RESEARCH CENTER
Sophia Antipolis - Méditerranée

FIELD

Activity Report 2017

Section Partnerships and Cooperations

Edition: 2018-02-19

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, Glascow (UK), Technische U. Wien (Austria), Evolute GmBH, Vienna (Austria).

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

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tool in a large number of key applications; somewhat surprisingly, however, several approaches of the CAD industry are outdated, and 3D geometry processing is becoming increasingly the weak link.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

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, Unversity of Strachlyde (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 Canterburry (UK) from February 21st to March 1st.

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)

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 Fondation, Scilab Enterprises, CESAMES, U. Rennes, and Inria. The purpose of the project is to develop and promote an open-source version of the ARCADIA Melody system design environment from Thales, renamed CAPPELLA for that purpose. 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 INS^{3}PECT

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 was agreement was also concluded between University Côte d’Azur (UCA) and ECNU, covering mostly our colaboration, 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 strenghtened 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 Reseach, 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)

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, 20117, 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. Morrissett (Cornell University).

We received Reynald Affeldt from AIST for a 10-days visit in November.

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. Guincestre).

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 Assignement.

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

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-advises 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 an emission chains by co-conceiving the antenna, the filters, and the amplifier. We are specifically in charge of the theoretical design of the filters, matching the impedance of a bi-polarized dual band antenna. This is a perfect training ground to test, apply and adapt our work on matching problems (see Section 5.2).

7.2.2. ANR MagLune

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

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

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

7.4. International Initiatives

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

7.4.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2016

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

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

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.

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. Caillau, 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. Caillau). 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. Nolot and J. Rouot participate in this project, the PI is O. Cots, from ENSEIHHT, Toulouse.

J.-B. Caillau is associate researcher of the team of the CNRS team Parallel Algorithms & Optimization team at ENSEEIHT, 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.

NACHOS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Inria Project Lab

7.1.1.1. C2S@Exa (Computer and Computational Sciences at Exascale)

Participants: Olivier Aumage [STORM project-team, Inria Bordeaux - Sud-Ouest], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri [Coordinator of the project], Jean-François Méhaut [CORSE project-team, Inria Grenoble - Rhône-Alpes], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is coordinating the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

7.1.2. ANR project

7.1.2.1. TECSER

Participants: Emmanuel Agullo [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Xavier Antoine [CORIDA project-team, Inria Nancy - Grand-Est], Patrick Breuil [Nuclétudes, Les Ulis], Thomas Frachon, Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri, Ludovic Moya, Guillaume Sylvand [Airbus Group Innovations].

Type: ANR ASTRID

Duration: May 2014 - April 2017

Coordinator: Inria

Partner: Airbus Group Innovations, Inria, Nuclétudes

Inria contact: Stéphane Lanteri

Abstract: the objective of the TECSER project is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. DEEP-ER

Title: Dynamic Exascale Entry Platform - Extended Reach

Program: FP7

Duration: October 2013 - September 2016

Coordinator: Forschungszentrum Juelich Gmbh (Germany)

Partner: Intel Gmbh (Germany), Bayerische Akademie der Wissenschaften (Germany), Ruprecht-Karls-Universitaet Heidelberg (Germany), Universitaet Regensburg (Germany), Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V (Germany), Eurotech Spa (Italy), Consorzio Interuniversitario Cineca (Italy), Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain), Xyratex Technology Limited (United Kingdom), Katholieke Universiteit Leuven (Belgium), Stichting Astronomisch Onderzoek in Nederland (The Netherlands) and Inria (France).

Inria contact: Stéphane Lanteri

Abstract: the DEEP-ER project aims at extending the Cluster-Booster Architecture that has been developed within the DEEP project with a highly scalable, efficient, easy-to-use parallel I/O system and resiliency mechanisms. A Prototype will be constructed leveraging advances in hardware components and integrate new storage technologies. They will be the basis to develop a highly scalable, efficient and user-friendly parallel I/O system tailored to HPC applications. Building on this I/O functionality a unified user-level checkpointing system with reduced overhead will be developed, exploiting multiple levels of storage. The DEEP programming model will be extended to introduce easy-to-use annotations to control checkpointing, and to combine automatic re-execution of failed tasks and recovery of long-running tasks from multi-level checkpoint. The requirements of HPC codes with regards to I/O and resiliency will guide the design of the DEEP-ER hardware and software components. Seven applications will be optimised for the DEEP-ER Prototype to demonstrate and validate the benefits of the DEEP-ER extensions to the Cluster-Booster Architecture.

7.2.1.2. 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.

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 Computaçao Científica (Brazil) - Coordenaçao de Matemática Aplicada e Computaciona - Frédéric Valentin

Start year: 2015

See also: http://www-sop.inria.fr/nachos/index.php/Main/HOMAR

The general scientific context of the collaboration proposed in the HOMAR project is the study of time dependent wave propagation problems presenting multiscale features (in space and time). The general goal is the design, analysis and implementation of a family of innovative high performance numerical methods particularly well suited to the simulation of such multiscale wave propagation problems. Mathematical models based on partial differential equations (PDE) embedding multiscale features occur in a wide range of scientific and technological applications involving wave propagation in heterogeneous media. Electromagnetic wave propagation and seismic wave propagation are two relevant physical settings that will be considered in the project. Indeed, the present collaborative project will focus on two particular application contexts: the interaction of light (i.e. optical wave) with nanometer scale structure (i.e. nanophotonics) and, the interaction of seismic wave propagation with geological media for quantitative and non destructive evaluation of imperfect interfaces.

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.

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 Reppublica, 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).

ABS Project-Team (section vide)

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 invesgators 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 Salpétrière (Dr. O. Colliot and S. Durrleman) on neuroimaging.

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

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

8.3. 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 Specialisée de Suisse Occidentale (Switzerland)

Istituto Giannina Gaslini (Italy)

Katholieke Universiteit Leuven (Belgium)

Lynkeus (Italy)

Motek Medical B.V. (Netherlands)

Ospedale Pediatrico Bambino Gesu (Italy)

Siemens Aktiengesellschaft (Germany)

Siemens Corporation (United States)

Technische Universiteit Delft (Netherlands)

University College London (United Kingdom)

Universitair Medisch Centrum Utrecht (Netherlands)

Universita Degli Studi di Roma Lapienza (Italy)

The University of Sheffield (United Kingdom)

Universitatea Transilvania Din Brasov (Romania)

Stichting Vu-Vumc (Netherlands)

Maat Francerl (France)

Inria contact: Xavier Pennec

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

1. it enhances existing disease models stemming from former EC-funded research (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 Alzheim disease. He is also collaborating with the "Progression Over Neurodegenerative Disorders" (POND) group (Prof. Daniel Alexander) for developing new computational models and techniques for learning characteristic patterns of disease progression using large longitudinal clinical data sets, with special focus on dementias.

8.4.3.1.4. 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.

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 reasearch consortium to foster collaborative research on Brain-Computer Interfaces on the topic of Learning, Interaction, Feedback and Training. It is coordinated by Maureen Clerc. Its members are from 6 Inria teams: ATHENA, CAMIN, HYBRID, MJOLNIR, NEUROSYS, POTIOC, and from Dycog team from CRNL Lyon, and University of Rouen. 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 sofware 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 comput ational 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

P.I : 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)

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. Grognard.
- **ANR-TripTic:** The objective of this project (2014-2018) is to document the biological diversity in the genus of the minute wasps *Trichogramma*, and to study the behavioral and populational traits relevant to their use in biological control programs.
- **ANR-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 transfered to other production systems. The main partners of UMT FioriMed are ASTREDHOR (National Institute of Horticulture) and the ISA Joint Research Unit of INRA-CNRS-Univ. Nice.
- **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 ennemies 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 comittee of the GDR .
- **ModStatSAP:** The objective of this INRA network is to federate researchers in applied mathematics and statistics and to promote mathematical and statistical 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) - Mélaine 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-bioproducts (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, Meghalya (India). This project financed the visit of Bapan Ghosh to ISA and BIOCORE, and the visit of Nicolas Bajeux to India.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Claude Aflalo (Ben Gurion University of the Neguev, 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 ≈1m 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 Mediterranée), 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.

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, Universita Cattolica del Sacro Cuore (UCSC), Centre hospitalier Universitaire Vaudois (CHUV)

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

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 form a practical point of view. We will take care in evaluating both functional and psychological effects of our solutions and to constrain technical choices to be acceptable by final user. CACAO project will be a good opportunity to combine "bioengineer" (DEMAR) and "physiology/rehabilitation" (NTAAI) visions and knowledges towards solutions for clinical applications.

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.

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

Contact : Hervé Guillard

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) “JOREK, 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)

COFFEE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The team is involved in the IDEX project UCA-JEDI.

- PhD of Laurence Beaude (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 Norvergian, 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.

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-Frazao (Unité de Génie Civil, Université catholique de Louvain, Belgium)

7.3.4. Participation in Other International Programs

Antoine ROUSSEAU was member of a successfull 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.

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

invitation of Moritz Helias and Tobias Kuehn, University of Aachen and Juelich Research Center (Germany), September 2017

Invitation of David Terman (as part of a sabbatical semester), Ohio State University (USA), October 2017

Invitation of Zack Kilpatrick, University of Colorado Boulder (USA), November 2017

5.2.1.1. Internships

Leila Bekri, co-supervised by Romain Veltz and Hélène Marie (IPMC), Feb.-Apr. 2017

Raphael Forquet, co-supervised by Romain Veltz and Hélène Marie (IPMC), until Jan. 2017

Anna Song, supervised by Olivier Faugeras, Feb.-June 2017

5.2.2. Visits to International Teams

Visit of Mathieu Desroches to Mirela Domijan (University of Liverpool, UK) in March 2017

Visit of Mathieu Desroches to Daniele Avitabile (University of Nottingham, UK) in August 2017

Visit of Fabien Campillo & Mathieu Desroches to Serafim Rodrigues (BCAM, Bilbao, Spain) in September 2017

Visit of Mathieu Desroches to Serafim Rodrigues (Basque Center for Applied Mathematics, Bilbao, Spain) in December 2017

5.2.2.1. Research Stays Abroad

One-month research stay of Mathieu Desroches at BCAM (Bilbao, Spain) on an invited professor scholarship to work with Serafim Rodrigues, June 2017

MORPHEME Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Labex Signalife

The MORPHEME team is member of the SIGNALIFE Laboratory of Excellence.

Florence Besse and Xavier Descombes are members of the Scientific Committee.

Florence Besse and Xavier Descombes participated in the selection committee for LabeX PhD program students.

7.1.2. 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. Thérond (iBV, Nice). Participants are iBV and Morpheme.

7.2.3. ANR DIG-EM

Participants: Grégoire Malandain, Xavier Descombes, Gaël Michelin.

Morphogenesis controls the proper spatial organization of the various cell types. While the comparatively simple process of patterning and cell differentiation has received considerable attention, the genetic and evolutionary drivers of morphogenesis are much less understood. In particular, we very poorly understand why some morphogenetic processes evolve very rapidly, while others show remarkable evolutionary stability.

This research program aims at developing a high-throughput computational framework to analyze and formalize high-throughput 4D imaging data, in order to quantify and formally represent with cellular resolution the average development of an organism and its variations within and between species. In addition to its biological interest, a major output of the project will thus be the development of robust general computational methods for the analysis, visualization and representation of massive high-throughput light-sheet data sets.

This 4-years project started october the 1st, 2014 and is leaded by P. Lemaire (CRBM, Montpellier). Participants are the CRBM, and two Inria project-team, Morpheme and Virtual Plants.

7.2.4. ANR PhaseQuant

Participants: Grégoire Malandain, Eric Debreuve.

The PhaseQuantHD project aims at developing a high-content imaging system using quadriwave lateral shearing interferometry as a quantitative phase imaging modality. Automated analysis methods will be developed and optimized for this modality. Finally an open biological study question will be treated with the system.

This 3-years project started october the 1st, 2014 and is leaded by B. Wattelier (Phasics, Palaiseau). Participants are Phasics, and three academic teams TIRO (UNS/CEA/CAL), Nice, Mediacoding (I3S, Sophia-Antipolis), and Morpheme.

7.2.5. Inria Large-scale initiative Morphogenetics

Participants: Grégoire Malandain, Xavier Descombes, Gaël Michelin.

This action gathers the expertise of three Inria research teams (Virtual Plants, Morpheme, and Evasion) and other groups (RDP (ENS-CNRS–INRA, Lyon), RFD (CEA-INRA-CNRS, Grenoble)) and aimed at understanding how shape and architecture in plants are controlled by genes during development. To do so, we will study the spatio-temporal relationship between genetic regulation and plant shape utilizing recently developed imaging techniques together with molecular genetics and computational modeling. Rather than concentrating on the molecular networks, the project will study plant development across scales. In this context we will focus on the Arabidopsis flower, currently one of the best-characterized plant systems.

7.2.6. Octopus Project

Participant: Eric Debreuve.

The Octopus project deals with automatic classification of images of zooplankton. It is conducted in collaboration with the Laboratoire d'Océanographie de Villefranche-sur-mer (LOV) et l'ENSTA Paris. The kickoff meeting took place in May 2015 and a 3-day *brainstorming* meeting on Deep Learning took place in December 2015. Participants are I3S (Frédéric Precioso and Mélanie Ducoffe), LOV (Marc Picheral and Jean-Olivier Irisson), and ENSTA Paris (Antoine Manzanera).

7.3. 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 Santnder, 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.

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 developping a software framework dedicated to the analysis of high throughput phenotyping data and models. It will based on the OpenAlea platform that provides methods and softwares for the modelling of plants, together with a user-friendly interface for the design and execution of scientific workflows. We also develop the InfraPhenoGrid infrastructure that allows high throughput computation and recording of provenance during the execution of Workflows.

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 ligh-sheet imaging of live embryos to quantitatively describe embryonic morphogenesis in ascidians, a class of animals that undergo very rapid genomic divergence, yet show an extraordinary stasis of embryonic morphologies, based on invariant early cell lineages shared by all studied species. The global aims of the proposal, which will bridge micro- and macroevolutionary scales of analysis, are: i) to provide a global systems-level description at cellular resolution of an animal embryonic program; ii) to use this description to characterize intra-specific and inter-specific patterns of morphogenetic variations; iii) to analyze possible molecular mechanisms explaining the unusual robustness of this program to environmental and genetic perturbations. To achieve these aims, we will combine advanced live light-sheet microscopy, computational biology, functional gene assays and evolutionary approaches.

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 living the meristem. Transcription factors belonging to the CUP-SHAPED COTYLEDON (CUC) genes and homeodomain genes of the KNOTTED-LIKE (KNOXI) family were shown to be essential for the control of leaf size and shape. In addition, the phytohormone auxin is a critical regulator of growth and development, involved in the regulation and coordination of cell division and cell expansion. The mechanisms of auxin signalling are based on a complex set of co-receptors exhibiting high to low affinity for auxin and an even more complex modular network of transcriptional repressors and activators tightly controlling the expression of a large set of genes.

The SERRATIONS project is based on recent data relative to key transcription factors regulating leaf morphogenesis and advanced knowledge on the generic signalling mechanisms of the phytohormone auxin that plays a critical role in the control and coordination of cellular responses sustaining leaf size and shape. The goal of the project is to identify auxin signalling modules involved in leaf morphogenesis and to integrate these data in mathematical modelling to provide new insights into complex regulatory networks acting on leaf morphogenesis and to further test model-derived hypotheses.

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 worklfows, (ii) data provenance, and (iii) virtual machines. This project brings together experts in data bases, algorithms and virtual environments, working in the domain of life science.

Funding: GDR - CNRS

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.

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 Hogie, William Lochet, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

The STINT project (*STructures INTerdites*) is led by the MC2 group (LIP, ENS-Lyon) and involves the G-SCOP laboratory (Grenoble).

The aim of STINT 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 metropolitean 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

Scool 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 AlDyNet, 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, Condordia 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 AlDyNet, 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 AlDyNet, 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.

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-supervied by Gerardo Rubino and Yassine Hadjadj-Aoul. Both PhDs started on the 1st of November 2017.

8.2. Regional Initiatives

ElectroSmart: This project benefits form the following fundings:

- a three year engineering position from the UCN@Sophia Labex for the 2016-2018 period (Ravi Mondi 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 projectâs 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 tesbed 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 Developement 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.

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, Hirschkoff, Martini, Sangiorgi.
- REPAS (Reliable and Privacy-Aware Software Systems via Bisimulation Metrics) is an ANR Project that started on October 2016 and that will finish on October 2020. The project aims at investigating quantitative notions and tools for proving program correctness and protecting privacy. In particular, the focus will be put on bisimulation metrics, which are the natural extension of bisimulation to quantitative systems. As a key application, we will develop a mechanism to protect the privacy of users when their location traces are collected. Main persons involved: Dal Lago, 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 Politecnica 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 Informatica, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project "Desarrollo y Análisis formal de sistemas complejos en contextos DistribuidOS: fundamentos, herramientas y aplicaciones (DArDOS)" (Development and formal analysis of complex systems in distributed contexts: foundations, tools and applications) January 2016 - December 2018, funded by the Spanish Ministerio de Economia y Competitividad.

8.3. International Initiatives

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

8.3.1.1. CRECOGI

Title: Concurrent, Resourceful and Effectful Computation, by Geometry of Interaction

International Partner (Institution - Laboratory - Researcher):

Tokyo (Japan) - Department of Computer Science, Graduate School of Information Science and Technology - Ichiro HASUO

Start year: 2015

See also: http://crecogi.cs.unibo.it

Game semantics and geometry of interaction (GoI) are two closely related frameworks whose strength is to have the characters of both a denotational and an operational semantics. They offer a high-level, mathematical (denotational) interpretation, but are interactive in nature. The formalization in terms of movements of tokens through which programs communicate with each other can actually be seen as a low-level program. The current limit of GoI is that the vast majority of the literature and of the software tools designed around it have a pure, sequential functional language as their source language. This project aims at investigating the application of GoI to concurrent, resourceful, and effectful computation, thus paving the way to the deployment of GoI-based correct-by-construction compilers in real-world software developments in fields like (massively parallel) high-performance computing, embedded and cyberphysical systems, and big data. The presence of both the japanese GoI community (whose skills are centered around effects and coalgebras) and the french GoI community (more focused on linear logic and complexity analysis) will bring essential, complementary, ingredients.

8.3.2. 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.

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.

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, Erdös-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-IT1

Title: Monte Carlo and Learning Schemes for Network Analytics

International Partners (Institution - Laboratory - Researcher):

IIT Bombay (India) - Department of Electrical Engineering - Prof. V.S. Borkar;

IIS Bangalore (India) - Department of Electrical Engineering - Prof. R. Sundaresan.

Duration: 2014 - 2017

Start year: 2014

The project aims to approach various computation problems in network analytics by means of Markov Chain Monte Carlo (MCMC) and related simulation techniques as well as machine learning algorithms such as reinforcement learning, ant colony optimization, etc. This will include network diagnostics such as ranking, centrality measures, computation on networks using local message passing algorithms, resource allocation issues pertaining to networks and network-based systems such as the internet, peer-to-peer networks, social networks. The work will involve both development of analytical tools and extensive validation thereof using simulation studies. The research will draw upon techniques from graph theory, probability, optimization, and distributed computation.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Professors / Researchers

Damiano Carra

Date: 6-8 December 2017

Institution: Univ. of Verona (Italy)

Koen de Turck

Date: 13-17 November 2017

Institution: CentraleSupelec (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 Thalasseryveettil

Date: 20 February 2017 - 20 August 2017

Institution: IIT Bengalore (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 Mumbay (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)

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).

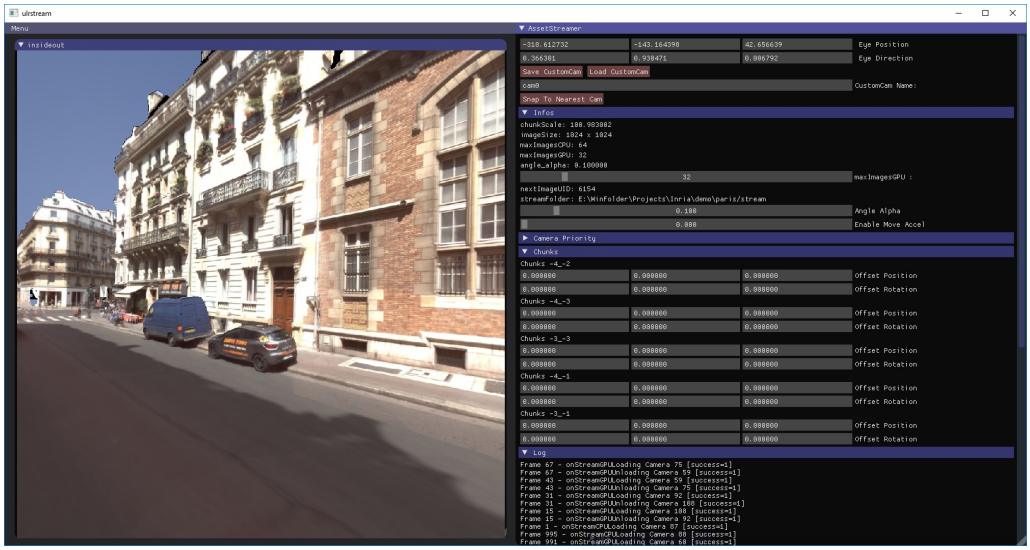

Figure 10. streamable dataset using 6500 pictures (usual not-streamable dataset has around 30 pictures)

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. D^3: 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: Reseach Innovation Action

Objectif: Virtual Heritage

Duration: November 2016 - October 2019

Coordinator: EXUS SA (UK)

Partner: Diginext (FR), ATHENA (GR), Noho (IRL), U Glasgow (UK), U York (UK)

Inria contact: George Drettakis

Abstract: Storytelling applies to nearly everything we do. Everybody uses stories, from educators to marketers and from politicians to journalists to inform, persuade, entertain, motivate or inspire. In the cultural heritage sector, however, narrative tends to be used narrowly, as a method to communicate to the public the findings and research conducted by the domain experts of a cultural site or collection. The principal objective of the EMOTIVE project is to research, design, develop and evaluate methods and tools that can support the cultural and creative industries in creating Virtual Museums which draw on the power of 'emotive storytelling'. This means storytelling that can engage visitors, trigger their emotions, connect them to other people around the world, and enhance their understanding, imagination and, ultimately, their experience of cultural sites and content. EMOTIVE 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.

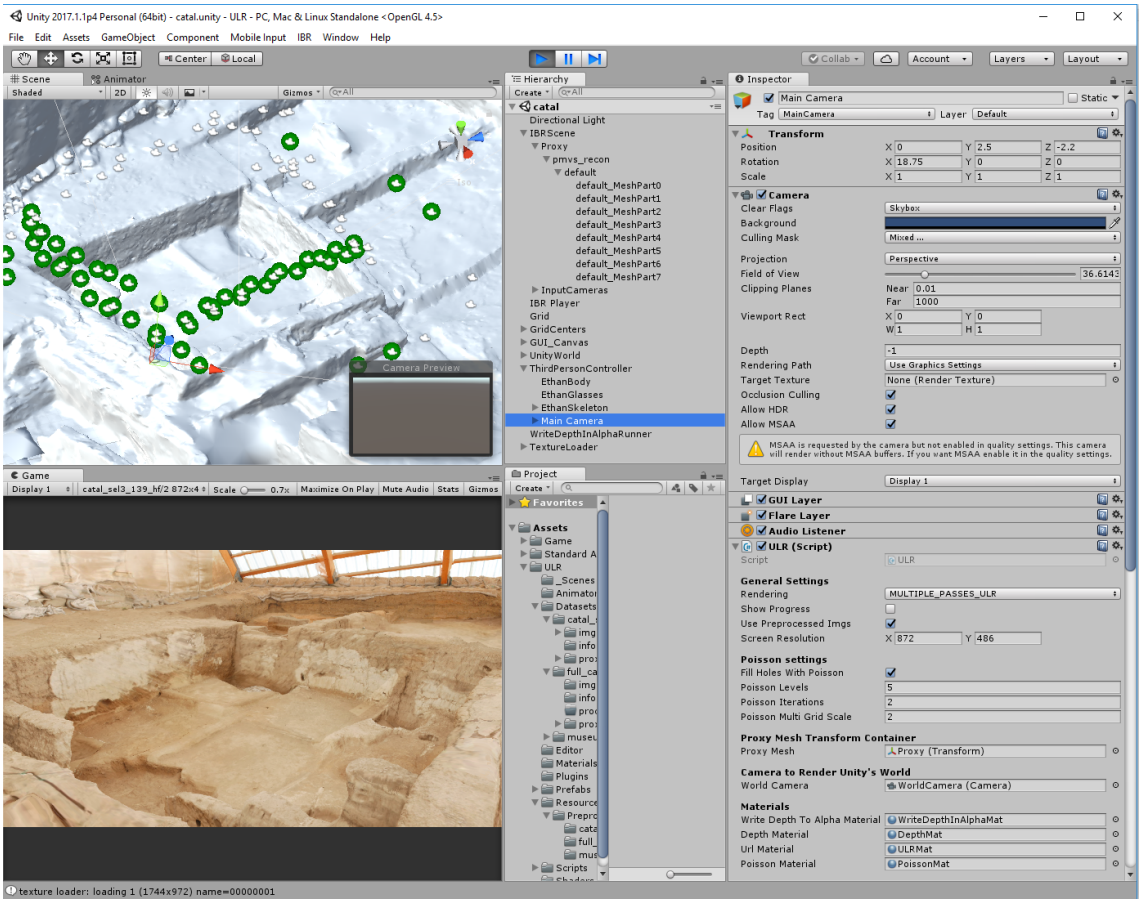

Figure 11. Screenshot of Unity IBR system developed for EMOTIVE.

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.

DOCaMEx (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 explicitation 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 Jéan-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 Zacharyschev, 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 Zacharyschev, Roman Kontchakov, Stanislav Kikot. She also visited the
- Rallou Thomopoulos visited the team of Alexandros Koulouris and Maria Papageorgiou atATEI 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

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 Alsthom. Its goal is to perform screwing for various industrial applications.

9.1.7. IRT b<>com NeedleWare

Participants: Hadrien Gurnel, Alexandre Krupa.

no Inria Rennes 9072, duration: 36 months.

This project started in October 2016. It supports Hadrien Gurnel's Ph.D. about the study of a shared control strategy fusing haptic and ultrasound visual control for assisting manual steering of needles for 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 Bellavoir, 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 acceptation.

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 Chevrie 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.

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 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: Visonium.

Duration: January 2015- December 2018.

Coordinator: Groupe Genious

Other partners: Inria(Stars), StreetLab, Fondation Ophtalmologique Rothschild, Fondation Hospitaliere Sainte-Marie.

Abstract: This French project from Industry Minister aims at designing a platform to re-educate at home people with visual impairment.

9.2.2.2. 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 Neovison as a SME, we address small fast paced local markets, where the quick assimilation of new technologies is crucial. Three thrusts identified will enable the monitoring of crowded scenes, each led by an academic partner in collaboration

with scientists from Honeywell: a) multi camera, multicoverage tracking of objects of interest, b) Anomaly detection and fusion of multimodal sensors, c) activity recognition and behavior analysis in crowded environments. We expect a long term impact on the field of video surveillance by: contributions to the state-of-the-art in the field, dissemination of results within the scientific and practitioners community, and establishing long term scientific exchanges between academia and industry, for a forum of scientific and industrial partners to collaborate on addressing technical challenges faced by scientists and the industry.'

9.3.2. 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 o 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: Francçois 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: Universita degli Studi di Genova, Italy

Supervisor: Carlos Fernando Crispim Junior, Michal Koperski

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 Cagliary (Sardinia), visited us for three months (October-December) to collaborate on the refinement and optimization of polycubes.
- David Bommes, 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): Sinkorn 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.

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, personnal assistants
- Eductation 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.), litterary 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 researhers 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 academies in order to create an inter-continental interdisciplinary consortium in Law and Artificial Intelligence areas including Natural Language Processing, Computational Ontologies, Argumentation, and Logic & Reasoning.

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

9.4. 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). DNITT 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.

ZENITH Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Labex NUMEV, Montpellier

URL: http://www.lirmm.fr/numev

We participate in the Laboratory of Excellence (labex) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences) headed by University of Montpellier in partnership with CNRS, and Inria. NUMEV seeks to harmonize the approaches of hard sciences and life and environmental sciences in order to pave the way for an emerging interdisciplinary group with an international profile. The project is decomposed in four complementary research themes: Modeling, Algorithms and computation, Scientific data (processing, integration, security), Model-Systems and measurements. Florent Masseglia co-heads the theme on scientific data.

9.1.2. Institute of Computational Biology (IBC), Montpellier

URL: http://www.ibc-montpellier.fr

IBC is a 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 Pl@ntNet project. A. Joly heads the work package on the development of the IT tools. This is a joint project with the AMAP laboratory, the TelaBotanica social network and the Agropolis foundation.

9.2.1.2. Institut de Convergence Agriculture numérique #DigitAg, (2017-2023), 275Keuro.

Participants: Esther Pacitti, Florent Masseglia, 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 Pl@ntNet data with the objective to model species distribution (a big data approach to species distribution modeling). The PhD student is supervised by Alexis Joly with François Munoz (ecologist, IRD) and Pascal Monestiez (statistician, INRA).

9.3. European Initiatives

9.3.1. 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 industral partners from Brazil (Petrobras) and EU (Repsol and Total as O&G industries), which benefit from the project's results. A last objective is to improve the cooperation between the leading research centres in EU and Brazil in HPC applied to energy. This includes sharing supercomputing infrastructures between Brazil and EU. In this project, Zenith is working on Big Data management and analysis of numerical simulations.

9.3.1.2. 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 Lluis Larriba Pey), HES-SO (Henning Müller), University of Catania (Concetto Spampinatto), The Open University (Stefan Rüger)
- North Africa: Univ. of Tunis (Sadok Ben-Yahia)
- Australia: Australian National University (Peter Christen)
- Central America: Technologico de Costa-Rica (Erick Mata, former director of the US initiative Encyclopedia of Life)

9.4.2. 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

Laboratorio Nacional de Computaçao Cientifica, Petropolis (Brazil), Fabio Porto

Universidade Federal Fluminense, Niteroi (Brazil), Daniel Oliveira

Centro Federal de Educa cao Tecnologica, 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).