 2017

Coordinator: Jane Hillston (University of Edinburgh, Scotland)

Other partners: University of Edinburgh (Scotland); Istituto di Scienza e Tecnologie della Informazione (Italy); IMT Lucca (Italy) and University of Southampton (England).

Abstract: The main objective of the QUANTICOL project is the development of an innovative formal design framework that provides a specification language for collective adaptive systems (CAS) and a large variety of tool-supported, scalable analysis and verification techniques. These techniques will be based on the original combination of recent breakthroughs in stochastic process algebras and associated verification techniques, and mean field/continuous approximation and control theory. Such a design framework will provide scalable extensive support for the verification of developed models, and also enable and facilitate experimentation and discovery of new design patterns for emergent behaviour and control over spatially distributed CAS.

9.3.1.2. HPC4E

Title: HPC for Energy

Program: H2020

Duration: 01 2016 – 01 2018

Coordinator: Barcelona Supercomputing Center

Inria contact: Stephane Lanteri

Other partners:

- Europe: Lancaster University (ULANC), Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), Repsol S.A. (REPSOL), Iberdrola Renovables Energía S.A. (IBR), Total S.A. (TOTAL).
- Brazil: Fundação Coordenação de Projetos, Pesquisas e Estudos Tecnológicos (COPPE), National Laboratory for Scientific Computation (LNCC), Instituto Tecnológico de Aeronáutica (ITA), Petróleo Brasileiro S. A. (PETROBRAS), Universidade Federal do Rio Grande do Sul (INF-UFRGS), Universidade Federal de Pernambuco (CER-UFPE)

Abstract: The main objective of the HPC4E project is to develop beyond-the-state-of-the-art high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using the state-of-the-art HPC systems. The other objective is to improve the cooperation between energy industries from EU and Brazil and the cooperation between the leading research centres in EU and Brazil in HPC applied to energy industry. The project includes relevant energy industrial partners from Brazil and EU, which will benefit from the project's results. They guarantee that TRL of the project technologies will be very high. This includes sharing supercomputing infrastructures between Brazil and EU. The cross-fertilization between energy-related problems and other scientific fields will be beneficial at both sides of the Atlantic.

Polaris is a member of the COST program on *Game Theory in Europe*.

9.3.2. Collaborations with Major European Organizations

TU Wien: Research Group Parallel Computing, Technische Universität Wien (Austria). We collaborate with Sascha Hunold on experimental methodology and reproducibility of experiments in HPC. In particular we co-organize the REPPAR workshop on “Reproducibility in Parallel Computing”.

BSC (Barcelona): Barcelona Supercomputer Center (Spain). We collaborate with the performance evaluation group through the HPC4E project and through the JLESC.

University of Edinburgh, Istituto di Scienza e Tecnologie della Informazione and IMT Lucca. we used to strongly collaborate through the Quanticol European project. Several projects are still actively developed, concerning the mean field and refined mean field approximation.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. North America

- JLESC (former JLPC) (Joint Laboratory for Extreme-Scale Computing) with University of Illinois Urbana Champaign, Argonne Nat. Lab and BSC. Several members of POLARIS are partners of this laboratory, and have done several visits to Urbana-Champaign or NCSA.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

- POLARIS has strong connections with both UFRGS (Porto Alegre, Brazil) and USP (Sao Paulo, Brazil). The creation of the LICIA common laboratory (see next section) has made this collaboration even tighter.
- POLARIS has strong bounds with the University of Illinois Urbana Champaign and Barcelona Supercomputer Center, within the (Joint Laboratory on Petascale Computing, see previous section).

9.4.3. Participation in Other International Programs

LICIA Bresil: Polaris is member of the common laboratory with Bresil. The founding director of LICIA is Jean-Marc Vincent.

9.4.3.1. South America

- *LICIA*: The CNRS, Inria, the Universities of Grenoble, Grenoble INP, and Universidade Federal do Rio Grande do Sul have created the LICIA (*Laboratoire International de Calcul intensif et d'Informatique Ambiante*). LICIA's main research themes are high performance computing, language processing, information representation, interfaces and visualization as well as distributed systems. Jean-Marc Vincent is the director of the laboratory on the French side and visited Porto Alegre for two weeks in November 2016.

More information can be found at <http://www.inf.ufrgs.br/licia/>.

- *ECOS-Sud*: POLARIS is a member of the Franco-Chilean collaboration network LEARN with CONICYT (the Chilean national research agency), formed under the ECOS-Sud framework. The main research themes of this network is the application of continuous optimization and game-theoretic learning methods to traffic routing and congestion control in data networks. Panayotis Mertikopoulos was an invited researcher at the University of Chile in October 2016.

More information can be found at <http://www.conicyt.cl/pci/2016/02/11/programa-ecos-conicyt-adjudica-proyectos-para-el-ano-2016>.

- POLARIS is the co-recipient of a project *STIC AmSud* that involves partners from Inria and CNRS (France), MINCYNT (Argentina) and ANII (from Uruguay).

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Research Stays Abroad

- 3/17: Panayotis Mertikopoulos visited Stanford University (Z. Zhou, N. Bambos, P. Glynn, S. Boyd)
- 04/17: Panayotis Mertikopoulos visited University of Wisconsin-Madison (W. Sandholm)
- 10/17: Panayotis Mertikopoulos visited Lancaster University (D. Leslie)
- 11/17: Panayotis Mertikopoulos visited U. Marseille-Aix (M. Faure, S. Bervoets).

POLSYS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- **French Ministry of Armies**

POLSYS has a collaboration with the French Ministry of Armies.

- **Grant GAMMA** (funded by PGM0).

GLOBAL ALGEBRAIC SHOOTING METHOD IN OPTIMAL CONTROL AND APPLICATIONS

Optimal control consists in steering a system from an initial configuration to a final one, while minimizing some given cost criterion. One of the current main challenges is to develop innovative methods for computing global solutions. This is crucial for applications where validating the global control laws is a crucial but a highly time consuming and expensive phase. GAMMA focuses on the wide range of optimal control problems having an algebraic structure, involving for instance polynomial or semi-algebraic dynamics and costs, or switches between polynomial models. In this case, GAMMA aims at designing methods relying on algebraic computations to the mainstream shooting method in order to yield optimal solutions that purely numerical techniques cannot provide.

8.2. National Initiatives

8.2.1. ANR

- **ANR Jeunes Chercheurs GALOP (Games through the lens of ALgebra and OPtimization)**

Duration: 2018–2022

GALOP is a Young Researchers (JCJC) project with the purpose of extending the limits of the state-of-the-art algebraic tools in computer science, especially in stochastic games. It brings original and innovative algebraic tools, based on symbolic-numeric computing, that exploit the geometry and the structure and complement the state-of-the-art. We support our theoretical tools with a highly efficient open-source software for solving polynomials. Using our algebraic tools we study the geometry of the central curve of (semi-definite) optimization problems. The algebraic tools and our results from the geometry of optimization pave the way to introduce algorithms and precise bounds for stochastic games.

Participants: E. Tsigaridas [contact], F. Johansson, H. Gimbert, J.-C. Faugère, M. Safey El Din.

8.2.2. Programme d'investissements d'avenir (PIA)

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

The RISQ project is certainly the biggest industrial project ever organized in quantum-safe cryptography. RISQ is one of few projects accepted in the call Grands Défis du Numérique which is managed by BPI France, and will be funded thanks to the so-called Plan d'Investissements d'Avenir.

The RISQ project is a natural continuation of POLSYS commitment to the industrial transfert of quantum-safe cryptography. RISQ is a large scale version of the HFEBoost project; which demonstrated the potential of quantum-safe cryptography.

POLSYS actively participated to shape the RISQ project. POLSYS is now a member of the strategic board of RISQ, and is leading the task of designing and analyzing quantum-safe algorithms. In particular, a first milestone of this task was to prepare submissions to NIST's quantum-safe standardisation process.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. A3

Type: PEOPLE

Instrument: Career Integration Grant

Duration: May 2013 - Apr. 2017

Coordinator: Jean-Charles Faugère

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

Inria contact: Elias Tsigaridas

Abstract: The project Algebraic Algorithms and Applications (A3) is an interdisciplinary and multidisciplinary project, with strong international synergy. It consists of four work packages. The first (Algebraic Algorithms) focuses on fundamental problems of computational (real) algebraic geometry: effective zero bounds, that is estimations for the minimum distance of the roots of a polynomial system from zero, algorithms for solving polynomials and polynomial systems, derivation of non-asymptotic bounds for basic algorithms of real algebraic geometry and application of polynomial system solving techniques in optimization. We propose a novel approach that exploits structure and symmetry, combinatorial properties of high dimensional polytopes and tools from mathematical physics. Despite the great potential of the modern tools from algebraic algorithms, their use requires a combined effort to transfer this technology to specific problems. In the second package (Stochastic Games) we aim to derive optimal algorithms for computing the values of stochastic games, using techniques from real algebraic geometry, and to introduce a whole new arsenal of algebraic tools to computational game theory. The third work package (Non-linear Computational Geometry), we focus on exact computations with implicitly defined plane and space curves. These are challenging problems that commonly arise in geometric modeling and computer aided design, but they also have applications in polynomial optimization. The final work package (Efficient Implementations) describes our plans for complete, robust and efficient implementations of algebraic algorithms.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: CryptoAction

Project title: Cryptography for Secure Digital Interaction

Duration: Apr. 2014 - Apr. 2018

Coordinator: Claudio ORLANDI

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

Program: COST

Project acronym: CRYPTACUS

Project title: Cryptanalysis of ubiquitous computing systems

Duration: Dec. 2014 - Dec. 2018

Coordinator: Gildas AVOINE

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

8.4. International Initiatives

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

8.4.1.1. GOAL

Title: Geometry and Optimization with ALgebraic methods.

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Dept. of Mathematics - Bernd Sturmfels

Start year: 2015

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

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

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

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

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- May – July 2017, Delaram Kahrobaei, Professor, CUNY, NYC, USA

8.5.1.1. Internships

- May – July 2017, Kelsey Horan, PhD student, CUNY, NYC, USA.
- Apr. – Nov. 2017, Eliane Koussa, Université de Versailles
- Apr. – Aug. 2017, Pascal Fong, Université de Versailles

POTIOC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Introspectibles - Collaborative research project :

Funding: Région Aquitaine

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: ULLO,

Following our work with the Introspectibles (Teegi, TOBE, Inner Garden), we are currently working with the ULLO company to bring these new interfaces to healthcare centers.

HOBIT - Maturation project :

Funding: Aquitaine Science Transfer

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: Université de Bordeaux

We are currently moving our platform HOBIT from his lab state to a commercial product.

Km 2.0 - Arts an Sciences program :

Funding: Idex Université Bordeaux

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: Léna D'Azy

We work with Cécile Léna for creating artistic installations based on interactive projection. See <http://www.facts-bordeaux.fr/RESIDENCES/KM-2.0>

Telekinetik juggling - Arts an Sciences program :

Funding: Idex Université Bordeaux

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: Le Cirque Inachevé

We work with Antoine Cléé from Cirque Inachevé for the design of an interactive environment where the artist will be able to juggle with zero gravity objects. The artist wear gloves, and interact with mini-drones supporting balls. See <http://www.facts-bordeaux.fr/RESIDENCES/Jonglerie-telekinetique>

Neuroperf :

Funding: Idex Université Bordeaux

Duration: 2017-2019

Coordinator: Jean-Arthur Micoulaud Franci

Local coordinator: Fabien Lotte

Partners: SANPSY - Potioc

This project aims at studying EEG-based Neurofeedback to reduce fatigue symptoms in sleep-deprived individuals. See <http://brain.labex.u-bordeaux.fr/Actualites/Selection-projets-recherche-Clinique-2017-i5064.html>

9.2. National Initiatives

eTAC: Tangible and Augmented Interfaces for Collaborative Learning:

Funding: EFRAN

Duration: 2017-2021

Coordinator: Université de Lorraine

Local coordinator: Martin Hachet

Partners: Université de Lorraine, Inria, ESPE, Canopé, OpenEdge,

the e-TAC project proposes to investigate the potential of technologies "beyond the mouse" in order to promote collaborative learning in a school context. In particular, we will explore augmented reality and tangible interfaces, which supports active learning and favors social interaction.

ANR Rebel:

Duration: 2016-2019

Coordinator: Fabien Lotte

Funding: ANR Jeune Chercheur Jeune Chercheuse Project

Partners: Disabilities and Nervous Systems Laboratory Bordeaux

Brain-Computer Interfaces (BCI) are communication systems that enable their users to send commands to computers through brain activity only. While BCI are very promising for assistive technologies or human-computer interaction (HCI), they are barely used outside laboratories, due to a poor reliability. Designing a BCI requires 1) its user to learn to produce distinct brain activity patterns and 2) the machine to recognize these patterns using signal processing. Most research efforts focused on signal processing. However, BCI user training is as essential but is only scarcely studied and based on heuristics that do not satisfy human learning principles. Thus, currently poor BCI reliability is probably due to suboptimal user training. Thus, we propose to create a new generation of BCI that apply human learning principles in their design to ensure the users can learn high quality control skills, hence making BCI reliable. This could change HCI as BCI have promised but failed to do so far.

ANR Project ISAR:

Duration: 2014-2017

Coordinator: Martin Hachet

Partners: LIG-CNRS (Grenoble), Diotasoft (Paris)

Acronym: Interaction en Réalité Augmentée Spatiale / Interacting with Spatial Augmented Reality

The ISAR project (Interaction with Spatial Augmented Reality) focuses on the design, implementation, and evaluation of new paradigms to improve interaction with the digital world when digital content is directly projected onto physical objects. It opens new perspectives for exciting tomorrow's applications, beyond traditional screen-based applications.

website: <https://team.inria.fr/potioc/scientific-subjects/papart/>

Inria Project Lab BCI-LIFT:

Duration: 2015-2018

Partners: Inria team Athena (Inria Sophia-Antipolis), Inria team Hybrid (Inria Rennes), Inria team Neurosys (Inria Nancy), LITIS (Université de Rouen), Inria team DEMAR (Inria Sophia-Antipolis), Inria team MINT (Inria Lille), DyCOG (INSERM Lyon)

Coordinator: Maureen Clerc (Inria Sophia Antipolis)

Local coordinator: Fabien Lotte

The aim is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. With this concern of usability as our driving objective, we will build non-invasive systems that benefit from advanced signal processing and machine learning methods, from smart interface design, and where the user immediately receives supportive feedback. What drives this project is the concern that a substantial proportion of human participants is currently categorized “BCI-illiterate” because of their apparent inability to communicate through BCI. Through this project we aim at making it easier for people to learn to use the BCI, by implementing appropriate machine learning methods and developing user training scenarios.

website: <http://bci-lift.inria.fr/>

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: ERC Starting Grant

Project acronym: BrainConquest

Project title: Boosting Brain-Computer Communication with High Quality User Training

Duration: 07/2017-06/2022

Coordinator: Fabien Lotte

Abstract: Brain-Computer Interfaces (BCIs) are communication systems that enable users to send commands to computers through brain signals only, by measuring and processing these signals. Making computer control possible without any physical activity, BCIs have promised to revolutionize many application areas, notably assistive technologies, e.g., for wheelchair control, and man-machine interaction. Despite this promising potential, BCIs are still barely used outside laboratories, due to their current poor reliability. For instance, BCIs only using two imagined hand movements as mental commands decode, on average, less than 80% of these commands correctly, while 10 to 30% of users cannot control a BCI at all. A BCI should be considered a co-adaptive communication system: its users learn to encode commands in their brain signals (with mental imagery) that the machine learns to decode using signal processing. Most research efforts so far have been dedicated to decoding the commands. However, BCI control is a skill that users have to learn too. Unfortunately how BCI users learn to encode the commands is essential but is barely studied, i.e., fundamental knowledge about how users learn BCI control is lacking. Moreover standard training approaches are only based on heuristics, without satisfying human learning principles. Thus, poor BCI reliability is probably largely due to highly suboptimal user training. In order to obtain a truly reliable BCI we need to completely redefine user training approaches. To do so, I propose to study and statistically model how users learn to encode BCI commands. Then, based on human learning principles and this model, I propose to create a new generation of BCIs which ensure that users learn how to successfully encode commands with high signal-to-noise ratio in their brain signals, hence making BCIs dramatically more reliable. Such a reliable BCI could positively change man-machine interaction as BCIs have promised but failed to do so far.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

- Program: DGA-DSTL Project

Project title: Assessing and Optimising Human-Machine Symbiosis through Neural signals for Big Data Analytics

Duration: 2014-2018

Coordinator: Damien Coyle and Fabien Lotte

Partners: Ulster University, UK, Potioc, France

Abstract: This project objective is to design new tools for Big Data analysis, and in particular visual analytics tools that tap onto human cognitive skills as well as on Brain-Computer Interfaces. The goal is to enable the user to identify and select relevant information much faster than what can be achieved by using automatic tools or traditional human-computer interfaces. More specifically, this project will aim at identifying in a passive way various mental states (e.g., different kinds of attention, mental workload, relevant stimulus perception, etc.) in order to optimize the display, the arrangement of the selection of relevant information.
- Program: ERASMUS+

Project acronym: VISTE

Project title: Empowering spatial thinking of students with visual impairment

Duration: 2016-2019

Coordinator: National Technical University of Athens (Greece)

Local coordinator: Anke Brock

Other partners: Intrasoft International SA (Greece), Casa Corpului Didactic Cluj (Romania), Liceul Special pentru Deficienti de Vedere Cluj-Napoca (Romania), Eidiko Dimotiko Sxolio Tiflon Kallitheas (Greece)

Abstract: VISTE addresses inclusion and diversity through an innovative, integrated approach for enhancing spatial thinking focusing on the unique needs of students with blindness or visual impairment. However, since spatial thinking is a critical competence for all students, the VISTE framework and associated resources and tools will focus on cultivating this competence through collaborative learning of spatial concepts and skills both for sighted and visually impaired students to foster inclusion within mainstream education. The VISTE project will introduce innovative educational practices for empowering students with blindness or visual impairment with spatial skills through specially designed educational scenarios and learning activities as well as through a spatial augmented reality prototype to support collaborative learning of spatial skills both for sighted and visually impaired students.

9.3.3. Collaborations with Major European Organizations

- Partner 1: Univ. Freiburg, Brain State Decoding Laboratory (M. Tangermann), Germany
- Topic 1: robust EEG spatial filters for single trial regression
- Partner 2: TU Graz, Neural Engineering lab (R. Scherer), Austria
- Topic 2: BCI pitfalls, negative results in BCI, guidelines for BCI design
- Partner 3: EPFL, Defitech Foundation Chair in Brain-machine Interface (R. Chavarriaga), Switzerland
- Topic 3: BCI pitfalls, negative results in BCI
- Partner 4: Oldenbourg University, Neuropsychology department (S. Debener, C. Zich), Germany
- Topic 4: guidelines for BCI design

Partner: Twente University (A. Nijholt), Enschede, The Netherlands

Topic: Handbook of Brain-Computer Interfaces

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. Other IIL projects

Presentation of Potioc research activities during the annual Inria-EPFL Workshop (Session MOOCS & e-learning)

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Partner: Université du Québec à Montréal, Institut des Sciences Cognitives (R. N’Kambou), Montreal, Canada

Topic: Learning companions for Brain-Computer Interfaces

Partner: North Carolina State University (Chang S. Nam), USA

Topic: Handbook of Brain-Computer Interfaces

9.4.3. Participation in Other International Programs

Partner: Flowers & Potioc teams, Inria Bordeaux, University of Waterloo, Canada

Funding: Univ. Bordeaux/Univ Waterloo joint grant call for project

Date: 2017-2018

Topic: Designing for Curiosity in Physical Spaces

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Research Stays Abroad

3 Members of team Potioc spend several months at the RIKEN Brain Science Institute (BSI), Cichocki’s advanced brain signal processing laboratory, Wakoshi, Japan.

- Fabien Lotte: 10 months in total, with the JSPS (Japan Society for the Promotion of Science) Invitation fellowship program
- Léa Pillette: 6 months in total, funded by the RIKEN BSI
- Aurélien Appriou: 3 months in total, funded by the RIKEN BSI

PRIVATICS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. FUI

Title: ADAGE (Anonymous Mobile Traffic Data Generation).

Type: FUI.

Duration: July 2016 - September 2018.

Coordinator: Orange.

Others partners: Inria, CNRS LAAS.

Abstract: The project ADAGE aims at developing solutions for the anonymization of mobility traces produced by mobile operators.

8.1.2. ANR

8.1.2.1. BIOPRIV

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

Type: ANR.

Duration: April 2013 - March 2017.

Coordinator: Morpho (France).

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

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

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

8.1.2.2. 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 .

8.1.2.3. 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.

8.1.3. Inria Innovation Laboratory

Title: LEELCO (Low End-to-End Latency COmmunications).

Duration: 3 years (2015 - 2018).

Coordinator: Inria PRIVATICS.

Others partners: Expway.

Abstract:

This Inria Innovation Lab aims at strengthening Expway (<http://www.expway.com/>) commercial offer with technologies suited to real-time data transmissions, typically audio/video flows. In this context, the end-to-end latency must be reduced to a minimum in order to enable a high quality interaction between users, while keeping the ability to recover from packet losses that are unavoidable with wireless communications in harsh environments. In this collaboration we focus on

new types of Forward Erasure Correction (FEC) codes based on a sliding encoding windows, and on the associated communication protocols, in particular an extension to FECFRAME (RFC6363) to such FEC codes. The outcomes of this work are proposed to both IETF and 3GPP standardisation organisations, in particular in the context of 3GPP mission critical communication services activity. The idea of this 3GPP activity is to leverage on the 3GPP Evolved Multimedia Broadcast Multicast Services (eMBMS) and on the existing Long Term Evolution (LTE) infrastructure for critical communications and such services as group voice transmissions, live high-definition video streams and large data transmissions. In this context, the advanced FEC codes studied in LEELCO offer a significant improvement both from the reduced latency and increased loss recovery viewpoints compared to the Raptor codes included in the existing standard (<https://hal.inria.fr/hal-01571609v1/en/>).

8.1.4. Inria CNIL project

Privatics is in charged of the Cnil-Inria collaboration. This collaboration was at the origin of the Mobilities project and it is now at the source of many discussions and collaborations on data anonymisation, risk analysis, consent or IoT Privacy. Privatics and Cnil are both actively involved on the IoTics project, that is the follow-up of the Mobilities projects. The goal of the Mobilities 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.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, ANR Chistera

8.2.1.1. COPES

Title: COnsumer-centric Privacy in smart Energy gridS

Programm: CHISTERA

Duration: December 2015 - december 2018

Coordinator: KTH Royal Institute of Technology

Inria contact: Cédric Lauradoux

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

8.2.1.2. UPRISE-IoT

Title: User-centric PRIVacy & Security in IoT

Programm: CHISTERA

Duration: December 2016 - december 2019

Coordinator: SUPSI (Suisse)

Inria contact: Claude Castelluccia

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

8.3. Regional Initiatives

8.3.1. ACDC

Title: ACDC

Type: AGIR 2016 Pole MSTIC.

Duration: September 2016 - 2017.

Coordinator: Inria.

Others partners: UGA.

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

8.3.2. AMNECYS

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

8.3.3. 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, Inria

- 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

PROSECCO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. AnaStaSec

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

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

Duration: January 2015 - December 2018.

Coordinator: Jérôme F  ret, Inria Antique (France)

Participant: Bruno Blanchet

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

8.1.1.2. AJACS

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

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

Duration: October 2014 - March 2019.

Coordinator: Alan Schmitt, Inria (France)

Participants: Karthikeyan Bhargavan, Bruno Blanchet, Nadim Kobeissi

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

8.1.1.3. SafeTLS

Title: SafeTLS: La s  curisation de l'Internet du futur avec TLS 1.

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

Duration: October 2016 - September 2020

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

Participants: Karthikeyan Bhargavan

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

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. ERC Consolidator Grant: CIRCUS

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

Duration: April 2016 - March 2021

Coordinator: Karthikeyan Bhargavn, Inria

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

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

8.2.1.2. ERC Starting Grant: SECOMP

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

Duration: Jan 2017 - December 2021

Coordinator: Catalin Hritcu, Inria

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

8.2.1.3. NEXTLEAP

Title: NEXTLEAP: NEXT generation Legal Encryption And Privacy

Programme: H2020

Duration: January 2016 - December 2018

Coordinator: Harry Halpin, Inria

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

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

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. Informal International Partners

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

- **F***: Microsoft Research (Cambridge, Redmond), IMDEA (Madrid)
- **TLS analysis**: Microsoft Research (Cambridge), Mozilla, University of Rennes
- **Web Security**: Microsoft Research (Cambridge, Redmond), Imperial College (London), University of Stuttgart
- **Micro-Policies**: University of Pennsylvania, Portland State University

8.3.2. Participation in Other International Programs

8.3.2.1. International Initiatives

Title: Advanced New Hardware Optimized for Policy Enforcement, A New HOPE

Program: DARPA SSITH

Duration: January 2016 - December 2018

Coordinator: Charles Stark, Draper Laboratory

Participants: Catalin Hritcu

Abstract: A New HOPE builds on results from the Inherently Secure Processor (ISP) project that has been internally funded at Draper. Recent architectural improvements decouple the tagged architecture from the processor pipeline to improve performance and flexibility for new processors. HOPE securely maintains metadata for each word in application memory and checks every instruction against a set of installed security policies. The HOPE security architecture exposes tunable parameters that support Performance, Power, Area, Software compatibility and Security (PPASS) search space exploration. Flexible software-defined security policies cover all 7 SSITH CWE vulnerability classes, and policies can be tuned to meet PPASS requirements; for example, one can trade granularity of security checks against performance using different policy configurations. HOPE will design and formalize a new high-level domain-specific language (DSL) for defining security policies, based on previous research and on extensive experience with previous policy languages. HOPE will formally verify that installed security policies satisfy system-wide security requirements. A secure boot process enables policies to be securely updated on deployed HOPE systems. Security policies can adapt based on previously detected attacks. Over the multi-year, multi-million dollar Draper ISP project, the tagged security architecture approach has evolved from early prototypes based on results from the DARPA CRASH program towards easier integration with external designs, and is better able to scale from micro to server class implementations. A New HOPE team is led by Draper and includes faculty from University of Pennsylvania (Penn), Portland State University (PSU), Inria, and MIT, as well as industry collaborators from DornerWorks and Dover Microsystems. In addition to Draper's in-house expertise in hardware design, cyber-security (defensive and offensive, hardware and software) and formal methods, the HOPE team includes experts from all domains relevant to SSITH, including (a) computer architecture: DeHon (Penn), Shrobe (MIT); (b) formal methods including programming languages and security: Pierce (Penn), Tolmach (PSU), Hritcu (Inria); and (c) operating system integration (DornerWorks). Dover Microsystems is a spin-out from Draper that will commercialize concepts from the Draper ISP project.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Claudia Diaz from KUL visited the group from 1-2 March and gave a seminar "Designing Mix-nets"
- Peter Schwabe visited Inria Paris on 11 April; he gave a seminar: From NewHope to Kyber.
- Joseph Bonneau (Stanford University) visited Inria on 20 April 2017, he gave a seminar: Public randomness, blockchains and proofs-of-delay
- Stefan Ciobaca (Alexandru Ioan Cuza University of Iai, Romania) visited Inria Paris on 15 May 2017; he gave a seminar: The RMT Tool for Rewriting Modulo Theories.
- Ana Nora Evans (University of Virginia) joined Inria as a Visiting Scientist Apr–Aug 2017; she gave a seminar: Using Verified Software Fault Isolation for a Formally Secure Compiler.
- David Evans (University of Virginia) joined Inria as a Visiting Scientist Apr–Aug 2017; he gave a seminar: Can Machine Learning Work in the Presence of Adversaries?

- Jean Yang (CMU) visited Inria Paris on 6 June 2017; she gave a seminar: Policy-Agnostic Programming for Database-Backed Applications.
- Amal Ahmed (Northeastern University) joined Inria as a Visiting Professor from September 2017; she gave a seminar: Prosecco Seminars: Compositional Compiler Verification for a Multi-Language World.
- Aaron Weiss (Northeastern University) joined Inria as a Visiting Scientist from September 2017.
- Amin Timany (KU Leuven) visited Inria Paris 6-8 December 2017; he gave a seminar: A Logical Relation for Monadic Encapsulation of State: Proving contextual equivalences in the presence of runST.
- Eric Rescorla visited Prosecco to discuss the design of TLS 1.3.

8.4.1.1. Internships

- Benjamin Lipp: Dec 2017 until May 2018, supervised by B. Blanchet, K. Bhargavan, and H. Halpin
- Iness Ben Guirat: Masters student 2017, supervised by H. Halpin
- Carmine Abate (University of Trento): Dec 2017 until May 2018
- William Bowman (Northeastern University): Oct 2017 until Dec 2017
- Keith Cannon (American University Paris): Mar 2017 until Sep 2017
- Théo Laurent (ENS Paris): Mar 2017 until Aug 2017
- Clément Pit-Claudel (MIT): Jul 2017 until Oct 2017

8.4.2. Visits to International Teams

- Catalin Hritcu, October 8-13, 2017, Aarhus University, Denmark.
- Catalin Hritcu, October 16-17, 2017, MPI-SWS, Saarbrücken, Germany.
- Catalin Hritcu, December 18, 2017, University of Iasi, Romania.

QUANTIC Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Emergences-Ville de Paris program, ENDURANCE project*

In the framework of the Ville de Paris program “EMERGENCES”, Zaki Leghtas has received a funding for his research program "Multi-photon processes in superconducting circuits for quantum error correction". This grant of 232k euros over 4 years will complement the ANR project of the same name obtained last year. Using this funding, we will purchase all the microwave and nano-fabrication equipment and consumables for the experiment based at ENS.

7.1.2. *DIM SIRTEQ, PhD fellowship*

In the framework of the project “DIM SIRTEQ Domaine d’intérêt Majeur: Science et Ingénierie Quantique” of Ile de France Region, we have received 18 months of PhD fellowship. This completes the funding from ANR GEARED of the PhD thesis of J. Guillaud, who has started his PhD under the supervision of M. Mirrahimi and P. Rouchon in September 2017.

7.1.3. *Programme Math-PSL, Postdoctoral fellowship*

In the framework of the programme Math-PSL of PSL Research University, we have received a 12 month postdoctoral fellowship. Paolo Forni has been hired as a postdoc on this funding.

7.2. National Initiatives

7.2.1. *ANR project GEARED*

This four-year collaborative ANR project, entitled “Reservoir engineering quantum entanglement in the microwave domain” and coordinated by Mazyar Mirrahimi, started on October 2014. The participants of the project are Mazyar Mirrahimi, François Mallet (QUANTIC project-team), Benjamin Huard (ENS Lyon), Daniel Esteve and Fabien Portier (Quantronics group, CEA Saclay), Nicolas Roch and Olivier Buisson (Institut Neel, Grenoble). This project deals with robust generation of entanglement as a key resource for quantum information processing (quantum simulation, computation and communication). The entangled states are difficult to generate and sustain as interaction with a noisy environment leads to rapid loss of their unique quantum properties. Through Geared we intend to investigate different complementary approaches to master the entanglement of microwave photons coupled to quantum superconducting circuits.

7.2.2. *ANR project ENDURANCE*

In the framework of the ANR program “Accueil de chercheur de haut niveau”, Zaki Leghtas has received a funding for his research program "Multi-photon processes in superconducting circuits for quantum error correction". This grant of 400k euros has allowed us to purchase the experimental equipment to build a new experiment based at ENS.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Partner 1: ENS Lyon

We are pursuing our interdisciplinary work about quantum control from theoretical aspects in direct collaboration with existing experiments (ENS Lyon) with the group of Benjamin Huard, former member of the QUANTIC team. Joint papers are published and underway. We are in particular working on the proper combination of two model reduction techniques in their experimental context: adiabatic elimination and Rotating-Wave Approximation. An ANR-JCJC project has been deposited by Alain Sarlette on this subject, with Benjamin Huard as external supporting collaborator.

Partner 2: University of Padova

Alain Sarlette has been pursuing a fruitful collaboration with the group of Francesco Ticozzi on dynamical systems aspects of quantum systems. Common work on the theory of quantum random walks is being finalized and we are working out a concrete plan about next possible steps.

Partner 3: Ghent University.

A. Sarlette is collaborating with applied mathematicians interested in quantum control at his former institution UGent (Dirk Aeyels, Lode Wylleman, Gert De Cooman) in the framework of thesis co-supervisions. Two students are in their last year PhD, in particular Simon Apers is finalizing a thesis centered around Quantum Walks, also in collaboration with Partner 2. A master student in applied physics has started an internship in 2017.

7.4. International Initiatives

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

TAQUILLA is an Inria associate team (between Quantic team and Yale university) with principal Inria investigator, Mazyar Mirrahimi, and principal Yale investigator Michel Devoret. In this framework, L. Verney, J. Guillaud and M. Mirrahimi visited Yale for respectively, 2, 3 and 4 months.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

P. S. Pereira da Silva (Escola Politécnica, PTC, University of SaoPaulo, Brazil) made a 2-week visit (July 3 to July 14) to investigate with Pierre Rouchon motion planning issues based on Lyapunov tracking for quantum gate generations.

7.5.2. Visits to International Teams

7.5.2.1. Research Stays Abroad

In the framework of TAQUILLA associate team, Mazyar Mirrahimi spent four months in the Qnantronics Laboratory of Michel H. Devoret and in the Rob Schoelkopf Lab at Yale University. Also, in this same framework Jérémie Guillaud and Lucas Verney spent respectively three months and two months in the same group.

RANDOPT Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- PGMO project “NumBER: Numerical Black Box Optimization for Energy Applications”, in collaboration with EDF, financing the postdoc of Asma Atamna, project length: 2 years (2016–2018), PI: Anne Auger
- PGMO project “AESOP: Algorithms Expensive Simulation-Based Optimization Problems”, a project involving several researchers from CentraleSupélec, Ecole des Mines de St.-Etienne, INRA Toulouse, JSI (Slovenia), Safran, Ruhr-Universität Bochum (Germany), and TU Dortmund University (Germany), project length: 2 years (2017–2019), PI: Dima Brockhoff

8.2. National Initiatives

8.2.1. ANR

- ANR project “NumBBO: Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers”, with partners DOLPHIN team (till 2016), Ecole des Mines de St.-Etienne and TU Dortmund University (Germany), Anne Auger was PI of this project which had a total budget of 660kEUR (2012–2017)
- ANR project “Big Multiobjective Optimization (BigMO)”, Dima Brockhoff participates in this project through the Inria team BONUS in Lille (2017–2020)

8.3. International Initiatives

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

8.3.1.1. s3-bbo

Title: Threefold Scalability in Any-objective Black-Box Optimization

International Partner (Institution - Laboratory - Researcher):

Shinshu (Japan) - Tanaka-Hernan-Akimoto Laboratory - Hernan Aguirre

Start year: 2015

See also: <http://francejapan.gforge.inria.fr/doku.php?id=associateteam>

This associate team brings together researchers from the TAO and Dolphin Inria teams with researchers from Shinshu university in Japan. Additionally, researchers from the University of Calais are external collaborators to the team. The common interest is on black-box single and multi-objective optimization with complementary expertises ranging from theoretical and fundamental aspects over algorithm design to solving industrial applications. The work that we want to pursue in the context of the associate team is focused on black-box optimization of problems with a large number of decision variables and one or several functions to evaluate solutions, employing distributed and parallel computing resources. The objective is to theoretically derive, analyze, design, and develop scalable black-box stochastic algorithms including evolutionary algorithms for large-scale optimization considering three different axes of scalability: (i) decision space, (ii) objective space, and (iii) availability of distributed and parallel computing resources.

We foresee that the associate team will make easier the collaboration already existing through a proposal funded by Japan and open-up a long term fruitful collaboration between Inria and Shinshu university. The collaboration will be through exchanging researchers and Ph.D. students and co-organization of workshops.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

- We are collaborating with Shinshu University and particularly Youhei Akimoto through our joint associate team.

8.3.2.2. Informal International Partners

- We are collaborating with Tea Tušar from the Josef-Stefan Institute in Ljubljana, Slovenia for extending and maintaining our COCO platform and on benchmarking in general.
- We are collaborating with Jun.-Prof. Tobias Glasmachers from the Ruhr-Universität Bochum in Germany on runtime analysis of adaptive stochastic algorithms.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Filip Matzner from Charles University Prague (Czech Republic) - Visit of one month in November 2017 to work on Evolution Strategies for reinforcement learning and classification problems.
- Prof. Dr. Youhei Akimoto from Shinshu University (Japan) - Visit of one month in November 2017 to work on several projects related to theory and algorithm design for large-scale optimization.
- Dr. Alexandre Chotard from KTU (Sweden) - Visit of one month in November 2017 to work on adaptive MCMC.
- Dr. Tea Tušar from the Josef-Stefan Institute (Slovenia) - Visit of one week in November 2017 to work on our projects around (multiobjective) blackbox optimization benchmarking.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

- Anne Auger and Dimo Brockhoff visited Jun.-Prof. Tobias Glasmachers and Prof. Günter Rudolph in Dortmund from April 10 till April 14, 2017

RAP2 Team

6. Partnerships and Cooperations

6.1. International Research Visitors

6.1.1. Visits of International Scientists

- Louigi Addario-Berri (McGill)
- Gabor Lugosi (ICREA and Pompeu Fabra)
- Cyril Marzouk (Paris Sud)
- Minmin Wang (Buenos Aires)
- S. Foss (Heriot-Watt University, UK)
- V. Gupta (University of Chicago, USA)

6.1.2. Visits to International Teams

- *Nicolas Broutin* visited the computer science department of McGill University (Canada), the CRM in Montreal, the mathematics institute in Nice and the university Aix-Marseille.
- *Wen Sun* has visited the Division of Applied Mathematics in Brown University to work with Kavita Ramanan, 07-16 Nov. 2017.

RAPSODI Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- The region Haut-de-France supported financially the organization of the FVCA8 conference.
- The PhD program of Ahmed Ait Hammou Oulhaj is partially supported (50%) by the region Haut-de-France (formerly Nord-Pas-de-Calais).

8.2. National Initiatives

8.2.1. ANR

C. Cancès is the coordinator of the ANR GEOPOR project (<http://www.agence-nationale-recherche.fr/Project-ANR-13-JS01-0007>). This project aims to study realistic models for complex porous media flows from a variational point of view, and to take advantage of this new approach to design and analyze some efficient numerical methods.

Title: Approche géométrique pour les écoulements en milieux poreux : théorie et numérique.

Type: Jeunes Chercheuses Jeunes Chercheurs SIMI 1- 2013

ANR Reference: ANR-13-JS01-0007-01

Coordinator: Clément Cancès, Inria Lille - Nord Europe.

Duration: January 2014 – June 2017

C. Chainais-Hillairet is a member of the ANR MOONRISE project (<http://moonrise.math.cnrs.fr/>). The MOONRISE project aims at exploring modeling, mathematical and numerical issues originating from the presence of high oscillations in nonlinear PDEs mainly from the physics of nanotechnologies and from the physics of plasmas.

Title: Modèles, Oscillations et schémas numériques.

Type: Fondements du numérique (DS0705) - 2014

ANR reference: ANR-14-CE23-0007

Coordinator: Florian MEHATS, Université de Rennes 1.

Duration: October 2014 - September 2019.

B. Merlet is a member of the ANR GEOMETRYA project (<https://www.ljll.math.upmc.fr/lemenant/GEOMETRYA/>). The GEOMETRYA project addresses several problems within the framework of geometric measure theory, from both theoretical and numerical viewpoints. Most of these problems are derived from the modeling of physical phenomena. The main topics are: the Geometric Measure Theory in singular metric spaces, the Plateau problem, the Mumford-Shah functional, irrigation and branched transport problems, the Willmore energy.

Title: Théorie géométrique de la mesure et applications

Type: Blanc SIMI 1 - 2012

ANR reference: ANR-12-BS01-0014

Coordinator: Hervé Pajot, Université Joseph Fourier (Grenoble).

Duration: january 2013 - june 2017.

I. Lacroix is the local coordinator at Université Lille 1 of the ANR BECASIM project (<http://becasim.math.cnrs.fr/>). This ANR project gathers mathematicians with theoretical and numerical backgrounds together with engineers. The objective is to develop numerical methods to accurately simulate the behavior of Bose-Einstein condensates.

Title: Simulation numérique avancée pour les condensats de Bose-Einstein.

Type: Modèles Numériques - 2012

ANR reference: ANR-12-MONU-0007

Coordinator: Ionut DANAILA, Université de Rouen.

Duration: January 2013 - November 2017.

8.2.2. *Labex CEMPI*

Title: Centre Européen pour les Mathématiques, la Physique et leurs interactions

Coordinator: Stephan De Bièvre.

Duration: January 2012 - December 2019.

Partners: Laboratoire Paul Painlevé and Laser physics department (PhLAM), Université Lille 1.

The "Laboratoire d'Excellence" Centre Européen pour les Mathématiques, la Physique et leurs interactions (CEMPI), a project of the Laboratoire de Mathématiques Paul Painlevé and the Laboratoire de Physique des Lasers, Atomes et Molécules (PhLAM), was created in the context of the "Programme d'Investissements d'Avenir" in February 2012.

The association Painlevé-PhLAM creates in Lille a research unit for fundamental and applied research and for training and technological development that covers a wide spectrum of knowledge stretching from pure and applied mathematics to experimental and applied physics.

One of the three focus areas of CEMPI research is the interface between mathematics and physics. This focus area encompasses three themes. The first is concerned with key problems of a mathematical, physical and technological nature coming from the study of complex behavior in cold atoms physics and non-linear optics, in particular fibre optics. The two other themes deal with fields of mathematics such as algebraic geometry, modular forms, operator algebras, harmonic analysis and quantum groups that have promising interactions with several branches of theoretical physics.

8.2.3. *Microturbu Project*

B. Merlet and T. Rey were both members of the Microturbu project. This project, headed by Stephan De Bièvre, was supported by the interdisciplinarity mission of the CNRS in 2017. Its purpose was to strengthen the collaborations between applied mathematicians from the Paul Painlevé laboratory and physicists from the PhLAM laboratory.

8.3. International Research Visitors

8.3.1. *Visits of International Scientists*

We have a long time collaboration with Ansgar Jüngel team from TU Wien. He visited Lille on January 9–13, 2017. His PhD Student, Anita Gerstenmayer came for the third time in Lille on July 3–7, 2017.

Ezzeddine Zahrouni (Univ. Carthage, Tunisia) was invited in Lille in May 2017 thanks to a support of the Labex CEMPI.

REALOPT Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Solhar (ANR-13-MONU-0007)

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computing platforms equipped with accelerators. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool. The focus of RealOpt in this project is on the scheduling aspect. Indeed, executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.

See also: <http://solhar.gforge.inria.fr/>

9.2. International Initiatives

9.2.1. Inria International Partners

In the follow-up of our 6 year Inria Associate Team project **SAMBA**, we have set an important research collaboration with Brazil (Universidade Federal Fluminense, Pontificia Universidade Catolica do Rio de Janeiro) and Chile (Universidad Adolfo Ibanez). This results in joint publications and frequent visits, including long stay by research students.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Teobaldo LEITE BULHOES, from Universidade Federal Fluminense (Niteroi, Brazil), visited the team from October 23rd to December 13th 2017.
- Orlando Rivera Letelier, from (Universidad Adolfo Ibanez, Chile, visited the team for January 2017.
- Eduardo UCHOA, from Universidade Federal Fluminense (Niteroi, Brazil), visited the team during two weeks from November 5th to 18th 2017.
- Xuding ZHU, from Zhejiang Normal University (Jinhua, China) visited the team during one month in June 2017.

REGAL Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Labex SMART - (2012–2019)

Members: ISIR (UPMC/CNRS), LIP6 (UPMC/CNRS), LIB (UPMC/INSERM), LJLL (UPMC/CNRS), LTCI (Institut Mines-Télécom/CNRS), CHArt-LUTIN (Univ. Paris 8/EPHE), L2E (UPMC), STMS (IRCAM/CNRS).

Funding: Sorbonne Universités, ANR.

Description: The SMART Labex project aims globally to enhancing the quality of life in our digital societies by building the foundational bases for facilitating the inclusion of intelligent artifacts in our daily life for service and assistance. The project addresses underlying scientific questions raised by the development of Human-centered digital systems and artifacts in a comprehensive way. The research program is organized along five axes and Regal is responsible of the axe “Autonomic Distributed Environments for Mobility.”

The project involves a PhD grant of 100 000 euros over 3 years.

7.1.2. ESTATE - (2016–2020)

Members: LIP6 (Regal, project leader), LaBRI (Univ. de Bordeaux); Verimag (Univ. de Grenoble).

Funding: ESTATE is funded by ANR (PRC) for a total of about 544 000 euros, of which 233 376 euros for Regal.

Objectives: The core of ESTATE consists in laying the foundations of a new algorithmic framework for enabling Autonomic Computing in distributed and highly dynamic systems and networks. We plan to design a model that includes the minimal algorithmic basis allowing the emergence of dynamic distributed systems with self-* capabilities, *e.g.*, self-organization, self-healing, self-configuration, self-management, self-optimization, self-adaptiveness, or self-repair. In order to do this, we consider three main research streams:

(i) building the theoretical foundations of autonomic computing in dynamic systems, (ii) enhancing the safety in some cases by establishing the minimum requirements in terms of amount or type of dynamics to allow some strong safety guarantees, (iii) providing additional formal guarantees by proposing a general framework based on the Coq proof assistant to (semi-)automatically construct certified proofs.

The coordinator of ESTATE is Franck Petit.

7.1.3. RainbowFS - (2016–2020)

Members: LIP6 (Regal, project leader), Scalify SA, CNRS-LIG, Télécom Sud-Paris, Université Savoie-Mont-Blanc.

Funding: is funded by ANR (PRC) for a total of 919 534 euros, of which 359 554 euros for Regal.

Objectives: RainbowFS proposes a “just-right” approach to storage and consistency, for developing distributed, cloud-scale applications. Existing approaches shoehorn the application design to some pre-defined consistency model, but no single model is appropriate for all uses. Instead, we propose tools to co-design the application and its consistency protocol. Our approach reconciles the conflicting requirements of availability and performance vs. safety: common-case operations are designed to be asynchronous; synchronisation is used only when strictly necessary to satisfy the application’s

integrity invariants. Furthermore, we deconstruct classical consistency models into orthogonal primitives that the developer can compose efficiently, and provide a number of tools for quick, efficient and correct cloud-scale deployment and execution. Using this methodology, we will develop an enterprise-grade, highly-scalable file system, exploring the rainbow of possible semantics, and we demonstrate it in a massive experiment.

The coordinator of RainbowFS is Marc Shapiro.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. *LightKone*

Title: Lightweight Computation for Networks at the Edge

Programm: H2020-ICT-2016-2017

Duration: January 2017 - December 2019

Coordinator: Université Catholique de Louvain

Partners:

Université Catholique de Louvain (Belgium)

Technische Universitaet Kaiserslautern (Germany)

INESC TEC - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciencia (Portugal)

Faculdade de Ciencias E Tecnologiada Universidade Nova de Lisboa (Portugal)

Universitat Politecnica De Catalunya (Spain)

Scality (France)

Gluk Advice B.V. (Netherlands)

Inria contact: Marc Shapiro

The goal of LightKone is to develop a scientifically sound and industrially validated model for doing general-purpose computation on edge networks. An edge network consists of a large set of heterogeneous, loosely coupled computing nodes situated at the logical extreme of a network. Common examples are networks of Internet of Things, mobile devices, personal computers, and points of presence including Mobile Edge Computing. Internet applications are increasingly running on edge networks, to reduce latency, increase scalability, resilience, and security, and permit local decision making. However, today's state of the art, the gossip and peer-to-peer models, give no solution for defining general-purpose computations on edge networks, i.e., computation with shared mutable state. LightKone will solve this problem by combining two recent advances in distributed computing, namely synchronisation-free programming and hybrid gossip algorithms, both of which are successfully used separately in industry. Together, they are a natural combination for edge computing. We will cover edge networks both with and without data center nodes, and applications focused on collaboration, computation, and both. Project results will be new programming models and algorithms that advance scientific understanding, implemented in new industrial applications and a startup company, and evaluated in large-scale realistic settings.

7.3. International Initiatives

7.3.1. Participation in Other International Programs

7.3.1.1. *STIC Amsud*

Title: PaDMetBio - Parallel and Distributed Metaheuristics for Structural Bioinformatics

International Partners (Institution - Laboratory - Researcher):

Universidade Federal do Rio Grande do Sul (Brazil)- Márcio Dorn

Universidad Nacional de San Luis (Argentina) - Verónica Gil-Costa

Universidad de Santiago de Chile (Chile) - Mario Inostroza-Ponta

Duration: 2017 - 2018

Start year: 2017

Structural bioinformatics deals with problems where the rules that govern the biochemical processes and relations are partially known which makes hard to design efficient computational strategies for these problems. There is a wide range of unanswered questions, which cannot be answered neither by experiments nor by classical modeling and simulation approaches. Specifically, there are several problems that still do not have a computational method that can guarantee a minimum quality of solution. Two of the main challenging problems in Structural Bioinformatics are (1) the three-dimensional (3D) protein structure prediction problem (PSP) and (2) the molecular docking problem for drug design. Predicting the folded structure of a protein only from its amino acid sequence is a challenging problem in mathematical optimization. The challenge arises due to the combinatorial explosion of plausible shapes, where a long amino acid chain ends up in one out of a vast number of 3D conformations. The problem becomes harder when we have proteins with complex topologies, in this case, their predictions may be only possible with significant increases in high-performance computing power. In the case of the molecular docking problem for drug design, we need to predict the preferred orientation of a small drug candidate against a protein molecule. With the increasing availability of molecular biological structures, smarter docking approaches have become necessary. These two problems are classified as NP-Complete or NP-Hard, so there is no current computational approach that can guarantee the best solution for them in a polynomial time. Because of the above, there is the need to build smarter approaches that can deliver good solutions to the problem. In this project, we plan to explore a collaborative work for the design and implementation of population based metaheuristics, like genetic and memetic algorithms. Metaheuristics are one of the most common and powerful techniques used in this case. The main goal of this project is to gather the expertise and current work of researchers in the areas of structural bioinformatics, metaheuristics and parallel and distributed computing, in order to build novel and high quality solutions for these hot research area.

7.3.1.2. CNRS-Inria-FAP's

Title: Autonomic and Scalable Algorithms for Building Resilient Distributed Systems

International Partner (Institution - Laboratory - Researcher):

Universida de Federal do Paraná (UFPR), Brazil, Prof. Elias Duarte

Duration: 2015–2017

In the context of autonomic computing systems that detect and diagnose problems, self-adapting themselves, the VCube (Virtual Cube), proposed by Prof. Elias Duarte, is a distributed diagnosis algorithm that organizes the system nodes on a virtual hypercube topology. VCube has logarithmic properties: when all nodes are fault-free, processes are virtually connected to form a perfect hypercube; as soon as one or more failures are detected, links are automatically reconnected to remove the faulty nodes and the resulting topology, connecting only fault-free nodes, keeps the logarithmic properties. The goal of this project is to exploit the autonomic and logarithmic properties of the VCube by proposing self-adapting and self-configurable services.

7.3.1.3. Capes-Cofecub

Title: CHOOSING - Cooperation on Hybrid cOmputing cLOuds for energy SavINg

French Partners: Paris XI (LRI), Regal, LIG, SUPELEC

International Partners (Institution - Laboratory - Researcher):

Universidade de São Paulo - Instituto de Matemática e Estatística - Brazil, Unicamp -
Instituto de Computação - Brazil

Duration: 2014–2018

The cloud computing is an important factor for environmentally sustainable development. If, in the one hand, the increasing demand of users drive the creation of large datacenters, in the other hand, cloud computing's "multitenancy" trait allows the reduction of physical hardware and, therefore, the saving of energy. Thus, it is imperative to optimize the energy consumption corresponding to the datacenter's activities. Three elements are crucial on energy consumption of a cloud platform: computation (processing), storage and network infrastructure. Therefore, the aim of this project is to provide different techniques to reduce energy consumption regarding these three elements. Our work mainly focuses on energy saving aspects based on virtualization, i.e., pursuing the idea of the intensive migration of classical storage/processing systems to virtual ones. We will study how different organizations (whose resources are combined as hybrid clouds) can cooperate with each other in order to minimize the energy consumption without the detriment of client requirements or quality of service. Then, we intend to propose efficient algorithmic solutions and design new coordination mechanisms that incentive cloud providers to collaborate.

7.3.1.4. Spanish research ministry project

Title: BFT-DYNASTIE - Byzantine Fault Tolerance: Dynamic Adaptive Services for Partitionable Systems

French Partners: Labri, Irisa, LIP6

International Partners (Institution - Laboratory - Researcher):

University of the Basque Country UPV - Spain, EPFL - LSD - Switzerland, Friedrich-Alexander-Universität Erlangen-Nürnberg - Deutschland, University of Sydney - Australia

Duration: 2017–2019

The project BFT-DYNASTIE is aimed at extending the model based on the alternation of periods of stable and unstable behavior to all aspects of fault-tolerant distributed systems, including synchrony models, process and communication channel failure models, system membership, node mobility, and network partitioning. The two main and new challenges of this project are: the consideration of the most general and complex to address failure model, known as Byzantine, arbitrary or malicious, which requires qualified majorities and the use of techniques from the security area; and the operation of the system in partitioned mode, which requires adequate reconciliation mechanisms when two partitions merge.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

Ajay Singh of Indian Institute Of Technology Hyderabad, India, was invited for a six-month internship, on data structures for concurrency and persistent memory. This work is published at the HiPC SRS 2017 workshop [43].

REO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Project “iFLOW”

Participants: Chloé Audebert, Jean-Frédéric Gerbeau, Florian Joly, Irene Vignon Clementel [co-Principal Investigator].

Period: 2013-2017.

This ANR-TecSan, co-managed by Eric Vibert (Paul Brousse Hospital) and Irene Vignon Clementel, aims at developing an Intraoperative Fluorescent Liver Optimization Workflow to better understand the relationship between architecture, perfusion and function in hepatectomy.

Other partners: DHU Hepatinov - Hôpital Paul Brousse, Inria Mamba, Fluoptics, IfADo, MID.

9.1.1.2. ANR Project “IFSMACS”

Participants: Muriel Boulakia, Céline Grandmont [local coordinator].

Period: 2015-2019.

The objective of this project, coordinated by Takéo Takahashi (Inria Nancy Grand-Est), is the mathematical analysis of systems involving structures immersed in a fluid. This includes the asymptotic analysis, the study of the controllability and stabilization of fluid-structure interaction systems, the understanding of the motion of self-propelled structures and the analysis and development of numerical methods to simulate fluid-structure systems.

9.1.1.3. Participation to other ANR projects

- Laurent Boudin is a member of the ANR Blanc project Kibord on kinetic models in biology and related domains
- Laurent Boudin is a member of the ANR TecSan Oxhelease
- Céline Grandmont is a member of the ANR TecSan Oxhelease
- Marina Vidrascu is a member of the ANR ARAMIS
- Irene Vignon Clementel is a member of the project iLite (09/16-), RHU-santé grant, a large French hospital-medical research consortium that aims at developing innovations for liver and tissue engineering (Inria PI: Dirk Drasdo).

9.1.2. Inria initiatives

9.1.2.1. ADT Project “PARASOL”

Participants: Miguel Ángel Fernández Varela [Principal Investigator], Axel Fourmont, Marina Vidrascu.

Period: 2016-2017

The aim of this project, coordinated by Miguel Ángel Fernández Varela, is to implement in the FELiScE library several balancing domain decomposition methods (BDD) for solid-mechanics.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. REVAMMAD

Title: “Retinal Vascular Modeling, Measurement and Diagnosis”

Programm: FP7

Duration: April 2013 - March 2017

Coordinator: University of Lincoln

Partners: : See the web site <http://revammad.blogs.lincoln.ac.uk/partners/>

Inria contact: J-F Gerbeau

REVAMMAD is a European Union project aimed at combatting some of the EU’s most prevalent chronic medical conditions using retinal imaging. The project aims to train a new generation of interdisciplinary scientists for the academic, clinical and industrial sectors, and to trigger a new wave of biomedical interventions. The role of REO team within this consortium is to propose a mathematical model and a simulation tool for the retina hemodynamics. See <http://revammad.blogs.lincoln.ac.uk> for more details.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

9.2.2.1. SimInhale COST

Participant: Irene Vignon Clementel.

Action MP1404, a pan-European network of experts in the field of inhaled medicine

9.3. International Research Visitors

9.3.1. Internships

- Gonzalo Castineira Veiga, Visiting PhD student, Universidade da Coruña, Apr 2017–Jun 2017

RITS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. COCOVEA

Title: Coopération Conducteur-Véhicule Automatisé

Instrument: ANR

Duration: November 2013 - April 2017

Coordinator: Jean-Christophe Popieul (LAMIH - University of Valenciennes)

Partners: LAMIH, IFSTTAR, Inria, University of Caen, COMETE, PSA, CONTINENTAL, VALEO, AKKA Technologies, SPIROPS

Inria contact: Fawzi Nashashibi

Abstract: CoCoVeA project aims at demonstrating the need to integrate from the design of the system, the problem of interaction with the driver in resolving the problems of sharing the driving process and the degree of freedom, authority, level of automation, prioritizing information and managing the operation of the various systems. This approach requires the ability to know at any moment the state of the driver, the driving situation in which he finds himself, the operating limits of the various assistance systems and from these data, a decision regarding activation or not the arbitration system and the level of response.

8.1.1.2. VALET

Title: Redistribution automatique d'une flotte de véhicules en partage et valet de parking

Instrument: ANR

Duration: January 2016 - December 2018

Coordinator: Fawzi Nashashibi

Partners: Inria, Ecole Centrale de Nantes (IRCCyN), AKKA Technologies

Inria contact: Fawzi Nashashibi

Abstract: The VALET project proposes a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers. An optimal routing algorithm is in charge of defining platoons drivers' routes to the parking areas where the followers are parked in a complete automated mode. The main idea of VALET is to retrieve vehicles parked randomly on the urban parking network by users. These parking spaces may be in electric charging stations, parking for car sharing vehicles or in regular parking places. Once the vehicles are collected and guided in a platooning mode, the objective is then to guide them to their allocated parking area or to their respective parking lots. Then each vehicle is assigned a parking place into which it has to park in an automated mode.

8.1.2. FUI

8.1.2.1. Sinetic

Title: Système Intégré Numérique pour les Transports Intelligents Coopératifs

Instrument: FUI

Duration: December 2014 - May 2017

Coordinator: Thomas Nguyen (Oktal)

Partners: Oktal, ALL4TEC, CIVITEC, Dynalogic, Inria, EURECOM, Renault, Armines, IFSTTAR, VEDECOM

Inria contact: Jean-Marc Lasgouttes

Abstract: The purpose of the project SINETIC is to create a complete simulation environment for designing cooperative intelligent transport systems with two levels of granularity: the system level, integrating all the components of the system (vehicles, infrastructure management centers, etc.) and its realities (terrain, traffic, etc.) and the component-level, modeling the characteristics and behavior of the individual components (vehicles, sensors, communications and positioning systems, etc.) on limited geographical areas, but described in detail.

8.1.2.2. PAC V2X

Title: Perception augmentée par coopération véhicule avec l'infrastructure routière

Instrument: FUI

Duration: September 2016 - August 2019

Coordinator: SIGNATURE Group (SVMS)

Partners: DigiMabee, LOGIROAD, MABEN PRODUCTS, SANEF, SVMS, VICI, Inria, VEDECOM

Inria contact: Raoul de Charette

Abstract: The objective of the project is to integrate two technologies currently being deployed in order to significantly increase the time for an automated vehicle to evolve autonomously on European road networks. It is the integration of technologies for the detection of fixed and mobile objects such as radars, lidars, cameras ... etc. And local telecommunication technologies for the development of ad hoc local networks as used in cooperative systems.

8.1.3. Competitivity Clusters

RITS team is a very active partner in the competitiveness clusters, especially MOV'EO and System@tic. We are involved in several technical committees like the DAS SUR of MOV'EO for example.

RITS is also the main Inria contributor in the VEDECOM institute (IEED). VEDECOM is financing the PhD theses of Mr. Fernando Garrido and Mr. Zayed Alsayed.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. AUTOCITS

Title: AUTOCITS Regulation Study for Interoperability in the Adoption of Autonomous Driving in European Urban Nodes

Program: CEF- TRANSPORT Atlantic corridor

Duration: November 2016 - December 2018

Coordinator: Indra Sistemas S.A. (Spain)

Partners: Indra Sistemas S.A. (Spain); Universidad Politécnica de Madrid (UPM), Spain; Dirección General de Tráfico (DGT), Spain; Inria (France); Instituto Pedro Nunes (IPN), Portugal; Autoridade Nacional de Segurança Rodoviária (ANSR), Portugal; Universidade de Coimbra (UC), Portugal.

Inria contact: Fawzi Nashashibi, Mohammad Abualhoul

Abstract: The aim of the Study is to contribute to the deployment of C-ITS in Europe by enhancing interoperability for autonomous vehicles as well as to boost the role of C-ITS as catalyst for the implementation of autonomous driving. Pilots will be implemented in 3 major Core Urban nodes (Paris, Madrid, Lisbon) located along the Core network Atlantic Corridor in 3 different Member States. The Action consists of Analysis and design, Pilots deployment and assessment, Dissemination and communication as well as Project Management and Coordination.

8.2.2. Collaborations with Major European Organizations

RITS is member of the **euRobotics AISBL** and the Leader of “People transport” Topic. This makes from Inria one of the rare French robotics representatives at the European level. See also: <http://www.eu-robotics.net/>

RITS is a full partner of **VRA – Vehicle and Road Automation**, a support action funded by the European Union to create a collaboration network of experts and stakeholders working on deployment of automated vehicles and its related infrastructure. VRA project is considered as the cooperation interface between EC funded projects, international relations and national activities on the topic of vehicle and road automation. It is financed by the European Commission DG CONNECT and coordinated by ERTICO – ITS Europe. See also: <http://vra-net.eu/>

8.3. International Initiatives

8.3.1. Participation in Other International Programs

8.3.1.1. ICT-Asia

SIM-Cities

Title: "Sustainable and Intelligent Mobility for Smart Cities"

International Partner (Institution - Laboratory - Researcher):

- Nanyang Technical University (NTU), School of Electrical and Electronic Engineering – Singapore. Prof. Dan Wei Wang

- National University of Singapore (NUS), Department of Mechanical Engineering – Singapore. Dr. Marcelo Ang

- Kumamoto University - Japan. Intelligent Transportation Systems Lab, Graduate School of Science and Technology, Prof. James Hu / Prof. Ogata

- Shanghai Jiao-Tong University (SJTU), Department of Automation – China. Prof. Ming Yang

- Hanoi University of Science and Technology, International Center MICA Institute – Vietnam. Prof. Eric Castelli

- Inria, RITS Project-Team – France. Dr. Fawzi Nashashibi

- Inria, e-Motion/CHROMA Project-Team – France. Dr. Christian Laugier

- Ecole Centrale de Nantes, IRCCyN – France. Prof. Philippe Martinet

Duration: Jan. 2015 - May 2017

Start year: 2015

This project aims at conducting common research and development activities in the field of sustainable transportation and advanced mobility of people and goods in order to move in the direction of smart, clean and sustainable cities.

RITS and MICA lab have obtained from the Vietnamese Program 911 the financing of the joint PhD thesis of Dinh-Van Nguyen (co-directed by Eric Castelli from MICA lab and Fawzi Nashashibi).

8.3.1.2. ECOS Nord – Venezuela

ECOS Nord

Title: "Les Techniques de l'Information et de la Communication pour la Conception de Systèmes Avancés de Mobilité durable en Milieu Urbain."

International Partner (Institution - Laboratory - Researcher):

- Simon Bolivar University, Department of Mecatronics – Venezuela. Dr. Gerardo Fernandez

- Inria, RITS Project-Team – France. Dr. Fawzi Nashashibi

Duration: Jan. 2014 - Dec. 2017

Start year: 2014

The main objective of this project is to contribute scientifically and technically to the design of advanced sustainable mobility systems in urban areas, particularly in dense cities where mobility, comfort and safety needs are more important than in other types of cities. In this project, we will focus on the contribution of advanced systems of perception, communication and control for the realization of intelligent transport systems capable of gradually integrating into the urban landscape. These systems require the development of advanced dedicated urban infrastructures as well as the development and integration of on-board intelligence in individual vehicles or mass transport.

This year, a session of courses has been organized at University Simon Bolivar, Caracas (Venezuela). Following several PhDs and interns recruitments from this university, prof G. Fernandez and J. Capeletto invited Raoul de Charette to organize a 32Hr Computer Vision Master Class in December 2017. PhDs Carlos Flores and Luis Roldao were also part of the master class and taught control (10Hr) and point cloud processing (7Hr), respectively.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Julio Blanco Deniz, Nievsabel Molina from Simon Bolivar University, Venezuela.

They both worked on a cascade control architecture based on PID controllers for a Citroen C1: the longitudinal control was developed by Julio Blanco Deniz, under the supervision of Carlos Flores and the lateral control (for the action on the steering wheel) was done by Nievsabel Molina, under the supervision of Francisco Navas. Using this architecture, a reference trajectory can be smoothly followed by the vehicle at different speeds.

Aitor Gomez, Alfredo Valle, Edgar Talavera Munoz from Universidad Politécnica de Madrid, Spain.

Ziyang Hong from Université de Bourgogne, Dijon, France.

Maradona Rodrigues from University of Warwick, United Kingdom.

Sule Kahraman from MIT, USA.

Arthur Lecert from ESIEE Paris, France. He was supervised by Pierre de Beaucorps.

RMOD Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CAR IMT Douai

Participants: Pablo Tesone, Guillermo Polito, Marcus Denker, Stéphane Ducasse with: L. Fabresse and N. Bouraqadi (IMT Douai)

From 2009, ongoing.

We have signed a convention with the CAR team led by Noury Bouraqadi of IMT Douai. In this context we co-supervised three PhD students (Mariano Martinez-Peck, Nick Papoylias and Guillermo Polito). The team is also an important contributor and supporting organization of the Pharo project.

Currently, Pablo Tesone is doing a PhD co-supervised by RMOD and Pr. L. Fabresse and N. Bouraqadi. We are preparing a collaboration in the Context of CPER Data in 2018.

9.2. National Initiatives

9.2.1. CEA List

Participants: Jason Lecerf, Stéphane Ducasse with T. Goubier (CEA List)

From 2016, ongoing.

Jason Lecerf started a shared PhD Oct 2016: *Reuse of code artifacts for embedded systems through refactoring*.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Namur University, Belgium

Participants: Anne Etien, Nicolas Anquetil, Olivier Auverlot, Stéphane Ducasse.

From Sept 2016 to Dec. 2018.

Lille Nord Europe European Associated Team with the PreCISE research center of Pr. A. Cleve from Namur University (Belgium).

This project aims to study the co-evolution between database structure and programs and to propose recommendations to perform required changes on cascade. These programs are either internal to the schema as functions or triggers or external as applications written in Java or Php built on top of the DB. Our intuition is that software engineering techniques can be efficient for such issues. This project also aims to unify the abstract representation of the DB and its relationships with the internal or external program.

University of Turin (Italy)

Participants: Marco Naddéo, Stéphane Ducasse.

From 2015 to 2017.

Marco Naddéo was a PhD student co-supervised by Damien Cassou, Stéphane Ducasse at RMoD and Viviana Bono from University of Turin (Italy): *A modular Approach of Object initialization for Pharo*, University Turin, November 2017.

VUB Brussels, Belgium

Participants: Guillermo Polito, Stéphane Ducasse.

From 2016, ongoing.

Student: Matteo Marra, collaboration with Eliza Gonzalez Boix. Guillermo Polito co-supervised Matteo Marra's master thesis. This collaboration led to a workshop paper [29] and a paper under revision for Programming 2018.

University of Prague

Participants: Stéphane Ducasse.

From 2015, ongoing.

We are working with Dr. Robert Pergl from the University of Prague. Stéphane Ducasse gave a lecture at the University of Prague in 2017.

9.4. International Initiatives

9.4.1. Informal International Partners

Uqbar Argentina

Participants: Pablo Tesone, Esteban Lorenzano, Guillermo Polito, Stéphane Ducasse.

From 2015, ongoing.

We are working with the Uqbar team from different Argentinian universities. We hired three of the people: Nicolas Passerini(engineer), Esteban Lorenzano (engineer) and Pablo Tesone (PhD).

Pharo in Research:

Participants: Pablo Tesone, Esteban Lorenzano, Guillermo Polito, Marcus Denker, Stéphane Ducasse.

From 2009, ongoing.

We are building an ecosystem around Pharo with international research groups, universities and companies. Several research groups (such as Software Composition Group – Bern, and Pleaid – Santiago) are using Pharo. Many universities are teaching OOP using Pharo and its books. Several companies worldwide are deploying business solutions using Pharo.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Serge Demeyer, Universiteit Antwerpen, Belgium. September 1st until December 31st, 2017. Sabbatical on the topic of Test Automation
- Andrew Black, Department of Computer Science, Portland State University, September 1st until December 9th. Sabbatical, Implementing the Grace Language using Pharo
- Fernando Brito, Université de Lisbonne, 27 to 18/2/2017
- Sébastien Proksch, 09/02/2017
- Sébastien Martinez, Université de Rennes 1, 09/03/2017
- Sergiu Ivanov, CNRS Grenoble, 9 to 10/2/2017
- Coen de Rover, Université Bruxelles, 28/02/17
- Yoshiki Oshima, YCombinator Research, 13 to 17/3/17
- Abdelghani Alidra, Université de Skikda, 15/05 to 18/06/2017
- Sergiu Ivanov, CNRS Grenoble, 21/04/17
- Ronie Salgado, Université du Chili, 11/9 to 22/9/2017
- Andy Zaidman, Université de Delft, 08/11/17
- Laurence Tratt, King's College London, 15/09/17
- Elisa Gonzales, Université de Bruxelles, 15/09/17
- Théo D'Hondt, Université de Bruxelles, 15/09/17

- Rim Drira, RIADI Laboratory - National School of Computer Science, Tunisia, 09/11/17
- Gordana Rakic, Université de Belgrade - Serbie, 29/11 to 6/12/2017
- Henda Ben Gezahla, Ecole Nationale des Sciences de l'Informatique (ENSI) en Tunisie, 7/11 to 12/11/2017
- Abir Mbaya, Université de Lyon, 11 to 15/12/2017
- Olivier Flückiger (Northeastern University, US) 28/11 to 01/12. Talk: Correctness of Speculative Optimizations with Dynamic Deoptimization
- Gabriel Scherer (Parsifal, Inria Saclay, France) 28/11 to 29/11. Talk: Correctness of Speculative Optimizations with Dynamic Deoptimization

9.5.1.1. Internships

- Thomas Dupriez, ENS Cachan/Paris-Saclay, from 2017-03-16 until 2017-07-21, and from 2017-08-07 until 2017-08-11
- Sophie Kaleba, from Apr 2017 until Sep 2017
- Clement Mastin, from May 2017 until Aug 2017
- Amal Noussi Mbeyim, Ecole Normale Supérieure de Rennes, from May 2017 until Jul 2017
- Morgane Pigny, until Feb 2017
- Jeremie Regnault, from Jun 2017 until Aug 2017
- Benoit Verhaeghe, Université des Sciences et Technologies de Lille, from May 2017 until Aug 2017

9.5.2. Visits to International Teams

- Anne Etien: Labri, Université Bordeaux 1, January 2017.
- Nicolas Anquetil, Julien Delplanque and Anne Etien, Visit Namur University (Belgium), Decembre 2017.
- Stéphane Ducasse: Technical University Prague, Czech Republic.
- Stéphane Ducasse: ENIS Tunisia.
- Stéphane Ducasse: University of Novi Sad, Serbia.
- Stéphane Ducasse: Maribor, Slovenia.
- Stéphane Ducasse: VUB Bussels, Belgium.
- Stéphane Ducasse: University de Bretagne Occidentale.
- Stéphane Ducasse: Software Vomposition Group University of Bern/Switzerland.
- Guillermo Polito: VUB Brussel, Belgium.

ROMA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *PhD grant laboratoire d'excellence MILYON-Mumps consortium*

The doctoral program from Labex MILYON dedicated to applied research in collaboration with industrial partners funds 50% of a 3-year PhD grant (the other 50% being funded by the MUMPS consortium) to work on improvements of the solution phase of the MUMPS solver. The PhD aims at answering industrial needs in application domains where the cost of the solution phase of sparse direct solvers is critical.

9.2. National Initiatives

9.2.1. *ANR*

ANR Project SOLHAR (2013-2017), 4 years. The ANR Project SOLHAR was launched in November 2013, for a duration of 48 months. It gathers five academic partners (the HiePACS, Cepage, ROMA and Runtime Inria project-teams, and CNRS-IRIT) and two industrial partners (CEA/CESTA and EADS-IW). This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators.

The proposed research is organized along three distinct research thrusts. The first objective deals with linear algebra kernels suitable for heterogeneous computing platforms. The second one focuses on runtime systems to provide efficient and robust implementation of dense linear algebra algorithms. The third one is concerned with scheduling this particular application on a heterogeneous and dynamic environment.

ANR JCJC Project CODAS (2018-2022), 4 years. The ANR project CODAS was accepted in July 2017. He will be launched in February 2018. It gathers a little team of five persons including Laure Gonnord (PI) and Christophe Alias.

This project aims at studying the combination of formal methods such as abstract interpretation and term rewriting to address the challenge of scheduling complex data structures as well as complex flow graph.

9.3. International Initiatives

9.3.1. *Inria International Labs*

9.3.1.1. *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 reimaged 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 simulations 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.

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

9.3.2.1. Keystone

Title: Scheduling algorithms for sparse linear algebra at extreme scale

International Partner (Institution - Laboratory - Researcher):

Vanderbilt University (United States) - Electrical Engineering and Computer Science -
Padma Raghavan

Start year: 2016

See also: <http://graal.ens-lyon.fr/~abenoit/Keystone>

The Keystone project aims at investigating sparse matrix and graph problems on NUMA multicores and/or CPU-GPU hybrid models. The goal is to improve the performance of the algorithms, while accounting for failures and trying to minimize the energy consumption. The long-term objective is to design robust sparse-linear kernels for computing at extreme scale. In order to optimize the performance of these kernels, we plan to take particular care of locality and data reuse. Finally, there are several real-life applications relying on these kernels, and the Keystone project will assess the performance and robustness of the scheduling algorithms in applicative contexts. We believe that the complementary expertise of the two teams in the area of scheduling HPC applications at scale (ROMA — models and complexity; and SSCL — architecture and applications) is the key to the success of this associate team. We have already successfully collaborated in the past and expect the collaboration to reach another level thanks to Keystone.

9.3.3. Inria International Partners

9.3.3.1. 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.
- Laure Gonnord has a regular collaboration with Sylvain Collange (Inria Rennes) in the context of the PROSPIEL associate team.

9.3.4. Cooperation with ECNU

ENS Lyon has launched a partnership with ECNU, the East China Normal University in Shanghai, China. This partnership includes both teaching and research cooperation.

As for teaching, the PROSFER program includes a joint Master of Computer Science between ENS Rennes, ENS Lyon and ECNU. In addition, PhD students from ECNU are selected to conduct a PhD in one of these ENS. Yves Robert is responsible for this cooperation. He has already given two classes at ECNU, on Algorithm Design and Complexity, and on Parallel Algorithms, together with Patrice Quinton (from ENS Rennes).

As for research, the JORISS program funds collaborative research projects between ENS Lyon and ECNU. Yves Robert and Changbo Wang (ECNU) are leading a JORISS project on resilience in HPC computing. Anne Benoit and Minsong Chen are leading a JORISS project on scheduling and resilience in cloud computing. In the context of this collaboration two students from ECNU, Li Han and Changjiang Gou, have joined Roma for their PhD.

9.3.4.1. Informal International Partners

- Christophe Alias has a regular collaboration with Sanjay Rajopadhye from Colorado State University (USA); this collaboration also includes Guillaume Iooss (Inria Parkas) and Sylvain Collange (Inria Rennes).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

- Louis-Claude Canon, Loris Marchal, and Frédéric Vivien supervised Dorel Butaciu, an Erasmus student, for three months (June–September 2017).
- Loris Marchal, Bertrand Simon and Frédéric Vivien supervised Hanna Nagy, an Erasmus student, for three months (June–September 2017).
- Laure Gonnord supervised Szabolcs-Martón Bagoly, an Erasmus student, for three months (June–September 2017).

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Yves Robert has been appointed as a visiting scientist by the ICL laboratory (headed by Jack Dongarra) at the University of Tennessee Knoxville. He collaborates with several ICL researchers on high-performance linear algebra and resilience methods at scale.
- Anne Benoit and Bora Uçar visit the School of Computational Science and Engineering Georgia Institute of Technology, Atlanta, GA, USA (August 2017–May 2018). During this stay, Anne Benoit taught the course CSE-6140 Computational Science and Engineering (CSE) Algorithms, taken by both senior level undergraduate and graduate students, and by distant learners. Anne and Bora are collaborating with Prof. Çatalyürek and his group members on problems of high performance computing including partitioning, load balancing and scheduling.

SECRET Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **ANR BRUTUS** (10/14 → 09/18)
Authenticated Ciphers and Resistance against Side-Channel Attacks
ANR program: Défi Société de l'information et de la communication
Partners: ANSSI, Inria (project-team SECRET and project-team MARELLE), Orange, University of Lille, University of Rennes, University Versailles-Saint Quentin
160 kEuros
The Brutus project aims at investigating the security of authenticated encryption systems. We plan to evaluate carefully the security of the most promising candidates to the CAESAR competition, by trying to attack the underlying primitives or to build security proofs of modes of operation. We target the traditional black-box setting, but also more "hostile" environments, including the hardware platforms where some side-channel information is available.
- **ANR DEREK** (10/16 → 09/21)
Relativistic cryptography
ANR Program: jeunes chercheurs
244 kEuros
The goal of project DEREK is to demonstrate the feasibility of guaranteeing the security of some cryptographic protocols using the relativistic paradigm, which states that information propagation is limited by the speed of light. We plan to study some two party primitives such as bit commitment and their security against classical and quantum adversaries in this model. We then plan to the integration of those primitives into larger cryptosystems. Finally, we plan on performing a demonstration of those systems in real life conditions.
- **ANR CBCRYPT** (10/17 → 09/21)
Code-based cryptography
ANR Program: AAP Générique 2017
Partners: Inria SECRET (coordinator), XLIM, Univ. Rouen, Univ. Bordeaux.
197 kEuros
The goal of CBCRYPT is to propose code-based candidates to the NIST call aiming at standardizing public-key primitives which resist to quantum attacks. These proposals are based either on code-based schemes relying on the usual Hamming metric or on the rank metric. The project does not deal solely with the NIST call. We also develop some other code-based solutions: these are either primitives that are not mature enough to be proposed in the first NIST call or whose functionalities are not covered by the NIST call, such as identity-based encryption, broadcast encryption, attribute based encryption or functional encryption. A third goal of this project is of a more fundamental nature: namely to lay firm foundations for code-based cryptography by developing thorough and rigorous security proofs together with a set of algorithmic tools for assessing the security of code-based cryptography.

- **ANR quBIC** (10/17 → 09/21)

Quantum Banknotes and Information-Theoretic Credit Cards

ANR Program: AAP Générique 2017

Partners: Univ. Paris-Diderot (coordinator), Inria SECRET, UPMC (LIP6), CNRS (Laboratoire Kastler Brossel)

87 kEuros

For a quantum-safe future, classical security systems as well as quantum protocols that guarantee security against all adversaries must be deployed. Here, we will study and implement one of the most promising quantum applications, namely unforgeable quantum money. A money scheme enables a secure transaction between a client, a vendor and a bank via the use of a credit card or via the use of banknotes, with maximal security guarantees. Our objectives are to perform a theoretical analysis of quantum money schemes, in realistic conditions and for encodings in both discrete and continuous variables, and to demonstrate experimentally these protocols using state-of-the-art quantum memories and integrated detection devices.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. PQCRYPTO

Title: Post-quantum cryptography for long-term security

Programm: H2020

Duration: March 2015 - March 2018

Coordinator: TECHNISCHE UNIVERSITEIT EINDHOVEN

Partners:

Academia Sinica (Taiwan)

Bundesdruckerei (Germany)

Danmarks Tekniske Universitet (Denmark)

Katholieke Universiteit Leuven (Belgium)

NXP Semiconductors Belgium Nv (Belgium)

Ruhr-Universitaet Bochum (Germany)

Stichting Katholieke Universiteit (Netherlands)

Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Darmstadt (Germany)

University of Haifa (Israel)

Inria contact: Nicolas Sendrier

Online banking, e-commerce, telemedicine, mobile communication, and cloud computing depend fundamentally on the security of the underlying cryptographic algorithms. Public-key algorithms are particularly crucial since they provide digital signatures and establish secure communication without requiring in-person meetings. Essentially all applications today are based on RSA or on the discrete-logarithm problem in finite fields or on elliptic curves. Cryptographers optimize parameter choices and implementation details for these systems and build protocols on top of these systems; cryptanalysts fine-tune attacks and establish exact security levels for these systems. Alternative systems are far less visible in research and unheard of in practice. It might seem that having three systems offers enough variation, but these systems are all broken as soon as large quantum computers are built. The EU and governments around the world are investing heavily in building quantum computers; society needs to be prepared for the consequences, including cryptanalytic

attacks accelerated by these computers. Long-term confidential documents such as patient health-care records and state secrets have to guarantee security for many years, but information encrypted today using RSA or elliptic curves and stored until quantum computers are available will then be as easy to decipher as Enigma-encrypted messages are today. PQCRYPTO will allow users to switch to post-quantum cryptography: cryptographic systems that are not merely secure for today but that will also remain secure long-term against attacks by quantum computers. PQCRYPTO will design a portfolio of high-security post-quantum public-key systems, and will improve the speed of these systems, adapting to the different performance challenges of mobile devices, the cloud, and the Internet of Things. PQCRYPTO will provide efficient implementations of high-security post-quantum cryptography for a broad spectrum of real-world applications.

9.2.1.2. QCALL

Title: Quantum Communications for ALL

Programm: H2020-MSCA-ITN-2015

Duration: December 2016 - November 2020

Coordinator: University of Leeds (UK)

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

Inria contact: Anthony Leverrier

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

9.2.1.3. ERC QUASYModo

Title: QUASYModo *Symmetric Cryptography in the Post-Quantum World*

Program: ERC starting grant

Duration: September 2017 - August 2022

PI: María Naya Plasencia

As years go by, the existence of quantum computers becomes more tangible and the scientific community is already anticipating the enormous consequences of the induced breakthrough in computational power. Cryptology is one of the affected disciplines. Indeed, the current state-of-the-art asymmetric cryptography would become insecure, and we are actively searching for alternatives. Symmetric cryptography, essential for enabling secure communications, seems much less affected at first sight: its biggest known threat is Grover's algorithm, which allows exhaustive key searches in the square root of the normal complexity. Thus, so far, it is believed that doubling key lengths suffices to maintain an equivalent security in the post-quantum world. The security of symmetric cryptography is completely based on cryptanalysis: we only gain confidence in the security of a symmetric primitive through extensive and continuous scrutiny. It is therefore not possible to determine whether a symmetric primitive might be secure or not in a post-quantum world without first understanding how a quantum adversary could attack it. Correctly evaluating the security of symmetric primitives in the post-quantum world cannot be done without a corresponding cryptanalysis toolbox, which neither exists nor has ever been studied. This is the big gap I have identified and that I plan to fill with this project. Next, doubling the key length is not a trivial task and needs to be carefully studied. My ultimate aim is to propose efficient solutions secure in the post-quantum world with the help of our previously obtained quantum symmetric cryptanalysis toolbox. This will help prevent the chaos that big quantum computers would generate: being ready in advance will definitely save a great amount of time and money, while protecting our current and future communications. The main challenge of QUASYModo is to redesign symmetric cryptography for the post-quantum world.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

9.2.2.1. COST Action IC1306

Program: COST

Project acronym: ICT COST Action IC1306

Project title: Cryptography for Secure Digital Interaction

Duration: January 2014 - November 2017

Coordinator: Claudio Orlandi, Aarhus University, Denmark

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

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

Anne Canteaut is co-leader of the working group on cryptographic primitives. She co-organized a 2-day workshop for PhD students and early-career researchers in symmetric cryptography, DISC 2016 (Bochum, Germany, March 23-24 2016) and a winter school dedicated to Symmetric Cryptography and Blockchain (Torremolinos, Spain, February 19-23, 2018). She also serves on the program committee of the CryptoAction Symposium organized every year.

9.2.2.2. QCDA

Program: QuantERA ERA-NET Cofund in Quantum Technologies

Project acronym: QCDA

Project title: Quantum Code Design and Architecture

Duration: February 2018 - January 2021

Coordinator: Earl Campbell, University of Sheffield, UK

Other partners: University of Sheffield (UK), TU Delft (Netherlands), TU Munich (Germany), University College London (UK)

Abstract: General purpose quantum computers must follow a fault-tolerant design to prevent ubiquitous decoherence processes from corrupting computations. All approaches to fault-tolerance demand extra physical hardware to perform a quantum computation. Kitaev's surface, or toric, code is a popular idea that has captured the hearts and minds of many hardware developers, and has given many people hope that fault-tolerant quantum computation is a realistic prospect. Major industrial hardware developers include Google, IBM, and Intel. They are all currently working toward a fault-tolerant architecture based on the surface code. Unfortunately, however, detailed resource analysis points towards substantial hardware requirements using this approach, possibly millions of qubits for commercial applications. Therefore, improvements to fault-tolerant designs are a pressing near-future issue. This is particularly crucial since sufficient time is required for hardware developers to react and adjust course accordingly.

This consortium will initiate a European co-ordinated approach to designing a new generation of codes and protocols for fault-tolerant quantum computation. The ultimate goal is the development of high-performance architectures for quantum computers that offer significant reductions in hardware requirements; hence accelerating the transition of quantum computing from academia to industry. Key directions developed to achieve these improvements include: the economies of scale offered by large blocks of logical qubits in high-rate codes; and the exploitation of continuous-variable degrees of freedom.

The project further aims to build a European community addressing these architectural issues, so that a productive feedback cycle between theory and experiment can continue beyond the lifetime of the project itself. Practical protocols and recipes resulting from this project are anticipated to become part of the standard arsenal for building scalable quantum information processors.

9.3. International Initiatives

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

9.3.1.1. CHOCOLAT

Title: Chosen-prefix Collision Attack on SHA-1 with ASICs Cluster

International Partner (Institution - Laboratory - Researcher):

NTU (Singapore) - SYLLAB - Peyrin Thomas

Start year: 2017

See also: <https://team.inria.fr/chocolat/>

The hash function SHA-1 is one of the most widely used hash functions in the industry, but it has been shown to not be collision-resistant by a team of Chinese researchers led by Prof. Wang in 2005. However, a real pair of colliding messages was only published recently by a team from CWI and Google, because the estimated attack complexity is around 2^{63} SHA-1 computations (this represents about 70000 years of computation on a normal PC).

While this SHA-1 collision clearly demonstrates the weakness of the algorithm, a much more powerful attack would be to find a collision such that the prefix of the colliding messages is chosen by some challenger beforehand. In particular, this would allow creating a rogue certificate authority certificate that would be accepted by browsers. Such an attack has already been deployed for certificates using the MD5 hash function, but MD5 is much weaker than SHA-1 and it has already been removed from most security applications. SHA-1 is still widely used and performing such an attack for certificates using SHA-1 would have a very big impact.

The objective of the project is to design a chosen-prefix collision attack against the SHA-1 hash function, and to implement the attack in practice. We estimate this will require 2^{70} computations.

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

Title: Discrete Mathematics, Codes and Cryptography

International Partner (Institution - Laboratory - Researcher):

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

Duration: 2014 - 2018

Start year: 2014

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

9.3.2.2. Informal International Partners

- Nanyang Technological University (Singapore): cryptanalysis of symmetric primitives.
- Ruhr-Universität Bochum (Germany): design and cryptanalysis of symmetric primitives.

9.3.3. Participation in Other International Programs

Anirudh Krishna, PhD student at Sherbrooke University (Canada) spends six months in our team within the MITACS program.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Giannicola Scarpa, Universidad Complutense de Madrid, Spain, April 2017.
- Thomas Peyrin, NTU Singapore, May 2017, July 2017 and January 2018.
- Kaisa Nyberg, University of Helsinki, Finlande, May 2017.
- Adi Shamir, The Weizmann Institute of Science, Rehovot, Israel, May 2017.
- Christof Beierle, Bochum University, Germany, visiting PhD student, April-June 2017.
- Özgül Küçük, Bilgi University, Turkey, July-August 2017 (Bourse SSHN du Gouvernement Français).

9.4.1.1. Internships

- Sristy Agrawal, Kolkata, India, June-Aug. 2017
- Tim Beyne, Univ. Leuven, Belgium, Aug.-Sept. 2017
- Mathilde De La Morinerie, École Polytechnique, April-July 2017
- Matthieu Lequesne, MPRI, March-Aug. 2017
- André Schrottenloher, MPRI and Telecom ParisTech, March-Aug. 2017
- Ferdinand Sibleyras, MPRI, March-Aug. 2017
- Valentin Vasseur, Univ. Grenoble, March-Aug. 2017
- Matthieu Vieira, ENS Lyon, May-July 2017

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- NTU, Singapore, October 16 - November 3, joint work within the CHOCOLAT Associate Team (G. Leurent).

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Gilles Celeux and Christine Keribin have a collaboration with the Pharmacoepidemiology and Infectious Diseases (PhEMI, INSERM) groups.

Sylvain Arlot and Pascal Massart co-organize a working group at ENS (Ulm) on statistical learning.

8.2. National Initiatives

8.2.1. ANR

SELECT is part of the ANR funded MixStatSeq.

8.3. International Initiatives

Gilles Celeux is one of the co-organizers of the international working group on model-based clustering. This year this workshop took place in Perugia, Italy

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

Kevin Bleakley stayed at the Pasteur Institute, Cambodia, while working on several collaborations in dengue fever research, from late 2016 until early 2017.

SEMAGRAMME Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. SLAM

Participants: Maxime Amblard [coordinator], Philippe de Groote, Sylvain Pogodalla.

Schizophrenia is well known among mental illnesses for the strength of the thought disorders it involves, and for their widespread and spectacular manifestations: from deviant social behavior to delusion, not to speak about affective and sensitive distortions. The SLAM project aims at exploring the specific manifestation of disorders in conversational speech. This is an interdisciplinary research, both empirical and theoretical, from several domains, namely psychology, philosophy, linguistic, and computer science.

After having built building a corpus of pathological uses of language [9], the first transcriptions of pathological interviews have been analyzed [8]. A processing chain was implemented for disfluences and part-of-speech. We have focused on implementing the treatment of lexicographical issues, and proposed an interface for SDRT-annotations. We also started to collect new data with new patients at the Centre Médical d'Aix-en-Provence, and to re-implement the SLAMtk tool.

The SLAM project was supported by the MSH-Lorraine, USR 3261, the region Grand Est, and the Université de Lorraine. We have organized the **fourth workshop (In)Coherence of Discourse** which gathered linguists, psychologists, and computer scientists in March 2017.

7.2. National Initiatives

7.2.1. DGLFLF (*Délégation générale à la langue française et aux langues de France*)

7.2.1.1. PLURAL

Participants: Bruno Guillaume [coordinator], Nicolas Lefebvre.

The objective of the PLURAL project is to build linguistic resources with GWAPs (Game With A Purpose) for poorly endowed languages. Unlike other languages, poorly endowed languages lack of freely available raw corpora. The goal of the PLURAL project is to provide a web interface to gather corpora in poorly endowed languages of France. First target languages are Alsatian and Guadeloupean creole. The main difficulty is to take into account orthographic diversity and regional diversity for these languages.

Partners of the PLURAL projet are: Université Paris-Sorbonne (Karën Fort, Alice Millour, André Thibault) and Université de Strasbourg (Delphine Bernhard).

Nicolas Lefebvre is engineer in the PLURAL project from October 2017 to March 2018.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

Maxime Amblard have started discussing with the Centre for Linguistic Theory and Studies in Probability (**CLASP**, University of Gothenburg, Sweden), about computational treatments of dialogues of patients with schizophrenia. We have common issues about the management such corpora and about the modeling of such interactions. As for now, ongoing discussions have not yet been turned into a formal project.

7.4. International Research Visitors

7.4.1. Visits to International Teams

7.4.1.1. Research Stays Abroad

Timothée Bernard visited New York University, USA, from September 1st to December 15th, 2017.

SEQUEL Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR BoB

Participants: Rémi Bardenet, Michal Valko.

- *Title:* Bayesian statistics for expensive models and tall data
- *Type:* National Research Agency
- *Coordinator:* CNRS (Rémi Bardenet)
- *Duration:* 2016-2020
- *Abstract:*

Bayesian methods are a popular class of statistical algorithms for updating scientific beliefs. They turn data into decisions and models, taking into account uncertainty about models and their parameters. This makes Bayesian methods popular among applied scientists such as biologists, physicists, or engineers. However, at the heart of Bayesian analysis lie 1) repeated sweeps over the full dataset considered, and 2) repeated evaluations of the model that describes the observed physical process. The current trends to large-scale data collection and complex models thus raises two main issues. Experiments, observations, and numerical simulations in many areas of science nowadays generate terabytes of data, as does the LHC in particle physics for instance. Simultaneously, knowledge creation is becoming more and more data-driven, which requires new paradigms addressing how data are captured, processed, discovered, exchanged, distributed, and analyzed. For statistical algorithms to scale up, reaching a given performance must require as few iterations and as little access to data as possible. It is not only experimental measurements that are growing at a rapid pace. Cell biologists tend to have scarce data but large-scale models of tens of nonlinear differential equations to describe complex dynamics. In such settings, evaluating the model once requires numerically solving a large system of differential equations, which may take minutes for some tens of differential equations on today's hardware. Iterative statistical processing that requires a million sequential runs of the model is thus out of the question. In this project, we tackle the fundamental cost-accuracy trade-off for Bayesian methods, in order to produce generic inference algorithms that scale favourably with the number of measurements in an experiment and the number of runs of a statistical model. We propose a collection of objectives with different risk-reward trade-offs to tackle these two goals. In particular, for experiments with large numbers of measurements, we further develop existing subsampling-based Monte Carlo methods, while developing a novel decision theory framework that includes data constraints. For expensive models, we build an ambitious programme around Monte Carlo methods that leverage determinantal processes, a rich class of probabilistic tools that lead to accurate inference with limited model evaluations. In short, using innovative techniques such as subsampling-based Monte Carlo and determinantal point processes, we propose in this project to push the boundaries of the applicability of Bayesian inference.

9.1.2. ANR Badass

Participants: Odalric Maillard, Émilie Kaufmann.

- *Title:* BAnDits for non-Stationarity and Structure
- *Type:* National Research Agency
- *Coordinator:* Inria Lille (O. Maillard)
- *Duration:* 2016-2020

- *Abstract:* Motivated by the fact that a number of modern applications of sequential decision making require developing strategies that are especially robust to change in the stationarity of the signal, and in order to anticipate and impact the next generation of applications of the field, the BADASS project intends to push theory and application of MAB to the next level by incorporating non-stationary observations while retaining near optimality against the best not necessarily constant decision strategy. Since a non-stationary process typically decomposes into chunks associated with some possibly hidden variables (states), each corresponding to a stationary process, handling non-stationarity crucially requires exploiting the (possibly hidden) structure of the decision problem. For the same reason, a MAB for which arms can be arbitrary non-stationary processes is powerful enough to capture MDPs and even partially observable MDPs as special cases, and it is thus important to jointly address the issue of non-stationarity together with that of structure. In order to advance these two nested challenges from a solid theoretical standpoint, we intend to focus on the following objectives: (i) To broaden the range of optimal strategies for stationary MABs: current strategies are only known to be provably optimal in a limited range of scenarios for which the class of distribution (structure) is perfectly known; also, recent heuristics possibly adaptive to the class need to be further analyzed. (ii) To strengthen the literature on pure sequential prediction (focusing on a single arm) for non-stationary signals via the construction of adaptive confidence sets and a novel measure of complexity: traditional approaches consider a worst-case scenario and are thus overly conservative and non-adaptive to simpler signals. (iii) To embed the low-rank matrix completion and spectral methods in the context of reinforcement learning, and further study models of structured environments: promising heuristics in the context of e.g. contextual MABs or Predictive State Representations require stronger theoretical guarantees.

This project will result in the development of a novel generation of strategies to handle non-stationarity and structure that will be evaluated in a number of test beds and validated by a rigorous theoretical analysis. Beyond the significant advancement of the state of the art in MAB and RL theory and the mathematical value of the program, this JCJC BADASS is expected to strategically impact societal and industrial applications, ranging from personalized health-care and e-learning to computational sustainability or rain-adaptive river-bank management to cite a few.

9.1.3. ANR ExTra-Learn

Participants: Alessandro Lazaric, Jérémie Mary, Michal Valko.

- *Title:* Extraction and Transfer of Knowledge in Reinforcement Learning
- *Type:* National Research Agency (ANR-9011)
- *Coordinator:* Inria Lille (A. Lazaric)
- *Duration:* 2014-2018
- *Abstract:* ExTra-Learn is directly motivated by the evidence that one of the key features that allows humans to accomplish complicated tasks is their ability of building knowledge from past experience and transfer it while learning new tasks. We believe that integrating transfer of learning in machine learning algorithms will dramatically improve their learning performance and enable them to solve complex tasks. We identify in the reinforcement learning (RL) framework the most suitable candidate for this integration. RL formalizes the problem of learning an optimal control policy from the experience directly collected from an unknown environment. Nonetheless, practical limitations of current algorithms encouraged research to focus on how to integrate prior knowledge into the learning process. Although this improves the performance of RL algorithms, it dramatically reduces their autonomy. In this project we pursue a paradigm shift from designing RL algorithms incorporating prior knowledge, to methods able to incrementally discover, construct, and transfer “prior” knowledge in a fully automatic way. More in detail, three main elements of RL algorithms would significantly benefit from transfer of knowledge. (i) For every new task, RL algorithms need exploring the environment for a long time, and this corresponds to slow learning processes for large environments. Transfer learning would enable RL algorithms to dramatically reduce the exploration

of each new task by exploiting its resemblance with tasks solved in the past. (ii) RL algorithms evaluate the quality of a policy by computing its state-value function. Whenever the number of states is too large, approximation is needed. Since approximation may cause instability, designing suitable approximation schemes is particularly critical. While this is currently done by a domain expert, we propose to perform this step automatically by constructing features that incrementally adapt to the tasks encountered over time. This would significantly reduce human supervision and increase the accuracy and stability of RL algorithms across different tasks. (iii) In order to deal with complex environments, hierarchical RL solutions have been proposed, where state representations and policies are organized over a hierarchy of subtasks. This requires a careful definition of the hierarchy, which, if not properly constructed, may lead to very poor learning performance. The ambitious goal of transfer learning is to automatically construct a hierarchy of skills, which can be effectively reused over a wide range of similar tasks.

- *Activity Report:* Research in ExTra-Learn continued in investigating how knowledge can be transferred into reinforcement learning algorithms to improve their performance. Pierre-Victor Chaumier did a 4 months internship in SequeL studying how to perform transfer neural networks across different games in the Atari platform. Unfortunately, the preliminary results we obtained were not very positive. We investigated different transfer models, from basic transfer of a fully trained network, to co-train over multiple games and retrain with initialization from a previous network. In most of the cases, the improvement from transfer was rather limited and in some cases even negative transfer effects appeared. This seems to be intrinsic in the neural network architecture which tends to overfit on one single task and it poorly generalizes over alternative tasks. Another activity was related to the study of macro-actions in RL. We proved for the first time under which conditions macro-actions can actually improve the learning speed of an RL exploration-exploitation algorithm. This is the first step towards the automatic identification and construction of useful macro-actions across multiple tasks.

9.1.4. ANR KEHATH

Participants: Olivier Pietquin, Alexandre Bérard.

- *Acronym:* KEHATH
- *Title:* Advanced Quality Methods for Post-Editon of Machine Translation
- *Type:* ANR
- *Coordinator:* Lingua & Machina
- *Duration:* 2014-2017
- *Other partners:* Univ. Lille 1, Laboratoire d'Informatique de Grenoble (LIG)
- *Abstract:* The translation community has seen a major change over the last five years. Thanks to progress in the training of statistical machine translation engines on corpora of existing translations, machine translation has become good enough so that it has become advantageous for translators to post-edit machine outputs rather than translate from scratch. However, current enhancement of machine translation (MT) systems from human post-edition (PE) are rather basic: the post-edited output is added to the training corpus and the translation model and language model are re-trained, with no clear view of how much has been improved and how much is left to be improved. Moreover, the final PE result is the only feedback used: available technologies do not take advantages of logged sequences of post-edition actions, which inform on the cognitive processes of the post-editor. The KEHATH project intends to address these issues in two ways. Firstly, we will optimise advanced machine learning techniques in the MT+PE loop. Our goal is to boost the impact of PE, that is, reach the same performance with less PE or better performance with the same amount of PE. In other words, we want to improve machine translation learning curves. For this purpose, active learning and reinforcement learning techniques will be proposed and evaluated. Along with this, we will have to face challenges such as MT systems heterogeneity (statistical and/or rule-based), and ML scalability so as to improve domain-specific MT. Secondly, since quality prediction (QP) on MT outputs is

crucial for translation project managers, we will implement and evaluate in real-world conditions several confidence estimation and error detection techniques previously developed at a laboratory scale. A shared concern will be to work on continuous domain-specific data flows to improve both MT and the performance of indicators for quality prediction. The overall goal of the KEHATH project is straightforward: gain additional machine translation performance as fast as possible in each and every new industrial translation project, so that post-edition time and cost is drastically reduced. Basic research is the best way to reach this goal, for an industrial impact that is powerful and immediate.

9.1.5. PEPS Project BIO

Participants: Émilie Kaufmann, Lilian Besson.

- *Title:* Bandits pour l'Internet des Objets
- *Type:* CNRS PEPS project
- *Coordinator:* CNRS (E. Kaufmann)
- *Duration:* april-december 2017
- *Abstract:* (in French) Dans le but d'améliorer le qualité et de minimiser les coûts énergétiques des communications entre les objets communicants et leurs stations de base, nous cherchons dans ce projet à adapter les avancées récentes du domaine de la radio intelligente à la spécificité des communications de type Internet des Objets. Vu l'engorgement du spectre fréquentiel, il est nécessaire pour ces objets d'apprendre à détecter de manière adaptative quand et sur quelle fréquence communiquer. Nous proposons pour cette tâche l'utilisation d'algorithmes dits de bandit à plusieurs bras, déjà connus dans le contexte de la radio intelligente, mais pas toujours adaptés à la spécificité des communications pour l'Internet des Objets. Nous introduirons de nouveaux algorithmes de bandit multi-joueurs, traduisant la coordination nécessaire entre les multiples objets en plus de l'apprentissage de la qualité des canaux fréquentiel. Ensuite nous envisagerons une nouvelle modélisation, de type bandit adversarial, pour décrire les communications dans des standards comme LoRa où les objets reçoivent des messages de confirmation des stations de bases, conduisant à des algorithmes minimisant la latence de ces communications.

9.1.6. National Partners

- ENS Paris-Saclay
 - M. Valko collaborated with V. Perchet on structured bandit problem. They co-supervise a PhD student (P. Perrault) together.
- Institut de Mathématiques de Toulouse
 - E. Kaufmann collaborated with Aurélien Garivier on sequential testing and structured bandit problems.
- CentraleSupélec Rennes
 - E. Kaufmann co-advises Lilian Besson, who works at CentraleSupélec with Christophe Moy. Christophe, Lilian and Émilie worked together on a PEPS project about bandits for Internet Of Things. One paper was published to the CROWNCOM conference, and another has been submitted to the ALT conference.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. H2020 BabyRobot

Program: H2020

Project acronym: BabyRobot

Project title: Child-Robot Communication and Collaboration

Duration: 01/2016 - 12/2018

Coordinator: Alexandros Potamianos (Athena Research and Innovation Center in Information Communication and Knowledge Technologies, Greece)

Other partners: Institute of Communication and Computer Systems (Greece), The University of Hertfordshire Higher Education Corporation (UK), Universitaet Bielefeld (Germany), Kungliga Tekniska Hogskolan (Sweden), Blue Ocean Robotics ApS (Denmark), Univ. Lille (France), Furhat Robotics AB (Sweden)

Abstract: The crowning achievement of human communication is our unique ability to share intentionality, create and execute on joint plans. Using this paradigm we model human-robot communication as a three step process: sharing attention, establishing common ground and forming shared goals. Prerequisites for successful communication are being able to decode the cognitive state of people around us (mindreading) and building trust. Our main goal is to create robots that analyze and track human behavior over time in the context of their surroundings (situational) using audio-visual monitoring in order to establish common ground and mind-reading capabilities. On BabyRobot we focus on the typically developing and autistic spectrum children user population. Children have unique communication skills, are quick and adaptive learners, eager to embrace new robotic technologies. This is especially relevant for special education where the development of social skills is delayed or never fully develops without intervention or therapy. Thus our second goal is to define, implement and evaluate child-robot interaction application scenarios for developing specific socio-affective, communication and collaboration skills in typically developing and autistic spectrum children. We will support not supplant the therapist or educator, working hand-in-hand to create a low risk environment for learning and cognitive development. Breakthroughs in core robotic technologies are needed to support this research mainly in the areas of motion planning and control in constrained spaces, gestural kinematics, sensorimotor learning and adaptation. Our third goal is to push beyond the state-of-the-art in core robotic technologies to support natural human-robot interaction and collaboration for edutainment and healthcare applications. Creating robots that can establish communication protocols and form collaboration plans on the fly will have impact beyond the application scenarios investigated here.

9.2.1.2. CHIST-ERA DELTA

Participants: Michal Valko, Émilie Kaufmann.

Program: CHIST-ERA

Project acronym: DELTA

Project title: Dynamically Evolving Long-Term Autonomy

Duration: October 2017 - December 2021

Coordinator: Anders Jonsson (PI)

Inria coPI: Michal Valko

Other partners: UPF Spain, MUL Austria, ULG Belgium

Abstract: Many complex autonomous systems (e.g., electrical distribution networks) repeatedly select actions with the aim of achieving a given objective. Reinforcement learning (RL) offers a powerful framework for acquiring adaptive behaviour in this setting, associating a scalar reward with each action and learning from experience which action to select to maximise long-term reward. Although RL has produced impressive results recently (e.g., achieving human-level play in Atari games and beating the human world champion in the board game Go), most existing solutions only work under strong assumptions: the environment model is stationary, the objective is fixed, and trials end once the objective is met. The aim of this project is to advance the state of the art of fundamental research in lifelong RL by developing several novel RL algorithms that relax the above assumptions. The new algorithms should be robust to environmental changes, both in terms of the observations that

the system can make and the actions that the system can perform. Moreover, the algorithms should be able to operate over long periods of time while achieving different objectives. The proposed algorithms will address three key problems related to lifelong RL: planning, exploration, and task decomposition. Planning is the problem of computing an action selection strategy given a (possibly partial) model of the task at hand. Exploration is the problem of selecting actions with the aim of mapping out the environment rather than achieving a particular objective. Task decomposition is the problem of defining different objectives and assigning a separate action selection strategy to each. The algorithms will be evaluated in two realistic scenarios: active network management for electrical distribution networks, and microgrid management. A test protocol will be developed to evaluate each individual algorithm, as well as their combinations.

9.2.1.3. CHIST-ERA IGLU

Program: CHIST-ERA

Project acronym: IGLU

Project title: Interactively Grounded Language Understanding

Duration: 11/2015 - 10/2018

Coordinator: Jean Rouat (Université de Sherbrooke, Canada)

Other partners: UMONS (Belgique), Inria (France), Univ-Lille (France), KTH (Sweden), Universidad de Zaragoza (Spain)

Abstract: Language is an ability that develops in young children through joint interaction with their caretakers and their physical environment. At this level, human language understanding could be referred as interpreting and expressing semantic concepts (e.g. objects, actions and relations) through what can be perceived (or inferred) from current context in the environment. Previous work in the field of artificial intelligence has failed to address the acquisition of such perceptually-grounded knowledge in virtual agents (avatars), mainly because of the lack of physical embodiment (ability to interact physically) and dialogue, communication skills (ability to interact verbally). We believe that robotic agents are more appropriate for this task, and that interaction is a so important aspect of human language learning and understanding that pragmatic knowledge (identifying or conveying intention) must be present to complement semantic knowledge. Through a developmental approach where knowledge grows in complexity while driven by multimodal experience and language interaction with a human, we propose an agent that will incorporate models of dialogues, human emotions and intentions as part of its decision-making process. This will lead anticipation and reaction not only based on its internal state (own goal and intention, perception of the environment), but also on the perceived state and intention of the human interactant. This will be possible through the development of advanced machine learning methods (combining developmental, deep and reinforcement learning) to handle large-scale multimodal inputs, besides leveraging state-of-the-art technological components involved in a language-based dialog system available within the consortium. Evaluations of learned skills and knowledge will be performed using an integrated architecture in a culinary use-case, and novel databases enabling research in grounded human language understanding will be released.

9.3. International Initiatives

9.3.1. With CWI

Title: Non-parametric sequential prediction project

Centrum Wiskunde & Informatica (CWI), Amsterdam (NL) - Peter Grünwald

Duration: 2016 - 2018

Start year: 2016

Abstract: The aim is to develop the theory of learning for sequential decision making under uncertainty problems.

In 2017, this collaboration involved D. Ryabko, É. Kaufmann, J. Ridgway, M. Valko, O. Maillard. A post-doc funded by Inria has been recruited in Fall 2016.

<https://project.inria.fr/inriacwi/projects/non-parametric-sequential-prediction-project/>

9.3.2. EduBand

Title: Educational Bandits

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Department of Computer Science, Theory of computation lab - Emma Brunskill

Start year: 2015

See also: <https://project.inria.fr/eduband/>

Education can transform an individual's capacity and the opportunities available to him. The proposed collaboration will build on and develop novel machine learning approaches towards enhancing (human) learning. Massive open online classes (MOOCs) are enabling many more people to access education, but mostly operate using status quo teaching methods. Even more important than access is the opportunity for online software to radically improve the efficiency, engagement and effectiveness of education. Existing intelligent tutoring systems (ITSs) have had some promising successes, but mostly rely on learning sciences research to construct hand-built strategies for automated teaching. Online systems make it possible to actively collect substantial amount of data about how people learn, and offer a huge opportunity to substantially accelerate progress in improving education. An essential aspect of teaching is providing the right learning experience for the student, but it is often unknown a priori exactly how this should be achieved. This challenge can often be cast as an instance of decision-making under uncertainty. In particular, prior work by Brunskill and colleagues demonstrated that reinforcement learning (RL) and multi-arm bandit (MAB) can be very effective approaches to solve the problem of automated teaching. The proposed collaboration is thus intended to explore the potential interactions of the fields of online education and RL and MAB. On the one hand, we will define novel RL and MAB settings and problems in online education. On the other hand, we will investigate how solutions developed in RL and MAB could be integrated in ITS and MOOCs and improve their effectiveness.

9.3.3. Allocate

Participants: Pierre Perrault, Julien Seznec, Michal Valko, Émilie Kaufmann, Odalric Maillard.

Title: Adaptive allocation of resources for recommender systems

Inria contact: Michal Valko

International Partner (Institution - Laboratory - Researcher):

Universität Potsdam, Germany A. Carpentier

Start year: 2017

We plan to improve a practical scenario of *resource allocation in market surveys*, such as product appraisals and music recommendation. In practice, the market is typically divided into segments: geographic regions, age groups, ... These groups are then queried for preference with some fixed rule of a number of queries per group. This testing is *costly and non-adaptive*. The reason is some groups are easier to estimate than others, but this is impossible to know a priori. Our challenge is **adaptively allocate the optimal number of samples** to each group and improve the efficiency of market studies, by providing *sample-efficient* solutions.

9.3.4. Informal International Partners

Adobe Research

Branislav Kveton *Collaborator*

Zheng Wen *Collaborator*

Sharan Vaswani *Collaborator*

M. Valko collaborated with Adobe Research on online influence maximization in social networks. This led to a publication in NIPS 2017.

Massachusetts Institute of Technology

Victor-Emmanuel Brunel *Collaborator*

M. Valko collaborated with V.-E. Brunel on the estimation of low rank determinantal point processes useful for diverse recommender systems.

Univertät Potsdam

Alexandra Carpentier *Collaborator*

M. Valko collaborated with A. Carpentier on adaptive estimation of the block-diagonal matrices with application to market segmentations. This collaboration formalized in September 2017 by creating a north-european associate team.

University of California, Berkeley

Victor Gabillon *Collaborator*

M. Valko collaborated with V. Gabillon on the sample complexities in unknown type of environments.

University of Southern California

Haipeng Luo *Collaborator*

M. Valko collaborated with H. Luo on online submodular minimization.

Adobe Research

Mohammad Ghavamzadeh *Collaborator*

A. Lazaric collaborated with Adobe Research on active learning for accurate estimation of linear models. This led to a publication in ICML 2017.

Stanford University

Carlos Riquelme *Collaborator*

A. Lazaric collaborated with Carlos Riquelme on active learning for accurate estimation of linear models. This led to a publication in ICML 2017.

Stanford University

Emma Brunskill *Collaborator*

A. Lazaric collaborated with Emma Brunskill on exploration-exploitation with options in reinforcement learning. This led to a publication in NIPS 2017.

University of California, Irvine

Anima Anandkumar *Collaborator*

Kamyar Azzizade *Collaborator*

A. Lazaric collaborated with A. Anandkumar and K. Azzizade on exploration-exploitation with in reinforcement learning with state clustering. This led to a submission to AI&Stats 2018.

University of Leoben

Ronald Ortner *Collaborator*

A. Lazaric collaborated with R. Ortner on exploration-exploitation in reinforcement learning with regularized optimization. This will lead to a submission to ICML 2018.

Politecnico di Milano

Marcello Restelli *Collaborator*

Matteo Pirota collaborate with M. Restelli on several topics in reinforcement learning. This will lead to publications to ICML 2017 and NIPS 2017.

Lancaster University

B. Balle *Collaborator*

O. Maillard collaborated on spectral learning of Hankel matrices. This led to a publication at ICML.

Mila, Université de Montréal

A. Courville *Collaborator*

F. Strub and O. Pietquin collaborate on deep reinforcement learning for language acquisition. This led to several papers at IJCAI, CVPR, and NIPS, as well as the guesswhat?! dataset and protocol, and the HOME dataset.

Uberlandia University, Brazil

C. Felicio *Collaborator*

Ph. Preux supervises this PhD on recommendation systems. This led to the defense of C. Felicio and a paper at UMAP.

9.3.5. International Initiatives**SequeL**

Title: The multi-armed bandit problem

International Partner (Institution - Laboratory - Researcher):

University of Leoben (Austria) Peter Auer

Duration: 2014 - 2018

Start year: 2014

In a nutshell, the collaboration is focusing on nonparametric algorithms for active learning problems, mainly involving theoretical analysis of reinforcement learning and bandits problems beyond the traditional settings of finite-state MDPs (for RL) or i.i.d. rewards (for bandits). Peter Auer from University of Leoben is a worldwide leader in the field, having introduced the UCB approach around 2000, along with its finite-time analysis. Today, SequeL is likely to be the largest research group working in this field in the world, enjoying worldwide recognition. SequeL and P. Auer's group have been collaborating for a couple of years now; they have co-authored papers, visited each other (sabbatical stay, post-doc), coorganized workshops; the STREP Complacs partially funds this very active collaboration.

9.3.6. International Initiatives**Contextual multi-armed bandits with hidden structure**

Title: Contextual multi-armed bandits with hidden structure

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) – Aditya Gopalan

Duration: 2015 - 2017

Recent advances in Multi-Armed Bandit (MAB) theory have yielded key insights into, and driven the design of applications in, sequential decision making in stochastic dynamical systems. Notable among these are recommender systems, which have benefited greatly from the study of contextual MABs incorporating user-specific information (the context) into the decision problem from a rigorous theoretical standpoint. In the proposed initiative, the key features of (a) sequential interaction between a learner and the users, and (b) a relatively small number of interactions per user with the system, motivate the goal of efficiently exploiting the underlying collective structure of users. The state-of-the-art lacks a wellgrounded strategy with provably near-optimal guarantees for general, low-rank user structure. Combining expertise in the foundations of MAB theory together with recent advances in spectral methods and low-rank matrix completion, we target the first provably near-optimal sequential low-rank MAB

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

- Harm de Vries, PhD student, University of Montreal, Canada, Jan-Jun 2017
- Mohammad Sadegh Talebi Mazraeh Shahi, PhD student, KTH Royal Institute of Technology, Sweden, Jun-Sep 2017
- Xuedong Shang, master student, ENS Rennes, Feb-Jun 2017
- Iuliia Olkhovskaia, master student, Moscow Institute of Physics and Technology, Russia, Feb-Jul 2017
- Georgios Papoudakis, master student, Aristotle University of Thessaloniki, Greece, May-Sep 2017
- Subhojyoti Mukherjee, master student, Indian Institute of technology, Sep-Nov 2017
- Mahsa Asadi, Shiraz University, Iran, Sep-Dec 2017

SERENA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

GiS: scientific collaboration network between ten public institutions from the Paris (Ile-de-France) region, focused on natural resources and environment. The project-team SERENA is a member.

9.2. National Initiatives

9.2.1. ANR

ANR DEDALES: “Algebraic and geometric domain decomposition for subsurface flow”. The project aims at developing high performance software for the simulation of two phase flow in porous media. It specifically targets parallel computers where each node is itself composed of a large number of processing cores, such as are found in new generation many-core architectures. The project had its intermediate review in December 2016, and received excellent marks from the expert panel.

The partners are **HIEPACS**, **Laboratoire Analyse, Géométrie et Application**, **University Paris 13**, **Maison de la Simulation**, and **ANDRA**. SERENA representants are M. Kern (grant leader) and M. Vohralík, period 2014–2017.

ANR GEOPOR: “Geometrical approach for porous media flows: theory and numerics”. A new approach to numerical methods for multiphase simulations based on the concept of gradient flows is investigated. With **Laboratoire Jacques-Louis Lions**, University Pierre and Marie Curie. SERENA representant is M. Vohralík, period 2013–2017.

ANR H2MNO4: “Original optimized object-oriented numerical model for heterogeneous hydrogeology”. The project H2MNO4 develops numerical models for reactive transport in heterogeneous media. The objective is to design both Eulerian and Lagrangian models. Three applications are concerned: freshwater supply, remediation of mine drainage, and waste geological disposal. The project relies on a consortium of six partners, involving four public research laboratories (**Inria**, **Geosciences Rennes**, **University of Lyon 1**, **University of Poitiers**, **Pprime Institute**), one public institution (**ANDRA**), and one enterprise (**ITASCA**). International collaborations are pursued with **University of San Diego (USA)** and **UPC (Spain)**. SERENA representant is G. Pichot, period 2012–2016.

ANR HHOMM: “Hybrid high-order methods on polyhedral meshes”, Theoretical foundations and applications (up to software development) for the recently-devised Hybrid high-order methods. Coordinated by D. Di Pietro, University of Montpellier. SERENA representant is A. Ern, period 2015–2019.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

ERC GATIPOR: “Guaranteed fully adaptive algorithms with tailored inexact solvers for complex porous media flows”. The subject of this project are new approaches to porous media multiphase flows: inexact Newton-multigrid solvers, local stopping criteria, adaptivity, and a posteriori error control. The goal is to guarantee the overall simulation error and to speed-up importantly the present-day simulations. SERENA representant is M. Vohralík (grant leader), period 2015–2020.

EoCoE: “Energy Oriented Center of Excellence” This project is coordinated by **Maison de la Simulation** and gathers 23 partners from 13 countries to use the tremendous potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable low carbon energy supply using HPC (High Performance Computing). SERENA representant M. Kern, period 2015–2018.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

OPENCPS

Program: ITEA 3

Project acronym: OPENCPS

Project title: Open cyber-physical system model-driven certified development

Duration: Dec 2015–Dec 2018

Coordinator: Magnus Eek

Other partners: AB SKF, **CEA**, ELTE-Soft Kft., ESI Group, **EDF**, Wqua Simulation AB, Ericsson, IncQuery Labs Kft., KTH, Linköping University, **RTE**, SICS, SIREHNA, Saab AB, Sherpa Engineering, Siemens Industrial Turbomachinery AB, VTT Technical Research Center of Finland Ltd.

Abstract: Cyber-physical systems put increasing demands on reliability, usability, and flexibility while, at the same time, lead time and cost efficiency are essential for industry competitiveness. Tools and environments for model-based development of cyber-physical systems are becoming increasingly complex and critical for the industry: tool interoperability, vendor lock-ins, and tool life-cycle support are some of the challenges. The project focuses on interoperability between the standards Modelica/UML/FMI, improved execution speed of (co-)simulation, and certified code generation.

MoRe

Program: Research, Development and Innovation Council of the Czech Republic

Project acronym: **MoRe**

Project title: Implicitly constituted material models: from theory through model reduction to efficient numerical methods

Duration: September 2012 – September 2017

Coordinator: Josef MÁLEK, **Charles University in Prague**. SERENA representant is M. Vohralík.

Other partners: **Institute of Mathematics, Czech Academy of Sciences; University of Oxford**

Abstract: A multidisciplinary project on nonlinear Navier–Stokes flows with implicit constitutive laws. It focuses on development of accurate, efficient, and robust numerical methods for simulations of the new class of implicit models.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Erik Burman, Professor at University College London, UK, unfitted methods.

Jean-Luc Guermond, Professor at Texas A&M University, USA, finite element methods.

Ulrich Rüde, Professor at Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany, multigrid methods.

Mary Wheeler, professor, University of Texas at Austin, USA, porous medial applications.

Barbara Wohlmuth, Professor at Technical University of München, Germany, mixed finite element methods.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Lars Diening, Professor at University of Bielefeld, Germany, February 17–23, 2017.

Christian Kreuzer, Professor at University of Dortmund, Germany, February 19–25, 2017.

Joscha Gedicke, post-doc at University Vienna, Austria, May 29–June 2, 2017.

Martin Eigel, post-doc at Weierstrass Institute Berlin, Germany, May 29–June 2, 2017.

Carsten Carstensen, Professor at Humboldt University Berlin, Germany, August 15–September 15, 2017.

Peter Minev, Professor at the University of Alberta, Canada, September 15–October 15, 2017.

Hend Ben Ameer, Professor at IPEST and member of ENIT-Lamsin, Tunis, Tunisia, October 23–November 3, 2017.

9.5.1.1. Internships

K. Talali, université de Fez, Morocco, April 1–August 31 (Master degree).

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Alexandre Ern participated as Invited Professor to the HIM Program on Multiscale Problems: Algorithms, Numerical Analysis and Computation, in Bonn, Germany, January 2017.

Martin Vohralík was invited for two weeks stay to **Charles University in Prague** collaboration with J. Málek, April 2017.

SERPICO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

ENSAI-CREST: Statistical methods and models for image registration, PhD thesis of Vincent Briane is co-funded by Inria and ENSAI-CREST and co-supervised by Myriam Vimond (ENSAI-CREST).

Région Bretagne: Identification, localization and enumeration of ribosomes within a tomogram by combining state-of-the-art denoising methods and object descriptor-based recognition (CATLAS, see Section 8.2.1) (PhD thesis of Emmnuel Moebel); motion saliency in video sequences (PhD thesis of Léo Maczyta).

BioGenOuest: Collaboration with S. Prigent (engineer) in charge of the organization of image processing services for Biogenouest bio-imaging facilities.

IGDR: Collaboration with J. Pecreaux, Y. Le Cunff (co-supervision of PhD thesis of A. Caranfil).

9.2. National Initiatives

9.2.1. *France-BioImaging project*

Participants: Charles Kervrann, Patrick Bouthemy.

The goal of the France-BioImaging project (<http://france-bioimaging.org/>) is to build a distributed coordinated French infrastructure for photonic and electronic cellular bioimaging, dedicated to innovation, training and technology transfer. High-computing capacities are needed to exhaustively analyse image flows. Serpico is co-head of the IPDM (Image Processing and Data Management) node of the FBI network composed of 6 nodes. In this context, we address the following scientific problems: i/ exhaustive analysis of bioimaging data sets; ii/ deciphering of key steps of biological mechanisms at organ, tissular, cellular and molecular levels through the systematic use of time-lapse 3D microscopy and image processing methods; iii/ storage and indexing of extracted and associated data and metadata through an intelligent data management system. Serpico recruited R&D engineers (2011-2016) to disseminate image processing software, to build the Mobyle@Serpico web portal and to manage the IGRIDA-Serpico cluster (200 nodes; batch scheduler: OAR; File management: Puppet/Git/Capistrano; OS: Linux Debian 7; User connexion: public ssh key) opened for end-users and dedicated to large scale computing and data sets processing (storage: 200 TeraBytes).

- **Coordinator:** CNRS (Jean Salamero, UMR 144 CNRS-Institut Curie).
- **Partners:** University of Paris-Diderot-Paris 7, Aix-Marseille University, University of Bordeaux, University of Montpellier, Institut Pasteur, Institut Curie, Inria, ENS Ulm, University of Paris Descartes, UPMC, Ecole Polytechnique, Inserm.
- **Funding:** Investissement d'Avenir Infrastructures Nationales en Biologie et Santé, ANR INBS-PIA 2011.
- **Total amount:** 26 000 Keuros (Inria Serpico: 606 Keuros).

9.2.2. *ANR DALLISH project (2016-2020): Data Assimilation and Lattice Light Sheet imaging for endocytosis/exocytosis pathway modeling in the whole cell*

Participants: Charles Kervrann, Vincent Briane, Ancageorgiana Caranfil, Antoine Salomon.

Cutting-edge LLS microscopy represents the novel generation of 3D fluorescence microscopes dedicated to single cell analysis, generating extraordinarily high resolved and sharp, but huge 3D images and videos. One single live cell experiment in one single biological condition can result into up to one terabyte of data. The goal of the project is to develop new paradigms and computational strategies for image reconstruction and 3D molecule tracking/motion estimation. Furthermore, establishing correspondences between image-based measurements and features, stochastic motion models, and underlying biological and biophysical information remains a challenging task. In a larger perspective, the quantitative description of image data corresponding to protein transport will be a prerequisite for understanding the functioning of a cell in normal and pathological situations including cancer, viral infection and neurodegenerative diseases.

- **Coordinator:**Inria (Charles Kervrann)
- **Partners:**Inria (Serpico, Beagle, Fluminance teams), INRA MaIAGE Unit Jouy-en-Josas, Institut Curie (UMR 144 CNRS & U1143 Inserm UMR 3666) Paris
- **Funding:**ANR (Agence Nationale de la Recherche) PRC (Collaborative Research Project)
- **Total amount:**440 Keuros (Inria Serpico: 170 Keuros).

9.3. European Initiatives

9.3.1. Major European Organizations with which the Team have followed Collaborations

ESFRI Euro-BioImaging initiative: SERPICO participates in the ESFRI Euro-BioImaging project, one of the four new biomedical science projects in the roadmap of the European Strategic Forum on Research Infrastructures (ESFRI). The mission of Euro-BioImaging is to provide access, service and training to state-of-the-art imaging technologies and foster the cooperation and networking at the national and European level including multidisciplinary scientists, industry, regional, national and European authorities. SERPICO also participates to the French counterpart, the so-called “France-BioImaging” (FBI) network which gathers several outstanding cellular imaging centers (microscopy, spectroscopy, probe engineering and signal processing) as described in Section 9.2.1 .

- **Coordinator:** EMBL (Jan Ellenberg, Heidelberg, Germany)
- **Partners:** 15 european countries in 2017
- **Funding:** Member states of the European Union

9.4. International Initiatives

9.4.1. Informal International Partners

Collaboration with Max-Planck Institute, Martinsried (Germany), Dr. Julio Ortiz and Antonio Martinez: Detection and segmentation of macromolecules in cryo-electron tomography (project in progress with Emmanuel Moebel and Charles Kervrann).

Collaboration with Aalborg University (Denmark), Prof. Rasmus Waagepetersen: Estimating equations for inhomogeneous determinantal point processes (project with Frédéric Lavancier).

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

9.4.2.1. CytoDI Inria Associated-Team

Title: Quantitative Imaging of Cytoskeleton Dynamics in 3D

International Partner:

University of Texas, SouthWestern Medical Center, Dallas (United States) - Gaudenz Danuser

Start year: 2016

See also: <http://serpico.rennes.inria.fr/doku.php?id=research:cytodi>

Participants: Sandeep Manandhar, Patrick Bouthemy, Charles Kervrann.

The main scientific goal of the Associated-Team is the spatiotemporal characterization and comparison of cytoskeleton networks involved in cell migration and observed through live cell imaging in three dimensions (3D). Those networks include the cytoskeleton, i.e., microtubules (MT), intermediate filaments (IF), dynamically resolvable by Bessel Beam Light Sheet fluorescent microscopy. The goal will be achieved through the design of local and global descriptors of the spatial conformation and deformation of the cytoskeleton. Subsequently, general metrics to compare and classify the MT and IF networks will be investigated. This study will be carried out on oncogenically transformed lung cancer epithelial cells.

The second meeting of the AT CytoDI took place in Rennes in July 2017 (visit of P. Roudot and K. Dean), to discuss and update current research direction and discuss scientific progress. Several meetings were organized with students (S. Manandhar, V. Briane, E. Moebel, T. Dubois, Q. Delannoy) to synchronize development in optical flow, co-orientation and visualization. The Danuser team focused on presenting recent imaging and analysis capacities as well as the current solution in development for the systematic analysis, contextualization and interpretation of 3D dynamics for quantitative biology.

9.5. International Research Visitors

9.5.1. Visits to International Teams

Emmanuel Moebel attended a summer school (one week): Signal Processing Meets Deep Learning (Capri, Italy, 4-8 september 2017).

Sandeep Manandhar attended a summer school (one week): VISION Understanding and Machine intelligence (Porto, Portugal, 7-14 July 2017).

SIERRA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- A. d'Aspremont: IRIS, PSL “Science des données, données de la science”.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- **ITN Spartan**

Title: Sparse Representations and Compressed Sensing Training Network

Type: FP7

Instrument: Initial Training Network

Duration: October 2014 to October 2018

Coordinator: Mark Plumbley (University of Surrey)

Inria contact: Francis Bach

Abstract: The SpaRTaN Initial Training Network will train a new generation of interdisciplinary researchers in sparse representations and compressed sensing, contributing to Europe's leading role in scientific innovation. By bringing together leading academic and industry groups with expertise in sparse representations, compressed sensing, machine learning and optimisation, and with an interest in applications such as hyperspectral imaging, audio signal processing and video analytics, this project will create an interdisciplinary, trans-national and inter-sectorial training network to enhance mobility and training of researchers in this area. SpaRTaN is funded under the FP7-PEOPLE-2013-ITN call and is part of the Marie Curie Actions — Initial Training Networks (ITN) funding scheme: Project number - 607290

- **ITN Macsenet**

Title: Machine Sensing Training Network

Type: H2020

Instrument: Initial Training Network

Duration: January 2015 - January 2019

Coordinator: Mark Plumbley (University of Surrey)

Inria contact: Francis Bach

Abstract: The aim of this Innovative Training Network is to train a new generation of creative, entrepreneurial and innovative early stage researchers (ESRs) in the research area of measurement and estimation of signals using knowledge or data about the underlying structure. We will develop new robust and efficient Machine Sensing theory and algorithms, together methods for a wide range of signals, including: advanced brain imaging; inverse imaging problems; audio and music signals; and non-traditional signals such as signals on graphs. We will apply these methods to real-world problems, through work with non-Academic partners, and disseminate the results of this research to a wide range of academic and non-academic audiences, including through publications, data, software and public engagement events. MacSeNet is funded under the H2020-MSCA-ITN-2014 call and is part of the Marie Skłodowska- Curie Actions — Innovative Training Networks (ITN) funding scheme.

- **ERC Sequoia**

Title: Robust algorithms for learning from modern data

Programm: H2020

Type: ERC

Duration: 2017-2022

Coordinator: Inria

Inria contact: Francis BACH

Abstract: Machine learning is needed and used everywhere, from science to industry, with a growing impact on many disciplines. While first successes were due at least in part to simple supervised learning algorithms used primarily as black boxes on medium-scale problems, modern data pose new challenges. Scalability is an important issue of course: with large amounts of data, many current problems far exceed the capabilities of existing algorithms despite sophisticated computing architectures. But beyond this, the core classical model of supervised machine learning, with the usual assumptions of independent and identically distributed data, or well-defined features, outputs and loss functions, has reached its theoretical and practical limits. Given this new setting, existing optimization-based algorithms are not adapted. The main objective of this project is to push the frontiers of supervised machine learning, in terms of (a) scalability to data with massive numbers of observations, features, and tasks, (b) adaptability to modern computing environments, in particular for parallel and distributed processing, (c) provable adaptivity and robustness to problem and hardware specifications, and (d) robustness to non-convexities inherent in machine learning problems. To achieve the expected breakthroughs, we will design a novel generation of learning algorithms amenable to a tight convergence analysis with realistic assumptions and efficient implementations. They will help transition machine learning algorithms towards the same widespread robust use as numerical linear algebra libraries. Outcomes of the research described in this proposal will include algorithms that come with strong convergence guarantees and are well-tested on real-life benchmarks coming from computer vision, bioinformatics, audio processing and natural language processing. For both distributed and non-distributed settings, we will release open-source software, adapted to widely available computing platforms.

8.3. International Initiatives

8.3.1. BigFOKS2

Title: Learning from Big Data: First-Order methods for Kernels and Submodular functions

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Computer Science Department - Chiranjib Bhattacharyya

Start year: 2016

See also: <http://mllab.csa.iisc.ernet.in/indo-french.html>

Recent advances in sensor technologies have resulted in large amounts of data being generated in a wide array of scientific disciplines. Deriving models from such large datasets, often known as “Big Data”, is one of the important challenges facing many engineering and scientific disciplines. In this proposal we investigate the problem of learning supervised models from Big Data, which has immediate applications in Computational Biology, Computer vision, Natural language processing, Web, E-commerce, etc., where specific structure is often present and hard to take into account with current algorithms. Our focus will be on the algorithmic aspects. Often supervised learning problems can be cast as convex programs. The goal of this proposal will be to derive first-order methods which can be effective for solving such convex programs arising in the Big-Data setting. Keeping this broad goal in mind we investigate two foundational problems which are not well addressed in existing literature. The first problem investigates Stochastic Gradient Descent Algorithms in the context of First-order methods for designing algorithms for Kernel based prediction functions on Large Datasets. The second problem involves solving discrete optimization problems arising in Submodular formulations in Machine Learning, for which first-order methods have not reached the level of speed required for practical applications (notably in computer vision).

8.4. International Research Visitors

8.4.1. Internships

- Marwa El Halabi, from Jan. until Apr. 2017, EPFL, Lausanne, Switzerland
- Jonathan Weed, from Mar. 2017 until May 2017, MIT, US
- Alfredo Zermini, from Mar 2017 until June 2017, University of Surrey, UK
- Billy Tang, visited from Sept. 2017 until Dec. 2017, University of Edimburgh, UK

SIROCCO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *CominLabs/InterCom project*

Participants: Aline Roumy, Thomas Maugey.

- Title : Interactive Communication (INTERCOM): Massive random access to subsets of compressed correlated data .
- Research axis : 7.4.2
- Partners : Inria-Rennes (Sirocco team and i4S team); LabSTICC, Telecom Bretagne, Signal & Communications Department; External partner: Kieffer L2S, CentraleSupélec, Univ. Paris Sud.
- Funding : Labex CominLabs.
- Period : Oct. 2016 - Nov. 2019.

This project aims to develop novel compression techniques allowing massive random access to large databases. Indeed, we consider a database that is so large that, to be stored on a single server, the data have to be compressed efficiently, meaning that the redundancy/correlation between the data have to be exploited. The dataset is then stored on a server and made available to users that may want to access only a subset of the data. Such a request for a subset of the data is indeed random, since the choice of the subset is user-dependent. Finally, massive requests are made, meaning that, upon request, the server can only perform low complexity operations (such as bit extraction but no decompression/compression). Algorithms for two emerging applications of this problem will be developed: Free-viewpoint Television (FTV) and massive requests to a database collecting data from a large-scale sensor network (such as Smart Cities).

9.2. European Initiatives

9.2.1. *FP7 & H2020 Projects*

9.2.1.1. *ERC-CLIM*

Participants: Pierre David, Elian Dib, Simon Evain, Christine Guillemot, Laurent Guillo, Mikael Le Pendu, Xiaoran Jiang, Jinglei Shi, Xin Su, Lara Younes.

Light fields yield a rich description of the scene ideally suited for advanced image creation capabilities from a single capture, such as simulating a capture with a different focus and a different depth of field, simulating lenses with different apertures, for creating images with different artistic intents or for producing 3D views. Light fields technology holds great promises for a number of application sectors, such as photography, augmented reality, light field microscopy, but also surveillance, to name only a few.

The goal of the ERC-CLIM project is to develop algorithms for the entire static and video light fields processing chain, going from compact sparse and low rank representations and compression to restoration, high quality rendering and editing.

9.3. International Initiatives

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

Title: Graph-based Omnidirectional video Processing

International Partner (Institution - Laboratory - Researcher):

Ecole Polytechnique Fédérale de Lausanne (Switzerland) - LTS4 - Pascal Frossard

Start year: 2017

See also: <http://people.rennes.inria.fr/Thomas.Maugey/wp/projects/gop/>

Due to new camera types, the format of the video data has become more complex than simple 2D images or videos as it was the case a few years ago. In particular, the omnidirectional cameras provide pixels on a whole sphere around a center point and enable a vision in 360°. In addition to the fact that the data size explodes with such cameras, the inherent structure of the acquired signal fundamentally differs from the 2D images, which makes the traditional video codec obsolete. In parallel of that, an important effort of research has been lead recently, especially at EPFL, to develop new processing tools for signals lying on irregular structures (graphs). It enables in particular to build efficient coding tools for new types of signals. The proposed research project will actually study how graphs can be built for defining a suitable structure on one or several 360° videos and then used for compression.

The collaboration between SIROCCO (Inria) and LTS4 (EPFL) has been very active in the recent years. However, only one-to-one collaboration was involved. When opening these new ambitious research direction, the project GOP will involve more than two or three researchers, and build a bidirectional collaboration between different people of the SIROCCO and LTS4 teams.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

We have international collaborations with:

- Reuben Farrugia, Prof. at the University of Malta, with whom we continue collaborating on light field super-resolution. The collaboration started during the sabbatical year (Sept. 2015-Aug. 2016) he spent within the team.
- Ehsan Miandji and Prof. Jonas Unger from Linköping Univ. with whom we collaborate on compressive sampling of light fields. Ehsan Miandji has spent 1.5 month (June- July 2017) within the team.
- Chiara Galdi and Jean Luc Dugelay, prof. at Eurecom, with whom we collaborate on the application of light fields to biometry. Chiara Galdi has spent one month in the team (April 2017).
- Ole Johanssen and Prof. Bastian Goldluecke, from Univ. of Konstanz, with whom we collaborate on scene flow estimation with deep learning. Ole Johanssen has spent one month (Nov. 20- Dec. 20, 2017) in the team.
- The study on guided image inpainting is carried out in collaboration with Prof. Pascal Frossard from EPFL (Ecole Polytechnique Fédérale de Lausanne).

SISTM Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The team have strong links with :

- Research teams of the research center INSERM U1219 : "Injury Epidemiology, Transport, Occupation" (IETO), "Biostatistics", "Pharmacoepidemiology and population impact of drugs", "Multi-morbidity and public health in patients with HIV or Hepatitis" (MORPH3Eus), "Computer research applied to health" (ERIAS) emerging research team.
- Bordeaux and Limoges CHU ("Centre Hospitalier Universitaire").
- Institut Bergonié, Univ Bordeaux through the Euclid platform
- Inria Project-team MONC and CQFD

The project team members are involved in:

- EUCLID/F-CRIN clinical trials platform (Laura Richert)
- The research project "Self-management of injury risk and decision support systems based on predictive computer modelling. Development, implementation and evaluation in the MAVIE cohort study" funded by the Nouvelle-Aquitaine regional council (Marta Avalos).
- Phenotyping from Electronic Health Records pilot project in cooperation with with the ERIAS Inserm emerging team in Bordeaux and the Rheumatology service from the Bordeaux Hospital (Boris Hejblum)

9.2. National Initiatives

9.2.1. Labex Vaccine Research Institute (VRI)

There are strong collaborations with immunologists involved in the Labex Vaccine Research Institute (VRI) as Rodolphe Thiébaud is leading the Biostatistics/Bioinformatics division <http://vaccine-research-institute.fr>.

Collaboration with Inserm PRC (pôle Recherche clinique).

9.2.2. Expert Appraisals

- Rodolphe Thiébaud is an expert for INCA (Institut National du Cancer) for the PHRC (Programme hospitalier de recherche Clinique en cancérologie) and for the PRME (Programme de recherche médico-économique en cancérologie).
- Rodolphe Thiébaud is a member of the CNU 46.04 (Biostatistiques, informatique médicale et technologies de communication).
- Rodolphe Thiébaud is a member of the Scientific Council of INSERM.
- Mélanie Prague is an expert for ANRS (France Recherche Nord&Sud Sida-HIV Hépatites) in the CSS 3 (Recherches cliniques et physiopathologiques dans l'infection à VIH).
- Laura Richert is an expert for the PHRC (Programme hospitalier de recherche Clinique).
- Marta Avalos is an expert for L'ANSM (Agence nationale de sécurité du médicament et des produits de santé)

9.2.3. Various Partnership

The project team members are involved in:

- DRUGS-SAFE platform funded by ANSM (Marta Avalos).

- F-CRIN (French clinical research infrastructure network) was initiated in 2012 by ANR under two sources of founding "INBS/Infrastructures nationales en biologie et en santé" and "Programme des Investissements d'avenir". (Laura Richert)
- I-REIVAC is the French vaccine research network. This network is part of the "Consortium de Recherche en Vaccinologie (CoReVac)" created by the "Institut de Microbiologie et des Maladies Infectieuses (IMMI)". (Laura Richert)
- INCA (Institut National du Cancer) funded the project « Evaluation de l'efficacité d'un traitement sur l'évolution de la taille tumorale et autres critères de survie : développement de modèles conjoints. » (Principal PI Virginie Rondeau Inserm U1219, Mélanie Prague is responsible of Work package 4 mechanistic modeling of cancer: 5800 euros).
- Contrat Initiation ANRS MoDeL-CI: Modeling the HIV epidemic in Ivory Coast (Principal PI Eric Ouattara Inserm U1219 in collaboration with University College London, Mélanie Prague is listed as a collaborator).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The member of SISTM Team are involved in EHVA (European HIV Vaccine Alliance):

Program: Most information about this program can be found at <http://www.ehv-a.eu>.

Coordinator: Rodolphe Thiébaud is Work Package leader of the WP10 "Data Integration".

Other partners: The EHVA encompasses 39 partners, each with the expertise to promote a comprehensive approach to the development of an effective HIV vaccine. The international alliance, which includes academic and industrial research partners from all over Europe, as well as sub-Saharan Africa and North America, will work to discover and progress novel vaccine candidates through the clinic.

Abstract: With 37 million people living with HIV worldwide, and over 2 million new infections diagnosed each year, an effective vaccine is regarded as the most potent public health strategy for addressing the pandemic. Despite the many advances in the understanding, treatment and prevention of HIV made over the past 30 years, the development of broadly-effective HIV vaccine has remained unachievable. EHVA plans to develop and implement:

Discovery Platform with the goal of generating novel vaccine candidates inducing potent neutralizing and non-neutralizing antibody responses and T-cell responses

Immune Profiling Platform with the goal of ranking novel and existing (benchmark) vaccine candidates on the basis of the immune profile

Data Management/Integration/Down-Selection Platform, with the goal of providing statistical tools for the analysis and interpretation of complex data and algorithms for the efficient selection of vaccines

Clinical Trials Platform with the goal of accelerating the clinical development of novel vaccines and the early prediction of vaccine failure.

The member of SISTM Team and particularly Laura Richert are also involved in other H2020 projects such as SenseCog, Medit'aging and Orthunion.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: The EBOVAC2 project is one of 8 projects funded under IMI Ebola+ programme that was launched in response to the Ebola virus disease outbreak. The project aims to assess the safety and efficacy of a novel prime boost preventive vaccine regimen against Ebola Virus Disease (EVD).

Project acronym: EBOVAC2

Project title: EBOVAC2

Coordinator: Rodolphe Thiébaut

Other partners: Inserm (France), Labex VRI (France), Janssen Pharmaceutical Companies of Johnson & Johnson, London School of Hygiene & Tropical Medicine (United Kingdom), The Chancellor, Masters and Scholars of the University of Oxford (United Kingdom), Le Centre Muraz (Burkina Faso), Inserm Transfert (France)

Abstract: Given the urgent need for an preventive Ebola vaccine strategy in the context of the current epidemic, the clinical development plan follows an expedited scheme, aiming at starting a Phase 2B large scale safety and immunogenicity study as soon as possible while assuring the safety of the trial participants.

Phase 1 trials to assess the safety and immunogenicity data of the candidate prime-boost regimen in healthy volunteers are ongoing in the UK, the US and Kenya and Uganda. A further study site has been approved to start in Tanzania. Both prime-boost combinations (Ad26.ZEBOV prime + MVA-BN-Filo boost; and MVA-BN-Filo prime + Ad26.ZEBOV boost) administered at different intervals are being tested in these trials.

Phase 2 trials (this project) are planned to start as soon as the post-prime safety and immunogenicity data from the UK Phase I are available. Phase 2 trials will be conducted in healthy volunteers in Europe (France and UK) and non-epidemic African countries (to be determined). HIV positive adults will also be vaccinated in African countries. The rationale for inclusion of European volunteers in Phase 2, in addition to the trials in Africa, is to allow for higher sensitivity in safety signal detection in populations with low incidence of febrile illnesses, to generate negative control specimens for assay development, to allow for inclusion of health care workers or military personnel that may be deployed to Ebola-endemic regions.

9.3.3. Collaborations with Major European Organizations

University of Oxford;

London School of Hygiene and Tropical Medicine;

University Hospital Hamburg;

Heinrich Pette Institute for Experimental Virology, Hambourg;

MRC, University College London

9.4. International Initiatives

9.4.1. Inria International Labs

Fred Hutchinson Cancer center, Seattle;

Baylor Institute for Immunology (Dallas);

Duke University;

Collaborations through clinical trials: NIH for the Prevac trial, NGO Alima for the Prevac trial, Several African clinical sites for Ebovac2 and Prevac trials;

NIH program project grant "Revealing Reservoirs During Rebound", Harvard School of Public Health (HSPH) and the University of California, San Diego (P01AI131385, total budget \$1.5M/yr for 5 years starting Oct 2017, both university manage the funding. Mélanie Prague is part of modelling unit of the "Quantitative Methods" research project (budget \$220,000/yr). The principal investigator for this core is Victor de Grutolla (HSPH) The overall goal of this grant is to characterize viral rebound following antiretroviral therapy cessation in cohorts of patients who have started therapy early in infection, as well as in a cohort of terminally-ill patients who will interrupt therapy before death and subsequently donate their bodies to research.

Project submitted by the Inria DYNMO-HIVE team with the laboratory “Program for evolutionary Dynamics” at Harvard (head Martin Nowak).

Denis Agniel from the RAND Corporation on developing statistical methods for the analysis of RNA-seq data (Boris Hejblum).

Tianxi Cai from Harvard University on developing methods for the linkage and analysis of Electronic Health Records data (Boris Hejblum).

Katherine Liao from Harvard University on the analysis of Electronic Health Records data in the context of Rheumatoid Arthritis (Boris Hejblum).

Machine learning team Data61 at CSIRO, Australia

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Alison Hill from “Program for evolutionary Dynamics” at Harvard visited the SISTM team twice (each time for 5 days) in May 2017 and July 2017. Main topic discussed was mechanistic modelling of new agents in HIV cure.

Linda Valeri from “Harvard medical school” visited the SISTM team 3 days. Main topic discussed was mediation analysis in high dimension.

Denis Agniel (RAND Corporation) visited B. Hejblum in Bordeaux for a week in May for a research collaboration

Visiting PhD student from Marcus Altfeld’s team: Annika Niehrs (2 week stay with SISTM).

9.5.2. Visits to International Teams

Marta Avalos visited David Conesa 1 week in October through the Erasmus+ program Universidad de Valencia (Espagne).

Mélanie Prague got invited in University of Pennsylvania (Philadelphia) for a 2-days research trip in the Biostatistics department on April 2-3 2017.

Mélanie Prague spend 10 days in Boston as an invited researcher in Harvard School of Public Health, Biostatistics department on April 10-15 2017.

Boris Hejblum visited Harvard University for a week in November 2017 for a research collaboration with Katherine Liao & Tianxi Cai.

9.5.2.1. Research Stays Abroad

Marta Avalos was a research visitor at CSIRO’s Data61 in Canberra, Australia from Dec. 2016 until June 2017. Collaboration with Cheng Soon Ong <http://www.ong-home.my/>

Perrine Soret was a research student visitor at CSIRO’s Data61 in Canberra (Australia) from Feb. 2017 to April 2017. Collaboration with Cheng Soon Ong. Funding: The University of Bordeaux Initiative of Excellence and Zellidja travel grants for a research visit of 3 months.

SOCRATE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Equipex FIT- Future Internet of Things

The FIT project is a national equipex (*équipement d'excellence*), headed by the Lip6 laboratory. As a member of Inria, Socrate is in charge of the development of an Experimental Cognitive Radio platform that is used as test-bed for SDR terminals and cognitive radio experiments. This has been operational since 2014 and is maintained for a duration of 7 years. To give a quick view, the user will have a way to configure and program through Internet several SDR platforms (MIMO, SISO, and baseband processing nodes).

8.1.2. 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.

8.1.3. 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.

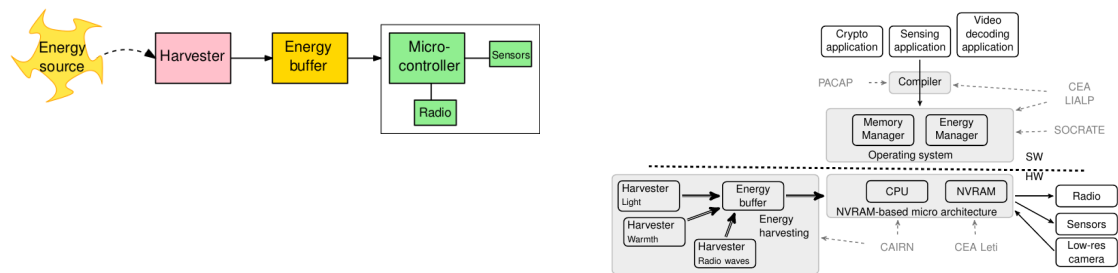


Figure 6. Example of system targeted by the ZEP project on the left, and on the right: the ZEP research program.

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 6, 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.

8.1.4. ANR - MetalibM

The goal of the MetalibM - “Automatic Generation of Function and Filters” (2014-2017, 200 keuros) project is to provide a tool for the automatic implementation of mathematical (libm) functions. A function f is automatically transformed into machine-proven C code implementing an polynomial approximation in a given domain with given accuracy. This project is led by Inria, with researchers from Socrate and AriC; PEQUAN team of Laboratoire d’Informatique de Paris 6 (LIP6) at Université Pierre et Marie Curie, Paris; DALI team from Université de Perpignan Via Domitia and Laboratoire d’Informatique, Robotique et Microélectronique de Montpellier (LIRMM); and SFT group from Centre Européen de Recherche Nucléaire (CERN).

8.1.5. ADT Sytare

The SYTARE project (Développement d’un SYStème embArqué faible consommation à mémoiRE persistante - ADT Inria 2015-2017) aims to develop and study novel operating system mechanisms for NVRAM-based embedded systems. The term NVRAM collectively describes an emerging generation of memory technologies which are both non-volatile and byte-addressable. These two properties together make the classical RAM+ROM memory architecture obsolete, and enable the design of embedded systems running on intermittent power. This is very attractive in the context of energy-constrained scenarios, for instance systems harvesting their power from the environment. But working with NVRAM also poses novel challenges in terms of software programming. For instance, application state consistency must be guaranteed accross reboots, even though the system includes both NVRAM and volatile elements (e.g. CPU, hardware peripherals). The SYTARE project is funded by Inria via the ADT program.

8.1.6. ADT CorteXlab

The Socrate project-team is in charge of the FIT/CorteXlab platform (section 5.6). This platform (ADT Inria 2015-2017) makes use of many complex technologies from signal processing to computer science through micro-electronics and FPGA. The objective of the CorteXlab ADT is to maintain a support to the user of the FPGA-based platform of CorteXlab and to provide tutorial and running experiment that will help them in building experimentation using the PicoSDR machines.

8.1.7. ANR - Ephyl

The general objective of the project EPHYL - “Enhanced PHY for Cellular Low Power Communication IoT” (2016-2019, 183 keuros) is to investigate coming and future LPWA technologies with the aim to improve coverage, data rate and connectivity while keeping similar level of complexity and power consumption at the node for the access. New waveforms enablers will be investigated and trialled in order to increase the efficiency of future systems and to provide efficient and fair access to the radio resource. The proposed new waveforms should comply with system constraints and with the coexistence of multiple communications.

8.1.8. ANR - Arburst

In this project Arburst - “Achievable region of bursty wireless networks” (2016-2020, 195 KEuros), we propose an original approach complementary to other existing projects. Instead of proposing one specific technical solution, our objective is to define a unified theoretical framework devoted to the study of IoT networks fundamental limits. We aim at establishing the fundamental limits for a decentralized system in a bursty regime which includes short packets of information and impulsive interference regime. We are targeting the fundamental limits, their mathematical expression (according to the usual information theory framework capturing the capacity region by establishing a converse and achievability theorems). We will use the recent results relative to finite block-length information theory and we will evaluate the margin for improvement between existing approaches and these limits and we will identify the scientific breakthrough that may bring

significant improvements for IoT/M2M communications. This project will contribute to draw the roadmap for the development of IoT/M2M networks and will constitute a unified framework to compare existing techniques, and to identify the breakthrough concepts that may afford the industry the leverage to deploy IoT/M2M technical solutions.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CYBERNETS

Title: Cybernetic Communication Networks: Fundamental Limits and Engineering Challenges

Programm: H2020

Duration: June 2015 - June 2017

Coordinator: Inria

Inria contact: Samir M. Perlaza

This Reintegration Panel proposal, CYBERNETS, focuses on the study of Cybernetic Communication Networks (CCN). CCNs are wireless networks that are context-aware, possess learning capabilities and artificial intelligence to guarantee reliability, efficiency and resilience to changes, failures or attacks via autonomous, self-configuring and self-healing individual and network behavior. Typical examples of CCNs are beyond-5G cellular systems and critical communication systems, e.g., law enforcement, disaster relief, body- area, medical instruments, space, and indoor/outdoor commercial applications. A practical implementation of a CCN requires extending classical communication systems to embrace the dynamics of fully decentralized systems whose components might exhibit either cooperative, non-cooperative or even malicious behaviors to improve individual and/or global performance. In this context, CYBERNETS aims to develop a relevant understanding of the interactions between information theory, game theory and signal processing to tackle two particular problems from both theoretical and practical perspectives: (I) use of feedback and (II) behavior adaptation in fully decentralized CCNs. In the former, the main objectives are: (i) to determine the fundamental limits of data transmission rates in CCNs with feedback; and (ii) to develop and test in real-systems, transmit-receive configurations to provide a proof-of-concept of feedback in CCNs. For the achievement of these practical objectives, CYBERNETS relies on the world-class testbed infrastructure of Inria at the CITI Lab for fully closing the gap between theoretical analysis and real-system implementation. In the latter, the main objectives are: (i) to identify and explore alternatives for allowing transmitter-receiver pairs to learn equilibrium strategies in CCNs with and without feedback; (ii) to study the impact of network-state knowledge on scenarios derived from the malicious behavior of network components.

8.2.1.2. COM-MED

Title: COMMunication systems with renewable Energy micro-grid

Programm: H2020

Duration: October 2016 - October 2019

Coordinator: Inria

Inria contact: Samir M. Perlaza

A smart micro-grid is a small-scale power-grid system consisting of a number of distributed energy sources and loads which is responsible to ensure power sufficiency in a small area. The effectiveness of a smart micro-grid depends on the proper implementation of a communications and networking system which monitors, controls and manages the grid's operations. Due to the ever growing worldwide energy consumption, the need of an efficient framework for managing the way power is distributed and utilized has increased. The main objective of the project COM-MED is to study the

fundamental interplay between communications and power networks in the context of smart micro-grids and renewable energy sources. On one hand, we study advanced signal processing techniques and communications methods to optimize the operation of smart micro-grid systems. On the other hand, we focus on mobile communications networks with renewable energy base-stations (BSs) and we investigate communications and networking techniques that take into account both data traffic and energy profiles to support high quality-of-service (QoS). The objectives of each technical WP have been assigned in such a way as to ensure that the project's target is realized during the project's time period. The theoretical results derived from the WPs 3, 4 and 5 will be tested using the telecommunication network of MTN in Cyprus but also the state-of-the-art equipment of the CITI/Inria research lab in France. The outcome of this project will provide a theoretical framework for the optimal cooperation between communications networks and power networks in the context of smart micro-grids and renewable energy sources. This is in line with the objectives of the call's theme "Renewable Energy" and is of paramount importance for the Mediterranean area. The consortium of the project has the expertise and the infrastructure to implement the objectives set and to bring the project to a successful end.

8.2.2. 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 identified as one of the COST platform: .

8.3. International Initiatives

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

8.3.1.1. CoWIN

Title: Cognitive Wireless Networks from Theory to Implementation

International Partner (Institution - Laboratory - Researcher):

Princeton (United States) - electrical engineering department - H. Vincent Poor

Start year: 2015

See also: <https://project.inria.fr/cowin/>

The objective of this team is to strengthen the research efforts on emerging software radio and cognitive radio technologies. The team will count on: first, the cognitive radio test-bed CorteXlab recently set up by the Socrate team within the FIT Equipex, second the leading position of Vincent Poor's team in the field of network information theory and third the Orbit Platform of Rutgers university. The goal is to lead research in both the information theory community and the applied research community so as to reinforce the link between both communities. This work will concern architecture and programs of software radio equipments, distributed and cognitive algorithms for radio resource allocation, cognitive radio scenario experimentations, fundamental limits of cooperative wireless channels and the set up of common experimental infrastructure and protocols for research on cognitive wireless networks.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Socrate has strong collaborations with several international partners.

- **Princeton University**, School of Applied Science, Department of Electrical Engineering, NJ. USA. This cooperation with Prof. H. Vincent Poor is on topics related to decentralized wireless networks. Samir M. Perlaza has been appointed as Visiting Research Collaborator at the EE Department for the academic period 2016-2017. Scientific-Leaders at Inria: Samir M. Perlaza and Jean-Marie Gorce.
- **Technical University of Berlin**, Dept. of Electrical Engineering and Computer Science, Germany. This cooperation with Prof. Rafael Schaffer is on secrecy and covert communications. Scientific-Leaders at Inria: Samir M. Perlaza.

- **National University Singapore (NUS)**, Department of Electrical and Computer Engineering, Singapore. This collaboration with Prof. Vincent Y. F. Tan is on the study of finite block-length transmissions in multi-user channels and the derivation of asymptotic capacity results with non-vanishing error probabilities. Scientific-Leaders at Inria: Samir M. Perlaza
- **University of Sheffield**, Department of Automatic Control and Systems Engineering, Sheffield, UK. This cooperation with Prof. Inaki Esnaola is on topics related to information-driven energy systems and multi-user information theory. Scientific-in-charge at Inria: Samir M. Perlaza.
- **Rutgers University**, Winlab, Orbit testbed. This cooperation with Ivan Seskar is related to experimental wireless testbed. Orbit has been one of the first wireless testbeds of its type. Tanguy Risset and Leonardo Sampaio-Cardoso have visited Winlab and I. Seskar visited the Socrate team for one week. Their collaboration is on the development of tools to ease experiment handling on wireless testbeds: visualisation, synchronization etc. Scientific-Leader at Inria: Tanguy Risset
- **University of Arizona**, Department of Electrical and Computer Engineering, Tucson, AZ, USA. This cooperation with Prof. Ravi Tandon is on topics related to channel-output feedback in wireless networks. Scientific-Leader at Inria: Samir M. Perlaza.
- **University of Cyprus**, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus. This cooperation with Prof. Ioannis Krikidis is on topics related to energy-harvesting and wireless communications systems. Scientific-Leaders at Inria: Guillaume Villemaud and Samir M. Perlaza.
- **Universidade Federal do Ceará**, GTEL, Departamento de Teleinformática, Fortaleza, Brazil. This recently started cooperation with Prof. Tarcisio Ferreira Maciel is on topics related to the optimization of radio resources for massive MIMO in 5G and 5G-like wireless communications systems. Scientific-in-charge at Inria: Leonardo Sampaio-Cardoso.
- **Universidad Nacional del Sur**, LaPSyC laboratory, Bahía Blanca, Argentina. This cooperation with Prof. Juan Cousseau is on topics related to Full-Duplex communications and Interference Alignment. Scientific-in-charge at Inria: Guillaume Villemaud.
- **Bell Labs New Jersey, USA**, This cooperation with Prof. Antonia Tulino (affiliated to Bell Labs and to University of Napoli, Italy) is on caching in wireless networks. The objective is to demonstrate the efficiency of caching at the edge of wireless networks through experimentations on CorteXlab. This work will be published in 2017 in a special issue of IEEE Communication magazine (Yasser Fadlallah, Antonia M. Tulino, Dario Barone, Giuseppe Vettigli, Jaime Llorca and Jean-Marie Gorce: Coding for caching in 5G networks, IEEE Communication Magazine, 2017, accepted for publication). Scientific leader at Inria : Jean-Marie Gorce.
- **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

8.4. International Research Visitors

- 2 month visit of Tarcisio F. Maciel (Federal University of Ceará, Brazil), working with Leonardo Sampaio-Cardoso on Radio Resource Allocation for Multi-User Communications: Background and Initial Perspectives for Joint Research on Resource Allocation & Massive MIMO.
- Visite and Talk of mme. Tarniceriu Technical University "Gh. Asachi" of Iasi in June.
- Visit and Talk of Mischa Dohler (King's College London) and Visa Koivunen (Aalto University, Finland) for HDR of Claire Goursaud.
- Visit and Talk of Gerhard Kramer (Technical University of Munich) for the PhD defense of Victor Quintero.

8.4.1. Visits to International Teams

8.4.1.1. Sabbatical programme

Samir M. Perlaza is currently on Sabbatical year at Princeton University since July 2017.

8.4.2. Internship

- Clarissa Arraes Herculano, INSA Lyon, from Apr 2017 until Aug 2017.
- Romain Fontaine, Inria, from Jun 2017 until Jul 2017
- Fatimazhra Kninech, INSA Lyon, from Mar 2017 until Aug 2017
- Ivan Kolodziejczyk, INSA Lyon, from May 2017 until Jul 2017
- Daniel Krebs, INSA Lyon, from Apr 2017 until Sep 2017
- Thibaud Vial Nokia, from Apr 2017 until Aug 2017.

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, Xavier Nicollin, Stephan Plassart, Sophie Quinton, Jean-Bernard Stefani.

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

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

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

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

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

8.2. National Initiatives

8.2.1. ANR

An ANR-PRCI project called RT-PROOFS will start in 2018, which involves the SPADES project-team, MPI-SWS, TU Braunschweig, and Onera.

8.3. European Initiatives

8.3.1. *Collaborations with Major European Organizations*

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

We also have a recent collaboration with the MPI-SWS in Kaiserslautern (Germany) on formal proofs for real-time systems. This collaboration will be concretized by an ANR-PRCI project called RT-PROOFS starting 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. Causalysis

Title: Causality Analysis for Safety-Critical Embedded Systems

International Partner (Institution - Laboratory - Researcher):

University of Pennsylvania (United States) - PRECISE center - Oleg Sokolsky

Start year: 2015

See also: <https://team.inria.fr/causalalysis/>

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

SPECFUN Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

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

7.2. International Research Visitors

7.2.1. Visits of International Scientists

- Marni Mishna (Simon Fraser University) visited the team for one week in January.
- Emre Sertöz (Max Planck Institute Leipzig) visited the team for one week in November. He worked with Pierre Lairez on applications to algebraic geometry of two tools developed at Specfun: the computations of periods (Lairez's PhD) and numerical analytic continuation (Mezzarobba's PhD, 2011).
- Karen Yeats (Simon Fraser University) visited the team for a few days in June. She continued a work on bijective combinatorics of words with Frédéric Chyzak. A text is now under writing.

7.2.1.1. Internships

- Pascal Fong did a Master internship from March to August. Under the supervision of Pierre Lairez and Mohab Safey El Din (UPMC), he studied the numerical computation of the length of plane algebraic curves.
- Rémy Garnier did a Master internship from March to July. Under the supervision of Alin Bostan and Frédéric Chyzak, he studied existing algorithms to solve linear differential systems for their rational-function solutions.
- Meissa M'baye did a Master internship from February to June. Under the remote supervision of Assia Mahboubi, he studied the principles of proof assistants and surveyed formalization methodologies for elementary number theory.

7.2.2. Visits to International Teams

- Frédéric Chyzak and Alin Bostan have been invited by the Erwin Schrödinger Institute (Vienna, Austria) for two weeks, to participate to the thematic program "Algorithmic and Enumerative Combinatorics" <http://www.mat.univie.ac.at/~kratt/esi4/>.
- Pierre Lairez visited Felipe Cucker (City University of Hong Kong) for two weeks. The outcome is a strengthened collaboration on the study of the complexity of numerical algorithms. A publication is in preparation: the second part of [10].
- Georges Gonthier was invited at the Newton Institute, for six weeks, as co-organiser and participant to the Big Proof thematic program.
- Assia Mahboubi visited Sander Dahmen (VU Amsterdam, The Netherlands) for three days. She has started a collaboration with his team, to obtain formal guarantees of computations for number theory.
- Assia Mahboubi has been invited by the Newton Institute (Cambridge, UK) for one month. She participated to the Big Proof thematic program.

SPHINX Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **Project Acronym :** iproblems
Project Title : Inverse Problems
Coordinator : David Dos Santos Ferreira
Duration : 48 months (2013-2017)
Partner: Institut Élie Cartan de Lorraine
URL: <http://www.agence-nationale-recherche.fr/Projet-ANR-13-JS01-0006>
- **Project Acronym :** IFSMACS
Project Title : Fluid-Structure Interaction: Modeling, Analysis, Control and Simulation
Coordinator: Takéo Takahashi
Participants: Julien Lequeur, Alexandre Munnier, Jean-François Scheid, Takéo Takahashi
Duration : 48 months (starting on October 1st, 2016)
Other partners: Institut de Mathématiques de Bordeaux, Inria Paris, Institut de Mathématiques de Toulouse
Abstract: The aim of this project is to analyze systems composed by structures immersed in a fluid. Studies of such systems can be motivated by many applications (motion of the blood in veins, fish locomotion, design of submarines, etc.) but also by the corresponding challenging mathematical problems. Among the important difficulties inherent to these systems, one can quote nonlinearity, coupling, free-boundaries. Our objectives include asymptotic analyses of FSIS, the study of controllability and stabilizability of FSIS, the understanding of locomotion of self-propelled structures and the analyze and development of numerical tools to simulate fluid-structure system.
URL: <http://ifsmacs.iecl.univ-lorraine.fr/>
- Xavier Antoine is member of the project TECSER funded by the French armament procurement agency in the framework of the Specific Support for Research Works and Innovation Defense (ASTRID 2013 program) operated by the French National Research Agency.
Project Acronym: TECSER
Project Title : Nouvelles techniques de résolution adaptées à la simulation haute performance pour le calcul SER
Coordinator: Stéphane Lanteri (Inria, NACHOS project-team)
Duration: 36 months (starting on May 1st, 2014)
Other partners: EADS (France Innovation Works Dep.), NUCLETUDES
URL: <http://www-sop.inria.fr/nachos/projects/tecser/index.php/Main/HomePage>
- **Project Acronym:** BoND
Project Title: Boundaries, Numerics and Dispersion.
Coordinator: Sylvie Benzoni (Institut Camille Jordan, Lyon, France)
Participant: Xavier Antoine
Duration: 48 months (starting on October 15th, 2013)
URL: <http://bond.math.cnrs.fr>

- Xavier Antoine is the local coordinator of the ANR project BECASIM.
Project acronym: BECASIM
Project Title: Bose-Einstein Condensates: Advanced SIMulation Deterministic and Stochastic Computational Models, HPC Implementation, Simulation of Experiments.
Coordinator: Ionut Danaila (Université de Rouen, France)
Participant: Xavier antoine
Duration: 48 months (plus an extension of 12 months, until November 2017)
Other partners: Laboratoire de Mathématiques Raphaël Salem, (Université de Rouen); Laboratoire Jacques-Louis Lions (Université Pierre et Marie Curie); Centre de Mathématiques Appliquées (Ecole Polytechnique); Centre d'Enseignement et de Recherche en Mathématiques et Calcul Scientifique (École des Ponts ParisTech); Loria; Laboratoire Paul Painlevé (Université Lille 1) et Inria-Lille Nord-Europe; Institut de Mathématiques et de Modélisation de Montpellier (Université Montpellier 2)
URL: <http://becasim.math.cnrs.fr>
- **Project Acronym:** QUACO
Project title: use of geometrical tools for the control of quantum system and application to MRI.
Coordinator: Thomas Chambrion
Duration: 48 months (starting January 1st 2018).
- **Project acronym:** ISDEEC
Project title: Interaction entre Systèmes Dynamiques, Equations d'Evolution et Contrôle
Coordinator: Romain Joly
Participant: Julie Valein
Other partners: Institut Fourier, Grenoble; Département de Mathématiques d'Orsay
Duration: 36 months (2017-2020)
URL: <http://isdeec.math.cnrs.fr/>

9.1.2. CNRS

Thomas Chambrion is the coordinator of the Research Project from CNRS Inphynity "DISQUO" (5300 euros, 2017).

9.2. International Initiatives

9.2.1. Participation in Other International Programs

D. Dos Santos Ferreira and J.-F. Scheid are members of the PHC Utique program ...

Program: PHC Utique

Project title: Équations aux Dérivées Partielles Déterministes et Stochastiques

Duration: January 2017-January 2020

Other partners: Laboratoire de Modélisation Déterministe et Aléatoire (LAMDA), École Supérieure des Sciences et de la Technologie de Hammam Sousse (ESSTHS), Université de Sousse, Tunisie.

Abstract: The main objective of this project is to study some systems of Ordinary Differential Equations (ODE) and Partial Differential Equations (PDE) in a deterministic and stochastic frameworks with analytical, numerical, probabilistic or statistical methods. A typical system considered in this project is the modeling and the numerical simulations of the myocardial infarction (heart attack). This phenomenon is studied as a fluid/structure interaction type process between the blood, the cholesterol deposit along the walls of an artery and the rupture of the atherosclerotic plaque formed by the cholesterol.

This is a project for a French-Tunisian collaboration and it involved a PhD thesis co-advised by J.-F. Scheid.

J. Valein is member of the project ICoPS:

Program: MATH-AmSud

Project acronym: ICoPS

Project title: Inverse and control problems for physical systems

Duration: 01/2017-12/2018

Coordinators: Alberto Mercado (Valparaíso, Chile), Emmanuelle Crépeau (Versailles), Daniel Alfaro (Rio de Janeiro, Brasil), Ivonne Rivas (Colombia)

Other partners: Centre Automatique et Systèmes (École des Mines de Paris), LAAS (Toulouse), Instituto de Matemática, Estadística e Física (Universidade Federal do Rio Grande do Sul, Brasil), Departamento de Matemáticas y Estadística, (Universidad Icesi, Pance, Cali, Colombia)

Abstract: We propose to study well-posedness, control properties, and coefficient inverse problems for partial differential equations appearing in models for several phenomena. We intend to study the inverse problems of recovering some coefficients in the previously mentioned equations, and also in nonlinear dispersive waves on trees, which appears for instance in model for the cardiovascular system. We intend to study numerical approximations, using numerical schemes like Galerkin, colocation, finite difference, among others. Finally, this proposal includes the determination of the reachable states in a control problem of KdV equation.

9.3. International Research Visitors

J.-F. Scheid has been visitor of the l'ESSTHS (Hammam-Sousse, Tunisia) for two weeks (work related to the thesis of Imen JBILI) and course on numerical methods for the Navier-Stokes equations).

9.3.1. Visits of International Scientists

Sorin Micu (University of Craiova) was an invited professor (University of Lorraine) from 12/01/2017 to 12/02/2017.

SPIRALS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Région Hauts-de-France

9.1.1.1. Citizen Awareness and Contribution to Air Quality Monitoring

Participants: Moncef Ouadia, Romain Rouvoy [correspondant], Lionel Seinturier, Antoine Veuiller.

This is a 3-year project (2015–17) in the context of the so-called "*Chercheur citoyen*" program. The partners are LISIC/Université Côte d'Opale (leader), ATMO Nord-Pas De Calais, Association Bâisseurs d'Economie Solidaire. This project targets the distributed monitoring of air quality with crowd-sensing solutions obtained via sensors connected to smart devices. We aim at inciting citizens to perform their own measures, and to obtain thanks to GPS geo-localization a large-scale database and a dynamic fine-grained cartography of air quality. This project takes advantage of the APISENSE[®] crowdsensing platform.

9.1.1.2. CIRRUS

Participants: Yahya Al-Dhuraibi, Stéphanie Challita, Guillaume Fieni, Christophe Gourdin, Philippe Merle [correspondant], Romain Rouvoy, Lionel Seinturier, Faiez Zalila.

CIRRUS is an 3-year (2017–20) joint team with the Scalair cloud operator and architect company funded by the Hauts-de-France region. The CIRRUS joint team is developing novel solutions in the domains of the on demand configuration of heterogeneous cloud resources, the management of cloud elasticity for all deployed services (SaaS, PaaS, IaaS) in order to guarantee quality of service and user quality of experience, and the taming of financial costs of cloud infrastructures.

9.1.2. Inria Lille - Nord Europe

9.1.2.1. ADT LibRepair

Participants: Benjamin Danglot, Martin Monperrus, Lionel Seinturier [correspondant], Simon Urli.

ADT LibRepair (2016–18) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of an integrated library of automated software repair algorithms and techniques. This ADT builds on our results about with the Astor, Nopol and NpeFix that have been obtained in the context of the defended PhD theses of Matias Martinez [65] and Benoit Cornu [54].

9.1.2.2. North European Lab LLEX

Participants: Martin Monperrus, Lionel Seinturier [correspondant].

North European Lab LLEX (2015–17) is an international initiative supported by the Inria Lille - Nord Europe Center that takes place in the context of a collaboration between Inria and University College London. LLEX deals with research on automatic diagnosis and repair of software bugs. Automatic software repair is the process of fixing software bugs automatically. An automatic software repair system fixes software bugs with no human intervention. The goal of automatic software repair is to save maintenance costs and to enable systems to be more resilient to bugs and unexpected situations. This research may dramatically improve the quality of software systems. The objective of the partnership is to work on the automated diagnosis of exceptions with a focus on null pointer exceptions.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR BottleNet

Participants: Romain Rouvoy [correspondant], Walter Rudametkin Ivey, Lionel Seinturier.

BottleNet is a 48-month project (2015–19) funded by ANR. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet *Quality of Experience* (QoE) and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users' devices. We plan to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

9.2.1.2. ANR SATAS

Participants: Philippe Merle [correspondant], Romain Rouvoy, Lionel Seinturier.

SATAS is a 48-month project (2015–19) funded by ANR. SATAS aims to advance the state of the art in massively parallel SAT solving with a particular eye to the applications driving progress in the field. The final goal of the project is to be able to provide a "pay as you go" interface to SAT solving services, with a particular focus on their power consumption. This project will extend the reach of SAT solving technologies, daily used in many critical and industrial applications, to new application areas, which were previously considered too hard, and lower the cost of deploying massively parallel SAT solvers on the cloud.

9.2.1.3. ANR Headwork

Participant: Pierre Bourhis [correspondant].

Headwork is a 48-month project (2016–21) funded by ANR. The main objective of Headwork is to develop data-centric workflows for programming crowd sourcing systems in flexible declarative manner. The problem of crowd sourcing systems is to fill a database with knowledge gathered by thousands or more human participants. A particular focus is to be put on the aspects of data uncertainty and for the representation of user expertise. This project is coordinated by D. Gross-Amblard from the Druid Team (Rennes 1). Other partners include the Dahu team (Inria Saclay), Sumo (Inria Bretagne), and Links (Inria Lille) with J. Nierhen and M. Sakho.

9.2.1.4. ANR Delta

Participant: Pierre Bourhis [correspondant].

Delta is a 48-month project (2016–21) funded by ANR. The project focuses on the study of logic, transducers and automata. In particular, it aims at extending classical framework to handle input/output, quantities and data. This project is coordinated by M. Zeitoun from LaBRI. Other partners include LIF (Marseille), IRIF (Paris-Diderot), and D. Gallois from the Inria Lille Links team.

9.2.2. Competitivity Clusters

9.2.2.1. FUI StoreConnect

Participants: Aurélien Bourdon, Julien Duribreux, Romain Rouvoy, Lionel Seinturier [correspondant], Antoine Veuille.

StoreConnect is a 24-month project (2016–18) funded by FUI and labelled by the PICOM (**Pôle des Industries du COMmerce**) competitiveness cluster. The partners are Tevolys, Ubudu (leader), Smile, STIME, Leroy Merlin, Insiteo, Inria Spirals, **Inria Fun**, **Inria Stars**. The goal of the project is to define a modular multi-sensors middleware platform for indoor geolocation.

9.2.3. Programme Investissement d'Avenir (PIA)

9.2.3.1. PIA OCCLware

Participants: Stéphanie Challita, Christophe Gourdin, Romain Rouvoy, Philippe Merle [correspondant], Lionel Seinturier, Faiez Zalila.

OCCIware is a 36-month project (2014–17) of the Programme Investissement d’Avenir Cloud Computing and Big Data 4th call for projects. The partners are Smile (leader), ActiveEon SA, Scalair, Institut Mines-Télécom/Télécom SudParis, Inria, Linagora GSO, Obeo, OW2 Consortium, and Université Grenoble Alpes. The project aims at defining a formal framework for managing every digital resources in the clouds, based on *Open Cloud Computing Interface* (OCCI) recommendations from *Open Grid Forum* (OGF).

9.2.4. Inria National Initiatives

9.2.4.1. Inria IPL BetterNet

Participants: Lakhdar Meftah, Romain Rouvoy [correspondant], Romain Sommerard, Antoine Veuiller.

BetterNet (2016–19) aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where: (1) tools, models and algorithms/heuristics will be provided to collect data, (2) acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society, and (3) new value-added services will be proposed to end-users. IPL BetterNet is led by Isabelle Chrisment (Inria Madynes), with the participation of the **Diana**, **Dionysos**, **Inria Chile**, **Muse**, and Spirals Inria project-teams, as well as the ARCEP French agency and the ip-label company.

9.2.5. Others

9.2.5.1. CNRS MASTODONS 2017 DoMaSQ’Air

Participants: Moncef Ouadia, Romain Rouvoy [correspondant].

DoMaSQ’Air is a 1-year project funded by the CNRS INS2I MASTODONS program on research in big data. This project gathers a pluridisciplinary team on the measurement and the continuous analysis of indoor and outdoor air quality. This project takes advantage of crowds of cheap and miniaturized sensors in relation with the Internet of Things and smart cities. In addition to the challenges raised by the massive amount of data generated by these cyber-physical systems, the project tackles questions related to the quality and privacy of data. DoMaSQ’Air is led by Romain Rouvoy with the participation of the PC2A laboratory on PhysicoChemistry of Combustion of the Atmosphere (CNRS/U. Lille) and the LISIC laboratory on Computer Science, Signal and Image (U. Côte d’Opale).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: H2020 ICT-10-2016.

Project acronym: STAMP.

Project title: Software Testing Amplification.

Duration: 36 months (2016–19).

Coordinator: Inria.

Other partners: ActiveEon (France), Atos (Spain), Engineering (Italy), OW2 (France), SINTEF (Norway), TellU (Norway), TU Delft (The Netherlands), XWiki (France).

Abstract: By leveraging advanced research in automatic test generation, STAMP aims at pushing automation in DevOps one step further through innovative methods of test amplification. It will reuse existing assets (test cases, API descriptions, dependency models), in order to generate more test cases and test configurations each time the application is updated. Acting at all steps of development cycle, STAMP techniques aim at reducing the number and cost of regression bugs at unit level, configuration level and production stage.

Participants: Benjamin Danglot, Martin Monperrus [correspondant].

Program: H2020 JU Shift2Rail.

Project acronym: X2Rail-1.

Project title: Start-up activities for Advanced Signalling and Automation System.

Duration: 36 months (2016–19).

Coordinator: Siemens.

Other partners: 19 partners, among others Bombardier, Siemens, Thales, IRT Railenium.

Abstract: Our contribution to the project is focused on adaptive communication middleware for cyber-physical railway systems.

Participants: Lionel Seinturier [correspondant].

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: EUREKA Celtic-Plus.

Project acronym: SENDATE.

Project title: SEcure Networking for a DATa Center Cloud in Europe.

Duration: 36 months (2016–19).

Coordinator: Nokia.

Other partners: 50+ partners in Finland, France, Germany, Norway, and Sweden. Selected partners involved: Nokia, Orange.

Abstract: The project addresses the convergence of telecommunication networks and IT in the context of distributed data centers. We are involved in the TANDEM subproject that targets the infrastructure of such a distributed system. More specifically, we are studying new approaches in terms of software engineering and component-based solutions for enabling this convergence of network and IT.

Participants: Lionel Seinturier [correspondant].

9.4. International Initiatives

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

9.4.1.1. SOMCA

Title: Self-Optimization of Service Oriented Architectures for Mobile and Cloud Applications

International Partner (Institution - Laboratory - Researcher):

Université du Québec À Montréal (Canada) - LATECE - Naouel MOHA

Start year: 2017

See also: <http://sofa.uqam.ca/somca.php>

The long-term goal of this research program is to propose a novel and innovative methodology embodied in a software platform, to support the runtime detection and correction of anti-patterns in large-scale service-oriented distributed systems in order to continuously optimize their quality of service. One originality of this program lies in the dynamic nature of the service-oriented environments and the application on emerging frameworks for embedded and distributed systems (e.g., Android/iOS for mobile devices, PaaS/SaaS for Cloud environments), and in particular mobile systems interacting with remote services hosted on the Cloud.

9.4.2. Participation in Other International Programs

9.4.2.1. PHC Zenon Cyprus - Project RRI-MobDev

Participants: Sarra Habchi, Lakhdar Meftah, Mohammad Naseri, Romain Rouvoy [correspondant], Walter Rudametkin Ivey, Romain Sommerard, Antoine Vastel.

RRI-MobDev (*Responsible Research and Innovation for Mobile Application Development*) is a 2-years (2017–2018) bilateral collaboration with UCLan Cyprus, an overseas campus of the University of Central Lancashire. Mobile applications are part of a complex ecosystem involving various stakeholders (developers, users, app stores, etc.) exposed to various threats, including not only malware, but also potential information leaks through the continuous interactions with remote servers. This project aims to study and alleviate this problem by intervening both with the users and the developers of mobile apps, with an aim of enabling a cleaner, safer and more responsible mobile app ecosystem.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Fernanda Madeiral Delfim, PhD Student from the Federal University of Uberlândia, Brazil, visited us from January to May 2017, and again in September 2017.

9.5.1.1. Internships

Mohammad Naseri, MSc. Student in Computer Science from Saarland University, Germany, is visiting us for 3 months, starting in November 2017.

Chaima Chakhava, MSc. Student in Computer Science from ESI Alger, Algeria, is visiting us for 6 months, starting in December 2017.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Thomas Durieux, PhD Student, spent 4 months from September to December 2017 in KTH, Sweden.

STARS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **NeuComp** is a project of the UCA Académie d'excellence: Réseaux, Information et Société Numérique" (C@UCA). NeuComp is focusing on the model of neuron networks Leaky Integrate and Fire (LIF). The main objective of C@UCA is the brain modelling and its simulation. In this framework, the Neucomp project focuses on (1) the implementation and verification of temporal properties of neural structures; (2) the design of electronic architectures of LIF neural networks; and (3) the comparison of this electronic implementation with neuromorphic computer results. In the NeuComp project, Inria (Stars) collaborate with the LEAT (Laboratoire d'Electronique, Antennes et Télécommunications), I3S (Laboratoire d'Informatique, Signaux et Systèmes), LJAD (Laboratoire J.A. Dieudonné), Clermond Ferrand University and Arizona Unniversity.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. MOVEMENT

Program: ANR CSOSG

Project acronym: MOVEMENT

Project title: AutoMatic BiOmetric Verification and PersonnEl Tracking for SeaMless Airport ArEas Security MaNagemenT

Duration: January 2014-June 2017

Coordinator: MORPHO (FR)

Other partners: SAGEM (FR), Inria Sophia-Antipolis (FR), EGIDIUM (FR), EVITECH (FR) and CERAPS (FR)

Abstract: MOVEMENT is focusing on the management of security zones in the non public airport areas. These areas, with a restricted access, are dedicated to service activities such as maintenance, aircraft ground handling, airfreight activities, etc. In these areas, personnel movements tracking and traceability have to be improved in order to facilitate their passage through the different areas, while insuring a high level of security to prevent any unauthorized access. MOVEMENT aims at proposing a new concept for the airport's non public security zones (e.g. customs control rooms or luggage loading/unloading areas) management along with the development of an innovative supervision system prototype.

9.2.1.2. SafEE

Program: ANR TESCAN

Project acronym: SafEE

Project title: Safe & Easy Environment for Alzheimer Disease and related disorders

Duration: December 2013-May 2017

Coordinator: CHU Nice

Other partners: Nice Hospital(FR), Nice University (CobTeck FR), Inria Sophia-Antipolis (FR), Aromatherapeutics (FR), SolarGames(FR), Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW), BDE (TW)

Abstract: SafeE project aims at investigating technologies for stimulation and intervention for Alzheimer patients. More precisely, the main goals are: (1) to focus on specific clinical targets in three domains behavior, motricity and cognition (2) to merge assessment and non pharmacological help/intervention and (3) to propose easy ICT device solutions for the end users. In this project, experimental studies will be conducted both in France (at Hospital and Nursery Home) and in Taiwan.

9.2.1.3. ENVISION

Program: ANR JCJC

Project acronym: ENVISION

Project title: Computer Vision for Automated Holistic Analysis of Humans

Duration: October 2017-September 2020

Coordinator: Antitza Dantcheva (Stars)

Abstract: The main objective of ENVISION is to develop the computer vision and theoretical foundations of efficient biometric systems that analyze appearance and dynamics of both face and body, towards recognition of identity, gender, age, as well as mental and social states of humans in the presence of operational randomness and data uncertainty. Such dynamics - which will include facial expressions, visual focus of attention, hand and body movement, and others, constitute a new class of tools that have the potential to allow for successful holistic analysis of humans, beneficial in two key settings: (a) biometric identification in the presence of difficult operational settings that cause traditional traits to fail, (b) early detection of frailty symptoms for health care.

9.2.2. FUI

9.2.2.1. Visionum

Program: FUI

Project acronym: Visionum

Project title: Visionum.

Duration: January 2015- December 2018.

Coordinator: Groupe Genious

Other partners: Inria(Stars), StreetLab, Fondation Ophtalmologique Rothschild, Fondation Hospital-iere Sainte-Marie.

Abstract: This French project from Industry Minister aims at designing a platform to re-educate at home people with visual impairment.

9.2.2.2. StoreConnect

Program: FUI

Project acronym: StoreConect.

Project title: StoreConnect.

Duration: September 2016 - September 2018.

Coordinator: Ubudu (Paris).

Other partners: Inria(Stars), STIME (groupe Les Mousquetaires (Paris)), Smile (Paris), Thevolys (Dijon).

Abstract: StoreConnect is an FUI project started in 2016 and will end in 2018. The goal to improve the shopping experience for customers inside supermarkets by adding new sensors such as cameras, beacons and RFID. By gathering data from all the sensors and combining them, it is possible to improve the way to communicate between shops and customers in a personalized way. StoreConnect acts as a middleware platform between the sensors and the shops to process the data and extract interesting knowledge organized via ontologies.

9.2.2.3. ReMinAry

Program: FUI

Project acronym: ReMinAry.

Project title: ReMinAry.

Duration: September 2016 - September 2019.

Coordinator: GENIOUS Systèmes,

Other partners: Inria(Stars), MENSIA technologies, Institut du Cerveau et de la Moelle épinière, la Pitié-Salpêtrière hospital.

Abstract: This project is based on the use of motor imagery (MI), a cognitive process consisting of the mental representation of an action without concomitant movement production. This technique consists in imagining a movement without realizing it, which entails an activation of the brain circuits identical to those activated during the real movement. By starting rehabilitation before the end of immobilization, a patient operated on after a trauma will gain rehabilitation time and function after immobilization is over. The project therefore consists in designing therapeutic video games to encourage the patient to re-educate in a playful, autonomous and active way in a phase where the patient is usually passive. The objective will be to measure the usability and the efficiency of the reeducative approach, through clinical trials centered on two pathologies with immobilization: post-traumatic (surgery of the shoulder) and neurodegenerative (amyotrophic lateral sclerosis).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. CENTAUR

Title: Crowded ENvironments moniToring for Activity Understanding and Recognition

Programm: FP7

Duration: January 2013 - December 2016

Coordinator: Honeywell

Partners:

Ecole Polytechnique Fédérale de Lausanne (Switzerland)

Honeywell, Spol. S.R.O (Czech Republic)

Neovision Sro (Czech Republic)

Queen Mary University of London (United Kingdom)

Inria contact: François Brémond

We aim to develop a network of scientific excellence addressing research topics in computer vision and advancing the state of the art in video surveillance. The cross fertilization of ideas and technology between academia, research institutions and industry will lay the foundations to new methodologies and commercial solutions for monitoring crowded scenes. Research activities will be driven by specific sets of scenarios, requirements and datasets that reflect security operators' needs for guaranteeing the safety of EU citizens. CENTAUR gives a unique opportunity to academia to be exposed to real life dataset, while enabling the validation of state-of-the-art video surveillance methodology developed at academia on data that illustrate real operational scenarios. The research agenda is motivated by ongoing advanced research activities in the participating entities. With Honeywell as a multi-industry partner, with security technologies developed and deployed in both its Automation and Control Solutions and Aerospace businesses, we have multiple global channels to exploit the developed technologies. With Neovision as a SME, we address small fast paced local markets, where the quick assimilation of new technologies is crucial. Three thrusts identified will enable the monitoring of crowded scenes, each led by an academic partner in collaboration

with scientists from Honeywell: a) multi camera, multicoverage tracking of objects of interest, b) Anomaly detection and fusion of multimodal sensors, c) activity recognition and behavior analysis in crowded environments. We expect a long term impact on the field of video surveillance by: contributions to the state-of-the-art in the field, dissemination of results within the scientific and practitioners community, and establishing long term scientific exchanges between academia and industry, for a forum of scientific and industrial partners to collaborate on addressing technical challenges faced by scientists and the industry.'

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: EIT Digital Activity

Project acronym: ELEMENT

Project title: Early detection of cognitive disorders on the basis of speech analysis

Duration: Jan 2017-Dec 2017

Coordinator: German Research Centre for Artificial Intelligence DFKI (Germany)

Other partners: Inria, Association Innovation Alzheimer (France) and University of Edinburgh (UK)

Abstract: ELEMENT is a new Innovation Activity to facilitate faster, earlier diagnosis and intervention for cognitive decline. The project aims to bring a unique new product to the European market that enables light-touch screening for cognitive decline in non-clinical settings, resulting in faster, earlier diagnosis and intervention.

9.4. International Initiatives

9.4.1. Informal International Partners

- **Collaborations with Asia:** Stars has been cooperating with the Multimedia Research Center in Hanoi MICA on semantics extraction from multimedia data. Stars also collaborates with the National Cheng Kung University in Taiwan and I2R in Singapore.
- **Collaboration with U.S.A.:** Stars collaborates with the University of Southern California.
- **Collaboration with Europe:** Stars collaborates with Multitel in Belgium, the University of Kingston upon Thames UK, and the University of Bergen in Norway.

9.4.2. Other IIL projects

9.4.2.1. The ANR SafeE (see section)

Stars collaborates with international partners such as Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW) and BDE (TW).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

This year, Stars has been visited by the following international scientists:

- Salwa Baabou, Ecole Nationale d'Ingénieurs de Gabès, Tunisia;
- Adlen Kerboua, University of Skikda, Algeria;

9.5.1.1. Internships

Abhishek Goel

Date: Aug 2017-Dec 2017

Institution: BITS Pilani, Rajasthan, India

Supervisor: Michal Koperski

Srijan Das

Date: Jan 2017- May 2017

Institution: National Institute of Technology, Rourkela, India

Supervisor: Michal Koperski

Salwa Babou

Date: Apr 2017-Sep 2017

Institution: Laboratoire d'Electroniques et des Technologies de l'Information, à l'ENIS, SFAX, Tunisia

Supervisor: François Brémond

Yu-Fen Chen

Date: Feb 2017-Aug 2017

Institution: National Tapei University of Technology, Tawain

Supervisor: Carlos Fernando Crispim Junior

Kuan-Ru Lee

Date: Aug 2017- Dec 2017

Institution: National Tapei University of Technology, Tawain

Supervisor: Carlos Fernando Crispim Junior

Chandraja Dharmana

Date: June 2017- Dec 2017

Institution: BITS Hyderabad, India

Supervisor: François Brémond

Shaira Kansal

Date: Jul 2017- Dec 2017

Institution: PEC, Chandigarh, India

Supervisor: Carlos Fernando Crispim Junior

Kartik Kartik

Date: Jul 2017- Dec 2017

Institution: PEC, Chandigarh, India

Supervisor: Carlos Fernando Crispim Junior

Rahul Pandey

Date: May 2017- Dec 2017

Institution: LMNIT, Rajasthan, India

Supervisor: Carlos Fernando Crispim Junior

Francesco Verrini

Date: Jun 2017- Dec 2017

Institution: Università degli Studi di Genova, Italy

Supervisor: Carlos Fernando Crispim Junior, Michal Koperski

STEEP Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

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

Project funded by ADEME and Grenoble metropolis

Duration: 2016 – 2019

Project coordinator : Remy Slama - INSERM. 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 (PM_{2.5}) 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 Rhône-Alpes Énergie-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.

8.2.2. *ESNET : Futures of ecosystem services networks for the Grenoble region*

Project funded by FRB (Fondation pour la Recherche sur la Biodiversité)

Program: “Modeling and Scenarios of Biodiversity” flagship program, Fondation pour la Recherche sur la Biodiversité (FRB). This project is funded by ONEMA (*Office National de l’Eau et des Milieux Aquatiques*).

Duration: 2013 – 2017

Coordinator: Sandra Lavorel (LECA)

Other partners: EDDEN (UPMF/CNRS), IRSTEA Grenoble (formerly CEMAGREF), PACTE (UJF/CNRS), ERIC (Lyon 2/CNRS)

Abstract: This project explores alternative futures of ecosystem services under combined scenarios of land-use and climate change for the Grenoble urban area in the French Alps. In this project, STEEP works in particular on the modeling of the land use and land cover changes, and to a smaller extent on the interaction of these changes with some specific services.

8.2.3. *CITiES: Calibrage et validation de modèles Transport - usage des Sols*

Project funded by ANR

Program: “Modèles Numériques” 2012, ANR

Duration: 2013 – 2017

Coordinator: Emmanuel Prados (STEPP)

Other partners: LET, IDDRI, IRTES-SET (“Systemes and Transports” lab of Univ. of Tech. of Belfort-Montbéliard), IFSTTAR-DEST Paris (formerly INRETS), LVMT (“Laboratoire Ville Mobilité Transport”, Marne la Vallée), VINCI (Pirandello Ingenierie, Paris), IAU Île-De-France (Urban Agency of Paris), AURG (Urban Agency of Grenoble), MOISE (Inria project-team)

Abstract: Calibration and validation of transport and land use models.

STORM Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. PIA

ELCI The ELCI project (Software Environment for HPC) aims to develop a new generation of software stack for supercomputers, numerical solvers, runtime and programming development environments for HPC simulation. The ELCI project also aims to validate this software stack by showing its capacity to offer improved scalability, resilience, security, modularity and abstraction on real applications. The coordinator is Bull, and the different partners are CEA, Inria, SAFRAN, CERFACS, CNRS CORIA, CENAERO, ONERA, UVSQ, Kitware and AlgoTech.

8.1.2. ANR

ANR SOLHAR (<http://solhar.gforge.inria.fr/doku.php?id=start>).

ANR MONU 2013 Program, 2013 - 2017 (36 months extended)

Identification: ANR-13-MONU-0007

Coordinator: Inria Bordeaux/LaBRI

Other partners: CNRS-IRIT, Inria-LIP Lyon, CEA/CESTA, EADS-IW

Abstract: This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. Several attempts have been made to accomplish the porting of these methods on such architectures; the proposed approaches are mostly based on a simple offloading of some computational tasks (the coarsest grained ones) to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool developed in the runtime team (Bordeaux). Although the SOLHAR project will focus on heterogeneous computers equipped with GPUs due to their wide availability and affordable cost, the research accomplished on algorithms, methods and programming models will be readily applicable to other accelerator devices such as ClearSpeed boards or Cell processors.

ANR Songs Simulation of next generation systems (<http://infra-songs.gforge.inria.fr/>).

ANR INFRA 2011, 01/2012 - 12/2015 (48 months)

Identification: ANR-11INFR01306

Coordinator: Martin Quinson (Inria Nancy)

Other partners: Inria Nancy, Inria Rhône-Alpes, IN2P3, LSIIT, Inria Rennes, I3S.

Abstract: The goal of the SONGS project is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

8.1.3. ADT - Inria Technological Development Actions

ADT SwLoc (<http://swloc.gforge.inria.fr/>)

Participants: Raymond Namyst, Pierre-André Wacrenier, Andra Hugo, Brice Goglin, Corentin Salingue.

Inria ADT Campaign 2017, 10/2017 - 9/2019 (24 months)

Coordinator: Raymond Namyst

Abstract: The Inria action ADT SwLoc has the aim to develop a new library allowing dynamic flexible partitioning of computing resources in order to execute parallel regions.

8.1.4. IPL - Inria Project Lab

C2S@Exa - Computer and Computational Sciences at Exascale **Participant:** Olivier Aumage.

Inria IPL 2013 - 2017 (48 months)

Coordinator: Stéphane Lantéri (team Nachos, Inria Sophia)

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

HAC-SPECIS - High-performance Application and Computers, Studying PErformance and Correctness In Simulation

Participants: Samuel Thibault, Luka Stanisic, Emmanuelle Saillard.

Inria IPL 2016 - 2020 (48 months)

Coordinator: Arnaud Legrand (team Polaris, Inria Rhône Alpes)

Since June 2016, the team is participating to the HAC-SPECIS <http://hacspecis.gforge.inria.fr/> Inria Project Lab (IPL). This national initiative aims at answering methodological needs of HPC application and runtime developers and allowing to study real HPC systems both from the correctness and performance point of view. To this end, it gathers experts from the HPC, formal verification and performance evaluation community.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. INTERTWINE

Title: Programming Model INTERoperability ToWards Exascale

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: EPCC

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Institut National de Recherche en Informatique et en Automatique (France)

Kungliga Tekniska Hogskolan (Sweden)

T-Systems Solutions for Research (Germany)

The University of Edinburgh (United Kingdom)

Universitat Jaume I de Castellon (Spain)

The University of Manchester (United Kingdom)

Inria contact: Olivier Aumage

This project addresses the problem of programming model design and implementation for the Exascale. The first Exascale computers will be very highly parallel systems, consisting of a hierarchy of architectural levels. To program such systems effectively and portably, programming APIs with efficient and robust implementations must be ready in the appropriate timescale. A single, “silver bullet” API which addresses all the architectural levels does not exist and seems very unlikely to emerge soon enough. We must therefore expect that using combinations of different APIs at different system levels will be the only practical solution in the short to medium term. Although there remains room for improvement in individual programming models and their implementations, the main challenges lie in interoperability between APIs. It is this interoperability, both at the specification level and at the implementation level, which this project seeks to address and to further the state of the art. INTERTWinE brings together the principal European organisations driving the evolution of programming models and their implementations. The project will focus on seven key programming APIs: MPI, GASPI, OpenMP, OmpSs, StarPU, QUARK and PaRSEC, each of which has a project partner with extensive experience in API design and implementation. Interoperability requirements, and evaluation of implementations will be driven by a set of kernels and applications, each of which has a project partner with a major role in their development. The project will implement a co- design cycle, by feeding back advances in API design and implementation into the applications and kernels, thereby driving new requirements and hence further advances.

8.2.1.2. *Mont-Blanc 2*

Title: Mont-Blanc

Programm: FP7

Duration: Sep. 2013 - Mar. 2017

Coordinator: BSC

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Atos/Bull (France)

ARM (United Kingdom)

Jülich (Germany)

LRZ (Germany)

University of Stuttgart (Germany)

CINECA (Italy)

CNRS (France)

CEA (France)

University of Bristol (United Kingdom)

Allinea Software (United Kingdom)

University of Cantabria (Spain)

Inria contact: Olivier Aumage

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

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

Program: PRACE

Project acronym: PRACE-5IP

Project title: PRACE Fifth Implementation Phase

Duration: 01/2017

Coordinator: PRACE

Abstract: The objectives of PRACE-5IP 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 transition to PRACE2 including analysis of TransNational Access;
- strengthening the internationally recognised PRACE brand;
- continuing and extend advanced training which so far provided more than 18 800 person-training days;
- preparing strategies and best practices towards Exascale computing;
- coordinating and enhancing the operation of the multi-tier HPC systems and services;
- 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 6 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;
- implementing a new flexible business model for PRACE 2;
- 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.

Inria contact for team STORM: Olivier Aumage

SUMO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR STOCH-MC: Model-Checking of Stochastic Systems using approximated algorithms (2014-2018)

- [web site at http://perso.crans.org/~genest/stoch.html](http://perso.crans.org/~genest/stoch.html).
- Led by Blaise Genest (SUMO);
- Participants: Nathalie Bertrand, Blaise Genest, Éric Fabre, Matthieu Pichené;
- Partners: Inria Project Team CONTRAINTEs (Rocquencourt), LaBRI (Bordeaux), and IRIF (Paris).

The aim of STOCH-MC is to perform model-checking of large stochastic systems, using controlled approximations. Two formalisms will be considered: Dynamic Bayesian Networks, which represent compactly large Markov Chains; and Markov Decision Processes, allowing non deterministic choices on top of probabilities.

9.1.2. ANR HeadWork: Human-Centric Data-oriented WORKflows (2016-2020)

- [web site at http://headwork.gforge.inria.fr/](http://headwork.gforge.inria.fr/)
- Led by David Gross-Amblard (Université Rennes 1);
- Participants : Loïc Hérouët, Éric Badouel;
- Partners: Inria Project-Teams Valda (Paris), DRUID (Rennes) SUMO (Rennes), LINKs (Lille), MNHN, Foule Factory.

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

9.1.3. IPL HAC-SPECIS: High-performance Application and Computers, Studying PErformance and Correctness In Simulation (2016-2020)

- [web site at http://hacspecis.gforge.inria.fr/](http://hacspecis.gforge.inria.fr/)
- Led by Arnaud Legrand (Inria Rhône-Alpes)
- Participants: Thierry Jéron, The Anh Pham.
- Partners: Inria project-teams Avalon (Lyon), POLARIS (Grenoble), HiePACS, STORM (Bordeaux), MExICo (Saclay), MYRIADS, SUMO (Rennes), VeriDis (Nancy).

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

This year we have been mainly intrested in dynamic partial-order-reduction methods that allow to reduce the explored state space, and a first prototype implementation of an existing method that combines DPOR with true-concurrency models.

9.1.4. CNRS INS2I JCJC SensAs (2017)

- Led by Ocan Sankur (SUMO).
- Participants: Ocan Sankur
- Partners: Benjamin Monmege, Pierre-Alain Reynier (Université Aix-Marseille).

Model-checking allows one to analyse the reliability of critical systems. There is currently an ongoing effort to extend formal verification and synthesis techniques to check non-functional properties such as performance, energy consumption or robustness, that are particularly important for real-time systems. SensAS is a project whose objective is to develop techniques to analyse the sensitivity of such systems with formal tools. In this context, a nominal behaviour, described with a deterministic timed automaton, is submitted to nondeterministic or stochastic perturbations. We seek then to quantify the variability of perturbed behaviours, giving formal guarantees on the computed result.

9.1.5. National informal collaborations

The team collaborates with the following researchers:

- Arnaud Sangnier (IRIF, UP7-Diderot) on the parameterized verification of probabilistic systems;
- François Laroussinie (IRIF, UP7-Diderot) on logics for multi-agent systems;
- Béatrice Bérard (LIP6) on problems of opacity and diagnosis, and on problems related to logics and partial orders for security;
- Serge Haddad (Inria team MExICo, LSV, ENS Paris-Saclay) on opacity and diagnosis;
- Patricia Bouyer (LSV, ENS Paris-Saclay) on the analysis of probabilistic timed systems and quantitative aspects of verification;
- Stefan Haar and Thomas Chatain (Inria team MExICo, LSV, ENS Paris-Saclay) on topics related to concurrency and time, and to modeling and verification of metro networks, multimodal systems and passenger flows;
- Éric Rutten and Gwenaél Delaval (Inria team Ctrl-A, LIG, Université Grenoble-Alpes) on the control of reconfigurable systems as well as making the link between Reax and Heptagon/BZR (<http://bzx.inria.fr/>);
- Didier Lime, Olivier H. Roux (LS2N Nantes) on topics related to stochastic and timed nets;
- Loïc Jezequel (LS2N Nantes) on topics related to stochastic and timed nets, and on distributed optimal planning;
- Yliès Falcone (CORSE LIG/Inria Grenoble) and Antoine Rollet (LaBRI Bordeaux) on the enforcement of timed properties;

9.2. International Initiatives

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

9.2.1.1. QuantProb

- Title: Quantitative analysis of non-standard properties in probabilistic models
- International Partner (Institution - Laboratory - Researcher):
Technical University of Dresde (Germany) - Faculty of Computer Science - Christel Baier
- Start year: 2016
- See also: <http://www.irisa.fr/sumo/QuantProb/>

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

9.2.2. Inria International Partners

9.2.2.1. Informal International Partners

The team collaborates with the following researchers:

- Jean-François Raskin, Gilles Geeraerts (Université Libre de Bruxelles, Belgium) on multiplayer game theory and synthesis;
- Thomas Brihaye (UMons, Belgium) on the verification of stochastic timed systems;
- Mickael Randour (UMons, Belgium) on quantitative games for synthesis;
- Kim G. Larsen (Aalborg University, Denmark) on quantitative timed games, and on topics related to urban train systems modeling;
- Josef Widder, Igor Konnov and Marijana Lažić (TU Wien, Austria) on the automated verification of randomized distributed algorithms.
- John Mullin (Polytechnique Montréal, Canada), on topics related to security and opacity;
- S. Akshay (IIT Bombay, India) on topics related to timed concurrent models;
- Andrea D'ariano (University Roma Tre, Italy), on topics related to train regulation;
- Stavros Tripakis, Srinivas Pinisetty (Aalto University, Finland) on runtime verification and enforcement.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Laurie Ricker visited the SUMO team for 2 months in May-June 2017.

9.3.1.1. Internships

- M2 Internship of Aina Toky Rasoamanana, Feb-July 2017, Nathalie Bertrand and Nicolas Markey
- L3 Internship of Balasubramanian A.R., May-July 2017, Nathalie Bertrand and Nicolas Markey

9.3.2. Visits to International Teams

9.3.2.1. Research Stays Abroad

- Éric Badouel made in September 2017 a one-month visit to Luca Bernardinello and Lucia Pomello from Milan University, and Carlo Ferigato from EJCR at Ispra. A work has been initiated on computer tools for the coordination of debates (from open citizen debates to parliamentary debates) and for managing the related documents (minutes, syntheses, ...) in an open data perspective.
- Engel Lefauchaux spent 6 weeks (May-June 2017) in Cagliari, working with Alessandro Giua and Carla Seatzu on the diagnosis of stochastic Petri nets.

TACOMA Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Project: EkoHub

Partner: Ekolis, Delaye transport, Telecom Bretagne

Starting: Nov 2014; Ending : Nov 2017

Contact: JM Bonnin

Abstract: The EkoHub project has been architected around our multi-technologies gateway and leverages on the one developed in the ITSSv6 European project. In addition to the multiple interfaces of our platforms, sensor devices have been incorporated into the project and we studied different scenarios elaborated with our professional partners (Layaye Logistics). Intelligent data management schemes are being studied to adapt to the communication environment and the needs of the application consuming the data. The data model has been derived from the outcomes of the SEAS project.

The final EkoHub demonstration held in november 2017 with project partners.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

Project: SCOOP@F part 2

Partner: MEDE, Renault, PSA

Starting: Jan 2016; Ending : Dec 2018

Coordinator: JM Bonnin

Abstract: SCOOP@F is a Cooperative ITS pilot deployment project that intends to connect approximately 3000 vehicles with 2000 kilometers of roads. It consists of 5 specific sites with different types of roads: Ile-de-France, "East Corridor" between Paris and Strasbourg, Brittany, Bordeaux and Isère. SCOOP@F is composed of SCOOP@F Part 1 from 2014 to 2015 (ongoing) and SCOOP@F Part 2 from 2016 to 2018. Its main objective is to improve the safety of road transport and of road operating staff during road works or maintenance. The project includes the validations of Cooperative ITS services in open roads, cross border tests with other EU Member States (Spain, Portugal and Austria) and development of a hybrid communication solution (3G-4G/ITS G5). We are involved in the project to study the security and privacy properties of the hybrid architecture that allow to use non dedicated communication networks (WiFi, 5G) as well as the vehicular dedicated communication technologies (G5).

Project acronym: SEAS (ITEA3)

Partners: Telecom Paris Tech, Telecom Saint Etienne, Mines Saint Etienne, Engie, Kerlink, BeNo-mad, ICAM, CNR, VTT

Starting: Feb 2014; ending: Jan 2017

Contact: JM Bonnin

Abstract: The SEAS project addresses the problem of inefficient and unsustainable energy consumption, which is due to a lack of sufficient means to control, monitor, estimate and adapt the energy use of systems versus the dynamic use situations and circumstances influencing the energy use. The objective of the SEAS project is to enable energy, ICT and automation systems to collaborate at consumption sites, and to introduce dynamic and refined ICT-based solutions to control, monitor and estimate energy consumption. Proposed solution should enable energy market participants to incorporate micro-grid environments and active customers. We are involved in the project to design a distributed system architecture and to implement two proofs of concept: the first one is related to the electric vehicle charging and the other one to the prevision of solar energy production.

Project: SCHIEF

Partner: TUM (Technical University of Munchen), IMT Atlantique, Eurecom

Starting: Sept 2016; **Ending :** Dec 2018

Coordinator: JM Bonnin

Abstract: In SCHEIF, we create a pilot for an enabler platform for the industrial Internet of Things. We envision a three-layered architecture with Sensors and actuators on the lowest layer. This layer includes industrial robots. On top of this hardware layer we envision site-local processing of data. Such a processing is beneficial since it allows keeping latency boundaries on the one hand and being in full control of all data on the other hand. The latency is relevant for enabling diverse time-critical operations as they often happen in industrial production environments. The local processing is relevant for protecting data. A privacy-conform processing is required to protect company secrets and to protect the privacy of workers. The third layer comprises data processing in the cloud. We envision mostly local data processing. However, offloading computing tasks to public or private clouds will be relevant for compute-intense tasks and those tasks that require coordination between production sites. The main scenario of SCHEIF is an industrial production site where mobile robots and human workers coexist. The focus is providing the data required to manage and optimize the production process always at the most suitable quality. The suitability of data relies on the requirements of the data producers and consumers. A planned demo scenario is a provoked system crash that leads to reprioritization of data streams to mitigate from the failure.

TADaaM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PIA ELCI, *Environnement Logiciel pour le Calcul Intensif*, 2014-2018

The ELCI PIA project is coordinated by BULL with several partners: CEA, Inria, SAFRAN, UVSQ.

This project aims to improve the support for numerical simulations and High Performance Computing (HPC) by providing a new generation software stack to control supercomputers, to improve numerical solvers, and pre- and post computing software, as well as programming and execution environment. It also aims at validating the relevance of these developments by demonstrating their capacity to deliver better scalability, resilience, modularity, abstraction, and interaction on some application use-cases. TADAAM is involved in WP1 and WP2 ELCI Work Packages. Emmanuel JEANNOT is the Inria representative in the ELCI steering committee.

9.1.2. ANR

ANR MOEBUS Scheduling in HPC (<http://moebus.gforge.inria.fr/doku.php>).

ANR INFRA 2013, 10/2013 - 9/2017 (48 months)

Coordinator: Denis Trystram (Inria Rhône-Alpes)

Other partners: Inria Bordeaux Sud-Ouest, Bull/ATOS

Abstract: This project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments.

ANR SATAS SAT as a Service (<http://www.agence-nationale-recherche.fr/Project-ANR-15-CE40-0017>).

AP générique 2015, 01/2016 - 12-2019 (48 months)

Coordinator: Laurent Simon (LaBRI)

Other partners: CRIL (Univ. Artois), Inria Lille (Spirals)

Abstract: The SATAS project aims to advance the state of the art in massively parallel SAT solving. The final goal of the project is to provide a “pay as you go” interface to SAT solving services and will extend the reach of SAT solving technologies, daily used in many critical and industrial applications, to new application areas, which were previously considered too hard, and lower the cost of deploying massively parallel SAT solvers on the cloud.

ANR DASH Data-Aware Scheduling at Higher scale (<https://project.inria.fr/dash/>).

AP générique JCJC 2017, 03/2018 - 02-2022 (48 months)

Coordinator: Guillaume AUPY (Tadaam)

Abstract: This project focuses on the efficient execution of I/O for High-Performance applications. The idea is to take into account some knowledge on the behavior of the different I/O steps to compute efficient schedules, and to update them dynamically with the online information.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

COLOC: the Concurrency and Locality Challenge (<http://www.coloc-itea.org>).

Program: ITEA2

Project acronym: COLOC

Project title: The Concurrency and Locality Challenge

Duration: November 2014 - November 2017

Coordinator: BULL/ATOS

Other partners: BULL/ATOS (France); Dassault Aviation (France) ; Enfeild AB (Sweden); Scilab entreprise (France); Teratec (France); Inria (France); Swedish Defebnse Research Agency - FOI (France); UVSQ (France).

Abstract: The COLOC project aims at providing new models, mechanisms and tools for improving applications performance and supercomputer resources usage taking into account data locality and concurrency.

NESUS: Network for Ultrascale Computing (<http://www.nesus.eu>)

Program: COST

Project acronym: NESUS

Project title: Network for Ultrascale Computing

Duration: April 2014 - April 2018

Coordinator: University Carlos III de Madrid

Other partners: more than 35 countries

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger than today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society. Emmanuel JEANNOT is the vice-chair of this Action.

9.2.2. Collaborations with Major European Organizations

Partner 1: INESC-ID, Lisbon, (Portugal)

Subject 1: Application modeling for hierarchical memory system

9.3. International Initiatives

9.3.1. Inria International Labs

Joint-Lab on Extreme Scale Computing (JLESC):

Coordinators: Franck Cappello (general) and Yves Robert (Inria coordinator).

Other partners: Argonne National Lab, University of Urbanna Champaign (NCSA), Tokyo Riken, Jülich Supercomputing Center, Barcelona Supercomputing Center (BSC).

Abstract: 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.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Partner 1: ICL at University of Tennessee

Subject 1: on instrumenting MPI applications and modeling platforms (works on HWLOC take place in the context of the OPEN MPI consortium) and MPI and process placement

Partner 2: Argonne National Lab

Subject 2: Topology-aware data aggregation for I/O intensive application

Partner 3: Vanderbilt University

Subject 3: Data-scheduling on hierarchical memories

9.4. Close cooperation with Industry

- Advanced Micro Devices, Inc. (AMD): AMD Zen micro-architecture and EPYC processors topology support in the Linux kernel.
- Oracle Corporation: Topology detection for SPARC processors and Solaris operating systems.
- ARM Holdings and Cavium, Inc.: ARM processor ACPI PPTT firmwares and Linux kernel topology information.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Aleksandar Ilic from University of Lisbon visited us to continue our collaboration on the Locality-aware Roofline Model [19].
- Tobias Fuchs from Ludwig-Maximilians-University of Munich visited us to improve the use of hardware locality in the DYLOC runtime system.

TAMIS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- ARED grant for Lamine Nouredine and Florian Dolt
- Postdocs grants for Najah Ben Said, Jeffrey Paul Burdges, Ronan Lashermes, Ludovic Claudepierre
- Starting Grant for hardware for Annelie Heuser from Rennes Metropole
- Software developer grant for Laurent Morin from "Chaire Mobilité dans une ville durable" (mobility in a sustainable city) by Fondation Université Rennes 1

9.2. National Initiatives

9.2.1. ANR

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

9.2.2. DGA

- PhD grant for Nisrine Jafri (2016–2019),
- PhD grant for Aurélien Palisse (2016–2019),
- PhD grant for Alexandre Gonzalves (2016–2019),
- PhD grant for Olivier Decourbe (2017–2020),
- PhD grant for Alexandre Zdhanov (2017–2020)

9.2.3. Autres

- INS2I JCJC grant for Axel Legay, Annelie Heuser, Fabrizio Biondi.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ACANTO

Title: ACANTO: A Cyberphysical social NeTwOrk using robot friends

Program: H2020

Duration: February 2015 - July 2018

Coordinator: Università di Trento

Partners:

Atos Spain (Spain), Envitel Tecnologia Y Control S.A. (Spain), Foundation for Research and Technology Hellas (Greece), Servicio Madrilenio Delud (Spain), Siemens Aktiengesellschaft Osterreich (Austria), Telecom Italia S.P.A (Italy), Università Degli Studi di Siena (Italy), Università Degli Studi di Trento (Italy), University of Northumbria At Newcastle. (United Kingdom)

Inria contact: Axel Legay

Despite its recognised benefits, most older adults do not engage in a regular physical activity. The ACANTO project proposes a friendly robot walker (the FriWalk) that will abate some of the most important barriers to this healthy behaviour. The FriWalk revisits the notion of robotic walking assistants and evolves it towards an activity vehicle. The execution of a programme of physical training is embedded within familiar and compelling every-day activities. The FriWalk operates as a personal trainer triggering the user actions and monitoring their impact on the physical and mental well-being. It offers cognitive and emotional support for navigation pinpointing risk situations in the environment and understanding the social context. It supports coordinated motion with other FriWalks for group activities. The FriWalk combines low cost and advanced features, thanks to its reliance on a cloud of services that increase its computing power and interconnect it to other assisted living devices. Very innovative is its ability to collect observations on the user preferred behaviours, which are consolidated in a user profile and used for recommendation of future activities. In this way, the FriWalk operates as a gateway toward a CyberPhysical Social Network (CPSN), which is an important contribution of the project. The CPSN is at the basis of a recommendation system in which users' profiles are created, combined into 'circles' and matched with the opportunity offered by the environment to generate recommendations for activities to be executed with the FriWalk support. The permanent connection between users and CPSN is secured by the FriPad, a tablet with a specifically designed user interface. The CPSN creates a community of users, relatives and therapists, who can enter prescriptions on the user and receive information on her/his state. Users are involved in a large number in all the phases of the system development and an extensive validation is carried out at the end.

Axel Legay and Olivier Zendra are the permanent researchers of Tamis involved in this project. The project supports two postdocs in Tamis.

9.3.1.2. DIVIDEND

Title: DIVIDEND: Distributed Heterogeneous Vertically Integrated Energy Efficient Data centres

Program: CHIST-ERA 2013

Duration: 10/2014 - 10/2016 (extended 10/2017)

Coordinator: University of Edinburgh (UK)

Partners:

École Normale Supérieure de Paris, Département d'Informatique (France); Inria (France); Ecole Polytechnique Fédérale de Lausanne, Computer & Communication Sciences (Switzerland); Queen's University of Belfast, School of Electronics, Electrical Engineering and Computer Science, Belfast (UK); University of Edinburgh, Scotland, (UK); University of Lancaster, School of Computing and Communications (UK); University Politehnica Timisoara, Department of Computer Engineering (Romania)

Inria contact: Albert Cohen

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

vertically integrated data centres and will take a first stab at resolving the energy crisis by improving the power usage effectiveness of data centres.

Contributions of Inria in the project addresses the development of an energy aware distributed heterogeneous system (distributed HSA) between data center applications and HSA accelerators. It includes the design of a common API able to interface two tasks: the monitoring of the energy consumption, and the management of distributed heterogeneous hardware at a data center scale. The project ended by a project review the 23th March 2017, and the last contributions to the project ended the 30th September 2017.

One of the main contribution is the design of and energy-aware distributed heterogeneous system architecture framework (D-HSA) built using the combination of three major levels: the hardware platform based on an aggregation of HSA compliant devices, the system level based on device drivers and energy monitoring libraries, and finally the application layer using an extension of standard OpenCL programming model. This OpenCL extension is proposed as the main API for the energy-aware distributed HSA, and was made available for the tools and applications developed in the project.

A second contribution is the specification and the implementation of a distributed extension of the standard HSA Runtime API, and its functional validation on a basic system. The extension integrates the discovery, the management, and the execution of kernel computations on remote HSA agents in a distributed environment. The validation is based on an implementation using the Message Passing Interface (MPI) standard on an HSA compliant AMD machine. The Distributed HSA extension proposed offers a fully functional API for managing remote and distributed HSA agents, but at the cost of a limitation of the capability of the D-HSA system: the standard HSA memory model, based essentially on a coherent shared memory, is not supported for distributed HSA agents. As a primary implementation, focusing on a functional support of the new D-HSA verbs, this works tend to demonstrate that the extension is light and easy-to-use for a set of examples.

Laurent Morin from Tamis is involved in this project

9.3.1.3. EMC2

Title: Embedded Multi-Core Systems for Mixed Criticality Applications in Dynamic and Changeable Real-Time Environments

Program: FP7

Duration: April 2014 - March 2017

Coordinator: Infineon Technologies

Partners:

Aicas (Germany) Avl Software and Functions (Germany), Denso Automotive Deutschland (Germany), Elektrobit Automotive (Germany), Evision Systems (Germany), Nxp Semiconductors Germany (Germany), Tttech Computertechnik (Austria), "kompetenzzentrum - Das Virtuelle Fahrzeug, Forschungsgesellschaft MbH" (Austria), Frequentis (Austria), Thales Austria (Austria), Blueice Bvba (Belgium), Freescale Polovodice Ceska Republika Sro (Czech Republic), Sysgo Sro (Czech Republic), Silkan Rt (France), "united Technologies Research Centre Ireland," (Ireland), Mbda Italia Spa (Italy), Fornebu Consulting As (Norway), Westerngeco As (Norway), Simula Research Laboratory As (Norway), Ixion Industry and Aerospace Sl (Spain), Visure Solutions Sl (Spain), Seven Solutions Sl (Spain), Telvent Energia (Spain), Instituto Tecnológico de Informatica (Spain), Ambar Telecomunicaciones Sl (Spain), Sics Swedish Ict (Sweden), Arcticus Systems (Sweden), Arccore (Sweden), Xdin Stockholm (Sweden), Systemite (Sweden), Stichting Imec Nederland (Netherlands), Tomtom International Bv (Netherlands), Infineon Technologies Uk Ltd (United Kingdom), Sundance Multiprocessor Technology Ltd (United Kingdom), Systonomy (United Kingdom), Ensilica Ltd (United Kingdom), Test and Verification Solutions Ltd (United Kingdom), Abb (Sweden), Ait Austrian Institute of Technology (Austria),

Alenia Aermacchi Spa (Italy), Avl List (Austria), Airbus Defence and Space (Germany), Bayerische Motoren Werke Aktiengesellschaft (Germany), Vysoke Ucení Technické V Brně (Czech Republic), Commissariat A L Energie Atomique et Aux Energies Alternatives (France), Consorzio Interuniversitario Nazionale Per l'Informatica (Italy), Centro Ricerche Fiat (Italy), Critical Software (Portugal), Chalmers Tekniska Högskola (Sweden), Danfoss Power Electronics As (Denmark), Danmarks Tekniske Universitet (Denmark), Ericsson (Sweden), Fraunhofer-Gesellschaft Zur Förderung Der Angewandten Forschung E.V (Germany), Hi Iberia Ingeniería Y Proyectos SL (Spain), Harokopio University (Greece), Infineon Technologies Austria (Austria), Institut Mikroelektronických Aplikací S.R.O. (Czech Republic), Inesc Id - Instituto de Engenharia de Sistemas E Computadores, Investigação E Desenvolvimento Em Lisboa (Portugal), Infineon Technologies (Germany), Integrasy (Spain), Instituto Superior de Engenharia Do Porto (Portugal), Kungliga Tekniska Högskolan (Sweden), Luleå Tekniska Universitet (Sweden), Magillem Design Services (France), Nxp Semiconductors Netherlands Bv (Netherlands), Offis E.V. (Germany), Philips Medical Systems Nederland Bv (Netherlands), Politecnico di Torino (Italy), Quobis Networks SL (Spain), Rockwell Collins France (France), Rigas Tehniskā Universitāte (Latvia), Selex Es Spa (Italy), Siemens Aktiengesellschaft (Germany), Systematic Paris Region Association (France), Sysgo (Germany), Thales Alenia Space Italia Spa (Italy), "thales Alenia Space España," (Spain), Technolution B.V. (Netherlands), Fundación Tecnalia Research & Innovation (Spain), Thales Communications & Security (France), Thales Avionics (France), Thales (France), Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek Tno (Netherlands), Technische Universität Braunschweig (Germany), Technische Universiteit Delft (Netherlands), Technische Universität Dortmund (Germany), Technische Universitaet Kaiserslautern (Germany), Technische Universitaet Wien (Austria), Technische Universiteit Eindhoven (Netherlands), Università Degli Studi di l'aquila (Italy), Università Degli Studi di Genova (Italy), The University of Manchester (United Kingdom), University of Bristol (United Kingdom), University of Limerick (Ireland), "ustav Teorie Informace A Automatizace Av Cr, V.V.I." (Czech Republic), Universitetet I Oslo (Norway), Vector Fabrics Bv (Netherlands), Volvo Technology (Sweden)

Inria contact: Albert Cohen and Axel Legay

Embedded systems are the key innovation driver to improve almost all mechatronic products with cheaper and even new functionalities. Furthermore, they strongly support today's information society as inter-system communication enabler. Consequently boundaries of application domains are alleviated and ad-hoc connections and interoperability play an increasing role. At the same time, multi-core and many-core computing platforms are becoming available on the market and provide a breakthrough for system (and application) integration. A major industrial challenge arises facing (cost) efficient integration of different applications with different levels of safety and security on a single computing platform in an open context. The objective of the EMC2 project (Embedded multi-core systems for mixed criticality applications in dynamic and changeable real-time environments) is to foster these changes through an innovative and sustainable service-oriented architecture approach for mixed criticality applications in dynamic and changeable real-time environments. The EMC2 project focuses on the industrialization of European research outcomes and builds on the results of previous ARTEMIS, European and National projects. It provides the paradigm shift to a new and sustainable system architecture which is suitable to handle open dynamic systems. EMC2 is part of the European Embedded Systems industry strategy to maintain its leading edge position by providing solutions for:

- . Dynamic Adaptability in Open Systems . Utilization of expensive system features only as Service-on-Demand in order to reduce the overall system cost. . Handling of mixed criticality applications under real-time conditions . Scalability and utmost flexibility . Full scale deployment and management of integrated tool chains, through the entire lifecycle

Approved by ARTEMIS-JU on 12/12/2013 for EoN. Minor mistakes and typos corrected by the Coordinator, finally approved by ARTEMIS-JU on 24/01/2014. Amendment 1 changes approved by ECSEL-JU on 31/03/2015.

The permanent members of Tamis who are involved are Axel Legay and Olivier Zendra. The project was initiated during the lifetime of the ESTASYS.Inria team.

9.3.1.4. ENABLE-S3

Title: ENABLE-S3: European Initiative to Enable Validation for Highly Automated Safe and Secure Systems

Program: H2020

Duration: 05/2016 - 04/2019

Coordinator: Avl List Gmbh (Austria)

Partners:

Aalborg Universitet (Denmark); Airbus Defence And Space Gmbh (Germany); Ait Austrian Institute Of Technology Gmbh (Austria); Avl Deutschland Gmbh (Germany); Avl Software And Functions Gmbh (Germany); Btc Embedded Systems Ag (Germany); Cavotec Germany Gmbh (Germany); Creanex Oy(Finland); Ceske Vysoke Ucení Technické V Praze (Czech Republic); Deutsches Zentrum Fuer Luft - Und Raumfahrt Ev (Germany); Denso Automotive Deutschland Gmbh (Germany); Dr. Steffan Datentechnik Gmbh (Austria); Danmarks Tekniske Universitet (Denmark); Evidence Srl (Italy); Stiftung Fzi Forschungszentrum Informatik Am Karlsruher Institut Fur Technologie (Germany); Gmv Aerospace And Defence Sa (Spain); Gmvis Skysoft Sa (Portugal); Politechnika Gdanska (Poland); Hella Aglaia Mobile Vision Gmbh (Germany); Ibm Ireland Limited (Ireland); Interuniversitair Micro-Electronica Centrum (Belgium); Iminds (Belgium); Institut National De Recherche Eninformatique Et Automatique (France); Instituto Superior De Engenharia Do Porto (Portugal); Instituto Tecnológico De Informatica (Spain); Ixion Industry And Aerospace Sl (Spain); Universitat Linz (Austria); Linz Center Of Mechatronics Gmbh (Austria); Magillem Design Services Sas (France); Magneti Marelli S.P.A. (Italy); Microelectronica Maser Spain; Mdal (France); Model Engineering Solutions Gmbh(Germany); Magna Steyr Engineering Ag & Co Kg (Austria); Nabto Aps (Denmark); Navtor As (Norway); Nm Robotic Gmbh (Austria); Nxp Semiconductors Germany Gmbh(Germany); Offis E.V.(Germany); Philips Medical Systems Nederland Bv(netherlands); Rohde & Schwarz Gmbh&Co Kommanditgesellschaft(Germany); Reden B.V. (Netherlands); Renault Sas (France); Rugged Tooling Oy(finland); Serva Transport Systems Gmbh(Germany); Siemens Industry Software Nvbelgium); University Of Southampton (Uk); Safetrans E.V. (Germany); Thales Alenia Space Espana, Saspain; Fundacion Tecnalia Research & Innovationspain; Thales Austria Gmbh (Austria); The Motor Insurance Repair Researchcentre (Uk); Toyota Motor Europe (Belgium); Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek Tno (Netherlands); Ttcontrol Gmbh (Austria); Tttech Computertechnik Ag (Austria); Technische Universiteit Eindhoven (Netherlands); Technische Universitat Darmstadt (Germany); Technische Universitaet Graz (Austria); Twt Gmbh Science & Innovation (Germany); University College Dublin, National University Of Ireland, Dublin (Ireland); Universidad De Las Palmas De Gran Canaria (Spain); Universita Degli Studi Di Modena E Reggio Emilia (Italy); Universidad Politecnica De Madrid (Spain); Valeo Autoklimatizace K.S. (Czech Republic); Valeo Comfort And Driving Assistance (France); Valeo Schalter Und Sensoren Gmbh (Germany); Kompetenzzentrum - Das Virtuelle Fahrzeug, Forschungsgesellschaft Mbh (Austria); Vires Simulationstechnologie Gmbh (Germany); Teknologian Tutkimuskeskus Vtt Oy (Finland); Tieto Finland Support Services Oy (Finland); Zilinska Univerzita V Ziline (Slovakia);

Inria contact: Axel Legay

The objective of ENABLE-S3 (<http://www.enable-s3.eu>) is to establish cost-efficient cross-domain virtual and semi-virtual V&V platforms and methods for ACPS. Advanced functional, safety and security test methods will be developed in order to significantly reduce the verification and validation

time but preserve the validity of the tests for the requested high operation range. ENABLE-S3 aspires to substitute today's physical validation and verification efforts by virtual testing and verification, coverage-oriented test selection methods and standardization. ENABLE-S3 is use-case driven; these use cases represent relevant environments and scenarios. Each of the models, methods and tools integrated into the validation platform will be applied to at least one use case (under the guidance of the V&V methodology), where they will be validated (TRL 5) and their usability demonstrated (TRL6). Representative use cases and according applications provide the base for the requirements of methods and tools, as well as for the evaluation of automated systems and respective safety. This project is industry driven and has the objective of designing new technologies for autonomous transportation, including to secure them. Tamis tests its results on the case studies of the project.

Axel Legay and Jean-Louis Lanet are involved in this project. The project supports one postdoc in Tamis starting in 2017.

9.3.1.5. *SUCCESS*

Title: SUCCESS: SecUre aCCESSibility for the internet of things

Program: CHIST-ERA 2015

Duration: 10/2016 - 10/2018

Coordinator: Middlesex University (UK)

Partners:

Middlesex University, School of Science and Technology (France); Inria (France); Université Grenoble Alpes, Verimag (FRANCE); Univesity of TWENTE, (Netherlands)

Inria contact: Axel Legay

The SUCCESS project ...The core idea of SUCCESS is to use formal methods and verification tools with a proven track record to provide more transparency of security risks for people in given IoT scenarios. Our core scientific innovation will consist on the extension of well-known industry-strength methods Our technological innovation will provide adequate tools to address risk assessment and adaptivity within IoT in healthcare environments and an open source repository to foster future reuse, extension and progress in this area. Our project will validate the scientific and technological innovation through pilots, one of which will be in collaboration with a hospital and will allow all stakeholders (e.g. physicians, hospital technicians, patients and relatives) to enjoy a safer system capable to appropriately handle highly sensitive information on vulnerable people while making security and privacy risks understandable and secure solutions accessible.

Within SUCCESS, the contribution of the TAMIS team consists in a framework for analyzing the security of a given IOT system, and notably whether it resists to attack. Our approach is to build a high-level model of the system, including vulnerabilities, as well as an attacker. We represent the set of possible attacks using an attack tree. Finally, we evaluate the probability that an attack succeeds using Statistical Model Checking.

In the TAMIS team, Axel Legay, Delphine Beaulaton, Najah Ben-Saïd and Jean Quilbeuf are involved in this project.

9.3.1.6. *TeamPlay*

Title: TeamPlay: Time, Energy and security Analysis for Multi/Many-core heterogeneous PLAtforms

Program: H2020

Duration: 01/2018 - 12/2020

Coordinator: Inria

Partners:

Absint Angewandte Informatik Gmbh (Germany), Institut National De Recherche en Informatique et Automatique (France), Secure-Ic Sas (France), Sky-Watch A/S (Denmark), Syddansk Universitet (Denmark), Sythmata Ypologistikis Orashs Irida Labs Ae (Greece), Technische Universität Hamburg-Harburg (Germany), Thales Alenia Space Espana (Spain), Universiteit Van Amsterdam (Netherlands), University Of Bristol (UK), University Of St Andrews (UK)

Inria contact: Olivier Zendra and Axel Legay

The TeamPlay (Time, Energy and security Analysis for Multi/Many-core heterogeneous PLATforms) project federates 6 academic and 5 industrial partners and aims to develop new, formally-motivated, techniques that will allow execution time, energy usage, security, and other important non-functional properties of parallel software to be treated effectively, and as first-class citizens. We will build this into a toolbox for developing highly parallel software for low-energy systems, as required by the internet of things, cyber-physical systems etc. The TeamPlay approach will allow programs to reflect directly on their own time, energy consumption, security, etc., as well as enabling the developer to reason about both the functional and the non-functional properties of their software at the source code level. Our success will ensure significant progress on a pressing problem of major industrial importance: how to effectively manage energy consumption for parallel systems while maintaining the right balance with other important software metrics, including time, security etc. The project brings together leading industrial and academic experts in parallelism, energy modeling/transparency, worst-case execution time analysis, non-functional property analysis, compilation, security, and task coordination. Results will be evaluated using industrial use cases taken from the computer vision, satellites, flying drones, medical and cyber security domains. Within TeamPlay, Inria and TAMIS coordinate the whole project, while being also in charge of aspects related more specifically to security.

The permanent members of Tamis who are involved are Axel Legay, Olivier Zendra and Annelie Heuser.

TAPDANCE Team

6. Partnerships and Cooperations

6.1. European Initiatives

6.1.1. FP7 & H2020 Projects

Woods applied for an ERC Consolidator award. The application was successful and begins in 2018.

6.2. International Research Visitors

6.2.1. Visits of International Scientists

David Doty (UC Davis) visited the team several times in 2017.

TAU Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **ACTEUR** 2014-2018 (236kEuros). Cognitive agent development for urban simulations,
Coordinator: P. Taillandier (IDEES, Univ Rouen)
Participant: Philippe Caillou
- **EPITOME** 2017-2020 (225kEuros). Efficient rePresentation TO structure large-scale satellite iM-
agEs,
Coordinator: Yuliya Tarabalka (Titane team, Inria Sophia-Antipolis)
Participant: Guillaume Charpiat

9.1.2. Others

- **ROMModel Reduction and Multiphysics Optimization** 2014-2017 (50 Keuros)
Coordinator: IRT System X
Participants: Marc Schoenauer, Michèle Sebag, François Gonard (PhD)
- **MAJOREA Collaborative Filtering Approach to Matching Job Openings and Job Seekers**, 2013-
2017 (105 kEuros)
Thomas Schmitt's PhD (funded by ISN).
Participants: Philippe Caillou, Michèle Sebag, Thomas Schmitt (PhD)
- **AMIQAP** 2015-2017 (12 months of Postdoctoral fellow). Qualité de vie au travail.
Project funded by ISN
Partners: Mines-Telecom SES, RITM (Univ. Paris Sud) and *La Fabrique de l'Industrie*
Extended for 6 months in 2018 via a donation from *La Fabrique de l'Industrie*
Participants: Philippe Caillou, Olivier Goudet, Isabelle Guyon, Michèle Sebag, Paola Tubaro,
Diviyan Kalainathan (PhD)
- **Nutriperso** 2017-2018, 37 kEuros. Personalized recommendations toward healthier eating practices.
U. Paris-Saclay IRS (*Initiative de Recherche Stratégique*)
Partners: INRA (coordinator), INSERM, Agro Paristech, Mines Telecom
Participants: Philippe Caillou, Flora Jay, Michèle Sebag, Paola Tubaro
- **POST** 2014-2017 (1,220 MEuros, including 500 kEuros for a 'private' cluster). Platform for the
optimization and simulation of trans-continental grids
ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie)
Coordinator: ARTELYS
Participants (in 2017, after Olivier Teytaud left): Vincent Berthier (PhD defended in Dec.), Marc
Schoenauer
- **E-LUCID** 2014-2017 (194 kEuros)
Coordinator: Thales Communications & Security S.A.S
Participants: Marc Schoenauer, Cyril Furtlehner, Luis Marti
- **PIA ADAMME** 2015-2018 (258 kEuros)
Coordinator: Bull SAS
Participants (in 2017): Marc Schoenauer, Guillaume Charpiat, Cécile Germain-Renaud, Yasmina
Bouzbiba, Etienne Brame

- **CNES contract** 2015-2017 (70 kEuros)
Coordinator: Manuel Grizonnet (CNES) & Yuliya Tarabalka (Inria Sophia-Antipolis, Titane team)
Participant: Guillaume Charpiat
- **NEXT** 2017-2021 (675 kEuros). Simulation, calibration, and optimization of regional or urban power grids
ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie)
Coordinator: ARTELYS
Participants Isabelle Guyon, Marc Schoenauer, Michèle Sebag, Victor Berger (PhD), Herilalaina Rakotoarison (PhD), Berna Bakir Batu (Post-doc)
- **BRAINTIME** 2017 (7 kEuros) Défi exploratoire interdisciplinaire de l'appel INFINITE (CNRS) concerning the functional connectome dynamics of the brain.
Coordinator: Andrea Brovelli (CNRS), Institut de Neurosciences de la Timone (INT)
Participants Aurélien Decelle, Cyril Furtlehner
- **CDS DeepGenetics** 2017 (6mois, 3k euros), Deep Learning for Population Genetics.
funded by Center for Data Science
Coordinators: Flora Jay and Guillaume Charpiat
Participants: Théophile Sanchez (master internship)

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

See.4C 2016-2017 (2.7 kEuros). SpatiotEmporal ForEcasting: Coopetition to meet Current Cross-modal Challenges
Participants: Isabelle Guyon

9.2.2. Collaborations with Major European Organizations

MLSpaceWeather 2015-2019. Coupling physics-based simulations with Artificial Intelligence.
Coordinator: CWI
Participants: Michèle Sebag, Aurélien Decelle, Cyril Furtlehner, Mhamed Hajaiej

ESA Tender 2015-2017
Coordinator: Bart Boonacker (TNO)
Participant: Marc Schoenauer, Dejan Tusar

9.3. International Initiatives

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

9.3.1.1. MDG-TAO

Title: Data-driven simulations for Space Weather predictions

International Partner: CWI (Netherlands) – **Multiscale Dynamics Group** – Enrico Camporeale
Start year: 2017

We propose an innovative approach to Space Weather modeling: the synergetic use of state-of-the-art simulations with Machine Learning and Data Assimilation techniques, in order to adjust for errors due to non-modeled physical processes, and parameter uncertainties. We envision a truly multidisciplinary collaboration between experts in Computational Science and Data assimilation techniques on one side (CWI), and experts in Machine Learning and Data Mining on the other (Inria). Our research objective is to realistically tackle long-term Space Weather forecasting, which would represent a giant leap in the field. This proposal is extremely timely, since the huge amount of (freely available) space missions data has not yet been systematically exploited in the current computational methods for Space Weather. Thus, we believe that this work will result in cutting-edge results and will open further research topics in space Weather and Computational Plasma Physics.

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

Isabelle Guyon partner of Google Zurich *Preparation of a competition AutoDL: Automatic Deep Learning*.

9.3.2.2. Informal International Partners

Marc Schoenauer partner of the ARC-DP (Australian Research Council Discovery Project) *Bio-inspired computing methods for dynamically changing environments*. Coordinator: University of Adelaide (Frank Neumann), 5 years from Nov. 2015, 400 k\$-AUS. Visit to Adelaide: 2 weeks in Feb. 2017. Paper in preparation.

Isabelle Guyon partner of UC Berkeley *Fingerprint verification with deep siamese neural networks using ultrasonic sensor data*. Co-advisor of a master student (Baiyu Chen). Partners: Alyosha Efros, Bernhard Boser.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- **Edgar Galvan Lopez** University College Dublin, April 2015 - April 2017, funded by the ELEVATE Fellowship, the Irish Research Council's Career Development Fellowship co-funded by Marie Curie Actions. Now Lecturer at Maynooth University, Ireland.

9.4.1.1. Internships

- **Tomas Lungenstrass** June 2016 - June 2017, self-funded, collaboration with Inria Chile. Worked on magnetic storm prediction under A. Decelle's, C. Furtlehner's and M. Sebag's supervision.

TEA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

Program: ANR

Project acronym: **Feever**

Project title: Faust Environment Everywhere

Duration: 2014-2016

Coordinator: Pierre Jouvelot, Mines ParisTech

Other partners: Grame, Inria Rennes, CIEREC

URL: <http://www.feever.fr>

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

9.1.2. PAI

Program: PAI/CORAC

Project acronym: CORAIL

Project title: Composants pour l'Avionique Modulaire Étendue

Duration: July 2013 - May 2017

Coordinator: Thales Avionics

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

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

9.2. International Initiatives

9.2.1. Inria International Labs

9.2.1.1. SACCADES

Title: Saccades

International Partner:

LIAMA

East China Normal University

Inria project-teams Aoste and Tea

Duration: 2003 - now

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

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

The ambition of SACCADES project is to develop

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

9.2.2. Inria Associate Teams

9.2.2.1. Composite

Title: Compositional System Integration

International Partner (Institution - Laboratory - Researcher):

- University of California, San Diego (United States) - Microelectronic Embedded Systems Laboratory - Rajesh Gupta

Start year: 2017

See also: <http://www.irisa.fr/prive/talpin/composite>

Most applications that run somewhere on the internet are not optimized to do so. They execute on general purpose operating systems or on containers (virtual machines) that are built with the most conservative assumptions about their environment. While an application is specific, a large part of the system it runs on is unused, which is both a cost (to store and execute) and a security risk (many entry points).

A unikernel, on the contrary, is a system program object that only contains the necessary the operating system services it needs for execution. A unikernel is build from the composition of a program, developed using high-level programming language, with modules of a library operating system (libOS), to execute directly on an hypervisor. A unikernel can boot in milliseconds to serve a request and shut down, demanding minimal energy and resources, offering stealthiest exposure time and surface to attacks, making them the ideal platforms to deploy on sensor networks, networks of embedded devices, smart grids and clouds.

The goal of COMPOSITE is to develop the mathematical foundations for sound and efficient composition in system programming: analysis, verification and optimization technique for modular and compositional hardware-system-software integration of unikernels. We intend to further this development with the prospect of an end-to-end co-design methodology to synthesize lean and stealth networked embedded devices.

9.2.3. Inria International Partners

9.2.3.1. Convex

Title: Compositional Verification of Cyber-Physical Systems

International Partner:

- Chinese Academy of Science, Institute of Software
- Beihang University
- Nanhong University
- Nankai University

Duration: 2017 - now

Formal modeling and verification methods have successfully improved software safety and security in vast application domains in transportation, production and energy. However, formal methods are labor-intensive and require highly trained software developers. Challenges facing formal methods stem from rapid evolution of hardware platforms, the increasing amount and cost of software infrastructures, and from the interaction between software, hardware and physics in networked cyber-physical systems.

Automation and expressivity of formal verification tools must be improved not only to scale functional verification to very large software stacks, but also verify non-functional properties from models of hardware (time, energy) and physics (domain). Abstraction, compositionality and refinement are essential properties to provide the necessary scalability to tackle the complexity of system design with methods able to scale heterogeneous, concurrent, networked, timed, discrete and continuous models of cyber-physical systems.

Project Convex wants to define a CPS architecture design methodology that takes advantage of existing time and concurrency modeling standards (MARTE, AADL, Ptolemy, Matlab), yet focuses on interfacing heterogeneous and exogenous models using simple, mathematically-defined structures, to achieve the single goal of correctly integrating CPS components.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Rajesh Gupta visited project-team TEA in August and gave two 68NQTR seminars on “Building Computing Machines That Sense, Adapt and Approximate” and on “Compositional Synthesis for High-level Design of System-Chips”.

Deian Stefan visited project-team TEA in September and gave a 68NQTR seminar on “Practical multi-core information flow control”

Shuvra Bhattacharyya visited project-team TEA in August and December and gave a 68NQTR seminar on “The DSPCAD Framework for Dataflow-based Design and Implementation of Signal Processing Systems”

9.3.2. Visits to International Teams

Jean-Pierre Talpin visited UC San Diego and UC Berkeley in the context of the associate-project Composite in June.

In the context of the IIP Convex, Jean-Pierre Talpin was invited at Beihang and Nanhang Universities in April, visited Beihang and Nankai Universities in July, and Beihang, Nankai and ECNU in November, to give seminars and a introductory course on model checking.

Jean-Pierre Talpin gave an invited talk on “Parametric model-checking the FTSP protocol ” at TU Wien June 30.

Simon Lunel visited CMU and UC San Diego in December to give seminars on “compositional proofs in differential dynamic logic”.

THOTH Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

Participants: Jakob Verbeek, Maha Elbayad.

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

9.2. National Initiatives

9.2.1. *ANR Project Macaron*

Participants: Julien Mairal, Zaid Harchaoui [University of Washington], Laurent Jacob [CNRS, LBBE Laboratory], Michael Blum [CNRS, TIMC Laboratory], Joseph Salmon [Telecom ParisTech], Mikita Dvornik, Thomas Dias-Alves, Daan Wymen.

The project MACARON is an endeavor to develop new mathematical and algorithmic tools for making machine learning more scalable. Our ultimate goal is to use data for solving scientific problems and automatically converting data into scientific knowledge by using machine learning techniques. Therefore, our project has two different axes, a methodological one, and an applied one driven by explicit problems. The methodological axis addresses the limitations of current machine learning for simultaneously dealing with large-scale data and huge models. The second axis addresses open scientific problems in bioinformatics, computer vision, image processing, and neuroscience, where a massive amount of data is currently produced, and where huge-dimensional models yield similar computational problems.

This is a 3 years and half project, funded by ANR under the program "Jeunes chercheurs, jeunes chercheuses", which started in October 2014. The principal investigator is Julien Mairal.

9.2.2. *ANR Project DeepInFrance*

Participant: Jakob Verbeek.

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

9.3. European Initiatives

9.3.1. *FP7 & H2020 Projects*

9.3.1.1. *ERC Advanced grant Allegro*

Participants: Cordelia Schmid, Pavel Tokmakov, Nicolas Chesneau, Vasiliki Kalogeiton, Konstantin Shmelkov, Daan Wymen, Xiaojiang Peng.

The ERC advanced grant ALLEGRO started in April 2013 for a duration of five years extended in 2017 for one year. 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, Dexiong Chen, Alberto Bietti, Hongzhou Lin.

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 Associate Teams Not Involved in an Inria International Labs

9.4.1.1. GAYA

Title: Semantic and Geometric Models for Video Interpretation

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Robotics Institute - Deva Ramanan

Start year: 2016

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

The primary goal of the associate team GAYA is to interpret videos, in terms of recognizing actions, understanding the human-human and human-object interactions. Despite several years of research, it is yet unclear what is an efficient and robust video representation to attack this challenge. In order to address this, GAYA will focus on building semantic models, wherein we learn the video feature representation with limited supervision, and also geometric models, where we study the geometric properties of object shapes to better recognize them. The team consists of researchers from two Inria project-teams (Thoth and WILLOW) and a US university (Carnegie Mellon University [CMU]). It will allow the three teams to effectively combine their respective strengths in areas such as inference and machine learning approaches for vision tasks, feature representation, large-scale learning, geometric reasoning. The main expected outcomes of this collaboration are: effective learnt representations of video content, new machine learning algorithms for handling minimally annotated data, large-scale public datasets for benchmarking, theoretical analysis of objects shapes and contours. In 2017, Gunnar Sigurdsson (PhD student of Abhinav Gupta [CMU]) visited the Thoth team to develop a new dataset of first- and third-person videos and an approach for learning a joint representation of these two modalities.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- **University of Edinburgh:** C. Schmid collaborates with V. Ferrari, full professor at university of Edinburgh. Vicky Kalogeiton started a co-supervised PhD in 2013 and graduated in 2017; she has been bi-localized between Uni. Edinburgh and Inria. Her subject is automatic learning of object representations in videos. The collaboration resulted in two joint publications in 2017 [19], [18].
- **MPI Tübingen:** C. Schmid collaborates with M. Black, a research director at MPI, starting in 2013. End of 2015 she was awarded a Humboldt research award funding a long-term research project with colleagues at MPI. She spent one month at MPI in May 2017. In 2017 the project resulted in the development of a large-scale synthetic human action dataset [12].
- **University of Washington:** Julien Mairal collaborates with Zaid Harchaoui, former member of the Lear team, on the topic of large-scale optimization. They co-advised one student, Hongzhou Lin, who defended his PhD in 2017.

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 Avancée). 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 to International Teams

9.5.1.1. Research Stays Abroad

- A. Bietti visited Microsoft Research at New York from September to December 2017, as part of the MSR-Inria joint centre collaboration.

TITANE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. *EPITOME: efficient representation to structure large-scale satellite images*

Participants: Nicolas Girard, Yuliya Tarabalka [PI].

The goal of this young researcher project is to devise an efficient multi-scale vectorial representation, which would structure the content of large-scale satellite images.

- Starting date: October 2017 - Duration: 4 years

9.1.1.2. *Faults_R_GEMS: Properties of FAULTS, a key to Realistic Generic Earthquake Modeling and hazard Simulation*

Participants: Lionel Matteo, Yuliya Tarabalka.

The goal of the project is to study the properties of seismic faults, using advanced math tools including learning approaches. The project is in collaboration with Arizona State University, CALTECH, Ecole Centrale Paris, ENS Paris, ETH Zurich, Geosciences Montpellier, IFSTTAR, IPGP Paris, IRSN Fontenay-aux-Roses, LJAD Nice, UNAVCO Colorado and Pisa University.

- Starting date: October 2017 - Duration: 4 years

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. *TITANIUM - Software Components for Robust Geometry Processing*

Type: IDEAS

Instrument: ERC Proof of concept

Duration: 18 months

Coordinator: Pierre Alliez

Inria contact: Pierre Alliez

Abstract: The TITANIUM project aims to develop a software demonstrator for geometry processing and 3D urban modeling, in order to facilitate the pre-commercialization of novel software components for the Computational Geometry Algorithms Library. The demonstrator will include novel approaches resulting from the ERC-funded IRON project (Robust Geometry Processing, StG-2010-257474), which are illustrated by publications presented at premier conferences in our field and a patent submitted in 2015. The expected outcomes of TITANIUM will be versatile methods for 3D reconstruction and simplification of data gathered from geometric measurements, as well as related methods specifically tailored to urban modeling. These methods represent a significant step forward by offering unrivaled levels of robustness, and automated generation of levels of detail that are semantically meaningful. The acronym TITANIUM, a robust and lightweight material, conveys our wish to streamline the geometric modeling pipeline through robust algorithms and lightweight representations. This Proof of Concept project will also implement the steps required for pre-commercialization. In view of this goal, we have included an industrial partner, GeometryFactory, a spinoff from Inria. We have already established preliminary contacts in the fields of metrology and geographic information systems. These contacts will provide real-world industrial case studies.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. *Declared Inria International Partners*

We collaborated with Mathieu Desbrun from Caltech, and Bedrich Benes from Purdue University.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Mathieu Desbrun, Professor at Caltech, visited us from August to October.
- Gianmarco Cherchi, PhD student from University of Cagliari (Sardinia), visited us for three months (October-December) to collaborate on the refinement and optimization of polycubes.
- David Bommers, junior researcher from RWTH Aachen, visited us in September.

9.4.1.1. Internships

- Leman Feng (Ecole des ponts): Generation and optimization of high-order meshes. In collaboration with Laurent Busé and Hervé Delingette.
- Vinay Datta Renigunta (Hyderabad, India): Sinkhorn iteration for optimal transport. In collaboration with David Cohen-Steiner.
- Armand Zampieri (Arts et Métiers Paristech): Aligning large-scale remote sensing images using neural networks.

TOCCATA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. ELEFFAN

Participant: Sylvie Boldo [contact].

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

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

Partners: ENSTA Paristech (A. Chapoutot)

9.2. National Initiatives

9.2.1. ANR CoLiS

Participants: Claude Marché [contact], Andrei Paskevich.

The CoLiS research project is funded by the programme “Société de l’information et de la communication” of the ANR, for a period of 60 months, starting on October 1st, 2015. <http://colis.irif.univ-paris-diderot.fr/>

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

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

9.2.2. ANR Vocal

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

The Vocal research project is funded by the programme “Société de l’information et de la communication” of the ANR, for a period of 60 months, starting on October 1st, 2015. <https://vocal.lri.fr/>

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

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

9.2.3. ANR FastRelax

Participants: Sylvie Boldo [contact], Guillaume Melquiond.

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

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

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

9.2.4. ANR Soprano

Participants: Sylvain Conchon [contact], Guillaume Melquiond.

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

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

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

9.2.5. FUI LCHIP

Participant: Sylvain Conchon [contact].

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

Partners: 2 technology providers (ClearSy, OCamlPro), in charge of building the architecture of the platform; 3 labs (IFSTTAR, LIP6, LRI), to improve LCHIP IDE features; 2 large companies (SNCF, RATP), representing public ordering parties, to check compliance with standard and industrial railway use-case.

The project lead by ClearSy has started in April 2016 and lasts 3 years. It is funded by BpiFrance as well as French regions.

9.2.6. ANR PARDI

Participant: Sylvain Conchon [contact].

Verification of PARAmeterized DIstributed systems. A parameterized system specification is a specification for a whole class of systems, parameterized by the number of entities and the properties of the interaction, such as the communication model (synchronous/asynchronous, order of delivery of message, application ordering) or the fault model (crash failure, message loss). To assist and automate verification without parameter instantiation, PARDI uses two complementary approaches. First, a fully automatic model checker modulo theories is considered. Then, to go beyond the intrinsic limits of parameterized model checking, the project advocates a collaborative approach between proof assistant and model checker. <http://pardi.enseiht.fr/>

The proof lead by Toulouse INP/IRIT started in 2016 and lasts for 4 years. Partners: Université Pierre et Marie Curie (LIP6), Université Paris-Sud (LRI), Inria Nancy (team VERIDIS)

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: COST (European Cooperation in Science and Technology).

Project acronym: EUTypes <https://eutypes.cs.ru.nl/>

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

Duration: 2015-2019

Coordinator: Herman Geuvers, Radboud University Nijmegen, The Netherlands

Other partners: 36 members countries, see http://www.cost.eu/COST_Actions/ca/CA15123?parties

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

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Ran Chen is a PhD student from Institute of Software (Chinese Academy of Sciences, Beijing, China) visiting the team for 10 months under the supervision of C. Marché and J.-J. Lévy (PiR2 team, Inria Paris). She worked on the formal verification of graphs algorithms [25], [17], and also in the context of the CoLiS project on verification of some aspects of the Unix file system and shell scripts [74] [11]

TONUS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The thesis of Pierre Gerhard devoted to numerical simulation of room acoustics is supported by the Alsace region. It is a joint project with CEREMA (Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement) in Strasbourg.

9.2. National Initiatives

9.2.1. *Contracts with Industry*

We are involved in a common project with the company AxesSim in Strasbourg. The objective is to help to the development of a commercial software for the numerical simulation of electromagnetic phenomena. The applications are directed towards antenna design and electromagnetic compatibility. This project was partly supported by DGA through "RAPID" (régime d'appui à l'innovation duale) funds. A CIFRE PhD has started in AxesSim on the same kinds of subjects in March 2015 (Bruno Weber). The new project is devoted to the use of runtime system in order to optimize DG solvers applied to electromagnetism [10]. The resulting software will be applied to the numerical simulation of connected devices for clothes or medicine. The project is supported by the "Banque Publique d'Investissement" (BPI) and coordinated by the Thales company.

9.2.2. *ANR*

ANR project PEPPSI (models for edge plasma physic in Tokamak) in *Programme Blanc* SIMI 9, started in 2013, ended this year.

Participants: David Coulette, Giovanni Manfredi [coordinator], Sever Hirstoaga.

9.2.3. *IPL FRATRES*

The TONUS project belongs to the IPL FRATRES (models and numerical methods for Tokamak).

Funded by the IPL, Xiaofei Zhao was a post-doctoral fellow until September 2017, under the joint supervision of Nicolas Crouseilles (team IPSO, Inria Rennes) and Sever Hirstoaga.

9.2.4. *IPL C2S@exa*

The TONUS and HIEPACS projects have obtained the financial support for the PhD thesis of Nicolas Bouzat thanks to the IPL C2S@exa (computational sciences at exascale). Nicolas Bouzat works at CEA Cadarache and is supervised locally by Guillaume Latu; the PhD advisors are Michel Mehrenberger and Jean Roman.

9.2.5. *HPC resources*

- GENCI project *Simulation numérique des plasmas par des méthodes semi-lagrangiennes et PIC adaptées*: 450 000 scalar computing hours on CURIE_standard (January 2016-January 2017). Coordinator: Michel Mehrenberger
Participants: Sever Hirstoaga, Guillaume Latu, Michel Mehrenberger, Thi Nhung Pham, Christophe Steiner, Yann Barsamian.
- GENCI project *Simulations 3D de plasmas deux espèces avec des méthodes particulières et semi-lagrangiennes*: 400 000 scalar computing hours accepted in October 2017 on supercomputer OCCI-GEN. Coordinator: Sever Hirstoaga
Participants: Yann Barsamian, Sever Hirstoaga, Michel Mehrenberger.

- PRACE project *SME HPC Adoption Programme in Europe: full simulation of an electromagnetic wave inside and outside a fully modeled human body*: 40 000 GPU computing hours accepted in October 2017 on supercomputer Piz Daint. Coordinator: Bruno Weber
Participants: Philippe Helluy, Bruno Weber.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. EUROfusion 2015-2017

- Eurofusion Enabling Research Project ER15-IPP01 (1/2015-12/2017) "Verification and development of new algorithms for gyrokinetic codes" (Principal Investigator: Eric Sonnendrücker, Max-Planck Institute for Plasma Physics, Garching).
Participants: Philippe Helluy, Sever Hirstoaga, Michel Mehrenberger.
- Eurofusion Enabling Research Project ER15-IPP05 (1/2015-12/2017) "Global non-linear MHD modelling in toroidal geometry of disruptions, edge localized modes, and techniques for their mitigation and suppression" (Principal Investigator: Matthias Hoelzl, Max-Planck Institute for Plasma Physics, Garching).
Participant: Emmanuel Franck.

9.4. International Initiatives

9.4.1. Participation in Other International Programs

Participants: David Coulette, Conrad Hillairet, Emmanuel Franck, Philippe Helluy [local coordinator].

ANR/SPPEXA "EXAMAG" is a joint French-German-Japanese project. Its goal is to develop efficient parallel MHD solvers for future exascale architectures. With our partners, we plan to apply highly parallelized and hybrid solvers for plasma physics. One of our objectives is to develop Lattice-Boltzmann MHD solvers based on high-order implicit Discontinuous Galerkin methods, using SCHNAPS and runtime systems such as StarPU.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Christian Klingenberg from Würzburg university was invited several times in 2017, by Philippe Helluy.

Roberto Ferretti was invited one month in 2017 at IRMA, by Michel Mehrenberger, for working on the stability of semi-Lagrangian schemes.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Philippe Helluy, Emmanuel Franck and David Coulette visited Christian Klingenberg at Würzburg university.

TOSCA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, 2014–2018) coordinated by F. Hamel (Univ. Aix-Marseille).

9.1.2. ITMO project

N. Champagnat, C. Fritsch and D. Villemonais are involved in an ITMO Cancer project (INSERM funding) on “Modeling ctDNA dynamics for detecting targeted therapy resistance” (2017-2020), involving researchers from IECL (Institut Elie Cartan de Lorraine), the Inria teams BIGS and TOSCA, ICL (Institut de Cancérologie de Lorraine), CRAN (Centre de Recherche en Automatique de Nancy) and CHRU Strasbourg (Centre Hospitalier Régional Universitaire). This project is coordinated by N. Champagnat.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Program: FP7

Project acronym: HBP

Project title: The Human Brain Project

Duration: April 2016 - March 2018 (second part)

Coordinator: EPFL

Other partners: see the webpage of the project.

Abstract: Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases. This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics, Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity. A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. International Initiatives

ECOS Discrelongmem

Title: On discretization procedures in Non-Gaussian long memory processes with applications in non parametric statistics and time series analysis

International Partner (Institution - Laboratory - Researcher):

Universidad de Valparaiso (Chile) - CIMFAV – Facultad de Ingenieria

PI: E. Tanré (France), S. Torrès (Chile)

Duration: 2016 - 2018

Start year: 2016

Keywords: Approximations of non-Gaussian long-memory processes. Fractional Poisson processes (fPp). Skew Fractional Process (SfP).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- E. Mordecki (Universidad de la Repùblica, Uruguay) has been visiting Nancy for two months in February-March 2017.

9.4.1.1. Internships

- Ahmed Amine Barnicha
Subject: Modelling avalanches
Date: Sept. 2017 - June 2018 (research project)
Institution: Écoles des Mines de Nancy.
- Quentin Cormier
Subject: Study of the limit equation associated to a model of interacting neurons
Date: May 2017 - Aug. 2017
Institution: Université Pierre et Marie Curie.
- Djibril Gueye
Subject: Analyse de modèles markoviens couplés pour la température régionalisée
Date: July 2017 - Oct. 2017
Institution: AIMS- Senegal.
- Marie Muzzolon
Subject: Estimation sans paramètres et simulation de Monte Carlo pour les processus ponctuels marqués : lien entre les méthodes ABC et les méthodes de type gradient stochastique.
Date: April 2017 - Sept. 2017 (research project)
Institution: Université de Lorraine.
- Fares Omari
Subject: Analyse de modèles markoviens couplés pour la température régionalisée
Date: July 2017 - Oct. 2017
Institution: ENSIIE.
- Medhi Talbi

Subject: Optimisation de portefeuille par une approche de type champ moyen

Date: :March 2017 - July 2018 (research project)

Institution: École Normale Supérieure Paris-Saclay.

9.4.1.2. Research Stays Abroad

- M. Deaconu has been invited one week in February to the Institute of Mathematics of the Romanian Academy, Bucarest, by Lucian Beznea.
- C. Fritsch spent three days in Munich in June to start a collaboration with Mehdi Gharasoo (Institute of Groundwater Ecology).
- D. Talay was an invited Professor at Columbia University (New York) in June. He gave a course on ergodic diffusion processes.
- E. Tanré have spent two weeks in Valparaíso (Chile) in December within the ECOS program (PIs: E. Tanré, S. Torres), working with S. Torres (Univ. of Valparaiso).

TROPICAL Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Projet ANR MALTHY (Méthodes ALgébriques pour la vérification de modèles Temporisés et HYbrides), responsable T. Dang. Partenaires : Verimag, CEA LIST, Inria Rennes, Inria Saclay, VISEO/Object Direct.
- Projet ANR DEMOCRITE ("DEmonstrateur d'un MOteur de Couverture des Risques sur un TErritoire), responsable Emmanuel Lapébie (CEA). Partenaires : CEA-GRAMAT, BSPP, Inria Saclay (Maxplus), Institut PPRIME - UPR3346 (CNRS, Univ. Poitiers, ISAE-ENSMA), IPSIS, SYSTEL, ARMINES-E.M. Alès-ISR, CERDACC (Univ. de Haute-Alsace).

9.1.2. Programme Gaspard Monge pour l'Optimisation

- Projet intitulé "Méthodes tropicales pour l'optimisation", responsable X. Allamigeon, faisant intervenir M. Akian, V. Boeuf, S. Gaubert, A. Hochart, R. Katz, et M. Skomra.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

- Collaboration with Ricardo D. Katz, CIFASIS-CONICET, Rosario (Argentina). Research invitation at CMAP during 2 months.

9.2.2. Participation in International Programs

- Collaboration with Gleb Koshevoy, Poncelet Laboratory, Moscow (research invitation of Gleb Koshevoy at CMAP during 2 months, research invitation of Stéphane Gaubert at Poncelet Laboratory during 1 week).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Gleb Koshevoy (Russian Academy of Sciences), Feb-March, 2017.
- Shmuel Friedland (University of Illinois at Chicago), one week in May 2017.
- Zheng Qu (Hong Kong University), June-July 2017
- Zheng Hua (Hong Kong University), June-July 2017
- Rajendra Bhatia (Indian Statistical Institute, New Delhi), 1 week in Dec 2017.
- Floris Claassens (University of Kent), 1 week in Dec 2017.

TYREX Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

AGIR

Title: Data-CILE

Call: Appel à projet Grenoble Innovation Recherche (AGIR-Pole)

Duration: 2016-2018

Coordinator: Nabil Layaïda

Abstract: The goal of this project is to contribute to foundational and algorithmic challenges introduced by increasingly popular data-centric paradigms for programming on distributed architectures such as spark and the massive production of big linked open data. The focus of the project is on building robust and more efficient workflows of transformations of rich web data. We will investigate effective programming models and compilation techniques for producing specialised language runtimes. We will focus on high-level specifications of pipelines of data transformations and extraction for producing valuable knowledge from rich web data. We will study how to synthesise code which is correct and optimised for execution on distributed platforms. The overall expected outcome is to make the development of rich-data-intensive applications less error-prone and more efficient.

8.2. National Initiatives

8.2.1. 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: October 2016 – September 2020

Coordinator: Pierre Genevès

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

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

8.2.2. PERSYVAL-lab LabEx

Title: Mobile Augmented Reality Applications for Smart Cities

Call: Persyval Labex ("Laboratoire d'excellence").

Duration: 2014 – 2017

Coordinators: Pierre Genevès and Nabil Layaïda

Others partners: NeCS team at GIPSA-Lab laboratory.

Abstract: The goal of this project is to increase the relevance and reliability of augmented reality (AR) applications, through three main objectives:

1. Finding and developing appropriate representations for describing the physical world (3D maps, indoor buildings, ways...), integrated advanced media types (3D, 3D audio, precisely geo-tagged pictures with lat., long. and orientation, video...)
2. Integrating the different abstraction levels of these data streams (ranging from sensors data to high level rich content such as 3D maps) and bridging the gap with Open Linked Data (the semantic World). This includes opening the way to query the environment (filtering), and adapt AR browsers to users' capabilities (e.g. blind people). The objective here is to provide an open and scalable platform for mobile-based AR systems (just like the web represents).
3. Increasing the reliability and accuracy of localization technologies. Robust and high-accuracy localization technologies play a key role in AR applications. Combined with geographical data, they can also be used to identify user-activity patterns, such as walking, running or being in an elevator. The interpretation of sensor values, coupled with different walking models, allows one to ensure the continuity of the localization, both indoor and outdoor. However, dead reckoning based on Inertial Navigation Systems (INS) or Step-and-Heading Systems (SHS) is subject to cumulative errors due to many factors (sensor drift (accelerometers, gyroscopes, etc.), missed steps, bad estimation of the length of each stride, etc.). One objective is to reduce such errors by merging and mixing these approaches with various external signals such as GPS and Wi-Fi or relying on the analyses of user trajectories with the help of a structured map of the environment. Some filtering methods (Kalman Filter, observer, etc.) will be useful to achieve this task.

Valda Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Valda has obtained a 10k€ budget from ENS in 2017, as a start-up grant from the team (*Action Concertée Incitative*).

Inria established a bilateral contract with the Centre – Val de Loire region, for the expertise and audit of a research project by Pierre Senellart. Because of delays due to the company being audited, the expertise is still in progress.

7.2. National Initiatives

7.2.1. ANR

Valda has been part of one ANR project in 2017 (Headwork, budget managed by Inria), together with IRISA (DRUID team, coordinator), Inria Lille (LINKS & SPIRAL), and Inria Rennes (SUMO), and two application partners: MNHN (Cesco) and FouleFactory. The topic is workflows for crowdsourcing. See <http://headwork.gforge.inria.fr/>.

In addition, another project (BioQOP, budget managed by ENS) will start in January 2018, with Morpho and GREYC, on the optimization of queries for privacy-aware biometric data management

7.3. International Initiatives

7.3.1. Informal International Partners

Valda has strong collaborations with the following international groups:

Univ. Edinburgh, United Kingdom: Peter Buneman and Leonid Libkin

Univ. Oxford, United Kingdom: Michael Benedikt, Evgeny Kharlamov, and Georg Gottlob

Dortmund University, Germany: Thomas Schwentick

Warsaw University, Poland: Mikołaj Bojańczyk and Szymon Toruńczyk

Tel Aviv University, Israel: Daniel Deutch and Tova Milo

Drexel University, USA: Julia Stoyanovich

Univ. California San Diego, USA: Victor Vianu

National University of Singapore: Stéphane Bressan

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Victor Vianu, Professor at UC San Diego and holder of an Inria international chair, spent 6 months within Valda: three months employed by Inria and three months as an ENS invited professor.

7.4.1.1. Internships

Deabrota Basu, PhD student at National University of Singapore, stayed 2.5 months within Valda, to work with Pierre Senellart.

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

- Pierre Senellart has spent around two months at the University of Edinburgh, collaborating with Peter Buneman and Leonid Libkin.
- Pierre Senellart has spent a cumulated time of more than one month at National University of Singapore, co-advising Deabrota Basu, PhD student working under the co-supervision of Stéphane Bressan.

VERIDIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR-DFG Project SMArT

Participants: Haniel Barbosa, Pascal Fontaine, Stephan Merz, Thomas Sturm.

The SMArT (Satisfiability Modulo Arithmetic Theories) project was funded by ANR-DFG Programmes blancs 2013, a bilateral (French-German) program of Agence Nationale de la Recherche and Deutsche Forschungsgemeinschaft DFG. It started in April 2014 and finished in September 2017. The project gathered members of VeriDis in Nancy and Saarbrücken, and the Systereel company.

The objective of the SMArT project was to provide advanced techniques for arithmetic reasoning beyond linear arithmetic for formal system verification, and particularly for SMT. The results feed back into the implementations of Redlog and veriT, which also serve as experimentation platforms for theories, techniques and methods designed within this project.

More information on the project can be found on <http://smart.gforge.inria.fr/>.

9.1.2. ANR Project IMPEX

Participants: Souad Kherroubi, Dominique Méry.

The ANR Project IMPEX, within the INS program, started in December 2013 for 4 years. It was coordinated by Dominique Méry, the other partners are IRIT/ENSEIHT, Systereel, Supelec, and Telecom Sud Paris. The work reported here also included a cooperation with Pierre Castéran from LaBRI Bordeaux.

Modeling languages provide techniques and tool support for the design, synthesis, and analysis of the models resulting from a given modeling activity, as part of a system development process. These languages quite successfully focus on the analysis of the designed system, exploiting the semantic power of the underlying modeling language. The semantics of this modeling languages are well understood by its users (in particular the system designers), i.e. the semantics is implicit in the model. In general, modeling languages are not equipped with resources, concepts or entities handling explicitly domain engineering features and characteristics (domain knowledge) underlying the modeled systems. Indeed, the designer has to explicitly handle the knowledge resulting from an analysis of this application domain [61], i.e. explicit semantics. At present, making explicit the domain knowledge inside system design models does not obey any methodological rules validated by practice. The users of modeling languages introduce these domain knowledge features through types, constraints, profiles, etc. Our claim is that ontologies are good candidates for handling explicit domain knowledge. They define domain theories and provide resources for uniquely identifying domain knowledge concepts. Therefore, allowing models to make references to ontologies is a modular solution for models to explicitly handle domain knowledge. Overcoming the absence of explicit semantics expression in the modeling languages used to specify systems models will increase the robustness of the designed system models. Indeed, the axioms and theorems resulting from the ontologies can be used to strengthen the properties of the designed models. The objective [50] is to offer rigorous mechanisms for handling domain knowledge in design models.

9.1.3. ANR Project Formedicis

Participant: Dominique Méry.

The ANR Project Formedicis, within the INS program, started in January 2017 for 4 years. It is coordinated by Bruno d'Augsbourg, the partners are ONERA, IRIT/ENSEIHT, ENAC, and LORIA.

During the last 30 years, the aerospace domain has successfully devised rigorous methods and tools for the development of safe functionally-correct software. During this process, interactive software has received a relatively lower amount of attention. However, Human-System Interactions (HSI) are important for critical systems and especially in aeronautics: new generations of aircraft cockpits make use of sophisticated electronic devices that may be driven by more and more complex software applications. The criticality of these applications require a high degree of assurance for their intended behavior. The report by the French *Bureau d'Enquêtes et d'Analyses* about the crash of the Rio-Paris flight AF 447 in 2009 pointed out a design issue in the behavior of the Flight Director interface as one of the original causes of the crash.

We believe that part of these issues are due to the lack of a well-defined domain specific “hub” language to represent interactive software design in a way that allows system designers to iterate on their designs before injecting them in a development process, and system developers to verify their software against the chosen design. Formediscis aims at designing such a formal hub language L , in which designers can express their requirements concerning the interactive behavior that must be embedded inside the interactive applications. The project will also develop a framework for validating, verifying, and implementing critical interactive applications designed and denoted in L .

More information on the project is available at <http://www.agence-nationale-recherche.fr/Project-ANR-16-CE25-0007>.

9.1.4. ANR Project PARDI

Participants: Marie Duflot-Kremer, Stephan Merz.

PARDI (Verification of parameterized distributed systems) is funded by ANR. The project started in January 2017 for a duration of 48 months. The project partners other than VeriDis are Toulouse INP (coordinator), Université Paris Sud, and Université Paris Marie Curie.

Distributed systems and algorithms are parameterized by the number of participating processes, the communication model, the fault model, and more generally the properties of interaction among the processes. The project aims at providing methodological and tool support for verifying parameterized systems, using combinations of model checking and theorem proving. VeriDis contributes its expertise on TLA^+ and its verification tools, and the integration with the Cubicle model checker is a specific goal of the project.

More information on the project is available at <http://pardi.enseeiht.fr/>.

9.1.5. Inria IPL HAC SPECIS

Participants: Marie Duflot-Kremer, Stephan Merz.

The goal of the **HAC SPECIS** (High-performance Application and Computers: Studying Performance and Correctness In Simulation) project is to answer methodological needs of HPC application and runtime developers and to allow studying real HPC systems with respect to both correctness and performance. To this end, this Inria Project Lab assembles experts from the HPC, formal verification, and performance evaluation communities.

HAC SPECIS started in 2016. VeriDis contributes through its expertise in formal verification techniques. In particular, our goal is to extend the functionalities of exhaustive and statistical model checking within the SimGrid platform.

9.1.6. Inria Technological Development Action CUIC

Participants: Jasmin Christian Blanchette, Simon Cruanes.

Most “theorems” initially given to a proof assistant are incorrect, whether because of a typo, a missing assumption, or a fundamental flaw. Novices and experts alike can enter invalid formulas and find themselves wasting hours, or even days, on an impossible proof. This project, funded by Inria and running from 2015 to 2017, supported the development of a counterexample generator for higher-order logic. This new tool, called Nunchaku, is intended for integration with various proof assistants. The project was coordinated by Jasmin Blanchette and also involved Inria Saclay – Île de France (Toccata group) and Inria Rennes – Bretagne

Atlantique (Celtique group), among others. Simon Cruanes worked on Nunchaku from October 2015 to September 2017, whereas Blanchette has developed an Isabelle frontend. Four releases have taken place so far, and the tool is an integral part of the Isabelle2017 official release. Work has started on Coq and TLAPS frontends, and we will soon work on a Lean frontend as well. The tool is described in [62] and was presented at a workshop last year [57]. A noteworthy development this year is the creation of a backend called SMBC, based on new ideas by Cruanes about how to combine SAT solving and narrowing [29].

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. ERC Matryoshka

Program: European Union's Horizon 2020 research and innovation program

Project acronym: Matryoshka

Duration: April 2017 – March 2022

Coordinator: Jasmin Blanchette (VU Amsterdam)

Proof assistants are increasingly used to verify hardware and software and to formalize mathematics. However, despite the success stories, they remain very laborious to use. The situation has improved with the integration of first-order automatic theorem provers—superposition provers and SMT (satisfiability modulo theories) solvers—through middleware such as Sledgehammer for Isabelle/HOL and HOLyHammer for HOL Light and HOL4; but this research has now reached the point of diminishing returns. Only so much can be done when viewing automatic provers as black boxes.

To make interactive verification more cost-effective, we propose to deliver very high levels of automation to users of proof assistants by fusing and extending two lines of research: automatic and interactive theorem proving. This is our grand challenge. Our starting point is that first-order (FO) automatic provers are the best tools available for performing most of the logical work. Our approach will be to enrich superposition and SMT with higher-order (HO) reasoning in a careful manner, in order to preserve their desirable properties. We will design proof rules and strategies, guided by representative benchmarks from interactive verification.

With higher-order superposition and higher-order SMT in place, we will develop highly automatic provers building on modern superposition provers and SMT solvers, following a novel stratified architecture. To reach end users, these new provers will be integrated in proof assistants and will be available as backends to more specialized verification tools. The users of proof assistants and similar tools stand to experience substantial productivity gains: From 2010 to 2016, the success rate of automatic provers on interactive proof obligations from a representative benchmark suite called Judgment Day has risen from 47% to 77%; with this project, we aim at 90%–95% proof automation.

The Matryoshka ERC grant of Jasmin Blanchette includes Pascal Fontaine and Uwe Waldmann as senior researchers.

9.2.1.2. FET-Open CSA SC²

Program: European Union's Horizon 2020 research and innovation program

Project acronym: SC²

Project title: Symbolic Computation and Satisfiability Checking

Duration: July 2016 – August 2018

Coordinator: James Davenport (U. of Bath, UK)

Other partners: see <http://www.sc-square.org/CSA/welcome.html>

The use of advanced methods for solving practical and industrially relevant problems by computers has a long history. Whereas Symbolic Computation is concerned with the algorithmic determination of exact solutions to complex mathematical problems, more recent developments in the area of Satisfiability Checking tackle similar problems but with different algorithmic and technological solutions.

Though both communities have made remarkable progress in the last decades, they still need to be strengthened to tackle practical problems of rapidly increasing size and complexity. Their separate tools (computer algebra systems and SMT solvers) are urgently needed to examine prevailing problems with a direct effect to our society. For example, Satisfiability Checking is an essential backend for assuring the security and the safety of computer systems. In various scientific areas, Symbolic Computation enables dealing with large mathematical problems out of reach of pencil and paper developments.

Currently the two communities are largely disjoint and unaware of the achievements of each other, despite strong reasons for them to discuss and collaborate, as they share many central interests. However, researchers from these two communities rarely interact, and also their tools lack common, mutual interfaces for unifying their strengths. Bridges between the communities in the form of common platforms and roadmaps are necessary to initiate an exchange, and to support and to direct their interaction. These are the main objectives of this CSA. We initiate a wide range of activities to bring the two communities together, identify common challenges, offer global events and bilateral visits, propose standards, and so on.

We believe that these activities will foster cross-fertilisation of both fields and bring mutual improvements. Combining the knowledge, experience and the technologies in these communities will enable the development of radically improved software tools.

This project is locally coordinated by Pascal Fontaine.

9.3. International Initiatives

9.3.1. Inria International Partners

Title: Kanazawa-Nancy for Satisfiability and Arithmetics (KANASA)

International Partner: Japan Advanced Institute for Science and Technology (Dept. Intelligent Robotics, Mizuhito Ogawa)

Starting year: 2016

During the last decade, there has been tremendous progress on symbolic verification techniques, spurred in particular by the development of SMT (satisfiability modulo theories) techniques and tools. Our first direction of research will be to investigate the theoretical background and the practical techniques to integrate Interval Constraint Propagation within a generic SMT framework, including other decision procedures and quantifier handling techniques. On the purely arithmetic side, we also want to study how to unite the reasoning power of all arithmetic techniques developed in the team, including simplex-based SMT-like reasoners, Virtual Substitution, and Cylindrical Algebraic Decomposition. In particular, this includes developing theory combination frameworks for linear and non-linear arithmetic. There is a strong incentive for these kind of combinations since even non-linear SMT problems contain a large proportion of linear constraints. The partnership is supported by a Memorandum of Understanding between JAIST and LORIA.

One PhD student from JAIST spent one year in the VeriDiS team, until May 2017. The partnership evolves towards applying SMT to find malware in obfuscated code.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Tung Vu Xuan

Date: 1 May 2016 – 30 April 2017

Institution: JAIST

Host: Pascal Fontaine

Tung Vu Xuan is a PhD student at JAIST, Japan. He was visiting VeriDis in the context of the KANASA project. He works mainly on Interval Constraint Propagation (ICP), a heuristic but powerful method for satisfiability checking of non-linear arithmetic (NLA) constraints. During his stay, we investigated techniques to combine ICP with decision procedures for NLA within an SMT context, and adapted the subtropical method from computer algebra to the context of SMT. This work is relevant for the SMaRT and SC² projects.

Andrew J. Reynolds

Date: 16 July 2017 – 17 September 2017

Institution: The University of Iowa

Host: Pascal Fontaine

Andrew J. Reynolds is a Research Scientist at the University of Iowa and one of main developers of the award-winning Satisfiability Modulo Theories (SMT) solver CVC4. His current research interests include implementing techniques in SMT solvers for unbounded strings and regular expressions, first-order quantified formulas and synthesis conjectures. He was an Inria invited researcher for two months in Nancy. We continued working on quantifier handling for SMT, along the lines of [20], and studied enumerative instantiation. This work contributes to the Matryoshka, SMaRT and SC² projects.

9.4.2. Internships

Poonam Kumari

Date: 1 March – 31 July

Institution: Université de Lorraine (Erasmus Mundus DESEM)

Host: Stephan Merz

Poonam Kumari worked on a translation from a restricted subset of TLA⁺ specifications into the input language of the Cubicle model checker for array-based parameterized systems.

VIRTUAL PLANTS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *New pearl*

Participants: Sixtine Passot, Yann Guédon, Soazig Guyomarc'h [Montpellier University, DIADE], Laurent Laplaze [IRD, DIADE].

Funding: Labex Agro (Contractor for Virtual Plants: CIRAD, from 2014 to 2017)

Pearl millet is an orphan crop regarding research effort despite its key role for food safety in Sub-Saharan Africa. The objective of the New Pearl project is to develop basic biological knowledges concerning Pearl millet development and genetic diversity. We are more specifically involved in the study of the root system development and the genetic diversity on the basis of root phenotypic traits.

7.1.2. *Integrated model of plant organ growth*

Participants: Yann Guédon, Christine Granier [INRA, LEPSE], Garance Koch [INRA, LEPSE], Nadia Bertin [INRA, PSH], Valentina Baldazzi [INRA, PSH].

Funding: Labex Agro (Contractor for Virtual Plants: CIRAD. From 2015 to 2018)

The objective of this project is to develop a generic model which will predict interactions among the main processes controlling the development of source and sink organs in tomato, i.e. cell division, cell expansion and endoreduplication in relation to carbon and water fluxes under fluctuating environment. To achieve this objective we will i) capitalize on expertise, multi-scale phenotyping tools and genetic resources already compiled on the fruit model tomato and the model plant *Arabidopsis thaliana*; ii) perform new experiments to collect phenotyping data currently missing in this field, especially concerning the early phase of fruit and leaf development in tomato and the interactions between genes and environment; iii) develop a process-based model of organ growth which will integrate knowledge collected at the different scales.

Partners: PSH, INRA, Avignon; LEPSE, INRA, Montpellier, Biologie du fruit et Pathologie INRA, Bordeaux;

7.2. National Initiatives

7.2.1. *HydroRoot*

Participants: Mikaël Lucas [IRD], Christophe Pradal, Christophe Godin, Yann Boursiac [BPMP], Christophe Maurel [BPMP].

Funding: ANR (Contractor for Virtual Plants: Cirad, From 2012 to 2016)

The HydroRoot project proposes a unique combination of approaches in the model plant *Arabidopsis thaliana* to enhance our fundamental knowledge of root water transport. Accurate biophysical measurements and mathematical modeling are used, in support of reverse and quantitative genetics approaches, to produce an integrated view of root hydraulics. The HydroRoot project will address as yet unknown facets of root water transport. It will lead to an integrated view of root hydraulics that considers both tissue hydraulics and root architecture and explains how these components are controlled at the molecular level by physiological and/or environmental cues. Because of its strong physiological and genetic background, this research may also directly impact on breeding programs, for production of crops with optimised water usage and stress responses.

7.2.2. *Phenome*

Participants: Christian Fournier, Christophe Pradal, Yann Guédon, Sarah Cohen-Boulakia, Christophe Pradal, Pierre Fernique, Jerome Chopard, Patrick Valduriez.

Funding: ANR-Investissement d'avenir (Contractor for Virtual Plants: INRA, From 2015 to 2018)

The goal of Phenome is to provide France with an up-to-date, versatile, high-throughput infrastructure and suite of methods allowing characterisation of panels of genotypes of different species under climate change scenarios. We are involved in the methodological part of the project, that aims at developing a software framework dedicated to the analysis of high throughput phenotyping data and models. It will be based on the OpenAlea platform that provides methods and softwares for the modelling of plants, together with a user-friendly interface for the design and execution of scientific workflows. We also develop the InfraPhenoGrid infrastructure that allows high throughput computation and recording of provenance during the execution of Workflows.

7.2.3. *DigEM*

Participants: Christophe Godin, Grégoire Malandain, Patrick Lemaire.

Funding: ANR (Contractor for Virtual Plants: Inria, From 2015 to 2019)

In this project, we will use advanced light-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.

7.2.4. *Leaf Serration*

Participants: Christophe Godin, Eugenio Azpeitia.

Funding: ANR (Contractor for Virtual Plants: Inria, From 2014 to 2019)

Leaf growth and development result from the coordination in time and space of cellular divisions and cellular expansion, and expansion of certain plant cells reaches up to one thousand times their size when leaving the meristem. Transcription factors belonging to the CUP-SHAPED COTYLEDON (CUC) genes and homeodomain genes of the KNOTTED-LIKE (KNOXI) family were shown to be essential for the control of leaf size and shape. In addition, the phytohormone auxin is a critical regulator of growth and development, involved in the regulation and coordination of cell division and cell expansion. The mechanisms of auxin signalling are based on a complex set of co-receptors exhibiting high to low affinity for auxin and an even more complex modular network of transcriptional repressors and activators tightly controlling the expression of a large set of genes.

The SERRATIONS project is based on recent data relative to key transcription factors regulating leaf morphogenesis and advanced knowledge on the generic signalling mechanisms of the phytohormone auxin that plays a critical role in the control and coordination of cellular responses sustaining leaf size and shape. The goal of the project is to identify auxin signalling modules involved in leaf morphogenesis and to integrate these data in mathematical modelling to provide new insights into complex regulatory networks acting on leaf morphogenesis and to further test model-derived hypotheses.

7.2.5. *Other national grants*

7.2.5.1. *Morphogenetics*

Participants: Christophe Godin, Olivier Ali, Frédéric Boudon, Jean Phillipe Bernard, Hadrien Oliveri, Christophe Pradal, Guillaume Cerutti, Grégoire Malandain, François Faure, Jan Traas, François Parcy, Arezki Boudaoud, Teva Vernoux.

Funding: Inria Project Lab (From 2013 to 2017)

Morphogenetics is an Inria transversal project gathering 3 Inria teams and two Inra teams. It aimed at understanding how flower shape and architecture are controlled by genes during development. Using quantitative live-imaging analysis at cellular resolution we will determine how specific gene functions affect both growth patterns and the expression of other key regulators. The results generated from these experiments will be integrated in a specially designed database (3D Atlas) and used as direct input to new predictive computational models for morphogenesis and gene regulation. Model predictions will then be further tested through subsequent rounds of experimental perturbation and analysis. A particular emphasis will be put on the modeling of mechanics in tissues for which different approaches will be developed.

Partners: RDP ENS-Lyon; Imagine Inria Team (Grenoble); Morpheme Inria Team (Sophia-Antipolis), UMR PCV (Grenoble).

7.2.5.2. *Rose*

Participants: Christophe Godin, Frédéric Boudon.

Funding: INRA - PhD project (From 2016 to 2019)

In this project we want to quantify and understand how sugars interfere with hormonal signals (auxin, cytokinins) to regulate lateral bud outgrowth of aerial stems of roses. Experiments will be made on Rose stems to test different levels of sugar conditions and hormonal concentrations on bud outgrowth. An extension of the recently published hormonal model of apical dominance will be made to take into account the role of carbon as a signaling molecule.

Partners: UMR SAGAH, Angers

7.2.5.3. *ReProVirtuFlow*

Participants: Christophe Pradal, Sarah Cohen-Boulakia, Jerome Chopard.

In the life science domain, scientists are facing the deluge and the size of available data, the composition of a myriad of existing tools, and the complexity of computational experiment. In this context, reproducing an experiment is particularly difficult, as evidenced by numerous recent studies. The aim of this GDR CNRS project is to make a complete review of existing approaches in this field, considering in priority as elements of solution: (i) scientific workflows, (ii) data provenance, and (iii) virtual machines. This project brings together experts in data bases, algorithms and virtual environments, working in the domain of life science.

Funding: GDR - CNRS

7.3. European Initiatives

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

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.

This project was accepted in July 2017 and started Nov. 2017.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

An important collaboration with the CIRAD research unit HortSys at the Reunion island and in particular Frédéric Normand and Isabelle Grechi has been established for several years. The topic of the collaboration is the study of the phenology of mango tree. This is a tripartite collaboration that also involves Pierre-Eric Lauri of the System research unit (INRA, Montpellier).

7.5. International Research Visitors

7.5.1. Research Stays Abroad

In the context of the project on mango modelling and the PhD of S. Persello, F. Boudon was positioned in the Reunion island in the Hortsys unit for one year until August. He developed there a project on Mango modelling in collaboration with F. Normand.

VISAGES Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Allocation d'Installation Scientifique – Rennes Métropole*

Participant: Emmanuel Caruyer.

Diffusion MRI has been a tremendous tool for the diagnosis of a number of brain pathologies such as abnormal development, neuro-degenerative or inflammatory disorders or brain tumors. Typical resolution in diffusion MRI is about 2mm – this suggests that in white matter, any volume element may contain millions of axons. Although currently we can characterize molecular diffusion, recent developments in diffusion MRI have shown the possibility to quantify more specifically some physical tissue parameters in white matter, such as axonal density and diameter: this means that we can retrieve information from a much smaller scale than the typical imaging resolution.

Acquisition time for this kind of measurements remains long and largely incompatible with in vivo application in humans. This project aims at developing novel signal processing and acquisition methods for the reconstruction of microstructural informations in a reasonable acquisition time. We will study how sparse representations can be applied to the diffusion signal, in order to enable microstructure information reconstruction. In conjunction with this, we will develop acquisition sequences adapted to these sparse representations, in order to reconstruct the diffusion signal from fewer measurements, using results from the compressive sensing theory.

9.2. National Initiatives

9.2.1. *Projet Fondation de France: PERINE*

Participants: Élise Bannier, Isabelle Corouge, Julie Coloigner, Maia Proisy, Jean-Christophe Ferré, Christian Barillot.

This study evaluates the effect of prenatal exposure to neurotoxicants on the developing brain. Following previous studies in the PELAGIE cohort this MRI study involves ASL, Diffusion and working memory as well as motor inhibition BOLD fMRI together with neuropsychological tests in children. Inclusions have started in November 2014 and lasted for 2 years. The MRI acquisitions of the PERINE projects have all been performed and 101 children included. A PhD started in January 2017 to process the functional MRI data of this project and Julie Coloigner was hired as a post doc to work on the Diffusion and ASL data.

9.2.2. *Projet Fondation de France: EPMR-MA*

Participants: Pierre-Yves Jonin, Élise Bannier, Christian Barillot, Quentin Duché.

This project evaluates memory effects in healthy adults and in patients presenting cognitive impairments using BOLD fMRI and diffusion MRI. The inclusions of patients started in 2016 and all inclusions will be over by the end of 2017. Quentin Duché was hired to process the functional MRI and diffusion data end of 2016 and his contract was extended until May 2018.

9.2.3. *ANR "MAIA", 2015 generic projects program*

Participants: Maia Proisy, Pierre Maurel, Antoine Legouhy, Olivier Commowick, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot.

Each year in France, 55 000 children are born prematurely, i.e., before the 37th week of gestation. Long-term studies of the outcome of prematurely born infants have clearly documented that the majority of such infants may have significant motor, cognitive, and behavioral deficits.

However, there is a limited understanding of the nature of the cerebral abnormality underlying these adverse neurologic outcomes. In this context, the emergence of new modalities of 3D functional MRI, e.g., Arterial Spin Labeling (ASL), or optical imaging technologies, e.g., Near InfraRed Spectroscopy (NIRS), brings new perspectives for extracting cognitive information, via metabolic activity measures. Other classical techniques devoted to cerebral signal measurement, such as ElectroEncephaloGraphy (EEG), provide cognitive information at the cortical level. Each of these various non-invasive imaging technologies brings substantial and specific information for the understanding of newborn brain development.

This project aims at developing innovative approaches for multi-image / multi-signal analysis, in order to improve neurodevelopment understanding methods. From a fundamental point of view, mathematics and computer science have to be considered in association with imaging physics and medicine, to deal with open issues of signal and image analysis from heterogeneous data (image, signal), considered in the multiphysics contexts related to data acquisition (magnetic, optic, electric signals) and biophysics modeling of the newborn brain. A sustained synergy between all these scientific domains is then necessary.

Finally, the sine qua non condition to reach a better understanding of the coupled morphological- cognitive development of premature newborns, is the development of effective software tools, and their distribution to the whole medical community. The very target of this project will be the design of such software tools for medical image / signal analysis, actually operational in clinical routine, and freely available. Academic researchers and industrial partners will work in close collaboration to reach that ambitious goal.

9.2.4. Fondation pour la recherche médicale (FRM) - Project "Hybrid EEG/IRM Neurofeedback for rehabilitation of brain pathologies"

Participants: Élise Bannier, Jean-Marie Batail, Isabelle Bonan, Isabelle Corouge, Jean-Christophe Ferré, Jean-Yves Gauvrit, Pierre Maurel, Mathis Fleury, Giulia Lioi, Christian Barillot.

The goal of this project is to make full use of neurofeedback (NF) paradigm in the context of brain rehabilitation. The major breakthrough will come from the coupling associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to “optimize” the neurofeedback protocol. We propose to combine advanced instrumental devices (Hybrid EEG and MRI platforms), with new hybrid Brain computer interface (BCI) paradigms and new computational models to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major mental and neurological disorders of the developmental and the aging brain (stroke, language disorders, Mood Depressive Disorder (MDD), ...). Though the concept of using neurofeedback paradigms for brain therapy has somehow been experimented recently (mostly through case studies), performing neurofeedback through simultaneous fMRI and EEG has almost never been done before so far (two teams in the world including us within the HEMISFER CominLabs project). This project will be conducted through a very complementary set of competences over the different involved teams: VISAGES U1228, HYBRID and PANAMA Teams from Inria/Irisa Rennes and EA 4712 team from U. of Rennes I.

9.2.5. PHRC EMISEP: Evaluation of early spinal cord injury and late physical disability in Relapsing Remitting Multiple Sclerosis

Participants: Élise Bannier, Christian Barillot, Emmanuel Caruyer, Benoit Combès, Olivier Commowick, Gilles Edan, Jean-Christophe Ferré, Anne Kerbrat, Haykel Snoussi.

Multiple Sclerosis (MS) is the most frequent acquired neurological disease affecting young adults (1/1000 inhabitants in France) and leading to impairment. Early and well adapted treatment is essential in patients presenting aggressive forms of MS. This PHRC project focusses on physical impairment and especially on the ability to walk. Several studies, whether epidemiologic or based on brain MRI, have shown that several factors were likely to announce aggressive development of the disease, such as age, number of focal lesions on baseline MRI, clinical activity. However, these factors only partially explain physical impairment progression, preventing their use at the individual level. Spinal cord is often affected in MS, as demonstrated in postmortem or imaging studies. Yet, early radiological depiction of spinal cord lesions is not always correlated with clinical symptoms. Preliminary data, on reduced number of patients, and only investigating the cervical spinal cord

have shown that diffuse spinal cord injury, observed via diffusion or magnetisation transfer imaging, would be correlated with physical impairment as evaluated by the EDSS score. Besides, the role of early spinal cord affection (first two years) in the evolution of physical impairment remains unknown.

In this project, we propose to address these different issues and perform a longitudinal study on Relapsing Remitting Multiple Sclerosis (RRMS) patients, recruited in the first year of the disease. Our goal is to show that diffuse and focal lesions detected spinal cord MRI in the first 2 years can be used to predict disease evolution and physical impairment at 5 years. Twelve centers are involved in the study to include 80 patients.

To date, all subjects have been included. H. Snoussi is working in the scope of his PhD thesis on diffusion imaging in the spinal cord starting with distortion correction. The results of this study were presented at the ESMRMB 2017 conference [38].

B. Combès started as a post doc in November 2016 to process the EMISEP imaging data, starting with morphological data processing (registration, segmentation) and magnetization transfer data processing. Preliminary results were presented at the ESMRMB and ECTRIMS 2017 conferences [33] [43].

9.2.6. Competitivity Clusters

9.2.6.1. The HEMISFER Project

Participants: Élise Bannier, Jean-Marie Batail, Isabelle Bonan, Isabelle Corouge, Claire Cury, Jean-Christophe Ferré, Jean-Yves Gauvrit, Marsel Mano, Pierre Maurel, Saman Norzade, Lorraine Perronnet, Christian Barillot.

The HEMISFER project ("Hybrid Eeg-MrI and Simultaneous neuro-FEedback for brain Rehabilitation") will be conducted at Inria Rennes with the support of the Cluster of Excellence "CominLabs"⁰. The goal of HEMISFER is to make full use of the neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. We propose to combine advanced instrumental devices (Hybrid EEG and MRI platforms), with new man-machine interface paradigms (Brain computer interface and serious gaming) and new computational models (source separation, sparse representations and machine learning) to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major neurological and psychiatric disorders of the developmental and the aging brain (stroke, attention-deficit disorder, language disorders, treatment-resistant mood disorders, ...). This project will be conducted with the HYBRID and PANAMA Teams from Inria Rennes, the EA 4712 team from University of Rennes I and the ATHENA team from Inria Sophia-Antipolis. This work will benefit from the research 3T MRI and MRI-compatible EEG systems provided by the NeurInfo in-vivo neuroimaging platform on which these new research protocols will be set up. A budget of 500keuros will be provided by the CominLabs cluster in the next 3 years to support this project (through experimental designs, PhDs, Post-docs and Expert Engineers).

9.2.6.2. France Life Imaging (FLI)

Participants: Christian Barillot, Olivier Commowick, Michael Kain, Florent Leray, Julien Louis, Aneta Morawin, Mathieu Simon, Yao Chi.

France Life Imaging (FLI) is a proposed large-scale research infrastructure project aimed at establishing a coordinated and harmonized network of biomedical imaging in France. This project was recently selected by the call "Investissements d'Avenir - Infrastructure en Biologie et Santé". One node of this project is the node Information Analysis and Management (IAM), a transversal node build by a consortium of teams that will contribute to the construction of a network for data storage and information processing. Instead of building yet other dedicated facilities, the IAM node will use already existing data storage and information processing facilities (LaTIM Brest; CREATIS Lyon; CIC-IT Nancy; VisAGeS U1228 Inria Rennes; CATI CEA Saclay; LSIIT/Cube Strasbourg) that will increase their capacities for the FLI infrastructure. Inter-connections and access to services will be achieved through a dedicated software platform that will be developed based on the expertise gained through successful existing developments. The IAM node has several goals. It aims

⁰<https://www.inria.fr/cominlabs-newsletter/april-2013-four-projects-selected/#hemisfer>

first at building a versatile facility for data management that will inter-connect the data production sites and data processing for which state-of-the-art solutions, hardware and software, will be available to infrastructure users. Modular solutions are preferred to accommodate the large variety of modalities acquisitions, scientific problems, data size, and adapted for future challenges. Second, it aims at offering the latest development that will be made available to image processing research teams. The team VisAGeS fulfills multiple roles in this nation-wide project. Christian Barillot is the chair of the node IAM, Olivier Commowick is participating in the working group workflow and image processing and Michael Kain the technical manager. Apart from the team members, software solutions like MedInria and Shanoir will be part of the final software platform.

9.2.6.3. OFSEP

Participants: Élise Bannier, Christian Barillot, Olivier Commowick, Gilles Edan, Jean-Christophe Ferré, Michael Kain, Inès Fakhfakh.

The French Observatory of Multiple Sclerosis (OFSEP) is one of 10 projects selected in January 2011 in response to the call for proposal in the “Investissements d’Avenir - Cohorts 2010” program launched by the French Government. It allows support from the National Agency for Research (ANR) of approximately € 10 million for 10 years. It is coordinated by the Department of Neurology at the Neurological Hospital Pierre Wertheimer in Lyon (Professor Christian Confavreux), and it is supported by the EDMUS Foundation against multiple sclerosis, the University Claude Bernard Lyon 1 and the Hospices Civils de Lyon. OFSEP is based on a network of neurologists and radiologists distributed throughout the French territory and linked to 61 centers. OFSEP national cohort includes more than 50,000 people with Multiple Sclerosis, approximately half of the patients residing in France. The generalization of longitudinal monitoring and systematic association of clinical data and neuroimaging data is one of the objectives of OFSEP in order to improve the quality, efficiency and safety of care and promote clinical, basic and translational research in MS. For the concern of data management, the Shanoir platform of Inria has been retained to manage the imaging data of the National OFSEP cohort in multiple sclerosis.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

- **OpenAire-Connect**

The OpenAire-Connect H2020 project will introduce and implement the concept of Open Science as a Service (OSaaS) on top of the existing OpenAIRE infrastructure, delivering out-of-the-box, on-demand deployable tools. OpenAIRE-Connect will adopt an end-user driven approach (via the involvement of 5 prominent research communities), and enrich the portfolio of OpenAIRE infrastructure production services with a Research Community Dashboard Service and a Catch-All Notification Broker Service. The first will offer publishing, interlinking, packaging functionalities to enable them to share and re-use their research artifacts (introducing methods, e.g., data, software, protocols). This effort, supported by the harvesting and mining “intelligence” of the OpenAIRE infrastructure, will provide communities with the content and tools they need to effectively evaluate and reproduce science. OpenAIRE-Connect will combine dissemination and training with OpenAIRE’s powerful NOAD network engaging research communities and content providers in adopting such services. These combined actions will bring immediate and long-term benefits to scholarly communication stakeholders by affecting the way research results are disseminated, exchanged, evaluated, and re-used. In this project VisAGeS is acting, through CNRS, as the French coordinator to develop the link with the Neuroimaging research community. This will be performed in the context of the FLI-IAM national infrastructure.

- Participants: Christian Barillot; Michael Kain; Camille Maumet
- Partners: PI: CNR, Italy; Athena Research And Innovation Center In Information Communication & Knowledge Technologies, Greece; Uniwersytet Warszawski, Poland; JISC LBG, UK; Universitaet Bremen, Germany; Universidade Do Minho, Portugal; CNRS (Visages, Creatis), France; Universita Di Firenze, Italy; Institut De Recherche Pour Le Developpement (IRD), France; European Organization For Nuclear Research (CERN), Switzerland; International Center For Research On The Environment And The Economy, Greece

- Budget: 2M € (120k€ for CNRS)
- **Health**
EIT Health aims to promote entrepreneurship and develop innovations in healthy living and active ageing, providing Europe with new opportunities and resources. EIT Health will enable citizens to lead healthier and more productive lives by delivering products, services and concepts that will improve quality of life and contribute to the sustainability of healthcare across Europe. EIT Health is a strong, diverse and balanced partnership of best-in-class organisations in education, research, technology, business creation and corporate and social innovation. EIT Health intends to foster cooperation and unlock Europe's innovation and growth potential – developing and retaining the best talents, creating high-quality jobs and boosting the global competitiveness of European industry. VisAGeS is involved in this project through the Inserm and Inria institutions. Christian Barillot is representing Inria as one expert in the dedicated WG “Healthy Brain”. VisAGeS is also concerned by the WG “big data”.
 - Participants: Christian Barillot, Michael Kain
 - Partners: see <https://www.eithealth.eu/partners>

9.4. International Initiatives

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

9.4.1.1. BARBANT

Title: Boston and Rennes, a Brain image Analysis Team

International Partner (Institution - Laboratory - Researcher):

Harvard University (United States) - Mathematics Department - Simon K. Warfield

Start year: 2015

See also: <https://team.inria.fr/barbant/>

BARBANT is an Inria associate team shared between Inria VisAGeS research team and the Computational Radiology Laboratory at the Boston Children's hospital (Harvard Medical School). This associate team aims at better understanding the behavior of normal and pathological Central Nervous System (CNS) organs and systems. Pathologies of particular interest to us are multiple sclerosis, psychiatric, and pediatric diseases such as pediatric multiple sclerosis or tuberous sclerosis. A major challenge is to characterize the future course of the pathological processes in each patient as early as possible in order to predict the progression of the disease and/or adverse neurological outcomes, and to develop better techniques for both monitoring response to therapy and for altering therapy (duration, dose and nature) in response to patient-specific changes in imaging characteristics. At term, this project will allow to introduce objective figures to correlate qualitative and quantitative phenotypic markers coming from the clinic and image analysis, mostly at the early stage of the pathologies. This will allow for the selection or adaptation of the treatment for patients at an early stage of the disease.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- Collaboration with the Department of Computer Science, University of Verona: Emmanuel Caruyer visited the group of Gloria Menegaz and Alessandro Daducci in the context of the 2017 School on Brain Connectomics (<http://brainconnectomics.org/>).
- Collaboration with Neuropoly, Polytechnique Montreal: Haykel Snoussi is visiting the group of Julien Cohen-Adad and received an Inria-MITACS fellowship for a 3 months period (Nov. 2017-Jan. 2018). He will be working on the processing of diffusion-weighted images of multiple sclerosis patients' spinal cord in the context of the EMISEP project.

- Collaboration with Department of Mathematics and Statistics at the Politecnico di Milano, Italy (Simone Vantini, Aymeric Stamm): Lorenzo Rota did visit the team between Oct. 2016 to March 2017 for his Tesi (Master degree) on "Application of shape analysis and functional data analysis tools on fiber bundles analysis".

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Simon Warfield and Benoit Scherrer, Harvard University, visited the VisAGeS team for the annual seminar on Jun. 2017.

9.5.2. Visits to International Teams

- Sudhanya Chatterjee visited the Computational Radiology Lab, the Boston Children's Hospital, at Harvard University in Nov. 2017. This stay was funded by the international program of University of Rennes 1. Christian Barillot and Olivier Commowick visited the same lab for a 3 days workshop in the context of the Associate Team.
- Haykel Snoussi visited the NeuroPoly Lab for 3 months from Nov. 2017. This stay was funded by the international program of University of Rennes 1.

WHISPER Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- City of Paris, 2016-2019, 100 000 euros. As part of the “Émergence - young team” program the city of Paris is supporting part of our work on domain-specific languages.

9.2. National Initiatives

9.2.1. ANR

ITrans - awarded in 2016, duration 2017 - 2020

Members: LIP6 (Whisper), David Lo (Singapore Management University)

Coordinator: Julia Lawall

Whisper members: Julia Lawall, Gilles Muller, Lucas Serrano, Van-Anh Nguyen

Funding: ANR PRCI, 287,820 euros.

Objectives:

Large, real-world software must continually change, to keep up with evolving requirements, fix bugs, and improve performance, maintainability, and security. This rate of change can pose difficulties for clients, whose code cannot always evolve at the same rate. This project will target the problems of *forward porting*, where one software component has to catch up to a code base with which it needs to interact, and *back porting*, in which it is desired to use a more modern component in a context where it is necessary to continue to use a legacy code base, focusing on the context of Linux device drivers. In this project, we will take a *history-guided source-code transformation-based* approach, which automatically traverses the history of the changes made to a software system, to find where changes in the code to be ported are required, gathers examples of the required changes, and generates change rules to incrementally back port or forward port the code. Our approach will be a success if it is able to automatically back and forward port a large number of drivers for the Linux operating system to various earlier and later versions of the Linux kernel with high accuracy while requiring minimal developer effort. This objective is not achievable by existing techniques.

9.3. International Initiatives

9.3.1. Inria International Labs

- EPFL-Inria Lab Our work on the Ipanema DSL [17] is done as part of the EPFL-Inria Lab. Baptiste Lepers (EPFL) is supported in 2017 as a joint postdoc between the Whisper and the groups of V. Kuncak and W. Zwaenepoel.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

- We collaborate with David Lo and Lingxiao Jiang of Singapore Management University, who are experts in software mining, clone detection, and information retrieval techniques. Our work with Lo and/or Jiang has led to 8 joint publications since 2013 [12], [68], [78], [83], [84], [85], [88], [86], at conferences including ASE and ICSME. The ITrans ANR is a joint project with them.
- We collaborate with Christoph Reichenbach of the University of Lund and Krishna Narasimhan of Itemis (Germany) on program transformation [18] and the design of tools for code clone management.

- We collaborate with Wouter Swierstra of the University of Utrecht (Netherlands) on type-directed structured differences [20].
- We collaborate with Eric Tanter of the University of Chile (Chile) on the theoretical and practical aspects of dependent interoperability [38] in type theory.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

As part of the Invited Professor program of LIP6, we have hosted Prof. Éric Tanter (University of Chile) for two weeks (December 2017) who took this opportunity to give an introductory master class as well as a research seminar on the topic of gradual typing.

9.4.1.1. Internships

- Lukas Gnirke, Oberlin College, January 2017, evaluation of our methodology for searching for examples to guide driver porting [16].
- Adina Johnson, Oberlin College, May - August 2017, analysis of the differences between the Linux kernel and the Android kernel.
- Jonathan Carroll, Oberlin College, May - August 2017, use of machine learning to identify stable-kernel relevant patches.
- Bhumika Goyal, October - November 2017, constification of Linux kernel structures, supported by the Linux Foundation's Core Infrastructure Initiative.
- Peio Borthelle, École Normale Supérieure de Lyon, June - July 2017, solving the Oware on a single machine.
- Darius Mercadier, Université Pierre et Marie Curie, January - August 2017, designing and implementing Usuba, a bitslicing compiler.

9.4.1.2. Research Stays Abroad

- Julia Lawall, visit to David Lo and Lingxiao Jiang at Singapore Management University (two weeks in May 2017).

WILLOW Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Agence Nationale de la Recherche (ANR): SEMAPOLIS

Participants: Mathieu Aubry, Josef Sivic.

The goal of the SEMAPOLIS project is to develop advanced large-scale image analysis and learning techniques to semantize city images and produce semantized 3D reconstructions of urban environments, including proper rendering. Geometric 3D models of existing cities have a wide range of applications, such as navigation in virtual environments and realistic sceneries for video games and movies. A number of players (Google, Microsoft, Apple) have started to produce such data. However, the models feature only plain surfaces, textured from available pictures. This limits their use in urban studies and in the construction industry, excluding in practice applications to diagnosis and simulation. Besides, geometry and texturing are often wrong when there are invisible or discontinuous parts, e.g., with occluding foreground objects such as trees, cars or lampposts, which are pervasive in urban scenes. This project will go beyond the plain geometric models by producing semantized 3D models, i.e., models which are not bare surfaces but which identify architectural elements such as windows, walls, roofs, doors, etc. Semantic information is useful in a larger number of scenarios, including diagnosis and simulation for building renovation projects, accurate shadow impact taking into account actual window location, and more general urban planning and studies such as solar cell deployment. Another line of applications concerns improved virtual cities for navigation, with object-specific rendering, e.g., specular surfaces for windows. Models can also be made more compact, encoding object repetition (e.g., windows) rather than instances and replacing actual textures with more generic ones according to semantics; it allows cheap and fast transmission over low- bandwidth mobile phone networks, and efficient storage in GPS navigation devices.

This is a collaborative effort with LIGM / ENPC (R. Marlet), University of Caen (F. Jurie), Inria Sophia Antipolis (G. Drettakis) and Acute3D (R. Keriven).

9.2. European Initiatives

9.2.1. European Research Council (ERC) Starting Grant: "Activia" - Ivan Laptev

Participant: Ivan Laptev.

WILLOW will be funded in part from 2013 to 2017 by the ERC Starting Grant "Activia" awarded to Ivan Laptev by the European Research Council.

‘Computer vision is concerned with the automated interpretation of images and video streams. Today’s research is (mostly) aimed at answering queries such as ‘Is this a picture of a dog?’, (classification) or sometimes ‘Find the dog in this photo’ (detection). While categorisation and detection are useful for many tasks, inferring correct class labels is not the final answer to visual recognition. The categories and locations of objects do not provide direct understanding of their function i.e., how things work, what they can be used for, or how they can act and react. Such an understanding, however, would be highly desirable to answer currently unsolvable queries such as ‘Am I in danger?’ or ‘What can happen in this scene?’. Solving such queries is the aim of this proposal. My goal is to uncover the functional properties of objects and the purpose of actions by addressing visual recognition from a different and yet unexplored perspective. The main novelty of this proposal is to leverage observations of people, i.e., their actions and interactions to automatically learn the use, the purpose and the function of objects and scenes from visual data. The project is timely as it builds upon the two key recent technological advances: (a) the immense progress in visual recognition of objects, scenes and human actions achieved in the last ten years, as well as (b) the emergence of a massive amount of

public image and video data now available to train visual models. ACTIVIA addresses fundamental research issues in automated interpretation of dynamic visual scenes, but its results are expected to serve as a basis for ground-breaking technological advances in practical applications. The recognition of functional properties and intentions as explored in this project will directly support high-impact applications such as detection of abnormal events, which are likely to revolutionise today's approaches to crime protection, hazard prevention, elderly care, and many others.'

9.2.2. European Research Council (ERC) Starting Grant: "Leap" - Josef Sivic

Participant: Josef Sivic.

The contract has begun on Nov 1st 2014. WILLOW will be funded in part from 2014 to 2018 by the ERC Starting Grant "Leap" awarded to Josef Sivic by the European Research Council.

'People constantly draw on past visual experiences to anticipate future events and better understand, navigate, and interact with their environment, for example, when seeing an angry dog or a quickly approaching car. Currently there is no artificial system with a similar level of visual analysis and prediction capabilities. LEAP is a first step in that direction, leveraging the emerging collective visual memory formed by the unprecedented amount of visual data available in public archives, on the Internet and from surveillance or personal cameras - a complex evolving net of dynamic scenes, distributed across many different data sources, and equipped with plentiful but noisy and incomplete metadata. The goal of this project is to analyze dynamic patterns in this shared visual experience in order (i) to find and quantify their trends; and (ii) learn to predict future events in dynamic scenes. With ever expanding computational resources and this extraordinary data, the main scientific challenge is now to invent new and powerful models adapted to its scale and its spatio-temporal, distributed and dynamic nature. To address this challenge, we will first design new models that generalize across different data sources, where scenes are captured under vastly different imaging conditions such as camera viewpoint, temporal sampling, illumination or resolution. Next, we will develop a framework for finding, describing and quantifying trends that involve measuring long-term changes in many related scenes. Finally, we will develop a methodology and tools for synthesizing complex future predictions from aligned past visual experiences. Our models will be automatically learnt from large-scale, distributed, and asynchronous visual data, coming from different sources and with different forms of readily-available but noisy and incomplete metadata such as text, speech, geotags, scene depth (stereo sensors), or gaze and body motion (wearable sensors). Breakthrough progress on these problems would have profound implications on our everyday lives as well as science and commerce, with safer cars that anticipate the behavior of pedestrians on streets; tools that help doctors monitor, diagnose and predict patients' health; and smart glasses that help people react in unfamiliar situations enabled by the advances from this project.'

9.3. International Initiatives

9.3.1. IMPACT: Intelligent machine perception

Participants: Josef Sivic, Jean Ponce, Ivan Laptev.

IMPACT is a 5-year collaborative project with Czech Technical University, Center for Robotics, Informatics and Cybernetics (CIIRC) (2017-2022). The IMPACT project focuses on fundamental and applied research in computer vision, machine learning and robotics to develop machines that learn to perceive, reason, navigate and interact with complex dynamic environments. For example, people easily learn how to change a flat tire of a car or perform resuscitation by observing other people doing the same task. This involves advanced visual intelligence abilities such as interpreting sequences of human actions that manipulate objects to achieve a specific task. Currently, however, there is no artificial system with a similar level of cognitive visual competence. Breakthrough progress in intelligent machine perception will have profound implications on our everyday lives as well as science and commerce, with smart assistive robots that automatically learn new skills from the Internet, safer cars that autonomously navigate in difficult changing conditions, or intelligent glasses that help people navigate never seen before environments.

9.3.2. Inria CityLab initiative

Participants: Josef Sivic, Jean Ponce, Ivan Laptev, Alexei Efros [UC Berkeley].

Willow participates in the ongoing CityLab@Inria initiative (co-ordinated by V. Issarny), which aims to leverage Inria research results towards developing “smart cities” by enabling radically new ways of living in, regulating, operating and managing cities. The activity of Willow focuses on urban-scale quantitative visual analysis and is pursued in collaboration with A. Efros (UC Berkeley).

Currently, map-based street-level imagery, such as Google Street-view provides a comprehensive visual record of many cities worldwide. Additional visual sensors are likely to be wide-spread in near future: cameras will be built in most manufactured cars and (some) people will continuously capture their daily visual experience using wearable mobile devices such as Google Glass. All this data will provide large-scale, comprehensive and dynamically updated visual record of urban environments.

The goal of this project is to develop automatic data analytic tools for large-scale quantitative analysis of such dynamic visual data. The aim is to provide quantitative answers to questions like: What are the typical architectural elements (e.g., different types of windows or balconies) characterizing a visual style of a city district? What is their geo-spatial distribution? How does the visual style of a geo-spatial area evolve over time? What are the boundaries between visually coherent areas in a city? Other types of interesting questions concern distribution of people and their activities: How do the number of people and their activities at particular places evolve during a day, over different seasons or years? Are there tourists sightseeing, urban dwellers shopping, elderly walking dogs, or children playing on the street? What are the major causes for bicycle accidents?

Break-through progress on these goals would open-up completely new ways smart cities are visualized, modeled, planned and simulated, taking into account large-scale dynamic visual input from a range of visual sensors (e.g., cameras on cars, visual data from citizens, or static surveillance cameras).

9.3.3. Associate team GAYA

Participants: Jean Ponce, Matthew Trager.

GAYA is a joint research team bringing together two Inria project-teams (Thoth, Grenoble and WILLOW, Paris) and Carnegie Mellon University, USA. It focuses on two research themes: (i) semantic structured interpretation of videos, and (ii) studying the geometric properties of object shapes to enhance state-of-the-art object recognition approaches.

Interpreting videos semantically in a general setting, involving various types of video content like home video clips, news broadcasts, feature films, which contain a lot of clutter, non-rigid motion, many “actors” performing actions, person-object and person-person interactions, varying viewpoints, is challenging. This task is being examined increasingly over the past decade, with the availability of large video resources, e.g., YouTube. Despite this progress, an effective video representation for recognizing actions is still missing. To address this critical challenge, we propose a joint optimization framework, wherein we learn the video representation and also develop models for action recognition. Specifically, we aim to exploit the spatio-temporal relations among pixels in a video through graphical models and novel deep learning feature representations.

The second research theme explores geometric aspects of computer vision, in particular how to model three-dimensional objects from their two-dimensional projections, and how the appearance of these objects evolves with changes in viewpoint. Beyond its theoretical interest, this work is critical for developing object recognition algorithms that take into account the three-dimensional nature of the visual world and go beyond the template-matching approaches dominant today. Duality is an important concept in this area, and we are investigating its application to the construction of visual hulls as well as the characterization of the topology of image contours using the Gauss map. Existing results are essentially limited to the Euclidean setting, and we are investigating their generalization to the general projective case.

Partners: CMU (Deva Ramanan, Martial Hebert, Abhinav Gupta, Gunnar Sigurdsson), Inria Thoth (Cordelia Schmid, Karteek Alahari, Pavel Tokmakov).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Prof. Alexei Efros (UC Berkeley, USA) visited Willow during June. Hildegard Kuehne (University of Bonn) and Jason Corso (University of Michigan) visited Willow during April.

9.4.1.1. Internships

Kai Han has visited Willow from the University of Hong Kong.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Jean Ponce is visiting New York University since September 2017.

WIMMICS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. SPARKS Team (I3S)

Wimmics is member of the I3S SPARKS team (Scalable and Pervasive softwARe and Knowledge Systems) led by Andrea Tettamanzi, with Johan Montagnat (CNRS, I3S). It is structured according to three axes: FORUM, ELK and S3.

9.1.1.1. SPARKS FORUM Axis

Wimmics contributes to the SPARKS FORUM research axis (FORmalizing with Users and Models). Catherine Faron Zucker and Alain Giboin are co-animators of FORUM.

9.1.1.2. SPARKS S3 Axis

Wimmics contributes to the SPARKS S3 research group (Scalable Software Systems). Olivier Corby contributes with federated distributed query processing in Corese with Johan Montagnat and Abdoul Macina. Catherine Faron Zucker and Franck Michel contribute on it with Johan Montagnat on heterogeneous data integration.

9.1.1.3. SPARKS ELK Axis

The ELK activity is about Extracting and Learning Knowledge. Andrea Tettamanzi is a co-animator of ELK with Frédéric Precioso (I3S, UNS).

9.2. National Initiatives

9.2.1. NiceCampus Research Lab

Participant: Nhan Le Thanh.

NiceCampus Research Lab (from training to/and through research to a Joint International Laboratory) is a framework for cooperation for research training. This framework is proposed by the University of Nice Sophia Antipolis to support the 911 Vietnamese research training program that aims to support the development of Vietnamese universities. The NiceCampus Lab Project was a winner of the AUF Call for Proposals 2016-2017. In this context, the MIRE (Maison de l'innovation et de la recherche NiceCampus) was created at University of Da Nang (Vietnam).

9.2.2. DILPROSPECT

Participant: Andrea Tettamanzi.

We participated in the interdisciplinary DILPROSPECT CNRS Project, with researchers of many other research units, including the UMR 7300 ESPACE and INRA on the study of the interface between constructed and natural land on the French Riviera.

9.2.3. AZKAR

Participants: Alain Giboin, Thierry Bergeron, Michel Buffa, Catherine Faron Zucker.

The AZKAR research project ⁰, funded by the BPI, started in 2014, ended in September 2017. This project brings together the world of robotics assistance and the Web of linked data. Its goal was to experiment P2P remote control of a mobile robot using only Web technologies, as well as using artificial intelligence supported by semantic Web formalisms, schemas and datasets in the context of museum visits. Many experiments took place at the Museum of the Great War of Meaux and at the Cité des Sciences de la Villette. The places thus visited at a distance, the spaces and the elements they contain are described with the help of an ontology of the scenes, objects, observation points and paths specific to the museum. Geography and collections are captured using linked data and integrated with Web resources external to the museum to enrich the scenes and objects observed. On this basis, we have designed a demonstrator to offer external media based on visited museum scenes, implementing SPARQL queries on a previously populated triplestore.

9.2.4. ANR WASABI

Participants: Michel Buffa, Elena Cabrio, Catherine Faron Zucker.

The ANR project WASABI started in January 2017 with IRCAM, Deezer, Radio France and the SME Parisson, consists in building a 2 million songs knowledge base of commercial popular music (rock, pop, etc.) Its originality is the joint use of audio-based music information extraction algorithms, song lyrics analysis algorithms (natural language processing), and the use of the Semantic Web. Web Audio technologies will then explore these bases of musical knowledge by providing innovative applications for composers, musicologists, music schools and sound engineers, music broadcasters and journalists.

9.2.5. ANR SIDES 3.0

Participants: Catherine Faron Zucker, Olivier Corby, Fabien Gandon, Alain Giboin, Andrea Tettamanzi.

Partners: Université Grenoble Alpes, Inria, Ecole Normale Supérieure de Lyon, Viseo, Theia.

SIDES 3.0 is an ANR project (2017-2020) which started in fall 2017. It is led by Université Grenoble Alpes (UGA) and its general objective is to introduce semantics within the existing SIDES educational platform ⁰ for medicine students, in order to provide them with added value educational services.

Web site: <https://www.uness.fr/projets/sides>

9.2.6. Ministry of Culture: DBpedia.fr

Participants: Elmahdi Korfed, Fabien Gandon.

This DBpedia.fr project proposes the creation of a French chapter of the DBpedia database. This project was the first project of the Semanticpedia convention signed by the Ministry of Culture, the Wikimedia foundation and Inria.

Web site: <http://dbpedia.fr>

9.2.7. Convention between Inria and the Ministry of Culture

Participant: Fabien Gandon.

We supervise the research convention with the Ministry of Culture to foster research and development at the crossroad of culture and digital sciences. This convention signed between Inria and the Ministry of Culture provides a framework to support projects at the cross-road of the cultural domain and the digital sciences.

9.2.8. QWANT-Inria Joint Laboratory

Participant: Fabien Gandon.

⁰<http://www.azkar.fr>

⁰<http://side-sante.org/>

We supervise the QWANT-Inria Joint Laboratory where joint teams are created and funded to contribute to the search engine research and development. The motto of the joint lab is Smart Search and Privacy with five research directions:

- Crawling, Indexing, Searching
- Execution platform, privacy by design, security, ethics
- Maps and navigation
- Augmented interaction, connected objects, chatbots, personal assistants
- Education technologies (EdTech)

9.2.9. *GDRI Zoomathia*

Participants: Catherine Faron Zucker, Franck Michel, Alexandre Monnin, Andrea Tettamanzi.

Wimmics is partner of the International Research Group (GDRI) Zoomathia funded by two CNRS institutes: INEE and INSHS. It aims at studying transmission of zoological knowledge from Antiquity to Middle-Age through material resources (bio residues, artefacts), iconography and texts.

One of the goals of the project is to design a thesaurus and semantically annotate resources, capturing different types of knowledge: zoonyme, historical period, zoological speciality (ethology, anatomy, physiology, psychology, zootechnique, etc.), literary genre or iconography.

This year, as a continuation of the work initiated with the *Muséum National d'Histoire Naturelle* of Paris during the last two years, we have proposed a model to represent taxonomic and nomenclatural information as Linked Data, and we published the french taxonomic register on the Web along this model.

On another note, we worked with researchers from CEPAM on the applying plagiarism detection methods in the analysis of manuscript transmission.

Web site: <http://www.cepam.cnrs.fr/zoomathia/>

9.2.10. *FUI PadDOC*

Participants: Patrice Pena, Alain Giboin.

PadDOC goal is to contribute to accelerating the digital transition of citizen, local and regional authorities, administrations and enterprises, by : (1) developing an open standard and innovative software and hardware resources to facilitate nearby or distant administrative formalities and procedures; (2) improving the security of the holder's personal data by putting these data under the exclusive control of the holder; (3) by exploiting unmarked communicating supports (such as smartphones or tablets) for all chain actors. PadDOC partners are: Docapost BPO, Anyces, ABC SmartCard and the teams Rainbow, Media-Coding and Wimmics. Started in November 2014, the project ended this year (June 2017). Wimmics contributed to the analysis, design and evaluation of the PadDOC security-oriented user interfaces

9.3. European Initiatives

Program: CHIST-ERA

Project acronym: ALOOF

Project title: Autonomous Learning of the Meaning of Objects

Duration: 2013-2017

Coordinator: University of Rome La Sapienza (Italy)

Other partners: University of Birmingham (United Kingdom), Technische Universität Wien (Austria), Inria Sophia Antipolis Méditerranée (France).

Abstract: The goal of ALOOF is to significantly advance the ability of today's autonomous systems to adapt to ever changing, dynamic real world environments by enabling them to learn about the meaning of objects from resources accessible through the Web. In ALOOF we focus on objects and the knowledge gaps a service robot will encounter about them. The fundamental contribution is to enable robots to translate between the representations they use in their situated experience and those on the Web.

Program: Research and Innovation Staff Exchange (RISE) project, funding under Marie Skłodowska-Curie grant

Project acronym: MIREL

Project title: MIning and REasoning with legal text

Duration: 2016-2019

Coordinator: Leendert van der Torre, University of Luxembourg

Other partners: University of Bologna (Italy), University of Torino (Italy), University of Huddersfield (UK), Inria (France), APIS (Bulgaria), Nomotika s.r.l. (Italy), DLVSystem s.r.l. (Italy), Zhejiang University (China), Research Organization of Information and Systems (Japan), University of Cape Town (South Africa), National University of La Plata (Argentina), National University of Córdoba (Argentina), Universidad Nacional del Sur in Bahía Blanca (Argentina), National ICT Australia Ltd (Australia), Stanford University (USA).

Abstract: The MIREL project will create an international and inter-sectorial network to define a formal framework and to develop tools for MIning and REasoning with Legal texts, with the aim of translating these legal texts into formal representations that can be used for querying norms, compliance checking, and decision support. MIREL addresses both conceptual challenges, such as the role of legal interpretation in mining and reasoning, and computational challenges, such as the handling of big legal data, and the complexity of regulatory compliance. It bridges the gap between the community working on legal ontologies and NLP parsers and the community working on reasoning methods and formal logic. Moreover, it is the first project of its kind to involve industrial partners in the future development of innovative products and services in legal reasoning and their deployment in the market. MIREL promotes mobility and staff exchange between SMEs to academics in order to create an inter-continental interdisciplinary consortium in Law and Artificial Intelligence areas including Natural Language Processing, Computational Ontologies, Argumentation, and Logic & Reasoning.

Web site: <http://www.mirelproject.eu/>

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. MoReWAIS

Title: Mobile Read Write Access and Intermittent to Semantic Web

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LANI - Moussa LO

Start year: 2016

See also: <https://project.inria.fr/morewais/>

MoReWAIS proposes to explore the specificities (advantages and constraints) of mobile knowledge sharing. The mobile application targeted in MoReWAIS must allow communities and their users to enrich and access more easily the knowledge base using the user's context with its richness (e.g. location, other users close-by) and addressing its limitations (e.g. intermittent access, limited resources).

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Fondazione Bruno Kessler, Digital Humanities and Human Language Technologies research units, Trento, Italy

University of Turin, Computer Science Department, Italy.

University of Luxembourg, Computer Science and Communication Lab, Luxembourg.

Data61, Brisbane, Australia.

MIRE-DNIIT : Innovation & Recherche at Danang International Institute of Technology

The project, in which Nhan Le Thanh (UNS) is involved, consists of installing within Danang University a UCA campus called DNIIT (Danang International Institute of Technology) with the objective of development and valorization of collaborative projects of applied research and implementation of UCA training centers at the Doctoral and Master level for Vietnamese students. The project obtained financial support from Ministry of Research and AUF (University Agency of La Francophonie). DNIIT was officially created on May 5th with the opening of six project and the setting up of the UCA e-Tourism Master's office.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

Oussama Lahlou

May-October

Institution: EMSI (Ecole Marocaine des Sciences de l'Ingénieur)

Subject: "An Ontology for modeling remote museum visits"

Supervisors: Michel Buffa, Thierry Bergeron

Yaroslav Nechaev

Ph.D. student, University of Trento, Italy (October 2017-present).

Subject: Improving the prediction of objects and relations on images by using large unsupervised corpora like Twitter and Wikipedia.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Raphaël Gazzotti

Date: March-April.

Visit of the Natural Language Processing research group of the Universidad Nacional de Córdoba, Argentina, for one month as a secondment of the MIREL H2020 Project.

We proceed to the tokenization of a small sample of questions and answers from the customer service of a big insurance company. Then, following a guideline, we annotated, thankfully to a graphical interface developed within the Natural Language Processing research group at the FaMAF, insurance-related concepts from this corpus and considered them as Named Entities. We mapped these concepts to two ontologies -YAGO and Property and Casualty data model developed by the Object Management Group that we translated to OWL format- [50]. We expect to map them to more ontologies and increase existing ones, like a financial ontology and another specific to communication, then ultimately to Linked Open Data. In a future step, we would like to identify and label automatically concepts using a small annotated corpus as a training set. We believe that annotated concepts can improve automatic categorization of questions and help to reason with different levels of abstraction.

XPOP Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

Mixed-Effects Models of Intracellular Processes: Methods, Tools and Applications (MEMIP)

Coordinator: Gregory Batt (InBio Inria team)

Other partners: InBio and IBIS Inria teams, Laboratoire Matière et Systèmes Complexes (UMR 7057; CNRS and Paris Diderot Univ.)

9.1.2. Institut National du Cancer (INCa)

Targeting Rac-dependent actin polymerization in cutaneous melanoma - Institut National du Cancer

Coordinator: Alexis Gautreau (Ecole Polytechnique)

Other partners: Laboratoire de Biochimie (Polytechnique), Institut Curie, INSERM.

9.2. International Initiatives

9.2.1. Informal International Partners

Marc Lavielle is Adjunct Professor at the Faculty of Pharmacy of Florida University.

Marc Lavielle is Adjunct Professor at the Faculty of Pharmacy of Buffalo University.

Julie Josse collaborates with Susan Holmes, Stanford University.

Eric Moulines regularly collaborates with Sean P. Meyn, University of Florida.

Geneviève Robin was recipient of a *Visiting Student Researcher Fellowship* from the France Stanford Centre for a research fellowship in the Department of Statistics at Stanford University. She worked on imputation of missing data to medical databases in a distributed framework.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Ricardo Rios, Universidad Central de Venezuela, Caracas: September 2017.

ZENITH Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Labex NUMEV, Montpellier*

URL: <http://www.lirmm.fr/numev>

We participate in the Laboratory of Excellence (labex) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences) headed by University of Montpellier in partnership with CNRS, and Inria. NUMEV seeks to harmonize the approaches of hard sciences and life and environmental sciences in order to pave the way for an emerging interdisciplinary group with an international profile. The project is decomposed in four complementary research themes: Modeling, Algorithms and computation, Scientific data (processing, integration, security), Model-Systems and measurements. Florent Massegia co-heads the theme on scientific data.

9.1.2. *Institute of Computational Biology (IBC), Montpellier*

URL: <http://www.ibc-montpellier.fr>

IBC is a 6 year project (2012-2018) with a funding of 2Meuros by the MENRT (PIA program) to develop innovative methods and software to integrate and analyze biological data at large scale in health, agronomy and environment. Patrick Valduriez heads the workpackage on integration of biological data and knowledge.

9.2. National Initiatives

9.2.1. *PIA (Projets Investissements d'Avenir)*

9.2.1.1. *Projet Floris'Tic (2015-2018), 430Keuro.*

Participants: Julien Champ, Alexis Joly.

Floris'tic aims at promoting the scientific and technical culture of plant sciences through innovative pedagogic methods, including participatory initiatives and the use of IT tools such as the one built within the PI@ntNet project. A. Joly heads the work package on the development of the IT tools. This is a joint project with the AMAP laboratory, the TelaBotanica social network and the Agropolis foundation.

9.2.1.2. *Institut de Convergence Agriculture numérique #DigitAg, (2017-2023), 275Keuro.*

Participants: Esther Pacitti, Florent Massegia, Patrick Valduriez.

#DigitAg brings together in a partnership of seventeen actors (public research and teaching organizations, transfer actors and companies) with the objective of accelerating and supporting the development of agriculture companies in France and in southern countries based on new tools, services and uses. Based in Montpellier with an office in Toulouse and Rennes and led by Irstea, #DigitAg's ambition is to become a world reference for digital agriculture. In this project, Zenith is involved in the analysis of big data from agronomy.

9.2.2. *Others*

9.2.2.1. *INRA/Inria PhD program, 100Keuros*

Participant: Alexis Joly.

This contract between INRA and Inria allows funding a 3-years PhD student (Christophe Botella). The addressed challenge is the large-scale analysis of PI@ntNet data with the objective to model species distribution (a big data approach to species distribution modeling). The PhD student is supervised by Alexis Joly with François Munoz (ecologist, IRD) and Pascal Monestiez (statistician, INRA).

9.3. European Initiatives

9.3.1. H2020 Projects

9.3.1.1. HPC4E

Participants: Reza Akbarinia, Florent Masseglia, Esther Pacitti, Patrick Valduriez.

Project title: High Performance Computing for Energy

Instrument: H2020

Duration: 2015 - 2017

Total funding: 2 Meuros

Coordinator: Barcelona Supercomputing Center (BSC), Spain

Partner: Europe: Inria, Lancaster University, Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, Repsol S.A., Iberdrola Renovables Energía S.A., Total S.A. Brazil: COPPE/Universidade Federal de Rio de Janeiro, LNCC, Instituto Tecnológico de Aeronáutica (ITA), Universidade Federal do Rio Grande do Sul, Universidade Federal de Pernambuco, Petrobras.

Inria contact: Patrick Valduriez

The main objective is to develop high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using HPC systems. The project also aims at improving the usage of energy using HPC tools by acting at many levels of the energy chain for different energy sources. Another objective is to improve the cooperation between energy industries from EU and Brazil. The project includes relevant energy industrial partners from Brazil (Petrobras) and EU (Repsol and Total as O&G industries), which benefit from the project's results. A last objective is to improve the cooperation between the leading research centres in EU and Brazil in HPC applied to energy. This includes sharing supercomputing infrastructures between Brazil and EU. In this project, Zenith is working on Big Data management and analysis of numerical simulations.

9.3.1.2. CloudDBAppliance

Participants: Reza Akbarinia, Boyan Kolev, Florent Masseglia, Esther Pacitti, Patrick Valduriez.

Project title: CloudDBAppliance

Instrument: H2020

Duration: 2016 - 2019

Total funding: 5 Meuros (Zenith: 500Keuros)

Coordinator: Bull/Atos, France

Partner: Europe: Inria Zenith, U. Madrid, INESC and the companies LeanXcale, QuartetFS, Nordea, BTO, H3G, IKEA, CloudBiz, and Singular Logic.

Inria contact: Florent Masseglia, Patrick Valduriez

The project aims at producing a European Cloud Database Appliance for providing a Database as a Service able to match the predictable performance, robustness and trustworthiness of on premise architectures such as those based on mainframes. The cloud database appliance features: (i) a scalable operational database able to process high update workloads such as the ones processed by banks or telcos, combined with a fast analytical engine able to answer analytical queries in an online manner; (ii) an operational Hadoop data lake that integrates an operational database with Hadoop, so operational data is stored in Hadoop that will cover the needs from companies on big data; (iii) a cloud hardware appliance leveraging the next generation of hardware to be produced by Bull, the main European hardware provider. This hardware is a scale-up hardware similar to the one of mainframes but with a more modern architecture. Both the operational database and the in-memory analytics engine will be optimized to fully exploit this hardware and deliver predictable performance. Additionally, CloudDBAppliance will tolerate catastrophic cloud data centres failures (e.g. a fire or natural disaster) providing data redundancy across cloud data centres. In this project, Zenith is in charge of designing and implementing the components for analytics and parallel query processing.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

We have regular scientific relationships with research laboratories in

- North America: Univ. of Waterloo (Tamer Özsu), UCSB Santa Barbara (Divy Agrawal and Amr El Abbadi)
- Asia: National Univ. of Singapore (Beng Chin Ooi, Stéphane Bressan), Wonkwang University, Korea (Kwangjin Park)
- Europe: Univ. of Madrid (Ricardo Jiménez-Periz), UPC Barcelona (Josep Lluís Larriba Pey), HES-SO (Henning Müller), University of Catania (Concetto Spampinato), The Open University (Stefan Rüger)
- North Africa: Univ. of Tunis (Sadok Ben-Yahia)
- Australia: Australian National University (Peter Christen)
- Central America: Tecnológico de Costa-Rica (Erick Mata, former director of the US initiative Encyclopedia of Life)

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

9.4.2.1. SciDISC

Title: Scientific data analysis using Data-Intensive Scalable Computing

Inria principal investigator: Patrick Valduriez

International Partner:

Universidade Federal do Rio de Janeiro (Brazil), Marta Mattoso and Alvaro Coutinho

Laboratório Nacional de Computação Científica, Petropolis (Brazil), Fabio Porto

Universidade Federal Fluminense, Niteroi (Brazil), Daniel Oliveira

Centro Federal de Educação Tecnológica, Rio de Janeiro (Brazil), Eduardo Ogasawara

Start year: 2017

See also: <https://team.inria.fr/zenith/scidisc/>

Data-intensive science requires the integration of two fairly different paradigms: high-performance computing (HPC) and data-intensive scalable computing (DISC). Spurred by the growing need to analyze big scientific data, the convergence between HPC and DISC has been a recent topic of interest. This project will address the grand challenge of scientific data analysis using DISC (SciDISC), by developing architectures and methods to combine simulation and data analysis. The expected results of the project are: new data analysis methods for SciDISC systems; the integration of these methods as software libraries in popular DISC systems, such as Apache Spark; and extensive validation on real scientific applications, by working with our scientific partners such as INRA and IRD in France and Petrobras and the National Research Institute (INCT) on e-medicine (MACC) in Brazil.

9.4.3. Participation In other International Programs

We are involved in LifeCLEF lab, a self-organized research platform whose main mission is to promote research, innovation, and development of computer-assisted identification of living organisms. It was initiated by Alexis Joly in 2014 in collaboration with several European colleagues: Henning Müller (CH), Robert B Fisher (UK), Andreas Rauber (AU), Concetto Spampinato (IT), Hervé Glotin (FR). Each year, LifeCLEF releases large-scale experimental data covering tens of thousands of species (plants images, birds audio recordings and fish sub-marine videos). About 100-150 research groups register each year to get access to it and tens of them submit reports describing their conducted research (published in CEUR-WS proceedings). Results are then synthesized and further analyzed in joint research papers.

9.4.3.1. International Initiatives

BD-FARM

Title: Big Data Management and Analytics for Agriculture and Farming

International Partner (Institution - Laboratory - Researcher):

Chubu University - International Digital Earth Applied Science Research Center (IDEAS),
Kiyoshi Honda

Duration: 2016 - 2017

Start year: 2016

See also: <https://team.inria.fr/zenith/bdfarm-2016-2018-stic-asia/>

World population is still growing and people are living longer and older. World demand for food rises sharply and current growth rates in agriculture are clearly not sufficient. But extreme flood, drought, typhoon etc, caused by climate change, give severe damages on traditional agriculture. Today, an urgent and deep redesign of agriculture is crucial in order to increase production and to reduce environmental impact. In this context, collecting, managing and analyzing dedicated, large, complex, and various datasets (Big Data) will allow improving the understanding of complex mechanisms behind adaptive, yield and crop improvement. Moreover, sustainability will require detailed studies such as the relationships between genotype, phenotype and environment. In other words, data science and ICT for agriculture must help improving production. Moreover, it has to be done while getting properly adapted to soil, climatic and agronomic constraints as well as taking into account the genetic specificities of plants.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Several international scientists visited the team and gave seminars

- Tamer Özsu (University of Waterloo, Canada): “Approaches to RDF Data Management and SPARQL Query Processing” on March 9.
- Dennis Shasha (NYU) “Reducing Errors by Refusing to Guess (Occasionally)” on June 1.
- Fabio Porto (LNCC, Brazil): “Database System Support of Simulation Data” on January 27 and “Simulation Data Management” on June 1.
- Marta Mattoso (UFRJ, Brazil): “Human-in-the-loop to Fine-tune Data in Real Time ” on December 14.

Jose Mario Carranza Rojas (PhD student, Technologico de Costa-Rica) spent two days per week in the team in the context of a 4 months internship at the Montpellier research lab AMAP in the context of the Floris’Tic project).