



RESEARCH CENTER  
Sophia Antipolis - Méditerranée

FIELD

Activity Report 2015

# Section Partnerships and Cooperations

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## ABS Project-Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

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

Title: Novel approaches to characterizing flexible macromolecular systems in biology

Modeling Large Protein Assemblies with Toleranced Models

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

Duration: one year

Coordinator: C. Robert (IBPC / CNRS)

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

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

## 7.2. International Research Visitors

### 7.2.1. Visits of International Scientists

#### 7.2.1.1. Internships

- N. Gayraud, from the MSc program *Computational biology and biomedicine* from the Univ. of Nice, completed his MSc internship under the guidance of F. Cazals, on the topic *Modeling cryo-electron microscopy maps*. Nathalie is now following-up as a PhD student in the Athena project team.
- S. Lundy (Supélec, Gif-sur-Yvette), completed a 3 months internship under the joint supervision of Dorian Mazauric and Jean-Daniel Boissonnat (Geometrica, Inria Sophia Antipolis Méditerranée) on the topic *Representation of simplicial complexes by directed graphs*.

## ACUMES Team

## 7. Partnerships and Cooperations

### 7.1. National Initiatives

#### 7.1.1. Project BOUM

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

#### 7.1.2. Project SOKA

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

### 7.2. European Initiatives

#### 7.2.1. FP7 & H2020 Projects

##### 7.2.1.1. TraM3

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

Duration: October 2010 - March 2016

Coordinator: Inria

Inria contact: Paola Goatin

Abstract: The project intends to investigate traffic phenomena from the macroscopic point of view, using models derived from fluid-dynamics consisting in hyperbolic conservation laws. The scope is to develop a rigorous analytical framework and fast and efficient numerical tools for solving optimization and control problems, such as queues lengths control or buildings exits design. See also: <http://www-sop.inria.fr/members/Paola.Goatin/tram3.html>

### 7.3. International Initiatives

#### 7.3.1. Inria International Labs

##### **Inria@SiliconValley**

Associate Team involved in the International Lab:

##### 7.3.1.1. ORESTE

Title: Optimal REroute Strategies for Traffic managEment

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2015

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

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

**LIRIMA**

Associate Team involved in the IIL :

#### 7.3.1.2. ANO

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

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

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

#### 7.3.2. Participation In other International Programs

- PHC PROCOPE Team *Transport Networks Modeling and Analysis*

Duration : Jan. 2014- Dec. 2015

Coordinator: P. Goatin (France), S. Göttlich (Germany)

Other partner: University of Mannheim (Germany)

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

## 7.4. International Research Visitors

### 7.4.1. Visits of International Scientists

#### 7.4.1.1. Internships

- H. Yoldas (May 2015, L'Aquila University): numerical study of a non-local version of Hughes' model for pedestrian flows.
- M. Pfirsching (September 2015): numerical schemes for non-local conservation laws.
- S. Villa (March-June 2015, Milano - Bicocca): moving bottlenecks in traffic flow.
- Z. Tabbakh (15 november- 15 december, EMI, Rabat) Modeling and optimization of lakes aeration process.

## AOSTE Project-Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. CIM PACA Design Platform

**Participant:** Robert de Simone.

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

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

## 9.2. National Initiatives

### 9.2.1. ANR

#### 9.2.1.1. HOPE

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

The **ANR HOPE** project focuses on hierarchical aspects for the high-level modeling and early estimation of power management techniques, with potential synthesis in the end if feasible.

Although this project was officially started in November 2013, it was in part postponed due to the replacement of a major partner (Texas Instruments) by another one (Intel). Current partners are CNRS/UNS UMR LEAT, Intel, Synopsys, Docea Power, Magillem, and ourselves. A publication on multiview modeling (including performance, power, and temperature) was presented at eSAME'2014, reflecting Ameni Khecharem ongoing PhD work.

#### 9.2.1.2. GeMoC

**Participants:** Matias Vara Larsen, Julien Deantoni, Frédéric Mallet.

This project is administratively handled by CNRS for our joint team, on the UMR I3S side. Partners are Inria (Triskell EPI), ENSTA-Bretagne, IRIT, Obeo, Thales TRT.

The project focuses on the modeling of heterogeneous systems using Models of Computation and Communication for embedded and real-time systems, described using generic means of MDE techniques (and in our case the MARTE profile, and most specifically its Time Model, which allows to specify precise timely constraints for operational semantic definition).

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

### 9.2.2. FUI

#### 9.2.2.1. FUI P

**Participants:** Abderraouf Benyahia, Dumitru Potop Butucaru, Yves Sorel.

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

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

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

#### 9.2.2.2. *FUI CLISTINE*

**Participants:** Robert de Simone, Amin Oueslati, Emilien Kofman.

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

#### 9.2.2.3. *FUI Waruna*

**Participants:** Liliana Cucu, Adriana Gogonel, Walid Talaboulma, Dorin Maxim.

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

### 9.2.3. *Investissements d'Avenir*

#### 9.2.3.1. *DEPARTS*

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

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

#### 9.2.3.2. *CLARITY*

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

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

Our technical contributions to the project achievement are described in subsection 7.2.

#### 9.2.3.3. *Capacites*

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



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

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

#### 9.3.1.1. FP7 PROXIMA

**Participants:** Liliana Cucu, Adriana Gogonel, Walid Talaboulma, Dorin Maxim, Cristian Maxim.

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

### 9.3.2. Collaborations in European Programs, except FP7 & H2020

#### 9.3.2.1. ITEA3 Assume

Project title: Affordable Safe And Secure Mobility Evolution

Duration: Oct. 2015 - Sept. 2018

Coordinator: Daimler AG (Germany)

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

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

## 9.4. International Initiatives

### 9.4.1. Inria International Labs

#### LIAMA

Associate Team involved in the International Lab:

#### *9.4.1.1. FM4CPS*

Title: Formal Models and tools for Cyber-Physical Systems

International Partner (Institution - Laboratory - Researcher):

ECNU (China) - Artificial Intelligence Lab - Jifeng He

Start year: 2015

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

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

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

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

## **9.5. International Research Visitors**

### ***9.5.1. Visits of International Scientists***

#### *9.5.1.1. Invited Professor*

Qingguo XU

Date: July 2014 to June 2015

Institution: Shanghai University (China)

#### *9.5.1.2. Internships*

Nieto Luis Agustin

Date: Sep 2015 - Feb 2016

Institution: Universidad de Buenos Aires (Argentina)

### ***9.5.2. Visits to International Teams***

#### *9.5.2.1. Sabbatical programme*

Mallet Frédéric

Date: Sep 2014 - Aug 2015

Institution: [ECNU](#) (China)

## **APICS Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

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

## **8.2. National Initiatives**

### **8.2.1. ANR COCORAM**

The ANR (Astrid) project COCORAM (Co-design et co-intégration de réseaux d'antennes actives multi-bandes pour systèmes de radionavigation par satellite) started January 2014. We are associated with three other teams from XLIM (Limoges University), geared respectively towards filters, antennas and amplifiers design. The core idea of the project is to realize dual band reception an emission chains by co-conceiving the antenna, the filters, and the amplifier. We are specifically in charge of the theoretical design of the filters, matching the impedance of a bi-polarized dual band antenna. This represent a perfect training ground to test, apply and adapt our work on matching problems (see Section 6.2).

### **8.2.2. ANR MagLune**

The ANR project MagLune (Magnétisme de la Lune) has been approved July 2014. It involves the Cerege (Centre de Recherche et d'Enseignement de Géosciences de l'Environnement, joint laboratory between Université Aix-Marseille, CNRS and IRD), the IGP (Institut de Physique du Globe de Paris) and ISTerre (Institut des Sciences de la Terre). Associated with Cerege are Inria (Apics team) and Irphe (Institut de Recherche sur les Phénomènes Hors Équilibre, joint laboratory between Université Aix-Marseille, CNRS and École Centrale de Marseille). The goal of this project (led by geologists) is to understand the past magnetic activity of the Moon, especially to answer the question whether it had a dynamo in the past and which mechanisms were at work to generate it. Apics participates in the project by providing mathematical tools and algorithms to recover the remanent magnetization of rock samples from the moon on the basis of measurements of the magnetic field it generates. The techniques described in Section 6.1 are instrumental for this purpose.

## **8.3. European Initiatives**

### **8.3.1. Collaborations with Major European Organizations**

Apics is part of the European Research Network on System Identification (ERNSI) since 1992.

System identification deals with the derivation, estimation and validation of mathematical models of dynamical phenomena from experimental data.

## **8.4. International Initiatives**

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

#### **8.4.1.1. IMPINGE**

Title: Inverse Magnetization Problems IN GEosciences.

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2013

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

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

## 8.4.2. Inria International Partners

### 8.4.2.1. Declared Inria International Partners

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

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

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

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

#### 8.5.1.1. Internships

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

### 8.5.2. Visits to International Teams

#### 8.5.2.1. Research stays abroad

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

## 8.6. List of international and industrial partners

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

## ASCLEPIOS Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. Consulting for Industry

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

### 8.1.2. Collaboration with national hospitals

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

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

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

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. MD PAEDIGREE

Title: Model-Driven European Paediatric Digital Repository

Programme: FP7

Period: March 2013 - February 2017

Coordinator: Ospedale Pediatrico Bambini Gesù, Rome.

Partners:

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

Biomolecular Research Genomics (Italy)

Deutsches Herzzentrum Berlin (Germany)

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

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

Haute Ecole Spécialisée de Suisse Occidentale (Switzerland)

Istituto Giannina Gaslini (Italy)

Katholieke Universiteit Leuven (Belgium)

Lynkeus (Italy)

Motek Medical B.V. (Netherlands)

Ospedale Pediatrico Bambino Gesù (Italy)

Siemens Aktiengesellschaft (Germany)

Siemens Corporation (United States)

Technische Universiteit Delft (Netherlands)

University College London (United Kingdom)

Universitair Medisch Centrum Utrecht (Netherlands)

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

Inria contact: Xavier Pennec

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

1. it enhances existing disease models stemming from former EC-funded research projects (Health-e-Child and Sim-e-Child) and from industry and academia, by developing robust and reusable multi-scale models for more predictive, individualised, effective and safer healthcare in several disease areas;
2. it builds on the eHealth platform already developed for Health-e-Child and Sim-e-Child to establish a worldwide advanced paediatric digital repository.

Integrating the point of care through state-of-the-art and fast response interfaces, MD-Paedigree services a broad range of off-the-shelf models and simulations to support physicians and clinical researchers in their daily work. MD-Paedigree vertically integrates data, information and knowledge of incoming patients, in participating hospitals from across Europe and the USA, and provides innovative tools to define new workflows of models towards personalised predictive medicine. Conceived as a part of the 'VPH Infostructure' described in the ARGOS, MD-Paedigree encompasses a set of services for storage, sharing, similarity search, outcome analysis, risk stratification, and personalised decision support in paediatrics within its innovative model-driven data and workflow-based digital repository. As a specific implementation of the VPH-Share project, MD-Paedigree fully interoperates with it. It has the ambition to be the dominant tool within its purview. MD-Paedigree integrates methodological approaches from the targeted specialties and consequently analyzes biomedical data derived from a multitude of heterogeneous sources (from clinical, genetic and metagenomic analysis, to MRI and US image analytics, to haemodynamics, to real-time processing of musculoskeletal parameters and fibres biomechanical data, etc.), as well as specialised biomechanical and imaging VPH simulation models.

#### 8.2.1.2. VP2HF

Title: Computer model derived indices for optimal patient-specific treatment selection and planning in Heart Failure

Programme: FP7

Period: October 2013 - September 2016

Coordinator: King's College, London.

Partners:

Centron Diagnostics Ltd (United Kingdom)  
CHU Côte de Nacre, Caen (France)  
King's College London (United Kingdom)  
Philips Technologie (Germany)  
Philips France (France)  
Simula Research Laboratory As (Norway)  
Université Catholique de Louvain (Belgium)  
Universitat Pompeu Fabra (Spain)

Inria contact: Dominique Chapelle / Maxime Sermesant

Heart failure (HF) is one of the major health issues in Europe affecting 6 million patients and growing substantially because of the ageing population and improving survival following myocardial infarction. The poor short to medium term prognosis of these patients means that treatments, such as cardiac re-synchronisation therapy and mitral valve repair, can have substantial impact. However, these therapies, are ineffective in up to 50% of treated patients and involve significant morbidity and substantial cost. The primary aim of VP2HF is to bring together image and data processing tools with statistical and integrated biophysical models mainly developed in previous VPH projects, into a single clinical workflow to improve therapy selection and treatment optimisation in HF. The tools will be tested and validated on 200 patients (including 50 historical datasets) across 3 clinical sites, including a prospective clinical study on 50 patients in the last year of the project. The key innovations in VP2HF, which make it likely that the project results will be commercially exploited and have major clinical impact, are:

1. all tools to process images and signals, and to obtain the statistical and biophysical models will be integrated into one clinical software platform that can be easily and intuitively used by clinicians and tried out in the prospective clinical study;
2. to select only the appropriate parts of the tool chain, we use a decision tree stratification approach, which will add maximum value to the predictions that will be used in individual patients, so that the more resource intensive parts will be used when they will add real value.

We expect that the study will result in substantially improved efficacy of the decision making process compared with current guidelines, and that an integrated package that is used as part of clinical workflow will ensure the industrial project partners, in particular Philips, will develop project outputs into dedicated products that will have significant clinical impact.

#### 8.2.1.3. MedYMA

Title: Biophysical Modeling and Analysis of Dynamic Medical Images

Programme: FP7

Type: ERC

Period: April 2012 - March 2017

Coordinator: Inria

Inria contact: Nicholas Ayache

During the past decades, exceptional progress was made with *in vivo* medical imaging technologies to capture the anatomical, structural and physiological properties of tissues and organs in patients, with an ever increasing spatial and temporal resolution. Physicians are now faced with a formidable overflow of information, especially when a time dimension is added to the already hard to integrate 3-D spatial, multimodal and multiscale dimensions of modern medical images. This increasingly hampers the early detection and understanding of subtle image modifications, which can have a vital impact on the patient's health. To change this situation, a new generation of computational models for the simulation and analysis of dynamic medical images is introduced. Thanks to their generative nature, they will allow the construction of databases of synthetic and realistic medical image sequences simulating various evolving diseases, producing an invaluable new resource for training and benchmarking. Leveraging on their principled biophysical and statistical foundations, these new models will bring an added clinical value once they have been personalized with innovative methods to fit the medical images of any specific patient. By explicitly revealing the underlying evolving biophysical processes observable in the images, this approach will yield new groundbreaking image processing tools to correctly interpret the patient's condition (computer aided diagnosis), to accurately predict the future evolution (computer aided prognosis), and to precisely simulate and monitor an optimal and personalized therapeutic strategy (computer aided therapy). First applications concern high impact diseases including brain tumors, Alzheimer's disease, heart failure and cardiac arrhythmia and will open new horizons in computational medical imaging.

## 8.3. International Initiatives

### 8.3.1. Inria International Labs

#### **Inria@SiliconValley**

Associate Team involved in the International Lab:

#### 8.3.1.1. *GeomStats*

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

International Partner (Institution - Laboratory - Researcher):

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

Starting year: 2015

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

The scientific goal of this associated team is to develop the field of geometric statistics that have key applications in computational anatomy. Computational anatomy is an emerging discipline at the interface of geometry, statistics, image analysis and medicine, which aim is to analyze and model the biological variability of the organs shapes at the population level. An important application in neuroimaging is the spatial normalization of subjects, which is necessary to compare anatomies and functions through images in populations with different clinical conditions.

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

### 8.3.2. Inria International Partners

#### 8.3.2.1. *Informal International Partners*

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

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

##### 8.3.2.1.2. Massachusetts General Hospital, Boston

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

##### 8.3.2.1.3. Other International Hospitals

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

## 8.4. International Research Visitors

### 8.4.1. *Research visits abroad*

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

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



## ATHENA Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

#### 8.1.1.1. ANR MRSEI LEMONS

**Participants:** Maureen Clerc, Théodore Papadopoulo.

**Duration:** *October 2015 to April 2017* The ANR MRSEI LEMONS aims to consolidate a European Network by organizing meetings and visits, in order to submit a proposal for a MSCA-ITN. The European consortium is led by Inria (coordinator Maureen Clerc).

#### 8.1.1.2. ANR MOSIFAH

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

**Duration:** *October 2013 to September 2017*

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

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

Appropriate diffusion models will be explored including second and fourth order DTI models as well as HARDI models such as the single shell Q-Ball Imaging (QBI). These various types of images will be processed within the right Riemannian mathematical framework to provide tensor as well as Ensemble Average Propagator (EAP) and Orientation Distribution Function (ODF) fields. Virtual cardiac fiber structure (VCFS) will then be modelled using myocardial fiber information derived from each of these imaging modalities. Finally, diffusion behavior of water molecules in these VCFSs will be simulated by means of quantum spin theory, which allows computing ex vivo and in vivo virtual diffusion magnetic resonance (MR) images at various scales ranging from a few microns to a few millimeters. From the obtained virtual diffusion MR images, multiscale and probabilistic atlas describing the 3D fiber architecture of the heart ex vivo and in vivo will be constructed. Meanwhile, the simulation involving a large number of water molecules, grid computing will be used to cope with huge computation resource requirement.

We expect to construct a complete database containing a very wide range of simulated (noise and artifact-free) diffusion images that can be used as benchmarks or ground-truth for evaluating or validating diffusion image processing algorithms and create new virtual fiber models allowing mimicking and better understanding the heart muscle structures. Ultimately, the proposed research can open a completely novel way to approach the whole field of heart diseases including the fundamental understanding of heart physiology and pathology, and new diagnosis, monitoring and treatment of patients.

#### 8.1.1.3. ANR VIBRATIONS

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

**Duration:** *February 2014 to January 2018*

Computational modeling, under the form of a “virtual brain” is a powerful tool to investigate the impact of different configurations of the sources on the measures, in a well-controlled environment.

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

The project follows a three-fold strategy:

- construct virtual brain models with both dynamic aspects (reproducing both hyperexcitability and hypersynchronisation alterations observed in the epileptic brain) and a realistic geometry based on actual tractography measures performed in patients
- explore the parameter space through large-scale simulations of source configurations, using parallel computing implemented on a computer cluster.
- confront the results of these simulations to simultaneous recordings of EEG, MEG and intracerebral EEG (stereotactic EEG, SEEG). The models will be tuned on SEEG signals, and tested versus the surface signals in order to validate the ability of the models to represent real MEG and EEG signals.

The project constitutes a translational effort from theoretical neuroscience and mathematics towards clinical investigation. A first output of the project will be a database of simulations, which will permit in a given situation to assess the number of configurations that could have given rise to the observed signals in EEG, MEG and SEEG. A second – and major - output of the project will be to give the clinician access to a software platform which will allow for testing possible configurations of hyperexcitable regions in a user-friendly way. Moreover, representative examples will be made available to the community through a website, which will permit its use in future studies aimed at confronting the results of different signal processing methods on the same ‘ground truth’ data.

## 8.1.2. ADT

### 8.1.2.1. ADT BOLIS

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

**Duration:** *December 2014 to December 2016*

ADT BOLIS aims to:

- build a software platform dedicated to inverse source localisation, building upon the elements of software found in FindSources3D. The platform will be modular, ergonomic, accessible and interactive. It will offer a detailed visualisation of the processing steps and the results. The goal is to provide a convenient graphical interface and a tool that can be easily distributed and used by professionals (target audience: clinicians and researchers).
- Upgrade medInria to use the latest libraries versions involved (this most notably encompasses VTK 6, Qt 5, and DTK 1.0). Then, these new versions will be used to implement a composer (a graphical tool to chain various actions in medInria) and to develop python scripting (for chaining actions and for adding non-regression testing).

### 8.1.2.2. ADT OpenViBE-X

**Participants:** Théodore Papadopoulo, Maureen Clerc, Nathanaël Foy.

**Duration:** *October 2014 to October 2016*

The OpenViBE-X ADT addresses the OpenViBE Brain Computer Interfaces (BCI) platform, in order to:

1. make BCI easier to apprehend by end-users
2. enrich the interaction with multimodal biosignals (eye gaze, heart-rate)
3. implement methods for auto-calibration and online adaptation of the classification
4. provide support, maintenance and dissemination for this software.

The OpenViBE platform is a central element to BCI research at Inria, and in the international community.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. ChildBrain ETN

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

Program: European Training Network

Project acronym: ChildBrain

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

Duration: March 2015 to March 2019

Coordinator: Prof. Paavo Leppänen, University of 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.

## 8.3. International Initiatives

### 8.3.1. Inria International Partners

#### 8.3.1.1. Informal International Partners

- SCIL Laboratory, Sherbrooke University, CA (Maxime Descoteaux)
- CMRR, University of Minnesota, USA (Christophe Lenglet)
- Verona University, It (Gloria Menegaz)
- Department of CISE, the University of Florida, Gainesville, USA (Baba C. Vemuri)
- Centre for Medical Image Computing (CMIC), Dept. Computer Science, UCL, UK (D. Alexander)
- SBIA, University of Pennsylvania Medical School, USA (R. Verma).
- University Houari Boumediene (USTHB, Algiers) (L. Boumghar) and University of Boumerdes, (D. Cherifi), Algeria.
- BESA company on EEG/MEG source localisation.
- CRM, Centre de Recherche Mathématiques, Montréal, Canada.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

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

#### 8.4.1.1. Internships

Guillermo Alejandro Gallardo Diez

Date: June 2015 - August 2015

Institution: Universidad de Buenos Aires (Argentina)

Etienne Guerlais

Date: October 2015 - February 2016

Institution: Ecole d'ingénieurs informatique CESI, eXia

Jelena Mladenovic

Date: April 2015 - September 2015

Institution: Université de Nice-Sophia Antipolis

Siobhan Powell

Date: May 2015 - Jul 2015

Institution: Queens Univeristy, Ontario (Canada)

## AYIN Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

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

## 9.2. International Initiatives

### 9.2.1. Inria International Partners

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

## 9.3. International Research Visitors

### 9.3.1. Visits of International Scientists

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

#### 9.3.1.1. Internships

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

### 9.3.2. Visits to International Teams

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

## 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) is to study and optimize a new concept consisting in coupling the production of microalgae with photovoltaic panels. The main idea is to derive the excess of light energy to PV electricity production, in order to reduce the phenomena of photoinhibition and overwarming both reducing microalgal productivity.
- **ANR-Facteur 4:** The objective of this project to produce non OGM strain of microalgae with enhanced performance. BIOCORE is involved in the directed selection of microalgae with interesting properties from an industrial point of view. The theory of competition is used to give a competitive advantage to some species. This competitive advantage can be provided by an online closed loop controller.
- **ANR-Phycover:** The overall objective of the PHYCOVER project is to identify a modular wastewater treatment process for the production of biogas. The method combines three modules. First, a high-rate algal pond is dedicated to the treatment of municipal wastewater. Then, an anaerobic digester capable of co-digesting biomass products (and others organic matter resources ) to significantly reduce biological and chemical contaminants while producing a sustainable energy as biogas is analysed. A final module transforms the residual carbon, nitrogen and phosphorus into high-value microalgae dedicated to aquaculture and green chemistry.
- **ANR-FunFit:** The objective of this project (2013-2017) is to develop a trait-based approach linking individual fitness of fungal plant pathogens to ecological strategies. The idea is to derive eco-epidemiological strategies from fitness optimization in colonized environments and during colonization, as well as understanding the coexistence of sibling species. This project is co-ordinated by F. Grogard.
- **ANR-TripTic:** The objective of this project (2014-2018) is to document the biological diversity in the genus of the minute wasps *Trichogramma*, and to study the behavioral and populational traits relevant to their use in biological control programs.
- **ANR-GESTER:** “Management of crop resistances to diseases in agricultural landscapes as a response to new constraints on pesticide use”, ANR Agrobiosphère, 2011–2016. This project aims at producing allocation scenarios of resistant varieties at the scale of cultivated landscapes, that will allow to limit disease development while ensuring sustainable efficiency of genetic resistances. BIOCORE participates in this project via MaIAGE, INRA Jouy-en-Josas.
- **ANR-MIHMES:** “Multi-scale modelling, from animal Intra-Host to Metapopulation, of mechanisms of pathogen spread to Evaluate control Strategies”, ANR – Investissement d’avenir, action Bioinformatique (ANR-10-BINF-07) & Fond Européen de Développement Régional des Pays-de-la-Loire (FEDER), 2012–2017. This project aims at producing scientific knowledge and methods for the management of endemic infectious animal diseases and veterinary public health risks. BIOCORE participates in this project via MaIAGE, INRA Jouy-en-Josas.
- **RESET:** The objective of this project is to control the growth of *E. coli* cells in a precise way, by arresting and restarting the gene expression machinery of the bacteria in an efficient manner directed at improving product yield and productivity. RESET is an “Investissements d’Avenir” project in Bioinformatics (managed by ANR) and it is coordinated by H. de Jong (Ibis, Inria)

- **SIGNALIFE:** Biocore is part of this Labex (scientific cluster of excellence) whose objective is to build a network for innovation on Signal Transduction Pathways in life Sciences, and is hosted by the Université Nice Sophia Antipolis.
- **OPTIBIO:** This project is devoted to the analysis of optimal control problems related to bioprocesses. The project is funded by Programme Gaspard Monge pour L'Optimisation et la Recherche Opérationnelle and coordinated by T. Bayen (U. Montpellier 2).
- **UMT FIORIMED:** FioriMed is a Mixed Technology Unit created in January 2015 to strengthen the production and dissemination of innovation to the benefit of ornamental horticulture. Horticultural greenhouses are seen as a "laboratory" for the actual implementation of agroecology concepts with the possibility of generic outcomes being transferred to other production systems. The main partners of UMT FioriMed are ASTREDHOR (National Institute of Horticulture) and the ISA Joint Research Unit of INRA-CNRS-Univ. Nice.

### 9.1.2. Inria funding

- **Inria Project Lab-Algae *in silico*:** The Algae *in silico* Inria Project Lab, funded by Inria and coordinated by O. Bernard, focuses on the expertise and knowledge of biologists, applied mathematician and computer scientists to propose an innovative numerical model of microalgal culturing devices. The latest developments in metabolic modelling, hydrodynamic modelling and process control are joined to propose a new generation of advanced simulators in a realistic outdoor environment. The project gathers 5 Inria project teams and 3 external teams.

### 9.1.3. INRA funding

- **Take Control:** This project, "Deployment strategies of plant quantitative resistance to take control of plant pathogen evolution," is funded by the PRESUME call of the SMaCH INRA metaprogram (Sustainable Management of Crop Health). BIOCORE is a partner together with INRA PACA (Sophia Antipolis and Avignon) and INRA Toulouse (2013-2016). This project provides the major part of the funding for the experiments held for Elsa Rousseau's thesis.
- **K-Masstec:** "Knowledge-driven design of management strategies for stem canker specific resistance genes", INRA Metaprogramme SMaCH, PRESUME action, 2013–2016. The project aims at developing efficient strategies for the deployment of genetic resistance in the field, based on knowledge issued from the understanding of the molecular interaction between distinct avirulence genes, and mainly the discovery of non-conventional gene-for-gene interactions.

### 9.1.4. Networks

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

## 9.2. European Initiatives

### 9.2.1. FP7 & H2020 Projects

**SysBioDRez:** Marie Curie International Incoming Fellowship FP7 (EC-PEOPLE) is a multidisciplinary CNRS-Inria project for the collaboration of Jeremie Roux (researcher) with both Paul Hofman (scientist in charge) and Jean-Luc Gouzé (partner lab), with the objective of linking *in vitro* quantitative dynamics to primary tumor samples profiling in order to determine the resistance probability of a specific combination of anti-cancer drugs in lung cancer, using computational methods (see [66]).

### **9.2.2. Collaborations with Major European Organizations**

Imperial college, Department of Chemical engineering (UK),  
Modelling and optimization of microalgal based processes.  
Imperial College, Centre for Synthetic Biology and Innovation, Dept. of Bioengineering (UK):  
Study of metabolic/genetic models  
University of Stuttgart, Institute for Systems Theory and Automatic Control (D):  
Identification of gene networks

## **9.3. International Initiatives**

### **9.3.1. Inria International Labs**

#### **Inria Chile**

Associate Team involved in the International Lab:

#### **9.3.1.1. GRENCORE**

Title: Modelling and control for energy producing bioprocesses  
International Partners (Institution - Laboratory - Researcher):  
CIRIC (Chile) - Méline Gautier  
PUCV (Chile) - Escuela de Ingenieria Bioquimica (EIB) - Gonzalo Ruiz Filippi  
UTFSM (Chile) - Departamento de Matematica - Eduardo Cerpa  
UFRO (Chile) - Chemical Engineering Department - David Jeison

Start year: 2014

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

The worldwide increasing energy needs together with the ongoing demand for CO<sub>2</sub> neutral fuels represent a renewed strong driving force for the production of energy derived from biological resources. In this scenario, the culture of oleaginous microalgae for biofuel and the anaerobic digestion to turn wastes into methane may offer an appealing solution. The main objective of our proposal is to join our expertise and tools, regarding these bioprocesses, in order to implement models and control strategies aiming to manage and finally optimize these key bioprocesses of industrial importance. By joining our expertises and experimental set-up, we want to demonstrate that closed loop control laws can significantly increase the productivity, ensure the bioprocess stability and decrease the environmental footprint of these systems. This project gathers experts in control theory and optimization (BIOCORE, UTFSM) together with experts in bioprocesses (PUCV and UFRO) and software development (CIRIC).

#### **9.3.1.2. Other IIL projects**

BIOCORE is involved in the Bionature project from Inria Chile – CIRIC (the Communication and Information Research and Innovation Center), in collaboration with four Chilean universities (Universidad de Chile, Universidad Tecnica Federico Santa Maria, Pontificia Universidad Catolica de Valparaiso, and Universidad de la Frontera). The Bionature project is devoted to natural resources management and the modeling and control of bioprocesses.

### **9.3.2. Inria International Partners**

#### **9.3.2.1. Informal International Partners**

GRIMCAPE, Université de Douala, Cameroon. Epidemiology.  
National Institute of Technology Meghalaya, India. Modelling of augmentative biological control.  
Univ. Ben Gurion : Microalgal Biotechnology Lab (IL), Member of the ESSEM COST Action ES1408 European network for algal-bioproducts (EUALGAE). Modelling of photosynthesis.



Universidad de la Frontera (CL), Modelling of CO<sub>2</sub> transfer in a microalgal absorption column.

## **9.4. International Research Visitors**

### **9.4.1. Visits of International Scientists**

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

## **9.5. Project-team seminar**

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

## **CASTOR Project-Team**

# **6. Partnerships and Cooperations**

## **6.1. National Initiatives**

### **6.1.1. ANR**

- ANEMOS : ANR-11-MONU-002  
ANEMOS : Advanced Numeric for Elms : Models and Optimized Strategies associates JAD Laboratory/Inria (Nice, Manager), IRFM-CEA (Cadarache), Maison de la Simulation (Saclay) and Inria EPI Bacchus (Bordeaux). Elms are disruptive instabilities occurring in the edge region (SOL) of a tokamak plasma. The development of Elms poses a major challenge in magnetic fusion research with tokamaks, as these instabilities can damage plasma-facing components, particularly divertor plates. The mitigation or suppression of large Elms is a critical issue for successful operation of ITER. Goal for ANEMOS is to develop and improve numerical tools in order to simulate physical mechanisms of Elms and to qualify some strategies for their control. We then need to design efficient numerical strategies on the most advanced computers available to contribute to the science base underlying of proposed burning plasma tokamak experiments such as ITER.
- LIVE-CAMS: Till September 30 th 2015, R. Pasquetti was involved in the ANR project LIVE-CAMS.
- MEDIMAX: In 2015 R. Pasquetti and F. Rappeti were involved in in the ANR project MEDIMAX.

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

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

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

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

Contact : Hervé Guillard

## 6.2. European Initiatives

### 6.2.1. FP7 & H2020 Projects

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

## 6.3. International Initiatives

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

#### 6.3.1.1. AMOSS

Title: Advanced Modeling on Shear Shallow Flows for Curved Topography : water and granular flows.

International Partner (Institution - Laboratory - Researcher):

NCKU (Taiwan)- Yih-Chin Tai

Start year: 2014

Our objective here is to generalize the promising modeling strategy proposed by S. Gavriluk (2012-2013) to genuinely 3D shear flows and also take into account the curvature effects related to topography. Special care will be exercised to ensure that the numerical methodology can take full advantage of massively parallel computational platforms and serve as a practical engineering tool. Cross validations will be achieved by experiments and numerical simulations with applications to landslides.

#### 6.3.1.2. Informal International Partners

The team collaborates with TUC technical University of Crete (Prof. Argyris Delis) on the subject of shallow water models. Part of this collaboration is common with the works done in the framework of the AMOSS associate team.

## 6.4. International Research Visitors

### 6.4.1. Visits of International Scientists

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

#### 6.4.1.1. Internships

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

## COATI Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. ANR

#### 9.1.1.1. ANR Blanc STINT, 2014-2017

**Participants:** Pierre Aboulker, Jean-Claude Bermond, David Coudert, Frédéric Havet, Luc Hogie, William Lochet, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

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

The aim of STINT is to answer the following fundamental question: *given a (possibly infinite) family  $\psi$  of graphs, what properties does a  $\psi$ -free graph have?* To this end, it will firstly establish bounds on some classical graph parameters (e.g., clique number, stability number, chromatic number) for  $\psi$ -free graphs. Then, it will design efficient algorithms to recognize  $\psi$ -free graphs and to determine or approximate some parameters for those graphs. These studies shall result in the development of new proof techniques.

(<http://www.ens-lyon.fr/LIP/MC2/STINT/>)

### 9.1.2. PEPS

#### 9.1.2.1. PEPS MoMis SYSTEMIC, 2015

**Participant:** Frédéric Giroire.

The SYSTEMIC project was led by COATI and involves the LAMA (Paris Est), GREDEG (Sophia Antipolis) and CREM (Rennes) laboratories.

The aim of SYSTEMIC was to bring together the expertises of researchers in economics, graph theory and financial mathematics to propose new models to evaluate the systemic risk of networks of financial institutions, and to propose new methods to mitigate the risk of contagions in such networks. The novelty of the project was in particular to consider strategies for a dynamic control of heterogeneous networks.

### 9.1.3. GDR Actions

#### 9.1.3.1. Action ResCom, ongoing (since 2006)

Réseaux de communications, working group of GDR RSD, CNRS.

(<http://rescom.asr.cnrs.fr/>)

#### 9.1.3.2. Action Graphes, ongoing (since 2006)

Action Graphes, working group of GDR IM, CNRS.

(<http://gtgraphes.labri.fr/>)

## 9.2. European Initiatives

### 9.2.1. Collaborations with Major European Organizations

AOR (Vassilis Zissimopoulos) : University of Athens, Department of Informatics and Telecommunications (Greece)

Combinatorial Optimization, Games and Applications (COGA), June 2015- September 2016

Participants : Jean-Claude Bermond, David Coudert, Frédéric Giroire, Nicolas Nisse, Stéphane Pérennes

## 9.3. International Initiatives

### 9.3.1. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

#### 9.3.1.1. *ALDYNET*

Title: Algorithm for large and Dynamic Networks

Inria principal investigator: Nicolas Nisse

International Partner (Institution - Laboratory - Researcher):

Universidad Adolfo Ibáñez, Santiago, Chile

Facultad de Ingeniería y Ciencias

Karol Suchan

Duration: 2013 - 2015

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

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

### 9.3.2. *Inria International Partners*

#### 9.3.2.1. *Informal International Partners*

Apart from formal collaboration COATI members maintain strong connections with the following international teams, with regular visits of both sides.

Univ. of Southern Denmark, Prof. Jorgen Bang Jensen

RWTH Aachen Univ., Lehrstuhl II für Mathematik, Germany, Prof. Arie M.C.A. Koster

Concordia Univ. - Montréal, Quebec, Canada, Prof. Brigitte Jaumard

#### 9.3.3. *Participation In other International Programs*

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

GAIATO : Graphs and Algorithms Applied to Telecommunications, International Cooperation FUNCAP/FAPs/Inria/INS2i-CNRS, no. INC-0083-00047.01.00/13, with Federal University of Ceará, Brasil, 2014-2016.

## 9.4. International Research Visitors

### 9.4.1. *Visits of International Scientists*

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

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

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

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

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

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

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

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

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

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

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

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

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

## **9.4.2. Visits to International Teams**

### *9.4.2.1. Research stays abroad*

David Coudert

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

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

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

Guillaume Ducoffe

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

Frédéric Giroire

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

Frédéric Havet

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

Univ. Orléans - LIFO, July 6-10 2015.

Nicolas Nisse

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

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

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

## COFFEE Project-Team

## 7. Partnerships and Cooperations

### 7.1. National Initiatives

#### 7.1.1. ANR

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

#### 7.1.2. National and European networks

- GdR MoMas.  
The research group MoMaS (Mathematical Modeling and Numerical Simulation for Nuclear Waste Management Problems ) has activities centered around scientific computing, design of new numerical schemes and mathematical modelling (upscaling, homogenization, sensitivity studies, inverse problems,...). Its goal is to coordinate research in this area, as well as to promote the emergence of focused groups around specific projects
- S. Junca is involved in the GdR-e “Wave Propagation in Complex Media for Quantitative and non Destructive Evaluation”.

### 7.2. Regional Initiatives

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

### 7.3. International Initiatives

#### 7.3.1. Inria International Partners

##### 7.3.1.1. Declared Inria International Partners

Team **COKLYCO**

Title: Modeling, analysis and simulation of kinetic and fluid models for MEMS

International Partner (Institution - Laboratory - Researcher):

Kyoto (Japan) - Department of Mechanical Engineering and Science (ME) - Aoki Kazuo

Start year: 2014 End year: 2016.

See also: [https://team.inria.fr/coffee/?page\\_id=323](https://team.inria.fr/coffee/?page_id=323)

We wish to elaborate and analyse new models of microscopic and macroscopic type for Micro-Electro-Mechanical Systems (MEMS). The tiny scales of such technical devices induce new and challenging difficulties. A specific attention will be paid to the treatment of coupling conditions from moving boundaries, and to the multi-scale character of the problem. The project is based on a strong interplay between mathematical analysis, experiments and numerical simulations, made possible by the composition of the team.

##### 7.3.1.2. Informal International Partners

Quite recently, S. Junca has started a collaboration with Mathias Legrand, from the Mechanical Engineering department at Mc Gill, Montréal with the supervision of the internship of a master student (S. Heng, 6 months, June-Nov. 2013). Furthermore, S. Junca is an active member of the European network “Wave propagation in complex media for quantitative and non destructive evaluation”<sup>0</sup>

<sup>0</sup><http://www.gdre-us.cnrs-mrs.fr/spip.php?rubrique8>

S. Krell has a collaboration with Martin Gander (University of Geneva, Switzerland) on domain decomposition methods, adapted to DDFV discretizations.

M. Ribot started a collaboration with Roberto Natalini a couple of years ago. Connections with experts in Firenze was the starting point of the research on biofilm formation and algae proliferation. M. Ribot and R. Natalini have also worked on new well-balanced strategy — the so-called AHO schemes — in order to preserve equilibria and to capture correctly large time solutions for complex PDEs system, without knowing explicitly the equilibrium solution. They have co-advised 2 PhD thesis.

Finally, we have many international collaborations, with variable peaks of activity, in our research networks: A. Vasseur (U. T. Austin), P.E. Jabin (Univ. Maryland), J.-A. Carrillo (Imperial College London), S. Jin (U. W. Madison and Jiao Tong Univ.), R. Aavatsmark (Univ. of Bergen), etc.

M. Ribot spent a semester, funded by CNRS at ICL, UK.

## **7.4. International Research Visitors**

### ***7.4.1. Visits of International Scientists***

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

#### ***7.4.1.1. Internships***

Luis Urrutia from Granada



## DEMAR Project-Team

## 6. Partnerships and Cooperations

### 6.1. Regional Initiatives

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

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

### 6.2. National Initiatives

#### 6.2.1. ADT SENSAS - SENSBIO

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

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

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

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

#### 6.2.2. INTENSE project

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

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

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

#### 6.2.3. BCI-LIFT: an Inria Project-Lab

**Participants:** Mitsuhiro Hayashibe, Saugat Bhattacharyya.

BCI-LIFT is a large-scale 4-year research initiative (2015-2018) which aim is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. We work on BCI-FES study for promoting motor learning.

## 6.3. European Initiatives

### 6.3.1. FP7 & H2020 Projects

Program: FP7

Project acronym: EPIONE

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

Duration: 2013-2017

Coordinator: AAU (Aalborg, Denmark)

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

Abstract: <http://project-epione.eu/>

## 6.4. International Initiatives

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

#### 6.4.1.1. NEUROPHYS4NEUROREHAB

Title: Development of neurophysiological test setup for customizing and monitoring patient-specific non-invasive electrical stimulation-facilitated neurorehabilitation.

International Partners (Institution - Laboratory - Researcher):

IITH (India) - Centre for VLSI and Embedded Systems Technology - Shubhajit Roy Chowdhury

IIT Gandhinagar (India) - \_\_\_Centre for Cognitive Science \_\_\_ - Uttama Lahiri

Start year: 2014

See also: <https://team.inria.fr/nphys4nrehab/>

Stroke presents with heterogeneous patient-specific impairments in motor, sensory, tone, visual, perceptual, cognition, aphasia, apraxia, coordination, and equilibrium where the functional limitations following stroke are varied, including gait dysfunction, fall risk, limited activities of daily living, difficulties in swallowing, reduced upper extremity function, altered communication, besides others. These heterogeneous patient-specific impairments make planning of the neurorehabilitation therapy challenging. Here, it may be important to stratify the stroke survivors for restorative neurorehabilitation based on the prognosis and the ability of the stroke survivor to undergo therapy depending on their cardiovascular and neuromuscular capacity besides psychological factors such as motivation where the therapy needs to be tailored to individual health condition. The WHO International Classification of Functioning (ICF) model recommends intervention at multiple levels (e.g., impairment, activity, participation) where environment and personal factors can play an important role in resource-limited India. In fact, deconditioned chronic stroke survivor will need to recondition their cardiovascular endurance, metabolic fitness, and muscle conditions with a gradual increase in the intensity (number of hours per day) and frequency (number of days per week) of therapy, providing a higher level as they improve their function. Towards that overarching goal in a low-resource setting, we propose development of neurophysiological screening and monitoring tools using low-cost sensors.

## 6.4.2. Inria International Partners

### 6.4.2.1. Declared Inria International Partners

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

### 6.4.3. Participation In other International Programs

France-Stanford GRANT :

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

## 6.5. International Research Visitors

### 6.5.1. Visits of International Scientists

#### 6.5.1.1. Internships

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

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

### 6.5.2. Visits to International Teams

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

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

#### 6.5.2.1. Research stays abroad

Christine Azevedo Coste is spending 2,5 months (November 2015-February 2016) at Brasilia University as an invited researcher. She is working in collaboration within Emerson FACHIN-MARTINS responsible of the NTAAI (Nucléo de Tecnologia Assistiva, Acessibilidade e Inovacão) initiative. Brazilian program: Science without borders (Ciências sem fronteiras) CAPES.

## DIANA Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

- **Plate-forme Telecom (Com4innov)** (2011-2017) is a DGCIS funded project, in the context of the competitiveness cluster SCS, that aims at providing to PACA region industrials wishing to develop or validate new products related to future mobile networks and services and M2M application, a networking infrastructure and tools helpful for development, test and validation of those products. Other partners : 3Roam, Audilog Groupe Ericsson, Ericsson, Eurecom, Inria, iQsim, MobiSmart, Newsteo, OneAccess, Orange Labs, SCS cluster, ST Ericsson, Telecom Valley. Our contribution is centred around providing a test methodology and tools for wireless networks experimentation. In the context of this project we have realized a study on MPTCP performance in a wireless-wired environment with Orange Labs Sophia. The software tools that were developed in the project have been integrated in the R<sup>2</sup>lab anechoic chamber.

## 8.2. National Initiatives

### 8.2.1. ANR

- **ANR FIT** (2011-2018): FIT (Future Internet of Things) aims at developing an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant programme. The project will benefit from a 5.8 million euro grant from the French government. Other partners are UPMC, IT, Strasbourg University and CNRS. See also <http://fit-equipex.fr/>.
- **ANR DISCO** (2014-2016): DISCO (DIstributed SDN COntrollers for rich and elastic network services) aims at exploring the way how Software Defined Networking changes network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. The project works throughout experimentations and application use cases on the next generation of Software-Defined Networking solutions for large and critical distributed systems. The project will study the distribution of the current SDN control plane and the optimization of network operations that the integrated system view of cloud computing-based architectures allows. See also <http://anr-disco.ens-lyon.fr/>.
- **ANR REFLEXION** (2015-2017): REFLEXION (REsilient and FLEXible Infrastructure for Open Networking) research project will study the robustness and scalability of the current SDN architectures and the flexibility leveraged by SDN for provisioning resources and virtualized network functions (VNF). The project will address four main scientific objectives: (1) Fault and disruption management for virtualized services, (2) Robust and scalable control plane for next generation SDN, (3) Dynamic performance management of low level resources in SDN/NFV environments and (4) Distribution and optimization of virtual network functions in SDN environments. Our contribution in this project will be focused on fault and disruption management for virtualized services. See also <http://anr-reflexion.telecom-paristech.fr/>.

- **ANR BottleNet** (2016-2019): BottleNet aims to deliver methods, algorithms, and software systems to measure Internet Quality of Experience (QoE) and diagnose the root cause of poor Internet QoE. This goal calls for tools that run directly at users' devices. The plan is to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. ANR BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

Program: FP7 FIRE programme

Project acronym:

Project title: Fed4Fire

Duration: October 2012 - October 2016

Coordinator: iMinds (Belgium)

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

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

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

### 8.3.2. EIT KIC funded activities

Program: FNS Future Networking Solutions Action Line

Project acronym: NFMD

Project title: Networks for Future Media Distribution (14082)

Duration: January 2015 to December 2015

Coordinator: Acreo, Sweden

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

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

## 8.4. International Initiatives

### 8.4.1. Inria International Labs

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

### 8.4.2. Inria International Partners

#### 8.4.2.1. Informal International Partners

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

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

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

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

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

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

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

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

#### 8.5.1.1. Internships

**Nicolas Aguilera Miranda**

Date: from October 2014 February 2015  
Institution: University of Chile, CIRIC  
Supervisor: Chadi Barakat  
Subject: Measurements of users' quality of experience over Adkintun Mobile

**Brahim Bellaoui**

Date: from Mar 2015 until Aug 2015  
Institution: University of Nice Sophia Antipolis  
Supervisor: Thierry Turletti, Damien Saucez and Walid Dabbous  
Subject: Optimization Framework and Fault Management for NFV and SDN

**Yuri Bushnev**

Date: from June 2015 until Aug 2015  
Institution: Saint Petersburg State University  
Supervisor: Thierry Turletti and Damien Saucez  
Subject: Robust programmable communication networks

**Anuvabh Dutt**

Date: from Aug 2015 until Sep 2015  
Institution: University of Nice Sophia Antipolis, International Master 1  
Supervisor: Arnaud Legout  
Subject: Analysis of Hashtag Relations to Identify Unusual User Activities on Twitter

**Anastasia Kuznetsova**

Date: from July 2015 until Aug 2015  
Institution: University of Nice Sophia Antipolis, International Master 1  
Supervisor: Arnaud Legout  
Subject: Analysis of Hashtag Relations to Identify Unusual User Activities on Twitter

**Mohamed Naoufal Mahfoudi**

Date: from Mar 2015 until Aug 2015  
Institution: University of Nice Sophia Antipolis, Ubinet Master  
Supervisor: Walid Dabbous and Thierry Turletti  
Subject: Reproducible and Realistic wireless Experiments in an Anechoic Chamber

**Thierry Spetebroot**

Date: from March 2015 until August 2015  
Institution: Polytech Nice Sophia, Ubinet Master  
Supervisor: Chadi Barakat  
Subject: From network-level measurements to expected Quality of Experience for Video applications

### 8.5.2. Visits to International Teams

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

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

#### *8.5.2.1. Research stays abroad*

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

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



## ECUADOR Project-Team

### 8. Partnerships and Cooperations

#### 8.1. National Initiatives

##### 8.1.1. ANR

###### 8.1.1.1. MAIDESC

Ecuador is coordinator of the ANR project MAIDESC, with Inria team Gamma3, University of Montpellier II, CEMEF-Ecole des Mines, Inria-Bordeaux, Lemma and Transvalor. MAIDESC concentrates on mesh adaptation and in particular meshes for interfaces, third-order accuracy, meshes for boundary layers, and curved meshes.

#### 8.2. European Initiatives

##### 8.2.1. FP7 & H2020 Projects

###### 8.2.1.1. AboutFlow

Type: PEOPLE

Instrument: Initial Training Network

Duration: 2012-2016

Coordinator: Jens-Dominik Mueller

Partner: Queen Mary University of London (UK)

Inria contact: Laurent Hascoët

Abstract: The aim of AboutFlow is to develop robust gradient-based optimisation methods using adjoint sensitivities for numerical optimisation of flows. <http://aboutflow.sems.qmul.ac.uk/>

###### 8.2.1.2. UMRIDA

Type:AAT

Instrument:Aeronautics and Air Transport

Duration: 2013-2016

Coordinator: Charles Hirsch

Partner: Numeca S.A. (Belgium)

Inria contact: Alain Dervieux

Abstract: UMRIDA addresses major research challenges in Uncertainty Quantification and Robust Design: develop new methods that handle large numbers of simultaneous uncertainties and generalized geometrical uncertainties. Apply these methods to representative industrial configurations.

#### 8.3. International Initiatives

##### 8.3.1. Inria International Labs

Ecuador participates in the Joint Laboratory for Exascale Computing (JLESC) together with colleagues at Argonne National Laboratory. Laurent Hascoët attended the JLESC meeting in Bonn, Germany, december 2-5.

#### 8.4. International Research Visitors

##### 8.4.1. Visits of International Scientists

- Krishna Narayanan from Argonne National Laboratory, september 21-25.

##### 8.4.2. Internships

- Marcin Wyrozebski from Warsaw University of Technology, september 1-30.

##### 8.4.3. Visits to International Teams

- Laurent Hascoët visited Argonne National Laboratory, april 13-23.

## **FOCUS Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. National Initiatives**

- REVER (Programming Reversible Recoverable Systems) is an ANR project that started on 1st December 2011 and with a 4-year duration. REVER aims to study the possibility of defining semantically well-founded and composable abstractions for dependable computing on the basis of a reversible programming language substrate, where reversibility means the ability to undo any distributed program execution, possibly step by step. The critical assumption behind REVER is that by adopting a reversible model of computation, and by combining it with appropriate notions of compensation and modularity, one can develop systematic and composable abstractions for recoverable and dependable systems. Main persons involved: Giachino, Lienhardt, Lanese, Laneve, Zavattaro.
- PACE (Processus non-standard: Analyse, Coinduction, et Expressivité) is an ANR project that started in 2013. The project targets three fundamental ingredients in theories of concurrent processes, namely coinduction, expressiveness, and analysis techniques. The project aims at processes that are beyond the realm of "traditional" processes. Specifically, the models studied exhibit one or more of the following features: probabilities, higher-order, quantum, constraints, knowledge, and confidentiality. These models are becoming increasingly more important for today's applications. Coinduction is intended to play a pivotal role. Indeed, the approaches to expressiveness and the analysis techniques considered in the project are based on coinductive equalities. Main persons involved: Hirschhoff (project coordinator), Dal Lago, Lanese, Sangiorgi, Zavattaro.
- ELICA (Expanding Logical Ideas for Complexity Analysis) is an ANR project which started on October 2014 and that we will finish on September 2018. ELICA is a project about methodologies for the static analysis of programs as for their resource consumption. The project's aim is to further improve on logical methodologies for complexity analysis (type systems, rewriting, etc.). More specifically, one would like to have more powerful techniques with less false negatives, being able at the same time to deal with nonstandard programming paradigms (concurrent, probabilistic, etc.). Main persons involved: Avanzini, Cappai, Dal Lago, Hirschhoff, Martini, Sangiorgi.

## **8.2. European Initiatives**

### **8.2.1. FP7 & H2020 Projects**

- ENVISAGE (Engineering Virtualized Services) is a EU FP7 project, with starting date October 1st, 2013, and with a 3-year duration. The project is about model-based development of virtualized services, including tool support for resource analysis. Most Focus members are involved.

### **8.2.2. Collaborations in European Programs, except FP7 & H2020**

- The ICT COST Action BETTY (Behavioural Types for Reliable Large-Scale Software Systems). initiated in October 2012 and with a 4-year duration, uses behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreographies. Main persons involved: Bravetti, Giachino, Hirschhoff, Lanese, Laneve, Mauro, Sangiorgi, Zavattaro.

- ICT COST Action IC1405 (Reversible computation - extending horizons of computing). Initiated at the end of April 2015 and with a 4-year duration, this COST Action studies reversible computation and its potential applications, which include circuits, low-power computing, simulation, biological modeling, reliability and debugging. Reversible computation is an emerging paradigm that extends the standard forwards-only mode of computation with the ability to execute in reverse, so that computation can run backwards as naturally as it can go forwards.

Main persons involved: Giachino, Lanese (vice-chair of the action), Bernadet

- ICT COST Action IC1402 ARVI (Runtime Verification beyond Monitoring) Initiated in December 2014 and with a 4-year duration, this COST Action studies runtime verification, a computing analysis paradigm based on observing a system at runtime to check its expected behavior.

Main persons involved: Lanese

### **8.2.3. Collaborations with Major European Organizations**

Simone Martini is a member of the Executive Board of EQANIE (European Quality Assurance Network for Informatics Education), from October 2014.

We list here the cooperations and contacts with other groups, without repeating those already listed in previous sections.

- ENS Lyon (on concurrency models and resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi, Vignudelli. Some visit exchanges during the year, in both directions. One joint PhD supervision (J.-M. Madiot).
- Inria EPI Spades (on models and languages for components, reversibility). Contact person(s) in Focus: Lanese. Some visit exchanges during the year, in both directions.
- Laboratoire d'Informatique, Université Paris Nord, Villetaneuse (on implicit computational complexity). Contact person(s) in Focus: Dal Lago, Martini. An Italian PhD student (Marco Solieri) is working on his PhD thesis with joint supervision (Martini, Guerrini).
- Institut de Mathématiques de Luminy, Marseille (on lambda-calculi, linear logic and semantics). Contact person(s) in Focus: Dal Lago, Martini.
- Team PPS, University of Paris-Diderot Paris 7 (on logics for processes, resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi. Some short visits in both directions during the year.
- IRILL Lab, Paris (on models for the representation of dependencies in distributed package based software distributions). Contact person(s) in Focus: Mauro, Zavattaro. Some short visits in both directions during the year.
- EPI Carte, Inria-Nancy Grand Est and LORIA (on implicit computational complexity). Contact person(s) in Focus: Dal Lago.
- LMU Munich (M. Hofmann) (on Implicit computational complexity and IntML). Contact person(s) in Focus: Dal Lago.
- IMDEA Software, Madrid (G. Barthe) (on Implicit computational complexity for cryptography). Contact person(s) in Focus: Dal Lago, Sangiorgi. Some visits during 2015.
- Facultad de Informatica, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project "ESTuDIo: ESpecificacion y Testing de sistemas altamente DIstribuidos" (Specification and Testing of Highly Distributed Systems) January 1, 2013 - December 31, 2015 (3 years), funded by the Spanish Ministerio de Economía y Competitividad.

## 8.3. International Initiatives

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

#### 8.3.1.1. CRECOGI

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

International Partner (Institution - Laboratory - Researcher):

    Todai (Japan) - Graduate School of Information Science and Technology - Ichiro HASUO

Start year: 2015

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

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

### 8.3.2. Participation In other International Programs

*Complexity Analysis of Higher-Order Rewrite Systems* is an FWF (Austrian Science Fund, see <http://www.fwf.ac.at/>) project which is conducted in Bologna from April 2014 to April 2016. The project aim is the development of logical methodologies for the static resource analysis of higher-order rewrite systems, a formal model of computation that closely captures the evaluation semantics of functional programs. Particular attention is paid to automation, so that the developed complexity-techniques can be integrated into the Tyrolean Complexity Tool, a highly modular complexity analyser for rewrite systems.

Main persons involved: Avanzini, Dal Lago.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

The following researchers have visited Focus for short periods; we list them together with the title of the talk they have given during their stay, or the topic discussed during their stay.

- Giovanni Pardini: "Lazy Security Controllers."
- Antonio Ravara: "Towards static deadlock resolution in the pi-calculus."
- Silvia Crafa: "Concurrency theory and concurrent languages: an evolutionary view of programming abstractions."
- Henning Kerstan: "Probabilistic Transition Systems."
- Jean-Bernard Stefani: "Location graphs: yet another global computing model (but with reason)."
- Isabel Oitavem: "P, NP and Pspace from a recursion-theoretic perspective."
- Reinhard Kahle: "Theories for Classes of Computational Complexity."
- Violet Ka I Pun: "Meeting Deadlines, Elastically."
- Volker Stolz: "Search-based composed refactorings."

- Giuseppe De Ruvo: "An Unusual Context for Formal Verification: Wiki Evolution."
- Manuel Mazzara: "Applications of reversibility".
- Claudio Antares Mezzina and Doriana Medic: "Calculi for reversibility".
- Thomas Leventis: " Theories in Probabilistic lambda-calculus."
- Mirko Viroli: "Perspectives on Aggregate Computing".
- Benoit Valiron and Claudia Faggian: "Resource control and linear logics".
- Beniamino Accattoli: "Abstract machines and resource control".
- Georg Moser, Thomas Powell and Stephane Gimenez: "Tools for computational complexity".
- Ichiro Hasuo, Akira Yoshimizu, and Ryo Tanaka: "Game semantics".
- Ales Bizjak: "Step-Indexed Logical Relations for Probability".
- Roberto Di Cosmo: "Preserving Software: challenges and opportunities for reproducibility of Science and Technology".

#### **8.4.2. Visits to International Teams**

January 14-28: Ugo Dal Lago visited Shanghai Jiaotong University, and collaborated with Yuxin Deng, as for the PACE project.

##### *8.4.2.1. Sabbatical programme*

Maurizio Gabbrielli is, since 15 September 2014, Head of the EIT ICT Labs Doctoral School with Paris as his principal location.

## GALAAD2 Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

### 7.1.1. GEOLMI

GEOLMI - Geometry and Algebra of Linear Matrix Inequalities with Systems Control Applications - is an ANR project working on topics related to the Geometry of determinantal varieties, positive polynomials, computational algebraic geometry, semidefinite programming and systems control applications.

The partners are LAAS-CNRS, Univ. de Toulouse (coordinator), LJK-CNRS, Univ. Joseph Fourier de Grenoble; Inria Sophia Antipolis Méditerranée; LIP6-CNRS Univ. Pierre et Marie Curie; Univ. de Pau et des Pays de l'Adour; IRMAR-CNRS, Univ. de Rennes.

More information available at <http://homepages.laas.fr/henrion/geolmi>.

### 7.1.2. ANEMOS

ANEMOS - Advanced Numeric for ELMs (Edge Localized Mode): Modeling and Optimized Schemes - is an ANR project devoted to the numerical modelling study of such ELM control methods as Resonant Magnetic Perturbations (RMPs) and pellet ELM pacing both foreseen in ITER. The goals of the project are to improve understanding of the related physics and propose possible new strategies to improve effectiveness of ELM control techniques. The study of spline spaces for isogeometric finite element methods is proposed in this context.

The partners are IRFM, CEA, Cadarache; JAD, University of Nice - Sophia Antipolis; Inria, Bacchus; Maison de la Simulation CEA-CNRS-Inria-University of Orsay- University of Versailles St Quentin.

## 7.2. International Initiatives

### 7.2.1. Participation In other International Programs

We have a bilateral collaboration between Galaad and the University of Athens-DIT team ERGA, headed by Ioannis Emiris for the period August 2014-August 2015. It is supported by both Inria and the University of Athens.

Title: Algebraic algorithms in optimization

Abstract: In the past decade, algebraic approaches to optimization problems defined in terms of multivariate polynomials have been intensively explored and studied in several directions. One example is the work on semidefinite optimization and, more recently, convex algebraic geometry. This project aims to focus on algebraic approaches for optimization applications in the wide sense. We concentrate on specific tools, namely root counting techniques, the resultant, the discriminant and non-negative polynomials, on which the two teams have extensive collaboration and expertise. We examine applications in convex algebraic geometry as well as to a newer topic for the two teams, namely game theory. A common thread to these approaches is to exploit any (sparse) structure.

We participate to a bilateral collaboration between France and Spain which is supported as a PICS from CNRS. The Spanish partner is the University of Barcelona (J. Burgos, C. D'Andrea, Martin Sombra) and the French partners are The university of Caen (F. Amoroso, M. Weimann), the University of Paris 6 (M. Chardin, P. Philippon) and GALAAD.

Title: Diophantine Geometry and Computer Algebra

Abstract: This project aims at exploring interactions between diophantine geometry and computer algebra by stimulating collaborations between experts in both domains. The research program focus on five particular topics: toric varieties and height, equidistribution, Diophantine geometry and complexity, Factorization of multivariate polynomials by means of toric geometry and study of singularities of toric parameterizations.

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

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

Abstract: The study of rational maps is of theoretical interest in algebraic geometry and commutative algebra, and of practical importance in geometric modeling. This research proposal focus on rational maps in low dimension, typically parameterizations of curves and surfaces embedded in the projective space of dimension 3, but also dominant rational maps in dimension two and three. The two main objectives amount to unravel geometric properties of these rational maps from the syzygies of their projective coordinates. The first one aims at extending and generalizing the determination of the closed image of a rational map, as well as its geometric features, whereas the second one will focus on the study of dominant rational maps, in particular on the characterization of those that are generically one-to-one.

## **7.3. International Research Visitors**

### **7.3.1. Visits of International Scientists**

#### *7.3.1.1. Internships*

Ibrahim Adamou (Université Dan Dicko DanKoulodo de Maradi, Niger), *Voronoi diagram of half-lines*, December 2015 - January 2016.

Nathan Clement (University of Texas at Austin, USA), *Offset of parametric curves*, Jun 2015-Aug 2015

Alexis Papagiannopoulos (NTUA, Athens, Greece), *Isogeometric analysis and parameterization of computational domains*, May 2015- September 2015.

Meng Wu (Hefei Univ. of Technology, China), *Splines over domain with arbitrary topology and isogeometric applications*, October 2015 - November 2015.

### **7.3.2. Visits to International Teams**

#### *7.3.2.1. Sabbatical programme*

Hubert Evelyne

Date: Sep 2015 - Feb 2016

Institution: Fields Institute, Toronto, Canada.

## GEOMETRICA Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. ANR *Présage*

**Participants:** Marc Glisse, Rémy Thomasse.

- Acronym: *Présage*.

- Type: ANR blanc.

- Title: *méthodes PRobabilistes pour l'Éfficacité des Structures et Algorithmes GÉométriques*.

- Coordinator: Xavier Goaoc.

- Duration: 31 december 2011 - 31 december 2015.

- Other partners: Inria VEGAS team, University of Rouen.

- Abstract: This project brings together computational and probabilistic geometers to tackle new probabilistic geometry problems arising from the design and analysis of geometric algorithms and data structures. We focus on properties of discrete structures induced by or underlying random continuous geometric objects. This raises questions such as:

- What does a random geometric structure (convex hulls, tessellations, visibility regions...) look like?
- How to analyze and optimize the behavior of classical geometric algorithms on *usual* inputs?
- How can we generate randomly *interesting* discrete geometric structures?

### 9.1.2. ANR *TOPDATA*

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

- Acronym : TopData.

- Type : ANR blanc.

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

- Coordinator : Frédéric Chazal (GEOMETRICA).

- Duration : 4 years starting October 2013.

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

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

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



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

## 9.2. European Initiatives

### 9.2.1. FP7 & H2020 Projects

#### 9.2.1.1. ERC GUDHI

Title: Algorithmic Foundations of Geometry Understanding in Higher Dimensions.

Program: FP7.

Type: ERC.

Duration: February 2014 - January 2019.

Coordinator: Inria.

PI: Jean-Daniel Boissonnat.

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

## 9.3. International Initiatives

### 9.3.1. CATS

Title: Computations And Topological Statistics.

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2015.

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

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

## **9.4. International Research Visitors**

### **9.4.1. Visits of International Scientists**

Ramsay Dyer (University of Groningen), May  
Arijit Ghosh (MPII, Saarbrücken), June-July  
Clément Maria (Queen's College, Brisbane), June  
Omer Brobowski (Duke University), May  
Jessica Cisewski (Carnegie Mellon), October  
Jisu Kim (Carnegie Mellon), May-July  
Yanir Kleiman (Tel Aviv University), October  
Bertrand Michel (Paris 6), 2015  
Jan Felix Senge (Bremen), October  
Primoz Skraba (Jozef Stefan Institute), May  
Kelly Spendlove (Rutgers), May-July  
Jian Sun (Tsinghua), February  
Justin Solomon (Stanford), February

#### *9.4.1.1. Internships*

Sivaprasad Sudhir (IIT Bombay), June-July  
Stéphane Lundy (Supélec), July-August  
Siargey Kachanovich (ENS Rennes), March-August  
Anatole Moreau (EPITA), May-August  
Tullia Padellini (Roma University), May-September  
Yuping Ren (Erasmus), January-July

### **9.4.2. Visits to International Teams**

#### *9.4.2.1. Research stays abroad*

- + Steve Oudot spent 1 month in July-August in the group of Benjamin Burton at the Pure Maths Department of University of Queensland, Australia.

## GRAPHDECO Project-Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. Regional Ph.D. Scholarship

The thesis of T. Thonat is financed in part by a Région Provence Alpes-Côte d'Azur Ph.D. scholarship, with the industrial support of Kaleidoscope (Toulon).

## 9.2. National Initiatives

### 9.2.1. ANR

#### 9.2.1.1. ANR ALTA

**Participants:** Emmanuelle Chapoulie, Stefan Popov, George Drettakis.

The ANR ALTA project started in October 2011, and focuses on the development of novel algorithms for realistic and efficient global illumination. The project is coordinated by the Grenoble Inria group ARTIS (N.Holzschuch), and the Bordeaux Inria group MANAO (X. Granier) is also a partner. Our participation is the study of error bounds for these algorithms and the development of interactive global illumination. This year we developed a new global illumination algorithm described in Sec. 7.2.12 which was published at EGSR [10].

#### 9.2.1.2. ANR DRAO

**Participants:** Emmanuel Iarussi, Adrien Bousseau.

<https://www-sop.inria.fr/members/Adrien.Bousseau/drao/>

The ANR DRAO is a young researcher project coordinated by Adrien Bousseau, in collaboration with the InSitu project team at Inria Saclay - Ile de France (W. Mackay and T. Tsandilas) and the MANAO project team (P. Barla and G. Guennebaud) and POTIOC project team (M. Hachet) at Inria Bordeaux - Sud Ouest. The goal of this collaboration is to develop novel drawing tools for amateurs as well as for expert designers and illustrators, combining expertise in Computer Graphics (REVES and MANAO) and Human-Computer Interaction (InSitu, POTIOC). This ANR project funds the PhD of Emmanuel Iarussi.

The first part of the project involved the observation of how people draw with existing tools. To do so we conducted observational studies where we will interview designers and illustrators and collect data by videotaping drawing sessions and by recording drawings with digital pens. In the second part of the project we deduced from our observations new user interfaces and rendering algorithms that automate part of the drawing process and enrich 2D drawings with realistic rendering capabilities. We combined computer vision and computer graphics techniques to estimate geometric information from sketches and then used this information to guide rendering algorithms that generate plausible depictions of material and lighting over the drawing. We also developed computer-assisted drawing lessons to help amateurs draw from photographs and 3D models, using image analysis algorithms to estimate the structure of a photograph and use that structure as guidance for drawing. To summarize, the goal of the ANR DRAO project was to make amateurs more confident in their drawing skills and to allow expert designers to produce complex illustrations more effectively.

The ANR DRAO has resulted in three publications this year on normal field estimation from rough sketches [7], 3D interpretation of line drawings [14] and jewelry design [8].

#### 9.2.1.3. ANR SEMAPOLIS

**Participant:** George Drettakis.

This ANR project started in October 2013. The goal is to use semantic information to improve urban reconstruction and rendering. The consortium is led by ENPC (R. Marlet) and includes the Inria Willow team and the GREY-C laboratory on image processing. Our contribution will be in the rendering part.

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

#### 9.3.1.1. CR-PLAY – Capture Reconstruct Play

<http://www.cr-play.eu>

Type: COOPERATION (ICT)

Instrument: Specific Targeted Research Project

Objectif: Creativity

Duration: November 2013 - October 2016

Coordinator: Testaluna SA (IT)

Partner: TU Darmstadt (DE), UC London (UK), U. Patras (GR), Miniclip UK, Cursor Oy (FI)

Inria contact: George Drettakis

Abstract: The goal of this project is to use image- and video-based rendering and relighting techniques in the context of games and in particular mobile or casual games. The computer graphics and vision partners (UCL, TUD) are leaders in their fields, and have developed algorithms allowing easy capture of scenes using images and video, and reconstruction using vision algorithms. UCL and Inria have developed image- and video-based rendering algorithms which can be useful for games. These tools need to be perfected, reducing artifacts and difficulty of use so that they can be useful and productive for games companies. For evaluation, the HCI lab of the University of Patras will provide cutting-edge methodologies to make the resulting systems useable. The consortium is led by the games company Testaluna, based in Genova Italy. Other industrial partners include Cursor Oy (a regional group of games companies in Finland, which is a leader in Europe in Casual games) and Miniclip, which is one of the major players in the online game market.

We have started specific scientific collaborations with TUD on capture guidance and IBR and with UCL on video-based rendering.

## 9.4. International Initiatives

### **Inria@SiliconValley**

Associate Team involved in the International Lab:

#### 9.4.1. CRISP2

Title: Creating and Rendering Images based on the Study of Perception

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science Department (EECS) - Maneesh Agrawala

Start year: 2014

See also: <http://www-sop.inria.fr/rees/crisp/>

The CRISP collaboration aims at developing novel techniques to create and manipulate effective numerical imagery. We adopt a multidisciplinary approach, focusing on understanding how people create and perceive images, on developing new rendering algorithms based on this understanding, and on building interactive tools that enable users to efficiently produce the images they have in mind. The participants of CRISP share complementary expertise in computer graphics, human computer interaction and human visual perception.

In 2015 we published two papers in the Computer Graphics Forum journal, which were presented at the Eurographics Symposium on Rendering (EGSR). In the first paper we used a model of texture similarity to transfer seasons between photographs. Our algorithm predicts how to change colors and textures in an image to give it the seasonal appearance of another image. In particular, our method captures season-related effects such as leaves on trees, snow and flooding. This work was done in collaboration with Alexei Efros who is an expert in data-driven image manipulation.

The second paper contributes to more traditional, physically-based rendering using bidirectional path tracing. The key idea behind our approach is to exploit combinatorial explosion to cheaply construct a set of light paths as the Cartesian product of the eye and light sub-paths. The novelty of our work is to approximate the contribution of these paths in a probabilistic manner, without constructing each path in the set explicitly. This work results from collaboration with Ravi Ramamoorthi.

We are currently focusing our efforts on two core topics of the CRISP collaboration: perceptual rendering and plausible image-based rendering. In particular, we plan to explore several projects related to the perception and rendering of stereo images. This research will greatly benefit from an Inria postdoc, George Koulieris, who will share his time between Inria and UC Berkeley. In addition, Martin S. Banks from UC Berkeley plans to spend part of his sabbatical at Inria.

CRISP has resulted in two publications this year with Aloyha Efros [9] and R. Ramamoorthi [10].

## 9.4.2. Inria International Partners

### 9.4.2.1. Declared Inria International Partners

**Canada.** A. Bousseau collaborates regularly with the University of Toronto (K. Singh) and the University of British Columbia (A. Sheffer).

**United Kingdom.** In the context of the postdoctoral fellowship of K. Vanhoey, we collaborate with I. Jermyn from Durham University.

**India.** A. Bousseau collaborates with Vinay Namboodiri from IIT Kanpur. They co-advised two master students, one came for an internship at Inria (Rahul Arora).

**United States.** We have several collaborations with Adobe Research. We worked on jewelry design [8] with Wilmot Li, who hosted Emmanuel Iarussi for an 3-months internship. We also work with Eli Shechtman and Sylvain Paris in the context of the multi-view inpainting project of T. Thonat. We collaborate with F. Durand from MIT in the context of the global illumination project [10]. We collaborate with Daniel Aliaga from Purdue University on sketch-based procedural modeling.

**Greece.** We collaborate with the Technical University of Crete in the context of the project on attention and Virtual Reality (G. Koulieris).

## 9.5. International Research Visitors

### 9.5.1. Visits of International Scientists

Prof. D. Aliaga from Purdue (US) visited in June for two weeks, Prof. K. Bala (Cornell, US), A. Shamir (IDC, IS), D. Salesin (Adobe, US) visited early September and participated in a workshop after the HDR defense of A. Bousseau. Prof. N. Mitra (UCL, UK), M. Alexa (TU Berlin, D) visited end September and participated in a scientific workshop after the defense of E. Iarussi.

#### *9.5.1.1. Internships*

Rahul Arora, was a Masters Intern, until Apr 2015 from IIT Kampur. Vivien Cabannes was a 3rd year intern from ENS Ulm from June 2015 until July 2015. Lorenzo Caroggio and Huayi Huang were last year engineering student interns from Univ. Genova in teh context of an ERASMUS exchange. Ayush Tewari was a Masters II intern from MOSIG Grenoble Feb. -Jul. 2015. Georgios Kopanas, was an ERASMUS intern from the Tech. Un. Thessaly, Sep.-Dec. 2015.

#### **9.5.2. Visits to International Teams**

G. Drettakis visited Berkeley in the context of the CRISP Associate team in August.

## GRAPHIK Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. ANR

#### 9.1.1.1. ASPIQ

**Participants:** Jean-François Baget, Fabien Garreau, Marie-Laure Mugnier, Jérôme Fortin, Michel Leclère.

ASPIQ (ASP technologies for Querying large scale multisource heterogeneous web information), is an ANR white project (duration: 4 years) that started in Oct. 2012. It involves partners from CRIL, LERIA and LSIS. The project coordinator is Odile Papini (LSIS). <http://aspiq.lsis.org/>

The main objective of this project is to propose:

- extensions of standard ASP for representing OWL2 tractable sublanguages;
- new operations for merging conflicting information in this extended ASP;
- the identification of subclasses of this extended ASP allowing for efficient query answering mechanisms;
- an implementation of a prototype reasoning system.
- *See Section 7.1 for this year's results (Extensions of the Framework).*

#### 9.1.1.2. Pagoda

**Participants:** Meghyn Bienvenu, Jean-François Baget, Marie-Laure Mugnier, Swan Rocher, Federico Ulliana.

Pagoda (Practical Algorithms for Ontology-based Data Access) is an ANR JCJC (young researchers) project that started in Jan. 2013 (duration: 4 years, extended to August 2017). The project coordinator is Meghyn Bienvenu (initially in LRI, now member of GraphIK). It involves partners from the EPI LEO, the LIG, and the Anatomy Laboratory of Grenoble. <http://pagoda.lri.fr/>

The primary aim of this project is to address challenges brought by scalability and the handling of data inconsistencies by developing novel OBDA (Ontology Based Data Access) query answering algorithms and practical methods for handling inconsistent data.

- *See Section 7.1 for this year's results.*

#### 9.1.1.3. Qualinca

**Participants:** Michel Leclère, Michel Chein, Madalina Croitoru, Rallou Thomopoulos, Alain Gutierrez, Swan Rocher, Marie-Laure Mugnier.

Qualinca is an ANR Contint project that started in Apr. 2012 (duration: 4 years, extended to September 2016). The project coordinator is Michel Leclère (GraphIK). It involves partners from LRI, LIG, ABES and INA. <http://www.lirmm.fr/qualinca/index8ece.html?q=en/en/home>

The main objective is to elaborate mechanisms allowing to:

- evaluate the quality of an existing document base;
- maintain a given level of quality by controlling updating operations;
- increase the quality of a given base;
- develop generic methods that take into account the quality of a given base (for instance for searching documents or interconnecting bases).
- *See Section 7.3 for this year's results.*

#### 9.1.1.4. *Dur-Dur*

**Participants:** Abdallah Arioua, Patrice Buche, Madalina Croitoru, Jérôme Fortin, Rallou Thomopoulos.

Dur-Dur (Innovations agronomiques, techniques et organisationnelles pour accroître la DURabilité de la filière blé DUR) is an ANR project that started in March 2014 (duration: 3 years). It is led by IATE Laboratory. <http://umr-iate.cirad.fr/projets/dur-dur>

The Dur-Dur project develops a systematic approach to investigate the questions related to the management of the nitrogen, energy and contaminants, to guarantee a global quality of products throughout the production and the processing chain. The knowledge representation task of Dur-Dur proposes to map the stakeholders' objectives into a multicriteria cartography, as well as possible means to reach them, and computes the compatibility / incompatibility of these objectives on the basis of argumentation methods. The research methods used are qualitative and based both on argumentation theory and on Social Multi- Criteria Evaluation (SMCE) theory. They will be extended and adapted to the needs of the project to provide a formal framework of assessment of the various orientations considered for the durum wheat chain.

## 9.2. European Initiatives

### 9.2.1. *FP7 & H2020 Projects*

#### 9.2.1.1. *EcoBioCap*

**Participants:** Patrice Buche, Madalina Croitoru, Jérôme Fortin, Nouredine Toumani.

EcoBioCap is a FP7-KBEE project that lasted 4 years and ended in March 2015. It was led by INRA (and scientifically managed by Montpellier IATE laboratory). It involved sixteen partners among which Cork University (Ireland), CSIC (Spain), Roma University La Sapienza (Italy), SIK (Sweden). The objective of EcoBioCAP was to “provide the EU food industry with customizable, ecoefficient, biodegradable packaging solutions with direct benefits both for the environment and EU consumers in terms of food quality and safety”. The budget was managed by IATE team.

- See Section 7.2 for this year's results.

#### 9.2.2. *Collaborations with Major European Organizations*

- On existential rules, we collaborate with TU Dresden and have scientific contacts with the University of Oxford.
- On description logics, we collaborate with the universities of Bremen, Liverpool, London, Rome and Vienna (new collaborations brought by Meghyn Bienvenu).
- On argumentation, we work with the universities of Aberdeen and Southampton.

## 9.3. International Research Visitors

Odile Papini, PR Univ. Aix-Marseille, is a visitor from Sept. 2015 (one year CNRS delegation) (see ASPIQ project in Section 9.1).

Pierre Bisquert is currently an international visitor for one year at the University of Amsterdam (from May 2015).

Rallou Thomopoulos is currently a visitor at the University of Quebec for one year (from July 2015).



## HEPHAISTOS Project-Team

## 9. Partnerships and Cooperations

### 9.1. Regional Initiatives

- B. Senach participated in the regional event : Workshop Santé - Maison des Sciences de l'Homme (NICE)
- project *Le refuge-Lecture: accessibilité à la compréhension d'un texte pour des personnes en situation de handicap (auditif, visuel, cognitif)*, Conseil général projet Santé
- CPER project MADORSON for the assistance to elderly people (with the STARS project)

### 9.2. National Initiatives

#### 9.2.1. Other activities

##### 9.2.1.1. FHU

- the team has been involved for the FHU *INOVPAIN : Innovative Solutions in Refractory Chronic Pain* that has been labeled in December

##### 9.2.1.2. Challenges and grants

- Submission to the I-Lab 2015 challenge (prize winner)
- Submission to Charles Foix Grant
- Submission to the call AUTON (CNRS) with Marc Relieu (Telecom ParisTech) (accepted)

##### 9.2.1.3. Euthenia Start-up

**Participants:** Ting Wang, Bernard Senach, Jean-Pierre Merlet.

We pursued our actions to evaluate technologies developed within HEPHAISTOS project team. The goal is to bring to the market an instrumented walker which provides to its users and to other stakeholder various information about walking performance. This year we proposed the creation of the Inria start-up Euthenia and we submitted to two national challenges. We won a prize for the I-Lab 2015 challenge (30 keuros) and were nominated for the Charles Foix Grant. Our Safe Walker was used as a pilot during the first Summer school of the European Institute of Technology and it was presented in Nice at the opening ceremony the Living Lab "27 Delvalle". For personal reasons the start-up is in stand-by for now but we hope to be able to reactivate it.

### 9.3. European Initiatives

#### 9.3.1. FP7 & H2020 Projects

##### 9.3.1.1. RAPP

Type: COOPERATION

Instrument: Specific Targeted Research Project

Objective: Robotic Applications for Delivering Smart User Empowering Applications

Duration: December 2013-December 2016

Coordinator: CERTH/ITI

Partner: CERTH/ITI(Greece), Inria, WUT (Poland), ORTELIO (UK), ORMYLIA (Greece), IN-GEMA (Spain)

Inria contact: David Daney, Jean-Pierre Merlet, Manuel Serrano

Abstract: our societies are affected by a dramatic demographic change, in the near future elderly and people requiring support in their daily life will increase and caregivers will not be enough to assist and support them. Socially interactive robots can help to confront this situation not only by physically assisting people but also functioning as a companion. The increasing sales figures of robots are pointing that we are in front of a trend break for robotics. To lower the cost for developers and to increase their interest on developing robotic applications, the RAPP introduces the idea of robots as platforms. RAPP (Robotic Applications for Delivering Smart User Empowering Applications) will provide a software platform in order to support the creation and delivery of robotics applications (RAPPs) targeted to people at risk of exclusion, especially older people. The open-source software platform will provide an API that contains the functionalities for implementing RAPPs and accessing the robot's sensors and actuators using higher level commands, by adding a middleware stack with added functionalities suitable for different kinds of robots. RAPP will expand the computational and storage capabilities of robots and enable machine learning operations, distributed data collection and processing, and knowledge sharing among robots in order to provide personalized applications based on adaptation to individuals. The use of a common API will assist developers in creating improved applications for different types of robots that target to people with different needs, capabilities and expectations, while at the same time respect their privacy and autonomy, thus the proposed RAPP Store will have a profound effect in the robotic application market. The results of RAPP will be evaluated through the development and benchmarking of social assistive RAPPs, which exploit the innovative features (RAPP API, RAPP Store, knowledge reuse, etc.) introduced by the proposed paradigm.

## 9.4. International Initiatives

### 9.4.1. Inria International Partners

#### 9.4.1.1. Informal International Partners

We have numerous international collaborations but we mention here only the one with activities that go beyond joint theoretical or experimental works:

- University of Bologna: 2 joint PhD student, publications
- University Innsbruck: joint conference organization
- Fraunhofer IPA, Stuttgart: joint conference organization
- Duisburg-Essen University: joint conference organization
- University of New-Brunswick: 1 joint PhD student
- University Laval, Québec: joint book
- University of Tokyo: joint conference organization
- Tianjin University, China: joint book

## 9.5. International Research Visitors

### 9.5.1. Visit of International Scientists

We have received our joint PhD student J. Pickard from University of New Brunswick, K. Hanahara from Kobe University while several other scientists from other domains have visited our robotics flat.

## **INDES Project-Team**

# **7. Partnerships and Cooperations**

## **7.1. National Initiatives**

### **7.1.1. ANR AJACS**

The AJACS project (Analyses of JavaScript Applications: Certification & Security) has been funded by the ANR for 42 months, starting December 2014. The goal of AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts. The Indes members are involved in the tasks WP2 Certified Analyses and WP3 Security of JavaScript Applications. The partners of this project include Inria teams Celtique (coordinator), Toccata, and Prosecco.

### **7.1.2. FUI UCF**

The 3 years long UCF project aims at developing a reactive Web platforms for delivering multimedia contents. The partners of the project are the startups Alterway, OCamlPro, and XWiki, and the academic research laboratories of University Pierre et Marie Curie and Denis Diderot.

## **7.2. European Initiatives**

### **7.2.1. FP7**

#### **7.2.1.1. MEALS**

Title: Mobility between Europe and Argentina applying Logics to Systems

Program: FP7

Instrument: International Research Staff Exchange Scheme

Duration: October 2011 - September 2015

Coordinator: Pedro D'Argenio

Partners:

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

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Dresden (Germany)

University of Leicester (United Kingdom)

Universitaet Desarlandes (Germany)

Universidad de Córdoba (Argentina)

Universidad de Buenos Aires (Argentina)

Inria contact: Castuscia Palamidessi

Abstract: The MEALS project (Mobility between Europe and Argentina applying Logics to Systems) goals cover three aspects of formal methods: specification (of both requirement properties and system behavior), verification, and synthesis. The Indes members are involved in the task of Security and Information Flow Properties (WP3). The partners in this task include University of Buenos Aires, University of Córdoba, Inria (together with Castuscia Palamidessi, Kostas Chatzikokolakis, Miguel Andrés) and University of Twente. The web page of the project can be found at <http://www.meals-project.eu>.

#### **7.2.1.2. RAPP**

Program: <http://rapp-project.eu>

Title: Robot App Store

Collaborator: Inria Coprin

Abstract: RAPP is a 36 months pan-european FP7 project, started in December 2013. Hop is used in the development of prototypes of the Coprin Ang rollator transfer device, for mobility assistance and activity monitoring.

### **7.2.2. Collaborations in European Programs, except FP7 & H2020**

**Program: ICT Cost Action IC1201**

Project acronym: BETTY

Project title: Behavioural Types for Reliable Large-Scale Software Systems

Duration: October 2012 - October 2016

Coordinator: Simon Gay, University of Glasgow

Other partners: Several research groups, belonging to 22 european countries

Abstract: The aim of BETTY is to investigate and promote behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreography.

**Program: ICT Cost Action IC1405**

Project title: Reversible computation - extending horizons of computing

Duration: November 2014 - November 2018

Coordinator: Irek Ulidowski, University of Leicester

Abstract: Reversible computation is an emerging paradigm that extends the standard forwards mode of computation with the ability to execute in reverse. It aims to deliver novel computing devices and software, and to enhance traditional systems. The potential benefits include the design of reversible logic gates and circuits - leading to low-power computing and innovative hardware for green ICT, new conceptual frameworks and language abstractions, and software tools for reliable and recovery-oriented distributed systems.

This Action is the first European network of excellence aimed at coordinating research on reversible computation.

## **7.3. International Research Visitors**

### **7.3.1. Visits of International Scientists**

#### *7.3.1.1. Internships*

Vineet Rajani

Date: December 2014 - March 2015

MPI (Germany)

Katyal Rohan

Date: June 2015 - Aug 2015

Institution: IIIT-D (India)

Francis Dolière Some

Date: July 2015 - Sept 2015

University of Ouagadougou (Burkina)

## LAGADIC Project-Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. *HandiViz project - SATT Ouest Valorisation*

**Participants:** François Pasteau, Marie Babel.

*duration: 12 months.*

This project started in June 2014. Thanks to a strong collaboration with Ergovie Company and the rehabilitation center Pôle Saint Hélier (Rennes), the semi-autonomous navigation solution designed for wheelchair systems (see Section 7.3.3 ) has been medically validated and tested by patients. The resulting technology is currently under transfer towards Ergovie (SATT/INSA funding). This technology, compliant with any off-the-shelf electrical wheelchair, is expected to be commercialized at mid 2016. We expect that this technology should be helpful for many handicapped people. In particular, intensive clinical trials have shown that such a system can lift the medical interdiction to drive wheelchairs for people who suffer from severe handicap such as hemispatial neglect or cerebral palsy.

### 9.1.2. *ARED NavRob*

**Participants:** Suman Raj Bista, Paolo Robuffo Giordano, François Chaumette.

*no Inria Rennes 8033, duration: 36 months.*

This project funded by the Brittany council started in October 2013. It supports in part Suman Raj Bista's Ph.D. about visual navigation (see Section 7.3.1 ).

### 9.1.3. *ARED DeSweep*

**Participants:** Lesley-Ann Dufлот, 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 Dufлот's Ph.D. about visual servoing based on shearlet transform. (see Section 7.6.5 ).

### 9.1.4. *ARED Locoflot*

**Participants:** Ide Flore Kenmogne Fokam, Vincent Drevelle, Eric Marchand.

*no Inria Rennes 9944, duration: 36 months.*

This project funded by the Brittany council started in October 2015. It supports in part Ide Flore Kenmogne Fokam's Ph.D. about cooperative localization in multi-robot fleets using interval analysis. (see Section 7.5.3 ).

### 9.1.5. *“Equipement mi-lourd Rennes Metropoles”*

**Participant:** Paolo Robuffo Giordano.

*no Irisa CNRS Rennes 14C0481, duration: 36 months.*

A grant from “Rennes Métropole” has been obtained in June 2014 and supports the activities related to the use of drones (quadrotor UAVs). The platform described in Section 6.12 has been purchased in part thanks to this grant.

## 9.2. National Initiatives

### 9.2.1. *ANR P2N Nanorobust*

**Participants:** Le Cui, Eric Marchand.

*no. URI 11FA310-06D, duration: 48 months.*

This project started in November 2011 and will end in March 2016. It is composed of a consortium managed by Femto-ST in Besançon with LPN and Isir in Paris, Thalès and Lagadic group through the “Université de Rennes 1”. Nanorobust deals with the development of micro- and nano-manipulation within SEM (Scanning Electron Microscope). We provided visual servoing techniques for positioning and manipulation tasks with a micrometer precision.

### 9.2.2. ANR Contint Visioland

**Participants:** Noël Mériaux, Patrick Rives, François Chaumette.

*no Inria Rennes 8304, duration: 48 months.*

This project started in November 2013. It is composed of a consortium managed by Onera in Toulouse with Airbus, Spikenet Technology, IRCCyN, and Lagadic. Its aim is to develop vision-based localization and navigation techniques for autonomous landing on a runway (see Section 7.1.4).

### 9.2.3. ANR Platinum

**Participants:** Patrick Rives, Vincent Drevelle.

*duration: 42 months.*

This project started in November 2015. It is composed of a consortium managed by Litis in Rouen with IGN Matis (Paris), Le2i (Le Creusot) and Lagadic group through Inria Sophia Antipolis. It aims at proposing novel solutions to robust long-term mapping of urban environments.

### 9.2.4. ANR SenseFly

**Participants:** Paolo Robuffo Giordano, Riccardo Spica, Thomas Bellavoir, Muhammad Usman.

*no IriSa CNRS 50476, duration: 36 months.*

The ANR “Jeune Chercheur” project SenseFly started in August 2015. Its goal is to advance the state-of-the-art in multi-UAV in the design and implementation of fully decentralized and sensor-based group behaviors by only resorting to onboard sensing (mainly cameras and IMU) and local communication (e.g., bluetooth communication, wireless networks). Topics such as individual flight control, formation control robust against sensor limitations (e.g., limited field of view, occlusions), distributed estimation of relative positions/bearings from local sensing, maintenance of architectural properties of a multi-UAV formation will be touched by the project. Part of the platforms described in Section 6.12 has been purchased thanks to this grant.

### 9.2.5. PEA Decsa

**Participants:** Aurélien Yol, François Chaumette, Eric Marchand.

*no Inria Rennes 6630, duration: 36 months.*

This project started in November 2011 and ended in November 2015. It was composed of a consortium managed by Astrium/Airbus with the Novadem, Sirehna, Spot Image and Magellium companies, and with the Inria Lagadic and Steep groups (Peter Sturm). It was devoted to the development of navigation and perception algorithms for small drones in urban environment.

### 9.2.6. Oseo Romeo 2

**Participants:** Nicolas Cazy, Suman Raj Bista, Fabien Spindler, François Chaumette.

*no Inria Rennes 7114, duration: 48 months.*

This project started in November 2012. It is composed of a large consortium managed by Aldebaran Robotics. It aims at developing advanced control and perception functionalities to a humanoid robot. It supports in part Suman Raj Bista’s Ph.D. about visual navigation (see Section 7.3.1), as well as Nicolas Cazy’s Ph.D. about model-based predictive control for visual servoing (see Section 7.2.3).

### 9.2.7. Equipex Robotex

**Participants:** Fabien Spindler, François Chaumette.

*no Inria Rennes 6388, duration: 10 years.*

Lagadic is one of the 15 French partners involved in the Equipex Robotex network. It is devoted to get significative equipments in the main robotics labs in France. In the scope of this project, we have got the humanoid robot Romeo (see Section 6.11 ).

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

#### 9.3.1.1. FP7 Space RemoveDEBRIS

**Participants:** Aurélien Yol, Eric Marchand, François Chaumette.

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2016

Coordinator: University of Surrey (United Kingdom)

Partners: Surrey Satellite Technology (United Kingdom), Astrium (Toulouse, France and Bremen, Germany), Isis (Delft, The Netherlands), CSEM (Neuchâtel, Switzerland), Stellenbosch University (South Africa).

Inria contact: François Chaumette

Abstract: The goal of this project is to validate model-based tracking algorithms on images acquired during an actual space debris removal mission. [38]

#### 9.3.1.2. Comanoid

**Participants:** Paolo Robuffo Giordano, François Chaumette.

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - January 2019

Coordinator: CNRS (Lirimm)

Partners: Airbus Groups (France), DLR (Germany), Università Degli Studi di Roma La Sapienza (Italy)

Inria contact: François Chaumette

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

### 9.3.1.3. Romans

**Participants:** Paolo Robuffo Giordano, Nicolo Pedemonte, Firas Abi Farraj, François Chaumette.

Title: Robotic Manipulation for Nuclear Sort and Segregation

Programm: H2020

Duration: May 2015 - May 2018

Coordinator: Univ. Birmingham (UK)

Partners: NLL (UK), CEA (France), Univ. Darmstat (Germany)

CNRS contact: Paolo Robuffo Giordano

The RoMaNS project aims at advancing the state of the art in autonomous, tele-operative and shared control for remote manipulation. This has far reaching cross-sector applications in nuclear, aerospace, oil and gas, space, food and agriculture. Within the nuclear industries of multiple EU states, it applies across the entire sector, such as waste processing, decommissioning, asset care, maintenance, repair, characterization and sampling. The novel technology that will be produced within this project will be applied to a very challenging and safety-critical nuclear “sort and segregate” industrial problem, which is driven by urgent market and societal needs. The purpose of nuclear sort and segregate is to place low-level waste in low-level storage containers, rather than occupying extremely expensive and resource intensive higher level storage containers and facilities. Also, Waste Requiring Additional Treatment (WRAT) will be either decontaminated, recycled, compacted, incinerated or grouted. Finally, any unstable waste items are sorted into a more suitable storage state. Indeed, it can be noted that cleaning up the past half century of nuclear waste, in the UK alone (mostly at the Sellafield site), represents one of the largest environmental remediation projects in Europe. Most EU countries have similar challenges. Many older EU nuclear sites (> 60 years in UK) contain large numbers of legacy storage containers, many of which have contents of mixed contamination levels, and sometimes unknown contents. Some of this waste have been temporarily stored in containers, which may need to be disrupted or cut open, to investigate their contents, before sorted and segregated. Any country that possesses a nuclear plant, even without a current backlog of legacy waste, will face similar challenges when they begin decommissioning. Vast quantities of highly contaminated plant machinery and infrastructure will have to be demolished, cut and resized, and the parts sorted and segregated. Much of this work can only be done by remote manipulation methods, because the high levels of radioactive material are hazardous to humans. In this respect, the RoMaNS project will address the following points: (i) development of novel hardware, and improvement the TRL level of existing experimental hardware, to enable robot arms and grippers with advanced capabilities, but which are suitable for deployment in high radiation environments; (ii) development of advanced autonomy methods for highly adaptive and generalizable automatic grasping and manipulation actions; (iii) development of hardware and software solutions for advanced bi-lateral tele-operation of arms and grippers; (iv) combination of autonomy and tele-operation methods using state-of-the-art understanding of mixed initiative planning, variable autonomy and shared control approaches; (v) delivery of a TRL 6 demonstration in an industrial plant-representative environment at the UK National Nuclear Lab Workington test facility, in close proximity to the Sellafield nuclear site.

## 9.4. International Initiatives

### 9.4.1. Inria Associate Teams not involved in an Inria International Labs

**Participants:** Marie Babel, Vishnu Karakkat Narayanan.

Sampen (Self Adaptive Mobile Perception and Navigation) is an Inria associated team with the Iceira Lab supervised by Prof Ren C. Luo at the National University of Taiwan. It has been accepted in 2014 for 2 years. The coordinator of the team for Inria is Anne Spalanzani from UPMF University at Grenoble. The other French participants are Marie Babel, Daney David (Phoenix group in Bordeaux) and Christian Laugier (e-Motion group in Grenoble).



The aim of the project is to propose a self-adaptive system of perception combined with a system of autonomous navigation. Usually, systems of perception rely on a set of specific sensors and a calibration is done in a specific environment. We propose to develop some methods to make perception systems adaptive to the environmental context and to the set of sensors used. This perception, that can be embedded on the mobile robot as well as on home structures (wall, ceiling, floor), will be helpful to localize agents (people, robot) present in the scene. Moreover, it will give information to better understand social scenes.

In the scope of this project, Marie Babel and Vishnu Karakkat Narayanan spent a one-week visit in Iceira Lab in April 2015. Vishnu Karakkat Narayanan was then invited to spend a three-month visit from August till November 2015 in that lab.

### **9.4.2. Inria International Partners**

#### *9.4.2.1. Informal International Partners*

- As a follow up to the long term collaboration with the “Centro de Tecnologia da Informação Renato Archer” (CTI) in Campinas (Brazil), Renato José Martins benefits a Ph.D. grant from the CNPq (2013-2017). He is co-directed by Patrick Rives and Samuel Siqueira Bueno from “Divisio de Robotica e Viseo Computacional” at CTI.
- Alexandre Krupa has a collaboration with Nassir Navab from the Technische Universität München concerning the joint supervision of Pierre Chatelain’s Ph.D.
- Patrick Rives has a collaboration with Javier Gonzales-Jimenez from the University of Malaga (Spain). Eduardo Fernandez-Moral who received his Ph.D. in Malaga by September 2014, is currently on a Postdoctoral position in Sophia Antipolis.

### **9.4.3. Participation In other International Programs**

The Lagadic group is one of the few external partners of the Australian Center for Robotic Vision [roboticvision.org](http://roboticvision.org). It groups QUT in Brisbane, ANU in Canberra, Monash University and Adelaide University. In the scope of this project, Riccardo Spica spent a six-month visit at ANU collaborating with Prof Rob Mahony, and François Chaumette spend a short visit at QUT and ANU in November 2015.

## **9.5. International Research Visitors**

### *9.5.1. Research stays abroad*

- Pierre Chatelain spent a nine-month visit in Nassir Navab’s lab at TUM, Germany, in the scope of his Ph.D. (see Section 9.4.2 ).
- Ricardo Spica spent a six-month visit in Rob Mahony’s lab at ANU, Canberra, in the scope of the Australian Center of Robotic Vision (see Section 9.4.3 ).
- Vishnu Karakkat Narayanan spent a three-month visit in Ren Luo’s lab at Iceira Lab, National Taiwan University, Taiwan, in the scope of his Ph.D as well as the SAMPEN associated team (see Section 9.4.1 ).

## LEMON Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

- **Cart'Eaux** project (funded by Languedoc Roussillon region): in partnership with colleagues of LIRMM and HSM (Montpellier) Carole DELENNE will develop a new method to gather various types of data in order to produce a regular and complete mapping of urban assainissement, in order to allow sharp and complete hydrodynamical modeling of urban pipes.
- The GeRIMU project (Gestion du Risque d'Inondation en Milieu Urbain) counts 3 partners: Cerec Ingénierie, HSM and Predict Services. In this project, the upscaled shallow water model with porosity SW2D developed at HSM is embedded in a software chain that will allow fast urban flood computations from forecasted precipitation fields. The project is funded under the Feder scheme. It has earned a distinction from the local Scientific Advisory Committee ("Coup de coeur du COSTI").

## 9.2. National Initiatives

### 9.2.1. ANR

Fabien MARCHE is member of the ANR project BonD (PI Sylvie Benzoni), 2013-2017

Fabien MARCHE is member of the ANR project ACHYLLES (PI Rodolphe Turpault), 2014-2017

Fabien CAMPILLO is member of the ANR project Siofadybio, 2015-2016

## 9.3. International Initiatives

### 9.3.1. Inria International Labs

#### 9.3.1.1. Nuwat / LIRIMA

With Moshen Chebbi (Phd student, ENIT, Tunis) we continue to explore the stochastic modeling for biotechnological problems. We proposed a framework that allows for both analysis and simulation of the models. This framework slightly generalized standard jump Markov processes on grids popularized by Tom Kurtz and co-workers. With Oussama Hadj-Abdelkader (Univ. Tlemcen) we continue to explore the nonlinear filtering techniques for the chemostat including unscented Kalman filtering and particle filtering.

#### 9.3.1.2. Inria Chile

Antoine ROUSSEAU visited Inria Chile in January, 2015 (2 weeks) in order to prepare a long stay in Chile in 2016.

### 9.3.2. Inria International Partners

#### 9.3.2.1. Declared Inria International Partners

In 2015, the *Marine Energies Research International Center* (MERIC) was launched in Chile by CORFO. Antoine ROUSSEAU will be the scientific coordinator for Inria, and several members of LEMON, CARDAMOM and TOSCA research teams will be involved in this 8 years project driven by DCNS. Antoine ROUSSEAU and Fabien MARCHE are involved in the research line *resource assessment & site characterization*.

#### 9.3.2.2. Informal International Partners

Vincent GUINOT collaborates with B.F. Sanders (Irvine University, Californie, USA)

Vincent GUINOT collaborates with S. Soares-Fraza (Unité de Génie Civil, Université catholique de Louvain, Belgium)

Antoine ROUSSEAU and Fabien MARCHE collaborate with Rodrigo Cienfuegos and Cristián Escauriaza (CIGIDEN and PUC Chile, Santiago)

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

Carine Lucas (Université of Orléans, France) spent several months in LEMON to collaborate with Antoine ROUSSEAU on nontraditional models in oceanography.

## MAESTRO Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. ANR Marmote

**Participants:** Alain Jean-Marie, Issam Rabhi.

ANR Program: Modèles Numériques (MN) 2012, number ANR-12-MONU-0019

Project title: MARKovian MOdeling Tools and Environments

Duration: January 2013 - June 2017

Coordinator: Alain Jean Marie (Inria)

Partners: Inria (project-teams DYOGENE, MAESTRO and MESCAL), Univ. Versailles-Saint-Quentin (DAVID lab.), Telecom SudParis (SAMOVAR lab.), Univ. Paris-Est Créteil (LACL), and Univ. Pierre-et-Marie-Curie (LIP6)

Abstract: ANRMARMOTE aims, among other goals, at realizing the prototype of a software environment dedicated to modeling with Markov chains. It brings together seven partner teams, expert in Markovian analysis, who will develop advanced solution algorithms and applications in different scientific domains: reliability, distributed systems, biology, physics and economics.

<https://wiki.inria.fr/MARMOTE/Welcome>

## 9.2. European Initiatives

### 9.2.1. FP7 & H2020 Projects

#### 9.2.1.1. CONGAS

**Participants:** Eitan Altman, Konstantin Avrachenkov, Yonathan Portilla, Alexandre Reiffers-Masson.

Title: Dynamics and COevolution in Multi-Level Strategic INteraction GAMEs

Programm: FP7

Duration: October 2012 - September 2015

Coordinator: Create-Net

Partners:

iNSPIRE, Create-Net (center for Research and Telecommunication Experimentation for Networked Communities) (Italy)

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

Electrical Engineering, Technion Israel Institute of Technology

Telecommunications Department, Technische Univ. Delft (Netherlands)

Computer Science Laboratory, Univ. d'Avignon et des Pays de Vaucluse (France)

Department of Information Engineering, Univ. di Pisa (Italy)

Inria contact: Konstantin Avrachenkov

Many real world systems possess a rich multi-level structure and exhibit complex dynamics that are the result of a web of interwoven interactions among elements with autonomous decision-making capabilities. CONGAS will develop new mathematical models and tools, rooted in game theory, for the analysis, prediction and control of dynamical processes in such complex systems. It will provide a coherent theoretical framework for understanding the emergence of structure and patterns in such systems, accounting for interactions spanning various scales in time and space, and acting at different structural and aggregation levels. This framework will be built around game theoretical concepts, in particular evolutionary and multi-resolution games, and will include also techniques drawn from graph theory, statistical mechanics, control and optimization theory. Specific attention will be devoted to systems that are prone to intermittency and catastrophic events due to the effect of collective dynamics. The theory developed in the project will be validated by considering three use cases, one on the growth of the Internet, one on business ecosystems and one on viral marketing dynamics in Internet marketplaces. The CONGAS Consortium comprises seven universities and research institution and includes leading scientists in game theory, evolutionary games, complex systems science, network science and data-driven analysis of socio-technical systems.

MAESTRO's task is to develop game theoretic models to model (a) the formation of technological and social network; (b) the routing for competing agents; and (c) the competition of information in social networks.

<http://www.congas-project.eu/>

### 9.2.2. Collaborations in European Programs, except FP7 & H2020

**Participants:** Konstantin Avrachenkov, Abdulhalim Dandoush.

Program: EU COST

Project acronym: ACROSS

Project title: Autonomous Control for a Reliable Internet of Services

Duration: November 2013 - November 2017

Coordinator: Rob Van Der Mei (CWI) and J.L. Van Den Berg (TNO), The Netherlands

Other partners: see <http://www.cost-across.nl/>

Abstract: Currently, we are witnessing a paradigm shift from the traditional information-oriented Internet into an Internet of Services (IoS). This transition opens up virtually unbounded possibilities for creating and deploying new services. Eventually, the ICT landscape will migrate into a global system where new services are essentially large-scale service chains, combining and integrating the functionality of (possibly huge) numbers of other services offered by third parties, including cloud services. At the same time, as our modern society is becoming more and more dependent on ICT, these developments raise the need for effective means to ensure quality and reliability of the services running in such a complex environment. Motivated by this, the aim of this Action is to create a European network of experts, from both academia and industry, aiming at the development of autonomous control methods and algorithms for a reliable and quality-aware IoS.

## 9.3. International Initiatives

### 9.3.1. Inria Associate Teams not involved in an Inria International Labs

#### 9.3.1.1. THANES

**Participants:** Eitan Altman, Konstantin Avrachenkov, Jithin Kazhuthuvelil Sreedharan, Philippe Nain, Giovanni Neglia, Alexandre Reiffers-Masson.

Title: THEory and Application of NETwork Science

International Partners (Institution - Laboratory - Researcher):

Purdue Univ. (USA) - Department of Computer Science - Bruno Ribeiro

UFRJ (Brazil) - Department of Computer and Systems Engineering - Edmundo de Souza e Silva, Daniel Ratton Figueiredo, Daniel Sadoc

Duration: 2014 – 2017

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

Our goal is to study how services in Online Social Networks (OSN) can be efficiently designed and managed. This research requires to answer 3 main questions: 1) How can the topology of an OSN be discovered? Many services need or can take advantage of some knowledge of the network structure that is usually not globally available and in any case changes continuously due to structural dynamics. 2) How does services' adoption spread across the OSN? On the one hand the popularity of a service is determined by word-of-mouth through the links of the OSN and, on the other end, the service may contribute to reshape the structure of the OSN (e.g. by creating new connections). 3) How do different services compete for the finite attention and money of OSN users? In particular our purpose is to provide analytical models (corroborated by simulations and experiments on real networks) to understand such complex interactions.

### 9.3.2. Inria International Partners

#### 9.3.2.1. Informal International Partners

MAESTRO has continued collaborations with researchers from GERAD, Univ. Montreal (Canada), Flinders Univ. (Australia), National Univ. of Rosario (Argentina), Technion - Israel Institute of Technology (Israel), Univ. of Arizona (USA), Univ. of Illinois at Urbana-Champaign (USA), Univ. of Liverpool (UK), Univ. of Massachusetts at Amherst (USA), Univ. of Florence (Italy), Univ. of Palermo (Italy), Univ. of Twente (The Netherlands) and Petrozavodsk State Univ. (Russia); Ghent Univ. (Belgium); see Sections 9.4.1.1 and 9.4.2 .

### 9.3.3. Participation In other International Programs

MAESTRO has continued collaborations with researchers from IIT Mumbai and IISc Bangalore. In 2015, these collaborations were partly supported by IFCAM and Cefipra.

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

#### 9.4.1.1. Professors / Researchers

Giuseppe Bianchi

Date: 9-10 December 2015

Institution: Univ. of Roma (Italy)

Vivek Borkar

Date: 10-18 October 2015

Institution: IIT Mumbai (India)

Jerzy Filar

Date: 6-10 July 2015

Institution: Flinders Univ. (Australia)

Vaishnav Janardhan

Date: 4 March 2015

Institution: Akamai Technologies (USA)

Moshe Haviv

Date: 28 September - 8 October 2015

Institution: Univ. of Jerusalem (Israel)

Jie Li

Date: 13 January - 15 April 2015

Institution: Univ. of Tsukuba (Japan)

Vladimir Mazalov

Date: 14-28 February and 18-24 November 2015

Institution: Russian Academy Of Sciences (Russia)

Leon Petrosjan

Date: 29 July 2015

Institution: St Petersburg Univ. (Russia)

Bruno Ribeiro

Date: 8-26 June 2015

Institution: Carnegie Mellon Univ. (USA)

Matteo Sereno

Date: October 2015 - March 2016

Institution: Univ. of Torino (Italy)

#### *9.4.1.2. Post-doc / Ph.D. students*

Tejas Bodas

Date: 15-30 March and 12 October - 11 December 2015

Institution: IIT Mumbai (India)

Rajib Ranjan Maiti

Date: 9-12 March 2015

Institution: CNR Pisa (Italy)

#### *9.4.1.3. Internships*

Andrea Cantore

Date: 1 March - 31 August 2015

Institution: Univ. Nice Sophia-Antipolis (France)

Supervisor: Giovanni Neglia

Amal Chaker

Date: 1 March - 31 August 2015

Institution: Univ. Nice Sophia-Antipolis (France)

Supervisor: Giovanni Neglia

Ashish Chandra

Date: 21 May - 20 July 2015

Institution: IIT Mumbai (India)

Supervisor: Konstantin Avrachenkov

Baptiste Goujaud

Date: 1 June - 31 August

Institution: ENS Cachan (France)

Supervisor: Eitan Altman

Mikhail Grigorev

Date: 15 September - 31 October 2015

Institution: MIPT (Russia)

Supervisor: Alain Jean-Marie

Lenar Iskhakov

Date: 15 September - 31 October 2015

Institution: MIPT (Russia)

Supervisor: Konstantin Avrachenkov

Wafa Khlif

Date: 1 March - 31 August 2015

Institution: Univ. Nice Sophia-Antipolis (France)

Supervisor: Sara Alouf

Maksim Mironov

Date: 15 September - 31 October 2015

Institution: MIPT (Russia)

Supervisor: Konstantin Avrachenkov

Dimitra Politaki

Date: 1 March - 31 August 2015

Institution: Univ. Nice Sophia-Antipolis (France)

Supervisor: Sara Alouf

Dimitra Tsigkari

Date: 15 October 2015 - 31 July 2016

Institution: Univ. of Thessaloniki (Greece)

Supervisor: Giovanni Neglia

Alina Tuholukova

Date: 1 March - 31 August 2015

Institution: Univ. Nice Sophia-Antipolis (France)

Supervisor: Konstantin Avrachenkov, Giovanni Neglia

## **9.4.2. Visits to International Teams**

### *9.4.2.1. Sabbatical programme*

Philippe Nain

Date: 1 March 2015 - 29 February 2016

Institution: MIT, Laboratory for Information & Decision Systems - LIDS (USA)

Activities: Besides conducting research with colleagues at MIT, Univ. of Massachusetts in Amherst, MA, and Raytheon BBN Technologies in Cambridge, MA, P. Nain has been asked by Inria to launch new scientific collaborations between Inria and universities of the East Coast and to strengthen existing ones. He attended the Inria-Industry Meeting (San Francisco, May 11, 2015) and the fifth BIS (Berkeley-Inria-Stanford) workshop (Berkeley May 12-14, 2015).

### *9.4.2.2. Research stays abroad*

Eitan Altman

Date: 16-20 February, 21-31 October, 21-28 December 2015

Institution: Technion (Israel)

Date: 27 April - 8 May 2015

Institution: New York Univ. - Tandon School of Engineering (USA)

Date: 20-30 May 2015

Institution: IISc Bangalore and IIT Mumbai (India)

Konstantin Avrachenkov

Date: 2-10 March 2015

Institution: IIT Mumbai (India)

Date: 11-19 May 2015

Institution: Yandex Research (Russia)

Ilaria Brunetti

Date: 5 January - 15 April 2015

Institution: Macquaire Univ. (Australia)

Alain Jean-Marie

Date: 3-25 October 2015

Institution: Univ. of Montreal (Canada)

Date: 7-18 December 2015

Institution: Univ. of Rosario (Argentina)

Jithin Kazhuthuveetil Sreedharan

Date: 1-14 August 2015

Institution: Univ. Federal do Rio de Janeiro (Brazil)

Arun Kadavankandy

Date: 25-29 May 2015

Institution: IIT Mumbai (India)

Philippe Nain

Date: 10-15 May 2015

Institution: Univ. of California, Berkeley (USA)

Date: June 4-6, 14-20, July 13-17, September 20-26, November 15-21, December 6-11 2015

Institution: Univ. of Massachusetts at Amherst (USA)

Giovanni Neglia

Date: 19 and 26 January; 2, 9 and 23 February; 2 and 9 March; 4-7 and 29 May; 13-17 July; 11-14 and 21 September; 22-23 October; 12-17 November 2015

Institution: Univ. of Florence (Italy)

Date: August 1-19 2015

Institution: Univ. Federal do Rio de Janeiro (Brazil)

Alexandre Reiffers-Masson

Date: 1-15 August 2015

Institution: New York Univ. - Tandon School of Engineering (USA)



## MARELLE Project-Team

## 8. Partnerships and Cooperations

### 8.1. National Initiatives

#### 8.1.1. ANR

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

- BRUTUS "Chiffrements authentifiés et résistants aux attaques par canaux auxiliaires", started on October 1st, 2014, for 60 months, with a grant of 41 kEuros for Marelle. Other partners are Université de Rennes 1, CNRS, secrétariat Général de la défense et de la sécurité nationale, and Université des Sciences et Technologies de Lille 1. The corresponding researcher for this contract is Benjamin Grégoire.
- FastRelax, "Fast and Reliable Approximations", started on October 1st, 2014, for 60 months, with a grant of 75 kEuros for Marelle. Other partners are Inria Grenoble (ARIC project-team), LAAS-CNRS (Toulouse), Inria Saclay (Toccata and Specfun project-teams), and LIP6-CNRS (Paris). The corresponding researcher for this contract is Laurence Rideau.

### 8.2. European Initiatives

#### 8.2.1. Collaborations in European Programs, except FP7 & H2020

Program: COST

Project acronym: CA15123EUTYPES

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

Duration: 30 October 2015– 29 October 2019

Coordinator: Herman Geuvers (Radboud University, Nijmegen)

Other partners: List too long to repeat here.

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

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

Europe has a strong type theory community, ranging from foundational research to applications in programming languages, verification and theorem proving, which is in urgent need of better networking. A COST Action that crosses the borders will support the collaboration between groups and complementary expertise, and mobilise a critical mass of existing type theory research.

### 8.3. International Initiatives

#### 8.3.1. Inria International Partners

##### 8.3.1.1. Informal International Partners

We have important collaborations with the team of Thierry Coquand at Chalmers and University of Göteborg.

We are setting up a collaboration with the team of Adam Chlipala at the Massachusetts Institute of Technology.

## **8.4. International Research Visitors**

### **8.4.1. Visits of International Scientists**

Isabela Dramnesc, from the University of Timișoara in Romania, visited our team in June and July to study proving techniques in the Coq context.

Tsvetan Dunchev, from the University of Bologna, visited our team in July to work on ELPI, the  $\lambda$ -prolog interpreter.

### **8.4.2. Visits to International Teams**

Yves Bertot organised a meeting with representants of University of Pennsylvania, Princeton University, Yale University, Harvard University, and the Massachusetts Institute of Technology in Boston in April. Janet Bertot, Philippe Nain, and Matthieu Sozeau from Inria also attended this meeting. The agenda of the meeting was preliminary discussions for the creation of a consortium around the Coq software system.

Enrico Tassi visited the team of Jesper Bengtson at the IT University in Copenhagen for a week at the end of September.

Cyril Cohen visited Chalmers university in February and October to work on cubical type theory.

Cyril Cohen was invited by AIST in Japan for a one-week stay in Tsukuba in November to work on formalization problems for robotics.

## **MCTAO Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

- The “région” *Provence Alpes Côte d’Azur* (PACA) partially supports Helen Heninger’s PhD . The other part comes from Thales Alenia space, see section 7.1 .
- The “région” *Provence Alpes Côte d’Azur* (PACA) partially supports Jérémy Rouot’s PhD.

## **8.2. National Initiatives**

### **8.2.1. ANR**

**Weak KAM beyond Hamilton-Jacobi (WKBHJ)**. Started march, 2013, duration: 4 years. Ludovic Rifford is in the scientific comitee.

**Géométrie et transport optimal de mesure (GMT)**. Ludovic Rifford is a member.

### **8.2.2. Others**

Bernard Bonnard and Ludovic Rifford participate in the GDR MOA, a CNRS network on Mathematics of Optimization and Applications. <http://gdrmoa.univ-perp.fr/>.

Jean-Baptiste Caillau is in the board of governors of the group SMAI-MODE (<http://smai.emath.fr/spip.php?article338>).

Jean-Baptiste Caillau is a member of the Centre de Compétences Techniques (CCT) Mécanique orbitale du CNES

Jean-Baptiste Caillau is the corresponding member in Dijon for the Labex AMIES (<http://www.agence-maths-entreprises.fr/>).

## **8.3. European Initiatives**

### **8.3.1. ANR/DFG franco-german project**

**Exploring the physical limits of spin systems: A challenge in medical imaging (Explosys)**. Started October, 2014, duration: 4 years.

Bernard Bonnard is a member of this project. The coordinators are Dominique Sugny (Dijon) and Stefen Glaser (Munich). The budget is approximately 500 K€.

## **8.4. International Research Visitors**

### **8.4.1. Visits of International Scientists**

Velimir Jurdjevic (University of Toronto), 1 month, September-October, 2015.

### **8.4.2. Visits to International Teams**

Ludovic Rifford stayed at Center for Mathematical Modeling, Universidad de Chile, Santiago (Chili), 6 months in March-August, 2015.

## MODEMIC Project-Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

#### 8.1.1. Labex Numev

Within the Labex Numev (Solutions Numériques, Matérielles et Modélisation pour L'Environnement et le Vivant<sup>0</sup>), the team has obtained several funding for internships and invitation of international visitors, for the coming year:

- six months of MsC internships on optimal control for bioprocesses (jointly with the LBE unit, Inra Narbonne),
- the venue of Prof. Chris Klausmeir from Michigan State Univ. about micro-algae modeling (jointly with the UMR EcoSols, Montpellier).

#### 8.1.2. Inter-teams seminar

J. Harmand is the coordinator of the inter-teams seminar about the modeling of bioprocesses<sup>0</sup>, involving the labs INRA-LBE (Narbonne), UMR LISPB (Toulouse) and the two Inria project teams BIOCORE and MODEMIC.

C. Lobry has been invited to participate to the “Séminaire au vert” of BIOCORE team in November 2015.

### 8.2. National Initiatives

#### 8.2.1. ANR Soil $\mu$ 3D

The team is partner of the ANR project SoilMicro-3D: *Emergent properties of soil microbial functions: Upscaling from 3D modeling and spatial descriptors of pore scale heterogeneity*, conducted by the UMR EGC for 4 years (2015-19). The other partners are UMR iEES, UMI UMMISCO, SIMBIOS (Scotland), UMR Géosciences Rennes, UMR JJL and UR Inra Science du Sol Orléans). The main goal of the project are

- develop new descriptors of the pore scale 3D soil heterogeneity that explain the fluxes measured at the core scale,
- improve the performance of 3D pore scale models to simulate processes from pores to cores with a reduction of the computational time,
- develop new simple models describing the soil micro-heterogeneity and integrating these micro-features into field-scale models.

The kick-off meeting is held in Jan 2016.

#### 8.2.2. PGM0 “OPTIBIO”

*OPTIBIO* (New challenges in the optimal control of bioprocesses<sup>0</sup>) is a new project funded by the french Foundation FMJH (Fondation Mathématique Jacques Hadamard) in 2014 for three years, within the program PGM0 (Gaspard Monge Program for Optimization and operations research).

The project is coordinated by T. Bayen (ACSIOM, Univ. Montpellier II) and the other partners are: MODEMIC, Univ. Limoges, EPI COMMANDS (Saclay) and EPI BIOCORE (Sophia Antipolis).

<sup>0</sup><http://www.lirmm.fr/numev>

<sup>0</sup><https://sites.google.com/site/journeesthematiquesdulbe/>

<sup>0</sup><http://www.math.univ-montp2.fr/~bayen/articles/posterPGMO.pdf>

The overall objective of this project is to address the optimization of bioprocesses over an *infinite horizon*. Infinite horizon optimal control is well suited for every problem where the time horizon is uncertain and can be expected to be large: e.g. economics models related to optimal growth and sustainable development, biological models such as the optimal control of interacting species and pest control, stabilization of controlled mechanical systems...The recent expectations of sustainable development raise new optimization problems that take into account auxiliary outputs, such as bio-gas production, that were neglected in the past. It appears that mathematical problems that come from the modeling of these processes are often difficult to solve, and one objective of the proposal is to develop new mathematical methods in order to address these issues. More precisely, the objective of the project is to study the following issues:

- Optimization of bioprocess over an infinite horizon.
- Development of accurate methods in order to deal with uncertainties that affects the chemostat model (uncertainties come from unknown parameters or noise from the measurements).
- Stabilization of the chemostat model including delay in the system.

### 8.2.3. INRA-MIA methodological networks

The team is involved in two new networks of the MIA (Applied Mathematics and Informatics) Department of INRA:

- MEDIA<sup>0</sup> (Modèles d'Équations Différentielles et Autres systèmes dynamiques pour l'écologie),
- REM<sup>0</sup> (RÉduction de Modèles),

that have been launched last year.

## 8.3. International Initiatives

### 8.3.1. Inria International Labs

#### Inria Chile

Associate Team involved in the International Lab:

#### 8.3.1.1. DYMECOS2

Title: Modeling of microbial ecosystems, bioprocesses control and numerical simulations

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Center for Mathematical Modeling (CMM) - Hector Ramirez

Start year: 2014

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

The objective is to develop, from expert knowledge and experimental observations, models of microbial ecosystems that are simple enough to carry out the determination of explicit "control laws", and realistic enough to represent real bio-processes. One of the difficulties is to identify the limits of the validity of these models, in terms of spatial heterogeneity and microbial population size. We aim also to obtain outcomes of the modeling for the optimal design of waste-water treatment plants.

### 8.3.2. Inria International Partners

#### 8.3.2.1. Informal International Partners

CESAME, Univ. Louvain, Belgium : D. Dochain

3BIO, Univ. Mons, Belgium : A. Vande Wouwer

Univ. Neuchâtel, Switzerland : M. Benaim

Univ. Newcastle, U.K. : M. Wade

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<sup>0</sup><http://www.netvibes.com/reseaumiamedia>

<sup>0</sup><https://sites.google.com/site/researeum2/>

MOMAT, Univ. Madrid, Spain : B. Ivorra

Univ. Sevilla, Spain : T. Caraballo

### **8.3.3. Participation In other International Programs**

#### **8.3.3.1. CIB (Centre Interfacultaire Bernoulli)**

Program: Bernoulli workshops

Title: The role of mathematics and computer science in ecological theory

Inria principal investigator: MODEMIC (C. Lobry),

Partners: EPFL, Lausanne (Switzerland).

Duration: July 2014 to Feb 2015

Abstract: A former collaboration of Inria with ecologists (the COREV network presently animated by R. Arditi) initiated (at the beginning of the 90s) by J-L. Gouzé and C. Lobry within the framework of the Inria project team COMORE, pursued then by MERE and COMORE raised an important event: the half-year *Mathematics and computer sciences in theoretical ecology* which we co-organize with R. Arditi (associated with D. de Angelis and L. Ginzburg) at the Federal Polytechnical School of Lausanne (Centre Interfacultaire Bernoulli).

The program lasted from July 1 to December 31, 2014 (see the 2014 activity report), but a follow-up workshop has been organized in February 2015 on the Persistence of population models in temporally fluctuating environments. This workshop has led to the writing of a review paper [31] in common.

Web-site: <http://mathcompecol.epfl.ch/>

#### **8.3.3.2. TREASURE**

Program: **Euromediterranean 3+3**

Title: Treatment and Sustainable Reuse of Effluents in semiarid climates

Inria principal investigator: MODEMIC (J. Harmand),

Partners: Centre de Biotechnology de Sfax, Department of environmental engineering (Tunisia), Ecole Nationale des Ingénieurs de Tunis, Dept. de Mathématiques (Tunisia), Institut National de la Recherche Agronomique, Dept. EA, MICA et MIA (France), National Research Center, Water Pollution Control (Egypt), University of Patras, Process Control Laboratory (Greece), University of Tlemcen, Automatic control (Algeria), University of santiago de compostella, Environmental engineering (Spain) Université Cadi Ayyad de Marrakech, Faculté des Sciences de Semlalia, Dépt. de Mathématiques (Morocco), Centre National de Recherche sur l'Eau et l'Energie, Université Française d'Egypte (Egypt)

Duration: Jan 2012 - Dec 2015

Abstract: The TREASURE network aims at integrating knowledge on the modeling, the control and the optimization of biological systems for the treatment and reuse of waste-waters in countries submitted to semi-arid climates under both socio-economical and agronomic constraints within the actual context of global changes. A special focus of the actual project concerns the integration of technical skills together with socio-economical and agronomic studies for the integrated solutions developed within the network to be evaluated and tested in practice in the partner's countries and, as possible as it may be within the context of the actual research network, valorizing these proposed technologies with the help of industrial on site in partners from South.

Web-site: <https://project.inria.fr/treasure>

#### **8.3.3.3. TASSILI**

Program: Hubert Curien Program

Title: Procédés membranaires pour le traitement anaérobie des eaux usées - Modélisation, commande et optimisation

Inria principal investigator: MODEMIC (J. Harmand),

Partners: LBE-INRA (Narbonne), Univ. Tlemcen (Algeria)

Duration: 3 years since 2014

Abstract: This project aims at promoting collaborations with our historical Algerian partners of the department of automatic control of the University of Tlemcen. The objectives of the project are to develop research on the modeling and the control of anaerobic systems through the co-advising of Zeyneb Khedim (PhD 'co-tutelle' between UM2 and Univ. Tlemcen).

#### 8.3.3.4. *MOSTICAW*

Program: STIC AmSud

Title: MOdeling the Spread and (opTIimal) Control of Arboviroses by Wolbachia

Inria principal investigator: P.A. Bliman (Inria Rocquencourt and Fundação Vargas, Rio de Janeiro, Brazil)

Partners: Inria (Rocquencourt and Metz), UPMC, CIRAD, MISTEA, Fundação Vargas (Brazil), Univ. Fed. Fluminense (Brazil), Fiocruz (Brazil), Univ. Buenos Aires (Argentina), UTFSM (Chile), Univ. de Chile, Univ. de Quindio (Colombia), Univ. Aut. de Occidente (Colombia), Nat. Univ. Nac. Mayor de San Marcos (Peru), Univ. of Asuncion (Paraguay).

Duration: 2016-2017

Abstract: The present project is concerned with new method of control of dengue fever, and potentially other severe diseases transmitted by mosquitoes *Aedes* (chikungunya, yellow fever). The goal of the project is to elaborate and analyze related models, along with control strategies, with the aim of testing concepts and estimating feasibility. The team is mainly involved in the modeling of interactions of bacteria *Wolbachia* with mosquitoes, and control systems tools (observers and optimal control).

## 8.4. International Research Visitors

### 8.4.1. *Visits of International Scientists*

Matthieu Sebbah

Subject: Optimal control for lagoon management

Date: from June 2015 until Sept 2105

Institution: Univ. Tecnico Federico Santa Maria, Valparaiso, Chile.

#### 8.4.1.1. *Internships*

Maria Crespo (PhD)

Subject: Consideration of inhomogeneity in activated sludge bioreactors for the bioremediation of water resources

Date: Feb 2015

Institution: Univ. Complutense, Madrid (Spain)

Pascale Cuevas (MsC)

Subject: Numerical simulation of the heterogeneity in transport diffusion with nutrients

Date: from Sep 2015 until Nov 2015

Institution: Univ. Santiago (Chile)

Yessmine Daoud (PhD)

Subject: Mathematical analysis of anaerobic digestion models

Date: from Mar 2015 until Jul 2015

Institution: LAMSIN, Tunis (Tunisia)

Alejandro Rojas-Palma (PhD)

Subject: Study of some problems related to modeling and optimization of bioprocesses

Date: from May 2015 until Oct 2015

Institution: Univ. of Chile

Victor Riquelme (PhD)

Subject: Optimal control for the preservation of exploited water resources

Date: from April 2015 until Nov 2015

Institution: Univ. of Chile

Camila Romero (MsC)

Subject: Minimal time crisis problem for Lotka-Volterra prey-predator model.

Date: from Jan 2015 until Mar 2015

Institution: Univ. of Chile

### **8.4.2. Visits to International Teams**

#### *8.4.2.1. Research stays abroad*

B. Cloez has spent one month in Switzerland at Univ. Neuchâtel and at CIB-EPFL, Lausanne.



## MORPHEME Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. *Renal tumor classification*

**Participants:** Alexis Zubiolo, Eric Debreuve, Xavier Descombes.

Informal collaboration with the team TIRO, CEA/UNS (Philippe Pognonec), and the histopathology department of the CHU Pasteur (Damien Ambrosetti), Nice.

## 8.2. National Initiatives

### 8.2.1. *LABEX SIGNALIFE*

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

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

Florence Besse and Grégoire Malandain participated in the selection committee for LabEx PhD programme students.

### 8.2.2. *ANR MOTIMO*

**Participants:** Laure Blanc-Féraud, Xavier Descombes, Eric Debreuve, Huei Fang Yang, Ana Rita Lopes Simoes.

In collaboration with Institut de Mathématiques de Toulouse, INRA, Institut de Mécanique des Fluides de Toulouse, Laboratoire J-A Dieudonné, et IMV Technologies (PME). Details on the ([website](#))

### 8.2.3. *ANR POXADRONO*

**Participants:** Florence Besse [PI], Xavier Descombes, Laure Blanc-Féraud.

The young researcher ANR project POXADRONO is in collaboration with Caroline Medioni, Hélène Bruckert, Giovanni Marchetti, Charlène Perrois and Lucile Palin from iBV. It aims at studying ARN regulation in the control of growth and axonal guidance by using a combination of live-imaging, quantitative analysis of images, bio-informatic analysis and genetic screening.

### 8.2.4. *ANR DIG-EM*

**Participants:** Grégoire Malandain, Xavier Descombes.

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

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

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

### 8.2.5. ANR PhaseQuant

**Participants:** Grégoire Malandain, Eric Debreuve.

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

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

### 8.2.6. Inria Large-scale initiative Morphogenetics

**Participants:** Grégoire Malandain, Xavier Descombes, Gaël Michelin.

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

### 8.2.7. Octopus Project

**Participant:** Eric Debreuve.

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

## 8.3. International Initiatives

### 8.3.1. Participation In other International Programs

ECOS-NORD PROJECT C15M01. In 2015 was the beginning of the execution of this project. The main work on this year was concentrated to understand clearly the DIC system located at UIS, its image formation model and phase recovery by simulations (joint paper accepted at ISBI 2016), and to acquire real data from it to be able to validate the simulated models.

Xavier Descombes was PI of a collaboration with the IITP in Moscow within a CNRS/RAS Grant (EDC26091) on the subject "Statistical Analysis of Images: mathematical modeling and applications".

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

Elena Zhizhina, Evgueny Pechersky and Serguei Komech from IITP Moscow (Russian Academy of Science) were invited one week respectively in october and in november.

Arturo Plata-Gomez, professor at the University Industrial of Santander (UIS) in Bucaramanga (Colombia) has visiting Morpheme from April 6 to April 24.

Simone Rebegoldi, Ph.D. student of the Department of Mathematics and Computer Science in University of Ferrara (Italy) spent 3 months in Morpheme group from may 1st to July 31.

### 8.4.2. Visits to International Teams

Laure Blanc-Feraud visited Universidad Industrial de Santander (UIS) in Colombia from December 3-11.

#### 8.4.2.1. Research stays abroad

Laure en Colombie

## 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](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-Universität Heidelberg (Germany), Universität Regensburg (Germany), Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung E.V (Germany), Eurotech Spa (Italy), Consorzio Interuniversitario Cineca (Italy), Barcelona Supercomputing Center - Centro Nacional de Supercomputación (Spain), Xyratex Technology Limited (United Kingdom), Katholieke Universiteit Leuven (Belgium), Stichting Astronomisch Onderzoek in Nederland (The Netherlands) and Inria (France).

Inria contact: Stéphane Lanteri

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

#### 7.2.1.2. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partner: Barcelona Supercomputing Center (Spain), Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas - CIEMAT (Spain), REPSOL SA (Spain), Iberdrola Renovables Energía SA (Spain), Lancaster University (United Kingdom), COPPE/UF RJ - Universidade Federal do Rio de Janeiro (Brazil), LNCC (Brazil), INF/UFGRS - Universidade Federal do Rio Grande do Sul (Brazil), CER/UFPE - Universidade Federal de Pernambuco (Brazil), PETROBRAS (Brazil), TOTAL SA (France), and Inria (France).

Inria contact: Stéphane Lanteri

Abstract: This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e.

biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO<sub>2</sub> emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

## 7.3. International Initiatives

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

#### 7.3.1.1. HOMAR

Title: High performance Multiscale Algorithms for wave pRopagation problems

International Partner (Institution - Laboratory - Researcher):

Laboratório Nacional de Computação Científica (Brazil) - Coordenação de Matemática Aplicada e Computaciona - Frédéric Valentin

Start year: 2015

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

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

### 7.3.2. Inria International Partners

#### 7.3.2.1. Informal International Partners

Prof. Liang Li, School of Mathematical Sciences, University of Electronic Science and Technology of China, Chengdu.

Dr. Maciej Klemm, University of Bristol, Communication Systems & Networks Laboratory, Centre for Communications Research, United Kingdom

Prof. Hugo Enrique Hernandez Figueroa, Universidade Estadual de Campinas, Faculdade de Engenharia Elétrica e de Computação, São Paulo, and Prof. Carlos Henrique da Silva Santos, Instituto Federal de Educação, Ciência e Tecnologia de São Paulo, Brazil

Dr. Urs Aeberhard and Dr. Markus Ermes, Theory and Multiscale Simulation, IEK-5 Photovoltaik, Forschungszentrum Jülich, Germany

### 7.3.3. Participation In other International Programs

#### 7.3.3.1. CNPq-Inria HOSCAR project

**Participants:** Reza Akbarinia [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Rossana Andrade [CSD/UFC], Hélène Barucq [MAGIQUE-3D project-team, Inria Bordeaux - Sud-Ouest], Alvaro Coutinho [COPPE/UFR], Julien Diaz [MAGIQUE-3D project-team, Inria Bordeaux - Sud-Ouest], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Antônio Tadeu Gomes [LNCC], Pedrodro Leite Da Silva Dias [LNCC, Coordinator of the project on the Brazilian side], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri [Coordinator of the project on the French side], Alexandre Madureira [LNCC], Nicolas Maillard [INF/UFRG], Florent Masegla [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Marta Mattoso [COPPE/UFR], Philippe Navaux [INF/UFRG], Esther Pacitti [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Fabio Porto [LNCC], Bruno Raffin [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Pierre Ramet [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Jean-Louis Roch [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Patrick Valduriez [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Frédéric Valentin [LNCC].

Since July 2012, the team is coordinating the HOSCAR <http://www-sop.inria.fr/hoscar> Brazil-France collaborative project. The HOSCAR project is a CNPq - Inria collaborative project between Brazilian and French researchers, in the field of computational sciences. The project is also sponsored by the French Embassy in Brazil.

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models (Group 1), (ii) scientific data management (Group 2), and (iii) high-performance software systems (Group 3). Several Brazilian institutions are participating to the project among which: LNCC (Laboratório Nacional de Computação Científica), COPPE/UFRJ (Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), INF/UFRGS (Instituto de Informática, Universidade Federal do Rio Grande do Sul) and LIA/UFC (Laboratórios de Pesquisa em Ciência da Computação Departamento de Computação, Universidade Federal do Ceará). The French partners are research teams from several Inria research centers.

## NEUROMATHCOMP Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

Olivier Faugeras is a member of the scientific committee of the "Axe Interdisciplinaire de Recherche de l'Université de Nice Sophia Antipolis" entitled "Modélisation Théorique et Computationnelle en Neurosciences et Sciences Cognitives".

## 7.2. National Initiatives

### 7.2.1. ANR

#### 7.2.1.1. KEOPS

See section "International Initiatives" below.

## 7.3. European Initiatives

### 7.3.1. FP7 & H2020 Projects

#### 7.3.1.1. MATHEMACS

Title: MATHEmatics of Multi-level Anticipatory Complex Systems

Programm: FP7

Duration: October 2012 - September 2015

Coordinator: Max Planck Institute for Mathematics in the Sciences

Partners:

see the [webpage](#) of the project.

Inria contact: Olivier Faugeras

The MATHEMACS project aims to develop a mathematical theory of complex multi-level systems and their dynamics. In addition to considering systems with respect to a given level structure, as is natural in certain applications or dictated by available data, the project has the unique goal of identifying additional meaningful levels for understanding multi-level systems. This is done through a general formulation based on the mathematical tools of information and dynamical systems theories.

To ensure that the theoretical framework is at the same time practically applicable, three key application areas are represented within the project, namely neurobiology, human communication, and economics. These areas not only provide us with some of the best-known epitomes of complex multi-level systems, but also constitute a challenging test bed for validating the generality of the theory since they span a vast range of spatial and temporal scales.

Furthermore, they have an important common aspect; namely, their complexity and self-organizational character is partly due to the anticipatory and predictive actions of their constituent units. The MATHEMACS project contends that the concepts of anticipation and prediction are particularly relevant for multi-level systems since they often involve different levels. Thus, as a further unique feature, the project includes the mathematical representation and modeling of anticipation in its agenda for understanding complex multi-level systems.

For validating the theory on large heterogeneous data sets, the project has a specific component with exclusive access to a wide range of data from human movement patterns to complex urban environments.

In this way, MATHEMACS provides a complete and well-rounded approach to lay the foundations of a mathematical theory of the dynamics of complex multi-level systems.

### 7.3.1.2. RENVISION

Title: Retina-inspired ENcoding for advanced VISION tasks

Programm: FP7

Duration: March 2013 - February 2016

Coordinator: Istituto Italiano di Tecnologia (Pattern Analysis and Computer vision) Vittorio Murino

Partners:

PAVIS, NET3 Fondazione Istituto Italiano di Tecnologia (Italy)

Institute for Adaptive and Neural Computation, The University of Edinburgh (United Kingdom)

Institute of Neuroscience, University of Newcastle Upon Tyne (United Kingdom)

Inria contact: Bruno Cessac

The retina is a sophisticated distributed processing unit of the central nervous system encoding visual stimuli in a highly parallel, adaptive and computationally efficient way. Recent studies show that rather than being a simple spatiotemporal filter that encodes visual information, the retina performs sophisticated non-linear computations extracting specific spatio-temporal stimulus features in a highly selective manner (e.g. motion selectivity). Understanding the neurobiological principles beyond retinal functionality is essential to develop successful artificial computer vision architectures. RENVISION's goal is, therefore, twofold: i) to achieve a comprehensive understanding of how the retina encodes visual information through the different cellular layers; ii) to use such insights to develop a retina-inspired computational approach to high-level computer vision tasks. To this aim, exploiting the recent advances in high-resolution light microscopy 3D imaging and high-density multielectrode array technologies, RENVISION will be in an unprecedented position to investigate pan-retinal signal processing at high spatio-temporal resolution, integrating these two technologies in a novel experimental setup. This will allow for simultaneous recording from the entire population of ganglion cells and functional imaging of inner retinal layers at near-cellular resolution, combined with 3D structural imaging of the whole inner retina. The combined analysis of these complex datasets will require the development of novel multimodal analysis methods. Resting on these neuroscientific and computational grounds, RENVISION will generate new knowledge on retinal processing. It will provide advanced pattern recognition and machine learning technologies to ICTs by shedding a new light on how the output of retinal processing (natural or modelled) allows solving complex vision tasks such as automated scene categorization and human action recognition.

### 7.3.1.3. HBP

Title: The Human Brain Project

Programm: FP7

Duration: October 2013 - March 2016

Coordinator: EPFL

Partners:

see the [webpage](#) of the project.

Inria contact: Olivier Faugeras

Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to



emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases.

This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics, Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity.

A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

## 7.4. International Research Visitors

### 7.4.1. Visits of International Scientists

- Paul Bressloff, a Professor of Applied Mathematics at the University of Utah visited the team in June-July as part of his Inria International chair.
- Ruben Herzog, Master student in Valparaíso, with A. Palacios, Centro Interdisciplinario de Neurociencia de Valparaíso, Univ de Valparaíso, Valparaíso. From May 4 th 2015 until May 29 th 2015.

#### 7.4.1.1. Internships

##### **Roberta Evangelista**

During her internship (May 2015-September 2015, funded by *Action Transverse*) supervised by E. Tanré (Tosca) and R. Veltz (Neuromathcomp), Roberta Evangelista worked on “A stochastic model of gamma phase modulated orientation selectivity”.

Neurons in primary visual cortex (V1) are known to be highly selective for stimulus orientation. Recent experimental evidence has shown that, in awake monkeys, the orientation selectivity of V1 neurons is modulated by gamma oscillations. In particular, neurons’ firing rate in response to the preferred orientation changes as a function of the gamma phase of spiking. The effect is drastically reduced for non-preferred orientations. We have introduced a stochastic model of a network of orientation-dependent excitatory and inhibitory spiking neurons. We have found conditions on the parameters such that the solutions of the mathematical model reproduce the experimental behavior.

##### **Quentin Cormier**

Quentin is co-supervised by E. Tanré (Tosca) and R. Veltz (Neuromathcomp). He is a Master 1 student from ENS Lyon.

We study numerically and theoretically a model of spiking neuron in interaction with plasticity. The synaptic weights evolve according to biological law of plasticity. We study the existence of separable time scales. We are also interested in the characterization of invariant distribution for the activity of the network and the distribution of the synaptic weights. During his internship, Quentin Cormier also develop a numerical code to simulate large networks of neurons evolving according to this dynamics.

## SCALE Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR Songs

Title: Simulation of Next Generation Systems

Program: Infra 13

Duration: January 2012 - December 2015

Coordinator: Inria (Nancy, Grenoble, Bordeaux)

Others partners: IN2P3 Villeurbanne, LSIIT Strasbourg, I3S Sophia-Antipolis, LINA Nantes

See also: <http://infra-songs.gforge.inria.fr/>

Abstract: SONGS (2012-2015) is the continuity of SIMGRID project (2009-2012), in the ANR INFRA program. The aim of SONGS is to continue the development of the SimGrid simulation platform for the study of large distributed architectures, including data grids, cloud computing facilities, peer-to-peer applications and HPC/exascale architectures.

### 8.1.2. FUI CloudForce (now OpenCloudWare)

Program: FSN, labelled by Minalogic, Systematic and SCS.

Duration: January 2012 - September 2015

Coordinator: France-Telecom Research

Others partners: ActiveEon, Armines, Bull, eNovance, eXo Platform, France Telecom (coordinator), Inria, IRIT-INP Toulouse, Linagora, OW2, Peergreen, Télécom Paris Tech, Télécom Saint Etienne, Thales Communications, Thales Services, Université Joseph Fourier, Université de Savoie - LISTIC, UShareSoft

See also: <http://www.opencloudware.org/>

Abstract: The OpenCloudware project aims at building an open software engineering platform for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures.

The results of OpenCloudware will contain a set of software components to manage the lifecycle of such applications, from modelling (Think), developing and building images (Build), to a multi-IaaS compliant PaaS platform (Run) for their deployment, orchestration, performance testing, self-management (elasticity, green IT optimisation), and provisioning. Applications will be deployed potentially on multi IaaS (supporting either one IaaS at a time, or hybrid scenarios). The results of the project will be made available as open source components through the OW2 Open Source Cloudware initiative.

### 8.1.3. Oseo-Isis Spinnaker

Duration: June 2011 - September 2015

Coordinator: Tagsys-RFID

Others partners: SMEs: Inside-Secure, STIC, Legrand; Academic: IPG, ENS des Mines de St Etienne, Un. du Maine, Un. F. Rabelais Tours, AETS ESEO Angers, Un. Marne la Vallée, Un. Paris 6, Un. Rennes 1, Inria.

See also: <http://www.spinnaker-rfid.com/>

Abstract: The objective of Spinnaker is to really allow RFID technology to be widely and easily deployed. The role of the OASIS team in this project is to allow the wide scale deployment and management of the specific RFID application servers in the cloud, so to build an end-to-end robust and flexible solution using GCM technology.

## **8.2. European Initiatives**

### **8.2.1. FP7 & H2020 Projects**

#### *8.2.1.1. DC4Cities*

Type: COOPERATION

Defi: FP7 Smartcities 2013

Instrument: Specific Targeted REsearch Project

Objectif: ICT-2013.6.2: Data Centers in an energy-efficient and environmentally friendly Internet

Duration: September 2013 - February 2016

Coordinator: Freemind Consulting (BE)

Partners: U. Mannheim (DE), U. Passau (DE), HP Italy Innovation Center (IT), Create-Net (IT), ENEA (IT), CESCA Catalonia (ES), Gas Natural SA (ES), Inst. Munic. Informatica Barcelona (ES), Inria (FR)

Inria contact: Eric Madelaine

See also:

Abstract: Data centres play two different and complementary roles in Smart Cities' energy policies: as ICT infrastructures supporting Smart City resource optimization systems - more in general, delivering ICT services to the citizens - and as large energy consumers. Therefore there are huge expectations on data centres being able to run at the highest levels of renewable energy sources: this is the great challenge of DC4Cities project.

The goal of DC4Cities is to make existing and new data centres energy adaptive, without requiring any modification to the logistics, and without impacting the quality of the services provided to their users. Finally new energy metrics, benchmarks, and measurement methodologies will be developed and proposed for the definition of new related standards. DC4Cities will promote the data centres role as an "eco-friendly" key player in the Smart Cities energy policies, and will foster the integration of a network of local renewable energy providers (also interconnected with local Smart Grids and Micro Grids) to support the pursued increase of renewable energy share.

#### **8.2.2. Collaborations with Major European Organizations**

Program: EIT Digital

Project acronym: Data Science programme, Activity 15 327 from Master School action line (MSL)

Project title: EIT Digital Data Science Master

Duration: submitted in 2014, funded from 2014 onwards

Coordinator: Farideh Heidari, Technische Universiteit Eindhoven

Other partners (besides UNS, with Françoise Baude as local coordinator): Univ. Politecnico Madrid, Univ. Trento, Politecnico Milano, Tech. Univ. Berlin, KTH

Abstract: The activity has successfully launched a new major for the EIT Digital KIC called "Data Science", with the purpose of breeding a new generation of ICT professionals, equipped with advanced technical and entrepreneurial skills in the key area of data science and data engineering. There is a tremendous demand in industry/society for data scientists, and hence a huge market potential for DS programs. DS positions in the industry requires a different educational program, with next to technical skills, more emphasis on awareness of multifaceted challenges and improving business efficiency based on the challenge outcomes. Expected impact is that DS graduates will be quickly recruited for attractive positions as they can help EU ICT industry achieve a higher rate of innovation successes.

## 8.3. International Initiatives

### 8.3.1. Inria International Labs

#### 8.3.1.1. CIRIC Chili

Ciric research line: Telecommunications

Inria principal investigator: Eric Madelaine

Duration: 2012 - 2021

This CIRIC activity is loosely coupled with our (now terminated) SCADA associated team with the Universidad de Chile (UdC). We have some research collaboration with our chilean colleagues, in particular on new usages of the GCM component model for cloud management[7].

#### 8.3.1.2. LIAMA Shanghai

Liama project: CASCADES

Inria principal investigator: Vania Joloboff

SCALE researchers involved: Eric Madelaine, Ludovic Henrio,

AOSTE researchers: Robert de Simone, Julien DeAntoni, Frederic Mallet

International Partner (Institution - Laboratory - Researcher):

East China Normal University (ECNU) Shanghai - Software Engineering Institute - MOE  
International Lab of Trustworthy Software : Jifeng HE, Changbo WANG, Huibiao ZHU,  
Min ZHANG, Yixiang CHEN.

Duration: 2016 - 2017

The SACCADDES project aims at improving the development of reliable cyber physical systems and more generally of distributed systems combining asynchronous with synchronous aspects, with different but complementary angles:

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

The Scale team is involved in particular, with our chinese partners, on studies of semantics and compositional properties, and on the development of software tools supporting the Model-Driven Engineering approaches.

This LIAMA project is tightly linked with our FM4CPS Associated team (Inria principal investigator: Robert de Simone, SCALE participants: Eric Madelaine, Ludovic Henrio, Oleksandra Kulankhina).

### 8.3.2. Inria International Partners

#### 8.3.2.1. Informal International Partners

- Advanced Real-Time Simulation Laboratory, Carleton University, Ottawa Canada: collaboration on simulation methodology, the DEVS formalism, and SDN Networks [16], [8], [15]

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

#### 8.4.1.1. Internships

- Alexandros Tsantilas. *Fuzzing a VM Scheduler*. Co-supervised by Ludovic Henrio. Master 2 Ubinet 2014-15

- Wafa Khlif. *How sustainable data centres can be ?* Co-supervised by Fabien Hermenier. Master 2 IFI 2014-15
- Mario Taddei. *An integrated system for building and running reproducible research.* Supervised by Olivier Dalle. Master 2 Ubinet, 2014-2015;

#### 8.4.1.2. *Research stays abroad*

- Olivier Dalle visited Carleton University (Ottawa, Canada) for one month (Dec 2015 - Jan 2016)
- Eric Madelaine visited East China Normal University in Shanghai for 3 weeks (July and November)

## STARS Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. ANR

#### 9.1.1.1. MOVEMENT

Program: ANR CSOSG

Project acronym: MOVEMENT

Project title: AutoMatic BiOmetric Verification and PersonnEl Tracking for SeaMless Airport ArEas Security MaNagemenT

Duration: January 2014-June 2017

Coordinator: MORPHO (FR)

Other partners: SAGEM (FR), Inria Sophia-Antipolis (FR), EGIDIUM (FR), EVITECH (FR) and CERAPS (FR)

Abstract: MOVEMENT is focusing on the management of security zones in the non public airport areas. These areas, with a restricted access, are dedicated to service activities such as maintenance, aircraft ground handling, airfreight activities, etc. In these areas, personnel movements tracking and traceability have to be improved in order to facilitate their passage through the different areas, while insuring a high level of security to prevent any unauthorized access. MOVEMENT aims at proposing a new concept for the airport's non public security zones (e.g. customs control rooms or luggage loading/unloading areas) management along with the development of an innovative supervision system prototype.

#### 9.1.1.2. SafEE

Program: ANR TESCAN

Project acronym: SafEE

Project title: Safe & Easy Environment for Alzheimer Disease and related disorders

Duration: December 2013-May 2017

Coordinator: CHU Nice

Other partners: Nice Hospital(FR), Nice University (CobTeck FR), Inria Sophia-Antipolis (FR), Aromatherapeutics (FR), SolarGames(FR), Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW), BDE (TW)

Abstract: SafEE project aims at investigating technologies for stimulation and intervention for Alzheimer patients. More precisely, the main goals are: (1) to focus on specific clinical targets in three domains behavior, motricity and cognition (2) to merge assessment and non pharmacological help/intervention and (3) to propose easy ICT device solutions for the end users. In this project, experimental studies will be conducted both in France (at Hospital and Nursery Home) and in Taiwan.

### 9.1.2. Investment of Future

#### 9.1.2.1. Az@GAME

Program: DGCIS

Project acronym: Az@GAME

Project title: Medical diagnosis aid tool for Alzheimer disease and similar pathologies (un outil d'aide au diagnostic médical sur l'évolution de la maladie d'Alzheimer et les pathologies assimilées).

Duration: January 2012- December 2015

Coordinator: Groupe Genius

Other partners: IDATE (FR), Inria(Stars), CMRR (CHU Nice) and CobTek( Nice University).

See also: <http://www.azagame.fr/>

Abstract: This French project aims at providing evidence concerning the interest of serious games to design non pharmacological approaches to prevent dementia patients from behavioral disturbances, most particularly for the stimulation of apathy.

### 9.1.3. FUI

#### 9.1.3.1. Visionum

Program: FUI

Project acronym: Visionum

Project title: Visonium.

Duration: January 2015- December 2018

Coordinator: Groupe Genius

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

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

## 9.2. European Initiatives

### 9.2.1. FP7 & H2020 Projects

#### 9.2.1.1. CENTAUR

Title: Crowded ENvironments moniTORing for Activity Understanding and Recognition

Programm: FP7

Duration: January 2013 - December 2016

Coordinator: Honeywell

Partners:

Computer Vision Laboratory, Ecole Polytechnique Federale de Lausanne (Switzerland)

honeywell, Spol. S.R.O (Czech Republic)

Data Centric Technologies Group, Neovision Sro (Czech Republic)

Centre for Intelligent Sensing, Queen Mary University of London (United Kingdom)

Inria contact: François Brémond

We aim to develop a network of scientific excellence addressing research topics in computer vision and advancing the state of the art in video surveillance. The cross fertilization of ideas and technology between academia, research institutions and industry will lay the foundations to new methodologies and commercial solutions for monitoring crowded scenes. Research activities will be driven by specific sets of scenarios, requirements and datasets that reflect security operators' needs for guaranteeing the safety of EU citizens. CENTAUR gives a unique opportunity to academia to be exposed to real life dataset, while enabling the validation of state-of-the-art video surveillance methodology developed at academia on data that illustrate real operational scenarios. The research agenda is motivated by ongoing advanced research activities in the participating entities. With

Honeywell as a multi-industry partner, with security technologies developed and deployed in both its Automation and Control Solutions and Aerospace businesses, we have multiple global channels to exploit the developed technologies. With Neovison as a SME, we address small fast paced local markets, where the quick assimilation of new technologies is crucial. Three thrusts identified will enable the monitoring of crowded scenes, each led by an academic partner in collaboration with scientists from Honeywell: (a) multi camera, multicoverage tracking of objects of interest, (b) Anomaly detection and fusion of multimodal sensors, (c) activity recognition and behavior analysis in crowded environments. We expect a long term impact on the field of video surveillance by: contributions to the state-of-the-art in the field, dissemination of results within the scientific and practitioners community, and establishing long term scientific exchanges between academia and industry, for a forum of scientific and industrial partners to collaborate on addressing technical challenges faced by scientists and the industry.

#### 9.2.1.2. PANORAMA

Title: Ultra Wide Context Aware Imaging

Programm: FP7

Duration: April 2012 - March 2015

Coordinator: Philips

Inria contact: François Brémond

PANORAMA aims to research, develop and demonstrate generic breakthrough technologies and hardware architectures for a broad range of imaging applications. For example, object segmentation is a basic building block of many intermediate and low level image analysis methods. In broadcast applications, segmentation can find people's faces and optimize exposure, noise reduction and color processing for those faces; even more importantly, in a multi-camera setup these imaging parameters can then be optimized to provide a consistent display of faces (e.g., matching colors) or other regions of interest. PANORAMA will deliver solutions for applications in medical imaging, broadcasting systems and security & surveillance, all of which face similar challenging issues in the real time handling and processing of large volumes of image data. These solutions require the development of imaging sensors with higher resolutions and new pixel architectures. Furthermore, integrated high performance computing hardware will be needed to allow for the real time image processing and system control. The related ENIAC work program domains and Grand Challenges are Health and Ageing Society - Hospital Healthcare, Communication & Digital Lifestyles - Evolution to a digital lifestyle and Safety & Security - GC Consumers and Citizens security.

#### 9.2.1.3. DEM@CARE

Title: Dementia Ambient Care: Multi-Sensing Monitoring for Intelligent Remote Management and Decision Support

Type: FP7

Defi: Cognitive Systems and Robotics

Instrument: Industry-Academia Partnerships and Pathway

Objective: development of a complete system providing personal health services to persons with dementia

Duration: November 2011-November 2015

Coordinator: Centre for Research and Technology Hellas (G)

Other partners: Inria Sophia-Antipolis (FR); University of Bordeaux 1(FR); Cassidian (FR), Nice Hospital (FR), LinkCareServices (FR), Lulea Tekniska Universitet (SE); Dublin City University (IE); IBM Israel (IL); Philips (NL); Vistek ISRA Vision (TR).

Inria contact: François Brémond



Abstract: The objective of Dem@Care is the development of a complete system providing personal health services to persons with dementia, as well as medical professionals, by using a multitude of sensors, for context-aware, multiparametric monitoring of lifestyle, ambient environment, and health parameters. Multisensor data analysis, combined with intelligent decision making mechanisms, will allow an accurate representation of the person's current status and will provide the appropriate feedback, both to the person and the associated medical professionals. Multi-parametric monitoring of daily activities, lifestyle, behavior, in combination with medical data, can provide clinicians with a comprehensive image of the person's condition and its progression, without their being physically present, allowing remote care of their condition.

## 9.3. International Initiatives

### 9.3.1. Inria International Labs

#### 9.3.1.1. Informal International Partners

##### 9.3.1.1.1. Collaborations with Asia:

Stars has been cooperating with the Multimedia Research Center in Hanoi MICA on semantics extraction from multimedia data. Stars also collaborates with the National Cheng Kung University in Taiwan and I2R in Singapore.

##### 9.3.1.1.2. Collaboration with U.S.A.:

Stars collaborates with the University of Southern California.

##### 9.3.1.1.3. Collaboration with Europe:

Stars collaborates with Multitel in Belgium, the University of Kingston upon Thames UK, and the University of Bergen in Norway.

#### 9.3.1.2. Other IIL projects

**The ANR SafEE (see section 9.1.1.2 )** collaborates with international partners such as Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW) and BDE (TW).

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

This year, Stars has been visited by the following international scientists:

- Salwa Baabou, Ecole Nationale d'Ingénieurs de Gabès, Tunisia;
- Siyuan Chen, University of New South Wales, Australia;
- Jesse Hoey, University of Waterloo, Canada;
- Adlen Kerboua, University of Skikda, Algeria;
- Caroala Strumia, University of Genova, Italy.

#### *9.4.1.1. Internships*

Ujjwal Ujjwal

Date: June 2015 - Nov 2015

Institution: International Institute of Information, Hyderabad (India)

Supervisor: François Brémond

Ghada Bahloul

Date: Jul 2015 - Sept 2015

Institution: Ecole Polytechnique de Sousse (Tunisia)

Supervisor: Rachid Guerchouche

Kanishka Nithin Dhandapani

Date: June 2015 - Nov 2015

Institution: IIT Madras (India)

Supervisor: Carlos Fernando Crispim Junior

Ramiro Leandro Diaz

Date: Jul 2015

Institution: UNICEN, Buenos Aires, Argentina

Supervisor: Carlos Fernando Crispim Junior

Alvaro Gomez Uria Covella

Date: Jan 2015 - Apr 2015

Institution: Universidad Nationale de Rosario, Argentina

Supervisor: Carlos Fernando Crispim Junior

#### **9.4.2. Visits to International Teams**

##### *9.4.2.1. Research stays abroad*

Piotr Bilinski

- Date: Apr 2015- Aug 2015
- Institution: Honeywell, Spol. S.R.O (Czech Republic)

## TITANE Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. *Grand Emprunt*

Culture 3D Clouds (started in October 2012, duration 3 years) is a national project aimed at devising a cloud computing platform for 3D scanning, documentation, preservation and dissemination of cultural heritage.

Information and communication technologies in the world offer new possibilities for cultural exchange, creation, education and shared knowledge to greatly expand the access to culture and heritage. Culture 3D Cloud is part of a process that aims to create a technical breakthrough approach in the field of digitization of heritage artifacts to allow the emergence of new viable business models. Today the field of 3D scanning artifacts heritage evolves slowly and only provides resources for researchers and specialists and the technology and equipment used for 3D scanning are sophisticated and require highly specialized skills. The cost is significant and limits the practicality. Culture 3D Clouds project aims at empowering the photographers and the distribution to the agencies and image banks that will develop a value chain to commercialize 3D reproductions demand for their customers and expand the market valuation of business assets (commercial publishers, public).

Partners: IGN, CMN, RMN, Inria, EISTI, CNRS-MAP, UCP-ETIS, CEA, HPC Project, ValEISTI, BeIngenious.

Web site: <http://c3dc.fr/>.

## 9.2. European Initiatives

### 9.2.1. *FP7 & H2020 Projects*

#### 9.2.1.1. *IRON - Robust Geometry Processing*

Type: IDEAS

Instrument: ERC Starting Grant

Duration: January 2011 - December 2015

Coordinator: Pierre Alliez

Inria contact: Pierre Alliez

Abstract: The purpose of this project is to bring forth the full scientific and technological potential of Digital Geometry Processing by consolidating its most foundational aspects. Our methodology draws from and bridges the two main communities (computer graphics and computational geometry) involved in discrete geometry to derive algorithmic and theoretical contributions that provide both robustness to noisy, unprocessed inputs, and strong guarantees on the outputs. The intended impact is to make the digital geometry pipeline as generic and ironclad as its Digital Signal Processing counterpart.

## 9.3. International Research Visitors

### 9.3.1. *Visits of International Scientists*

#### 9.3.1.1. *Internships*

Venkata Kusupati (IIT Bombay): design of anisotropic metrics on surfaces.

Hao Fang (Ecole Centrale Paris): scale-space analysis of mesh simplification for urban scenes.

Guillaume Matheron (ENS Paris): an efficient approach to compute the optimal transportation cost for surface reconstruction.

## 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).
- A. Lejay is member of the ANR H2MNO4 (Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology, ANR Cosinus, 2012–2015) coordinated by Joceyline Erhel (IRISA, Rennes).
- E. Tanré is member of the ANR SloFaDyBio (Slow Fast Dynamics in Biology, ANR-14-CE25-0019, 2015-2017) coordinated by M. Desroches (EPI NEUROMATHCOMP, Inria Sophia Antipolis).

### 9.1.2. Contract with ADEME

**Participants:** Mireille Bossy, Sélim Kraria.

**Modéol** Since April 2013, M. Bossy was the coordinator of the MODÉOL collaboration project funded by the French Environment and Energy Agency (ADEME), and involving the IPSL (CNRS) and the French company Maïa Eolis. The overall goal of the project concerns the modeling and prediction of wind potential in France, in particular the quantification of uncertainties and the analysis of multi-scale variability.

Concerning the Inria workpackage, in collaboration with Antoine Rousseau, from the team LEMON, we completed the SDM code with complex terrain description. We also improved the downscaling procedure that allows SDM to downscale its own simulation outputs.

## 9.2. European Initiatives

### 9.2.1. FP7 & H2020 Projects

- J. Inglis is a member of the European project MatheMACS (European Union Seventh Framework Programme no. 318723).

## 9.3. International Initiatives

### 9.3.1. Inria International Labs

#### **Inria Chile**

Associate Team involved in the International Lab:

### 9.3.1.1. ANESTOC-TOSCA

Title: Stochastic modelling of biology and renewable energies

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (Chile) - ANESTOC Center (ANESTOC) -  
Rebolledo Rolando

Start year: 2014

See also: [http://www.anestoc.cl/es/?page\\_id=1112](http://www.anestoc.cl/es/?page_id=1112)

This French-Chilean Associated Team deals with stochastic modeling and simulation issues for renewable energies (wind and waves) and neurosciences. It is a follow-up of a long collaboration in which each of the side takes benefit from the other side know-how and structures. This project aims at transferring and valuing to Chilean companies the results of researches on renewable energies, mainly wind prediction at the windfarm's scale and waves energy potential of a site using video.

Mireille Bossy is managing the WINDPOS project, in collaboration with Antoine Rousseau (LEMON team) and two engineers of Inria Chile, Cristian Paris and Jacques Morice. Based on the stochastic Lagrangian modeling of the wind at small scale (see SDM SOFTWARE), WINDPOS aims to develop a wind farm simulator software, able to provide fine statistical information for the managing of electricity production.

This year the WINDPOS project focused on the validation of the approach by comparison with measurements. We also tested the simulation of a 10 mills farm in complexe terrain with strong elevation.

Antoine Lejay is working with Rolando Rebolledo (PUC) on the stochastic modeling of the Oscillating Water Column to transform waves into energy.

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

- L. Beznea (Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucarest) has been visiting TOSCA Nancy for 10 days in March.
- B. Cloez (INRA Montpellier) has been visiting TOSCA Nancy for 3 days in January.
- J. Claisse (Ecole Polytechnique) has been visiting TOSCA Nancy for 3 days in January.
- F. Campillo (LEMON team, Inria Sophia) has been visiting TOSCA Nancy for one week in August.
- M. Andrade Resptrepo (Univ. Paris 7) has been visiting TOSCA Nancy for 3 days in December.
- The TOSCA *seminar* organized by J. Inglis and A. Richard in Sophia Antipolis has received the following speakers: Cédric Bernardin (Laboratoire Dieudonné, Université Nice Sophia-Antipolis), Romuald Elie (Ceremade, Université Paris Dauphine), Roberta Evangelista (NEUROMATHCOMP-TOSCA, Inria Sophia-Antipolis), José R. León (Inria Grenoble, UCV de Venezuela), Soledad Torres (CIMFAV – Valparaiso, Chile), Arnulf Jentzen (ETH Zurich), Marielle Simon (PUC, Rio de Janeiro), Philip Protter (Columbia University), Jean-François Jabir (CIMFAV – Valparaiso, Chile), Sean Ledger (University of Oxford), Alexandre Brouste (Université du Maine, Le Mans).

#### 9.4.1.1. Internships

CHIKHAOUI Maroua

Subject: Gestion de risque de portefeuille : Estimation de VaR et CVaR

Date: May 2015 - Sept. 2015

Institution: ESPRIT (Ecole Supérieure Privée d'Ingénierie et de Technologie, Tunisie) et Polytech'Nice-Sophia.

CORMIER Quentin

Subject: Réseaux de neurones à décharge avec phénomènes de plasticité

Date: Oct. 2015 - Feb. 2016

Institution: ENS Lyon.

EVANGELISTA Roberta

Subject: A stochastic model of gamma phase modulated orientation selectivity

Date: May 2015 - Sept. 2015

Institution: the Master in computational neuroscience, at the BCCN Berlin.

### ***9.4.2. Visits to International Teams***

#### *9.4.2.1. Research stays abroad*

- A. Richard has spent two weeks in Valparaíso and Santiago (Chile) in January, and two weeks in Santiago in June, working with R. Rebolledo and S. Torres.

## VIRTUAL PLANTS Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. Agropolis computational plant seminar

**Participants:** Yann Guédon, Thierry Fourcaud [CIRAD, AMAP], Christine Granier [INRA, LEPSE], Soazig Guyomarc'h [Montpellier 2 University, DIADE], Laurent Laplaze [IRD, DIADE].

Funding: Agropolis foundation (Contractor for Virtual Plants: CIRAD. From 2013 to 2016)

In the context of the creation of a world-level pole on plant science in the region Languedoc-Roussillon, we created a monthly seminar on plant modeling and its applications. The seminar is organized by Yann Guédon, Thierry Fourcaud (CIRAD, AMAP), Christine Granier (INRA, LESPE), Soazig Guyomarc'h (Montpellier 2 University, DIADE) and Laurent Laplaze (IRD, DIADE) with the support of Agropolis International and Agropolis Foundation. In 2015, we organized a two-day workshop devoted to the modeling of plant development from the cellular to the organ scale.

### 8.1.2. MecaFruit3D

**Participants:** Mik Cieslak, Frédéric Boudon, Christophe Godin, Nadia Bertin [PSH, Avignon].

Funding: Labex Agro (Contractor for Virtual Plants: INRA, from 2013 to 2016)

The fruit cuticle plays a major role in fruit development and shelf-life. It is involved in water losses, cracking, and protection against stress, and thus it may have major economic impacts. Objectives of the project are to better understand the multiple roles of the fruit cuticle in the control of fleshy fruit growth and quality.

The multicellular model for fruit growth that we develop (see section 6.3.2) will be used to study qualitatively the impact of the cuticle mechanical properties.

Partners: PSH, INRA, Avignon; LCVN, IES, Université Sud de France, Montpellier.

### 8.1.3. Integrated model of plant organ growth

**Participants:** Yann Guédon, Christine Granier [INRA, LEPSE], Garance Koch [INRA, LEPSE], Nadia Bertin [INRA, PSH], Valentina Baldazzi [INRA, PSH].

Funding: Labex Agro (Contractor for Virtual Plants: CIRAD. From 2015 to 2018)

The objective of this project is to develop a generic model which will predict interactions among the main processes controlling the development of source and sink organs in tomato, i.e. cell division, cell expansion and endoreduplication in relation to carbon and water fluxes under fluctuating environment. To achieve this objective we will i) capitalize on expertise, multi-scale phenotyping tools and genetic resources already compiled on the fruit model tomato and the model plant *Arabidopsis thaliana*; ii) perform new experiments to collect phenotyping data currently missing in this field, especially concerning the early phase of fruit and leaf development in tomato and the interactions between genes and environment; iii) develop a process-based model of organ growth which will integrate knowledge collected at the different scales.

Partners: PSH, INRA, Avignon; LEPSE, INRA, Montpellier, Biologie du fruit et Pathologie INRA, Bordeaux;

### 8.1.4. SegmentationEvaluation

**Participants:** Sophie Ribes, Benjamin Gilles [LIRMM], Guillaume Baty, Alizon Konig, Guillaume Cerutti.

Funding: IBC (Contractor for Virtual Plants: UM, 2015)

The goal of this project is to develop a framework allowing a robust validation for image segmentation. Segmentation is an ill-posed problem, and conventional validation approaches are corrupted by both intra and inter observer variabilities. We plan to develop: efficient tools allowing a creation of gold standard segmentation data (Alizon Konig, master internship under the supervision of Sophie Ribes); robust metrics to quantify differences between ground truth and algorithmic results.

Partners: ICAR, LIRMM, Montpellier.

## 8.2. National Initiatives

### 8.2.1. *HydroRoot*

**Participants:** Mikaël Lucas [IRD], Christophe Pradal, Christophe Godin, Yann Boursiac [BPMP], Christophe Maurel [BPMP].

Funding: ANR (Contractor for Virtual Plants: Cirad, From 2012 to 2016)

The HydroRoot project proposes a unique combination of approaches in the model plant *Arabidopsis thaliana* to enhance our fundamental knowledge of root water transport. Accurate biophysical measurements and mathematical modeling are used, in support of reverse and quantitative genetics approaches, to produce an integrated view of root hydraulics. The HydroRoot project will address as yet unknown facets of root water transport. It will lead to an integrated view of root hydraulics that considers both tissue hydraulics and root architecture and explains how these components are controlled at the molecular level by physiological and/or environmental cues. Because of its strong physiological and genetic background, this research may also directly impact on breeding programs, for production of crops with optimised water usage and stress responses.

### 8.2.2. *Phenome*

**Participants:** Christian Fournier, Christophe Pradal, Sarah Cohen-Boulakia, Simon Artzet, Jerome Chopard, Patrick Valduriez.

Funding: ANR-Investissement d'avenir (Contractor for Virtual Plants: INRA, From 2015 to 2018)

The goal of Phenome is to provide France with an up-to-date, versatile, high- throughput infrastructure and suite of methods allowing characterisation of panels of genotypes of different species under climate change scenarios. We are involved in the methodological part of the project, that aims at developing a software framework dedicated to the analysis of high throughput phenotyping data and models. It will be based on the OpenAlea platform that provides methods and softwares for the modelling of plants, together with a user-friendly interface for the design and execution of scientific workflows. We also develop the InfraPhenoGrid infrastructure that allows high throughput computation and recording of provenance during the execution of Workflows.

### 8.2.3. *DigEM*

**Participants:** Christophe Godin, Grégoire Malandain, Patrick Lemaire.

Funding: ANR (Contractor for Virtual Plants: Inria, From 2015 to 2019)

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



### 8.2.4. Leaf Serration

**Participants:** Christophe Godin, Eugenio Azpeitia.

Funding: ANR (Contractor for Virtual Plants: Inria, From 2014 to 2019)

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

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

### 8.2.5. Other national grants

#### 8.2.5.1. MARS-ALT 2.0

**Participants:** Guillaume Baty, Christophe Pradal, Christophe Godin.

Funding: Inria ADT (Contractors for Virtual Plants: Inria from 2013 to 2015)

The goal of this project is to integrate in a single software platform all the software tools and algorithms that have been developed in various projects about meristem modeling in our teams. More precisely, we aim at building 3D models of meristem development at cellular resolution based on images obtained with confocal or multiphoton microscopy. This set of components will be used by biologists and modelers making it possible to build such meristem structures, to explore and to program them. This platform is embedded in the OpenAlea framework and is based on the imaging components of the platform MedInria. Asclepios, RDP ENS-Lyon/INRA, PHIV CIRAD

#### 8.2.5.2. SCOOP

**Participants:** Pierre Fernique, Yann Guédon, Christophe Pradal, Christophe Godin, Frédéric Boudon, Jean-Baptiste Durand.

Funding: Inria ADT (Contractors for Virtual Plants: Inria from 2014 to 2016)

The goal of this project is to improve the software quality and the dissemination of Vplants components for plant phenotyping. Virtual Plants team has played a pioneering role in the development of methods for analyzing plant development that take account of the complexity of plant architecture. Numerous software components has been developed for more than 20 years and a profound re- engineering is now necessary to facilitate the collaborations with biologist and agronomists of CIRAD, INRA and IRD and to help the dissemination of ours methods in the scientific community.

#### 8.2.5.3. Echap

**Participants:** Christophe Pradal, Christian Fournier, Corinne Robert [INRA, EGC].

Funding: ONEMA (Contractor for Virtual Plants: INRA, From 2012 to 2014)

The objective of the ECHAP project is to reduce the frequency of treatments and the doses of pesticides applied on crops by taking advantage of natural mechanisms of disease escape related to crop architecture and by optimizing interception of pesticides by plant canopies. It focuses on the development of an integrative, yet modular, modeling tool on the OpenAlea platform that couples wheat architectural development, the interception and fate of fungicides and the dynamics of a pathogen. Various scenarios combining climate x architecture x fungicide treatment will be simulated to identify and propose efficient strategies of pesticide applications. Partners: UMR EGC (Paris-Grignon), UMR LEPSE (Montpellier), ARVALIS (Institut du végétal, France), ALTERRA (Research Institute for the Green World, The Netherlands), ADAS Intitute (UK), CNRS, and IRSTEA .

#### 8.2.5.4. Morphogenetics

**Participants:** Christophe Godin, Frédéric Boudon, Christophe Pradal, Grégoire Malandain, François Faure, Jan Traas, François Parcy, Arezki Boudaoud, Teva Vernoux.

Funding: Inria Project Lab (From 2013 to 2016)

Morphogenetics is an Inria transversal project gathering 3 Inria teams and two Inra teams. It aimed at understanding how flower shape and architecture are controlled by genes during development. Using quantitative live-imaging analysis at cellular resolution we will determine how specific gene functions affect both growth patterns and the expression of other key regulators. The results generated from these experiments will be integrated in a specially designed database (3D Atlas) and used as direct input to new predictive computational models for morphogenesis and gene regulation. Model predictions will then be further tested through subsequent rounds of experimental perturbation and analysis. A particular emphasis will be put on the modeling of mechanics in tissues for which different approaches will be developed.

Partners: RDP ENS-Lyon; Imagine Inria Team (Grenoble); Morpheme Inria Team (Sophia-Antipolis), UMR PCV (Grenoble).

#### 8.2.5.5. Rose

**Participants:** Christophe Godin, Frédéric Boudon, Christophe Pradal.

Funding: INRA - Projet de Pari Scientifique (From 2012 to 2015)

In this project we want to quantify and understand how sugars interfere with hormonal signals (auxin, cytokinins) to regulate lateral bud outgrowth of aerial stems of roses. Experiments will be made on Rose stems to test different levels of sugar conditions and hormonal concentrations on bud outgrowth. An extension of the recently published hormonal model of apical dominance will be made to take into account the role of carbon as a signaling molecule.

Partners: UMR SAGAH, Angers

## 8.3. International Initiatives

### 8.3.1. ANR-DFG

#### 8.3.1.1. AlternApp

**Participants:** Yann Guédon, Maryam Aliee.

Funding: ANR-DFG (Contractor for Virtual Plants: INRA, From 2015 to 2019)

The aim of the AlternApp project is to investigate functional hypotheses on the genetic and environmental control of floral induction in apple tree progenies. Two segregating populations will be studied in two different environmental conditions for floral induction and bearing behavior, in order to identify genomic regions associated with regular phenotypes. The specific contribution of the team will be to develop statistical methods to quantify phenotype and genotype, as well as years and climatic effects on alternation. Transcriptome of varieties contrasted in their bearing behavior and artificially set into high or low cropping conditions will be explored by New Generation Sequencing Technology (NGS) to identify new candidate genes and allelic variations of interest. By this project, new results are expected on floral induction in apple tree in relation to their alternate bearing behavior and more applied results linked to the discovery of allelic variation in key genes that could be used in breeding programs.

Partners: AFEF INRA team (Montpellier), PIAF INRA team (Clermont-Ferrand), JKI (Dresden, Germany), UHOH (Hohenheim, Germany), Foundation E. Mach (San Michele all'Adige, Italy)

### 8.3.2. Inria International Partners

#### 8.3.2.1. Informal International Partners

An important collaboration with the CIRAD research unit HortSys at the Reunion island and in particular Frédéric Normand has been established for several years. The topic of the collaboration is the study of the phenology of mango tree. Three members of the team have been visiting our collaborators during the year. This is a tripartite collaboration that also involves Pierre-Eric Lauri of the AGAP/AFEF team.

We have for several years a strong partnership with Ted de Jong group at UC Davis concerning the influence of various agronomic practices (water stress, pruning) on fruit tree branching and production [21]. This is a tripartite collaboration that also involves Evelyne Costes of the AGAP/AFEF team.

A collaboration in plant phenotyping with the CSIRO and the INRA/Lepse team has been established for several years. The topic of the collaboration is to develop a full pipeline using OpenAlea 2.0 on plant phenotyping platforms. This is a joint collaboration with UMR LEPSE in Montpellier (François Tardieu).

A collaboration started in the last two years with the group of Henrik Jönsson of the Sainsbury Lab, Cambridge, UK. The collaboration is related to several modeling projects in the context of shoot apical and flower meristems development, with a particular focus on the use of quantitative 3D reconstructions of meristem structures. Yassin Refahi from the Sainsbury Lab is regularly paying visits to Montpellier. The Virtual Plants team is also regularly invited to Cambridge.

#### 8.3.2.2. BioSensors

**Participants:** Guillaume Cerutti, Sophie Ribes, Frédéric Boudon, Christophe Godin, Teva Vernoux [ENS-Lyon], Géraldine Brunoud [ENS-Lyon], Carlos Galvan-Ampudia [ENS-Lyon].

**Funding:** Human Frontiers - HFSP (From 2014 to 2017)

We propose to elucidate the basis for positional information by hormones during plant morphogenesis. While it is known that cell fate decisions require simultaneous input from multiple hormones, to-date a precise understanding of how these signals are coordinated and act together to drive morphogenesis does not exist. Our limited mechanistic understanding is largely due to the difficulty to quantify the distribution of these small molecules in space and time. To explore this fundamental question, we will exploit recent advances in synthetic biology to engineer an RNA-based biosensor platform applicable to a broad range of small molecules and in particular to hormones. Using live-imaging technologies, we will use the sensors to obtain quantitative dynamic 3D maps of hormone distributions and relate these maps to the spatio-temporal distribution of cell identities, both during normal morphogenesis and upon perturbations of hormone levels. This analysis will be done on the shoot apical meristem, one of the best characterized developmental systems in higher plants. In this context, mathematical approaches will be essential to analyze and establish a predictive model for how multiple hormones influence cell fate in a spatio-temporal manner.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

The team received several visitors from foreign research groups in 2015:

- Farah Ben Naoum, from Sidi Bel Abbes University, Algeria, visited the team last summer for 1 month.
- Yoan Coudert, from University of Cambridge, UK, visited the team for 3 months.
- David Ford, from University of Washington, USA, visited the team for 1 week.
- Winfried Kurth of the University of Goettingen, Germany, visited the team for 1 week in June.
- Dennis Shasha, from Courant Institute of Mathematics, New York University, in the context of an Inria international chair, visited the team during its stay.
- Julia Pulwiski, PhD student of the University of Calgary visited the team 2 weeks in May-June.

## **8.4.2. Visits to International Teams**

### *8.4.2.1. Research stays abroad*

- Frédéric Boudon visited Frédéric Normand of the UR Hortsys at the CIRAD La Réunion two weeks in April.
- Christophe Pradal visited Frédéric Normand of the UR Hortsys and Ian Bally and Paula Ibell of the University of Queensland at the CIRAD La Réunion two weeks in May.
- Christophe Pradal visited Professor Kurth of the University of Goettingen, Germany one week in November.

## **WIMMICS Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

### **8.1.1. Seminar with UNS**

We organize a seminar with Lise Arena (UNS, Gredeg) and Bernard Conein (UNS, Gredeg) between Inria and Univ. Nice-Sophia Antipolis on *Digital artifacts and materialities*. We organize a seminar on *Law, Philosophy and Digitality* between UNS faculties of Law and Philosophy and Inria. Alexandre Monnin will address the impact of digital technologies on law itself.

### **8.1.2. PEPS GéoIncertitude**

We participated in the CNRS PEPS GéoIncertitude, with researchers of the UMR 7300 ESPACE of Nice and of the IRIT of Toulouse on the modeling of uncertainty in Geography using fuzzy logic and possibility theory, which was re-financed for a second year.

### **8.1.3. SPARKS Team (I3S)**

Wimmics is member of the I3S SPARKS team (Scalable and Pervasive softwARE and Knowledge Systems). It is structured according to three axes: FORUM, ELK and S3.

#### **8.1.3.1. SPARKS FORUM Axis**

Wimmics contributes to the SPARKS FORUM research axis (FORMalizing with Users and Models). Catherine Faron-Zucker and Alain Giboin are co-animators of FORUM.

#### **8.1.3.2. SPARKS ELK Axis**

Wimmics contributes to the SPARKS ELK research axis (Knowledge Learning and Extracting). Andrea Tettamanzi is co-animator of ELK. Elena Cabrio, Tom Bosc and Farhad Nooralahzadeh contribute on it.

#### **8.1.3.3. SPARKS S3 Axis**

Wimmics contributes to the SPARKS S3 research group (Scalable Software Systems). Olivier Corby, Fuqi Song and Erwan Demairy contribute with federated distributed query processing in Corese with Johan Montagnat and Abdoul Macina. Catherine Faron-Zucker and Franck Michel contribute on it with Johan Montagnat on heterogeneous databases federation.

### **8.1.4. HCI Group (I3S)**

**Participant:** Alain Giboin.

The HCI Group animated by Anne-Marie Dery brings together I3S researchers conducting or wishing to conduct research related to Human-Computer Interaction. The group specifically addresses the issues of how to conduct user experiments to evaluate the UIs of the software developed in SPARKS. The group establishes collaborations between researchers in the design and implementation of experiments. This year Wimmics collaborated in the design, running and analysis of two experiments aiming at identifying and testing a set of principles for designing tabletop applications. One of the experiment involved Alzheimer people.

Wimmics also contributed to a working paper on the teaching of task modeling in the HCI curriculum of Polytech (with Philippe Renevier, Anne-Marie Dery and Gaëtan Rey). This paper was requested by the AFIHM working group “Enseignement sur l’analyse de tâches : leçons acquises et nouveaux défis”.

### **8.1.5. MSHS: Axis-2 ”ICT, Usage and Communities”**

**Participants:** Alain Giboin, Alexandre Monnin, Fabien Gandon, Emilie Palagi.

Axis-2 of the "Maison des Sciences Humaines et Sociales (MSHS) du Sud-Est (Nice)" aims to federate interdisciplinary research on the relationships between ICT, Practices and Communities. Wimmics is mainly involved in one of the Axis-2 groups-projects, "Artifacts and Coordination." This group-project studies the impact of cognitive technologies on the social and cognitive coordination between individuals in organizational and community contexts. Alain Giboin is co-animator of this group-project with Lise Arena (GREDEG). He is also co-animator (with Pierre Thérouanne (Lapcos), Lise Arena and Agnès Festré (GREDEG)) of the project "Acceptability of digital devices: an interdisciplinary perspective." During the first workshop organized this year on this topic, a talk was given by Alain Giboin on "Mesurer l'acceptabilité des collecticiels : de l'observation et/ou de la théorisation des activités collectives à l'élaboration de critères de mesure de l'acceptabilité". Alexandre Monnin is co-animator (with Lise Arena and Bernard Conein (GREDEG)) of a series of seminars on "Digital Artifacts and Materialities." During the first seminar, talks were given by Alexandre Monnin on "Quelques réflexions autour des couples artefacts/objets et numérique/matérialité", and by Alain Giboin on "Les personas comme artefacts substitués des utilisateurs dans un processus de conception".

## 8.2. National Initiatives

### 8.2.1. *BPI funded project : AZKAR*

**Participants:** Alain Giboin, Thierry Bergeron, Michel Buffa, Catherine Faron-Zucker.

AZKAR is a two years French project funded by BPI (Banque Publique d'Investissement), focused on *Fast Control of Mobile Robots over the Internet*, using Web technologies such as WebRTC and semantic Web technologies. The project started September 15th 2014. The first step of the project will be the evaluation/benchmarking of video and data solutions over internet, based on the WebRTC technology. The second step will consist in helping the robotic partner in the project (the Robosoft company) to implement these solutions on a real mobile robot that will be deployed in museums or in homes for helping seniors in their daily tasks. Semantic Web technologies, will be used in the project for describing the services, the context of the application domain, the content transmitted, etc.

This year, Wimmics main contributions were: a state-of-the-art on the techniques for transferring Web-based data/audio/video ; prototypes based on the technologies selected from the state-of-the-art ; a procedure and quantitative and qualitative criteria for benchmarking the prototypes.

### 8.2.2. *ANR LabCom SMILK*

**Participants:** Farhad Nooralahzadeh, Elena Cabrio, Fabien Gandon.

SMILK (Social Media Intelligence and Linked Knowledge) is a joint laboratory (LabCom, 2013-2016) between the Wimmics team and the Research and Innovation unit of VISEO (Grenoble). Natural Language Processing, Linked Open Data and Social Networks as well as the links between them are at the core of this LabCom. The purpose of SMILK is both to develop research and technologies in order to retrieve, analyze, and reason on textual data coming from Web sources, and to make use of LOD, social networks structures and interaction in order to improve the analysis and understanding of textual resources. Topics covered by SMILK include: use of data and vocabularies published on the Web in order to search, analyze, disambiguate and structure textual knowledge in a smart way, but also to feed internal information sources; reasoning on the combination of internal and public data and schemes, query and presentation of data and inferences in natural formats.

### 8.2.3. *Ministry of Culture: DBpedia.fr*

**Participants:** Raphaël Boyer, Fabien Gandon.

This project named "DBpedia.fr" proposes the creation of a French chapter of the base DBpedia used in many English applications, in particular for the publication of cultural collections. Because DBpedia is focused on the English version of Wikipedia it ignores some of the French topics and their data. This project aims at extracting a maximum of RDF data from the French version and providing a stable and scalable end-point for them. We now consider means to improve both the quantity and the quality of the data. The DBpedia.fr project was the first project of the Semanticpedia convention signed by the Ministry of Culture, the Wikimedia foundation and Inria.

A new complete DBpedia extraction has been performed, together with a technical documentation to reproduce it and a documentation for the users has been done too. In addition we have included the last community user interface and adapted it for French DBpedia. This version is more ergonomic and detailed, but also integrates a new SPARQL editor named Flint for students and beginners. A new DBpedia service from the community has been adapted for the French version: it's called "fragments", a service made for minimizing server processing.

Some scripts have been developed, one for generation of statistics based on log, others for grouping the abstracts of each language, based on redirections and interlanguages linked data. Also to increase our amount of available data, we created a new extractor that can extract historic and make statistics of modifications of each Wikipedia article.

Web site: <http://wimmics.inria.fr/projects/dbpedia>

#### **8.2.4. Ministry of Culture: GT 6**

**Participant:** Fabien Gandon.

We supervised the working group GT6 Ministry of Culture on the creation of a research convention to foster research and development at the crossroad of culture and digital sciences.

#### **8.2.5. ANR OCKTOPUS**

**Participants:** Fabien Gandon, Catherine Faron-Zucker, Zide Meng.

OCKTOPUS is an ANR project (2012-2016). The objective of OCKTOPUS is to increase the potential social and economic benefit of the large and quickly growing amounts of user-generated content, by transforming it into useful knowledge. We believe that it is possible to considerably improve upon existing generic Information Retrieval techniques by exploiting the specific structure of this content and of the online communities which produce it. Specifically, we will focus on a multi-disciplinary approach in order to address the problem of finding relevant answers to questions within forums and question-answer sites. To create metrics and predictors of content quality and use them to improve the search experience of a user, we will take advantage of:

- the experience of the CRG (the management research institute of Ecole Polytechnique and CNRS) to understand better the incentives of, and interactions between individuals who produce online content within large communities;
- the experience of the Wimmics research team to analyze the structural and temporal aspects of the complex typed social graphs found within these communities;
- the ability of Alcméon (a start-up developing a search application dedicated to user-generated content) to integrate and test the results of OCKTOPUS within a common demonstration framework, in order to assess their practical usefulness when applied to concrete large-scale datasets.

Partners: Alcméon, CRG, Inria Wimmics.

Web site: <http://ocktopus.alcmeon.com>

#### **8.2.6. GDRI Zoomathia**

**Participants:** Olivier Corby, Catherine Faron-Zucker, Alexandre Monnin, Andrea Tettamanzi.

Wimmics is partner of International Research Group (GDRI) Zoomathia funded by two CNRS institutes: INEE and INSHS. It aims at studying transmission of zoological knowledge from Antiquity to Middle-Age through material resources (bio residues, artefacts), iconography and texts.

One of the goals of the project is to design a thesaurus and semantically annotate resources, capturing different types of knowledge: zoonyme, historical period, zoological speciality (ethology, anatomy, physiology, psychology, zootechnique, etc.), literary genre or iconography.

We started to work on 1) the translation of manual annotations of middle-age structured texts from XML to RDF, 2) the automatic extraction of RDF annotations from text using NLP techniques and 3) the exploitation of these semantic metadata to help historians in their studies of knowledge transmission through these texts.

Web site: <http://www.cepam.cnrs.fr/zoomathia/>

### **8.2.7. Semantic EDUCLOUD Carnot Project**

**Participants:** Oscar Rodriguez Rocha, Catherine Faron-Zucker.

Partner : GAYAtch. This project was just accepted this year on the topic of *semantic Web for e-learning*. This is a joint project with Gayatech on the recommendation of pedagogical resources adapted to user profile and context in the EDUCLOUD 06 Serious Game. To get help in his quests and various quiz testing his knowledge, the gamer can use external digital resources (books, video, TV, Web) and an in-game social network to work with his teacher and comrades. In this context, and to meet the needs of GAYATECH developing edutainment solutions, the Semantic EDUCLOUD project aims to improve the recommendation of educational resources to learners in EDUCLOUD 06, by using semantic Web and social Web models and techniques.

### **8.2.8. Carnot Project Vigiglobe**

**Participants:** Elena Cabrio, Serena Villata.

Partner : Vigiglobe.

This project was just accepted this year on the topic of *Natural Language Argumentation on Twitter: Retrieval of Argumentative Structures and Reasoning*. This is a joint project with Vigiglobe on the natural language processing of argumentation on Twitter to retrieve argumentative structures and reason on them. The goal of the project is to : (1) Automate the selection and annotation of tweets, i.e., retrieval of those tweets that can be considered as arguments (2) Automate the assignment of labels to the type of relation holding between arguments - positive relation or negative relation. (3) Create an argumentation graph illustrating the relations between the arguments about a certain subject, and the further application of argumentation semantics to compute the set of “winning” arguments This graph-based visualization provides a summary of the ongoing discussion on Twitter.

### **8.2.9. FUI PadDOC**

**Participants:** Patrice Pena, Alain Giboin.

PadDOC goal is to contribute to accelerating the digital transition of citizen, local and regional authorities, administrations and enterprises, by : (1) developing an open standard and innovative software and hardware resources to facilitate nearby or distant administrative formalities and procedures; (2) improving the security of the holder’s personal data by putting these data under the exclusive control of the holder; (3) exploiting unmarked communicating supports (such as smartphones or tablets) for all chain actors. PadDOC partners are: Docapost BPO, Anyces, ABC SmartCard and the teams Rainbow, Media-Coding and Wimmics. Wimmics will contribute to: (1) the analysis, design and evaluation of the PadDOC security-oriented user interfaces; (2) the impact assessment of the chain of actors participating in the experiment to validate the viability of the PadDOC social system. The PadDOC project officially began in November 2014.

This year, Wimmics main contributions were: a state-of-the-art on user-centered privacy and security (leading to the identification of the security and privacy aspects to be taken into account, from a user’s point of view, in the design of a mobile device used to communicate personal data and documents); a field study of users performing administrative procedures from the point of view of security and privacy; and the functional mock-ups of the GUIs of the PadDOC mobile application to be used by the client of a commercial or administrative service.



## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. ALOOF CHIST-ERA

**Participants:** Valerio Basile, Elena Cabrio, Fabien Gandon.

ALOOF (Autonomous Learning of the Meaning of Objects) is a European project (CHIST-ERA 2015-2018) to enable robots to use the ever-growing amount of knowledge available on the Web, by learning from there about the meaning of previously unseen objects, expressed in a form that makes them applicable when acting in situated environments. Partners include: University of Rome La Sapienza (Italy), University of Birmingham (United Kingdom), Technische Universität Wien (Austria), Inria Sophia Antipolis Méditerranée (France).

Web site: <http://www.dis.uniroma1.it/~aloof>

## 8.4. International Initiatives

### 8.4.1. Inria International Labs

We participate to the LIRIMA Africa (Laboratoire international de recherche en informatique et mathématiques appliquées) where we have a long term collaboration with University Gaston Berger in Saint-Louis, Senegal, with Pr. Moussa Lo. We host two PhD students in co-supervision with UBG: Papa Fary Diallo and Oumy Seye [60].

### 8.4.2. Inria Associate Teams not involved in an Inria International Labs

#### 8.4.2.1. SEEMPAD

**Participants:** Elena Cabrio, Serena Villata, Valerio Basile, Fabien Gandon, Claude Frasson.

##### **SEEMPAD**

Title: Social Exchanges and Emotions in Mediated Polemics - Analysis and Data

International Partner (Institution - Laboratory - Researcher):

University of Montréal (Canada) - Higher Educational Research ON tutoring systems (Heron) - Claude Frasson

Start year: 2014

Team site: <https://project.inria.fr/seempad/>

Generating, annotating and analyzing a dataset that documents a debate. We aim at synchronizing several dimensions: social links (intensity, alliances, etc.); interactions happening (who talks to whom); textual content of the exchanged messages; social-based semantic relations among the arguments; emotions, polarity, opinions detected from the text; emotions, physical state detected from sensors.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

#### 8.5.1.1. Internships

Lautaro Petaccio

Title: Design and development of a fact-checking framework based on argumentation theory and Natural Language Processing techniques.

Date: August 2015-December 2015

Institution: Universidad de Buenos Aires (Argentina)

Supervisor: Elena Cabrio, Serena Villata

Clémence Chauvet

Title: GUI for a requirement system  
Date: from June 2015 until August 2015  
Univ. Nice  
Supervisor: Isabelle Mirbel et Serena Villata

Molka Dhouib

Title: Integration and enrichment of cultural heritage metadata on the Web of Data.  
Date: until September 2015  
Univ. Nice, Master 2  
Supervisor: Catherine Faron-Zucker, Elena Cabrio

Raphael Gazzotti

Title: Checking OWL profile conformance with SPARQL Template Transformation Language  
Date: from May 2015 until September 2015  
Univ. Nice, Master 2  
Supervisor: Olivier Corby

Racha Gouareb

Title: Semantic Annotation of Lyrics  
Date: from May 2015 until October 2015  
Univ. Nice  
Supervisor: Michel Buffa, Catherine Faron-Zucker

Ahmed Missaoui

Title: Integration and enrichment of cultural heritage metadata on the Web of Data  
Date: October 2014 - February 2015  
Univ. Nice  
Supervisor: Elena Cabrio, Catherine Faron-Zucker and Serena Villata

Baffoue Kangah

Title: Robot Navigation Web Control  
Date: from May 2015 until October 2015  
Univ. Nice  
Supervisor: Michel Buffa, Catherine Faron-Zucker

Garance Vallat

Title: Semantic Web based platform for bibliography query and visualisation  
Date: from June 2015 until August 2015  
Univ. Nice, Master 1  
Supervisor: Olivier Corby, Mireille Blay-Fornarino (I3S)

Reda Zarhbouch

Title: From user requirement to BPMN service composition modeling  
Date: from May 2015 until October 2015  
Univ. Nice, Master MIAGE  
Supervisor: Isabelle Mirbel

Konstantina Poulida

Title: Extraction of Zoological Knowledge from Ancient and Middle-Age Scientific Texts  
Date: from November 2015 to January 2016  
Inria, University of Patras, Greece  
Supervisor: Catherine Faron-Zucker, Andrea Tettamanzi

## **8.5.2. Visits to International Teams**

### *8.5.2.1. Research stays abroad*

Catherine Faron-Zucker spent the month of July at the Hasso Platner Institute (HPI) in Potsdam, Germany. She presented her research work in a seminar of the Semantic Web group.

Alexandre Monnin spent the month of November at the Digital Cultures Research Center (Leuphana University, Lüneburg, Germany), as a Research Fellow, to participate in the discussions on the semester's topic ("Non-knowledge and Digital Cultures"). Among other things he did a response to a talk delivered by Jeannie Moser's on "Mistrust", did two interviews on digital cultures, and participate in the non-knowledge seminar organized in Braunschweig, Germany.

## ZENITH Project-Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. Labex NUMEV, Montpellier

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

We are participating in the Laboratory of Excellence (labex) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences) headed by University of Montpellier 2 in partnership with CNRS, University of Montpellier 1, and Inria. NUMEV seeks to harmonize the approaches of hard sciences and life and environmental sciences in order to pave the way for an emerging interdisciplinary group with an international profile. The NUMEV project is decomposed in four complementary research themes: Modeling, Algorithms and computation, Scientific data (processing, integration, security), Model-Systems and measurements. Florent Masegla co-heads (with Pascal Poncelet) the theme on scientific data.

### 9.1.2. Institut de Biologie Computationnelle (IBC), Montpellier

URL: <http://www.abc-montpellier.fr>

IBC is a 5 year project with a funding of 2Meuros by the MENRT (PIA program) to develop innovative methods and software to integrate and analyze biological data at large scale in health, agronomy and environment. Patrick Valduriez heads the workpackage on integration of biological data and knowledge.

## 9.2. National Initiatives

### 9.2.1. PIA (*Projets Investissements d'Avenir*)

#### 9.2.1.1. Datascale (2013-2015), 250Keuros

**Participants:** Reza Akbarinia, Florent Masegla, Saber Salah, Patrick Valduriez.

The Datascale project is a PIA on big data with Bull (leader), CEA, ActiveEon SAS, Armadillo, Twenga, IPGP, Xedix and Inria (Zenith) . The goal of the project is to develop the essential technologies for big data, including efficient data management, software architecture and database architecture, and demonstrate their scalability with representative applications. In this project, the Zenith team works on data mining with Hadoop MapReduce.

#### 9.2.1.2. Xdata (2013-2015), 125Keuros

**Participants:** Julien Diener, Patrick Valduriez.

The X-data project is a PIA with Data Publica (leader), Orange, La Poste, EDF, Cinequant, Hurence and Inria (Indes, Planete and Zenith) . The goal of the project is to develop a big data platform with various tools and services to integrate open data and partners's private data for analyzing the location, density and consuming of individuals and organizations in terms of energy and services. In this project, the Zenith team heads the workpackage on data integration.

#### 9.2.1.3. PIA Floris'Tic (2015-2018), 430Keuro.

**Participants:** Julien Champ, Alexis Joly.

Floris'tic is a PIA aimed at promoting the scientific and technical culture of plant sciences through innovative pedagogic methods, including participatory initiatives and the use of IT tools such as the one built within the Pl@ntNet project. A. Joly heads the work package on the development of the IT tools. This is a joint project with the AMAP laboratory and the TelaBotanica social network.

## 9.2.2. Others

### 9.2.2.1. CIFRE INA/Inria (2013-2016), 100Keuros

**Participants:** Alexis Joly, Valentin Leveau, Patrick Valduriez.

This CIFRE contract with INA allows funding a 3-years PhD (Valentin Leveau). This PhD addresses research challenges related to large-scale supervised content-based retrieval in distributed environments.

### 9.2.2.2. CNRS INS2I Mastodons (2013-2015), 90Keuros

**Participants:** Alexis Joly, Florent Masseglia, Esther Pacitti [leader], Patrick Valduriez.

This project deals with the problems of big data in the context of life science, where masses of data are being produced, e.g. by Next Generation Sequencing technologies or plant phenotyping platforms. In this project, Zenith addresses the specific problems of large-scale data analysis and data sharing.

## 9.3. European Initiatives

### 9.3.1. FP7 Projects

#### 9.3.1.1. CoherentPaaS

**Participants:** Carlyna Bondiombouy, Boyan Kolev, Oleksandra Levchenko, Patrick Valduriez.

Project title: A Coherent and Rich Platform as a Service with a Common Programming Model

Instrument: Integrated Project

Duration: 2013 - 2016

Total funding: 5 Meuros (Zenith: 500Keuros)

Coordinator: U. Madrid, Spain

Partner: FORTH (Greece), ICCS (Greece), INESC (Portugal) and the companies MonetDB (Netherlands), QuartetFS (France), Sparsity (Spain), Neurocom (Greece), Portugal Telecom (Portugal).

Inria contact: Patrick Valduriez

Accessing and managing large amounts of data is becoming a major obstacle to developing new cloud applications and services with correct semantics, requiring tremendous programming effort and expertise. CoherentPaaS addresses this issue in the cloud PaaS landscape by developing a PaaS that incorporates a rich and diverse set of cloud data management technologies, including NoSQL data stores, such as key-value data stores and graph databases, SQL data stores, such as in-memory and column-oriented databases, hybrid systems, such as SQL engines on top on key-value data stores, and complex event processing data management systems. It uses a common query language to unify the programming models of all systems under a single paradigm and provides holistic coherence across data stores using a scalable, transactional management system. CoherentPaaS will dramatically reduce the effort required to build and the quality of the resulting cloud applications using multiple cloud data management technologies via a single query language, a uniform programming model, and ACID-based global transactional semantics. CoherentPaaS will design and build a working prototype and will validate the proposed technology with real-life use cases. In this project, Zenith is in charge of designing the CloudMdsQL language and implementing its compiler/optimizer and query engine.

#### 9.3.1.2. HPC4E

**Participants:** Reza Akbarinia, Florent Masseglia, Esther Pacitti, Patrick Valduriez.

Project title: High Performance Computing for Energy

Instrument: H2020

Duration: 2015 - 2017

Total funding: 2 Meuros

Coordinator: Barcelona Supercomputing Center (BSC), Spain

Partner: Europe: Inria, Lancaster University, Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, Repsol S.A., Iberdrola Renovables Energía S.A., Total S.A. Brazil: COPPE/Universidade Federal de Rio de Janeiro, LNCC, Instituto Tecnológico de Aeronáutica (ITA), Universidade Federal do Rio Grande do Sul, Universidade Federal de Pernambuco, PETROBRAS.

Inria contact: Patrick Valduriez

The main objective is to develop beyond-the-state-of-the-art high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using the state-of-the-art HPC systems. The project also aims at improving the usage of energy using HPC tools by acting at many levels of the energy chain for different energy sources. Another objective is to improve the cooperation between energy industries from EU and Brazil. The project includes relevant energy industrial partners from Brazil (PETROBRAS) and EU (REPSOL and TOTAL as O & G industries), which will benefit from the project's results. A last objective is to improve the cooperation between the leading research centres in EU and Brazil in HPC applied to energy industry. This includes sharing supercomputing infrastructures between Brazil and EU. The cross-fertilization between energy-related problems and other scientific fields will be beneficial at both sides of the Atlantic. In this project, Zenith is working on Big Data management and analysis of numerical simulations.

## 9.4. International Initiatives

### 9.4.1. Inria Associate Teams

#### 9.4.1.1. MUSIC

Title: MUltiSite Cloud (MUSIC) data management

Inria principal investigator: Esther Pacitti

International Partner):

Laboratorio Nacional de Computação Científica, Petropolis (Brazil) - Fabio Porto

Universidade Federal do Rio de Janeiro (Brazil) - Alvaro Coutinho and Marta Mattoso

Universidade Federal Fluminense, Niteroi (Brazil) - Daniel Oliveira

Centro Federal de Educação Tecnológica, Rio de Janeiro (Brazil) - Eduardo Ogasawara

Duration: 2014 - 2016

See also: <https://team.inria.fr/zenith/projects/international-projects/music/>

The cloud has become a good match for managing big data since it provides unlimited computing, storage and network resources on demand. By centralizing all data in a large-scale data-center, the cloud significantly simplifies the task of system administration. But for scientific data, where different organizations may have their own data-centers, a distributed (multisite) cloud model where each site is visible from outside, is needed. The main objective of this research and scientific collaboration is to develop a multisite cloud architecture for managing and analyzing scientific data, including support for heterogeneous data; distributed scientific workflows, and complex big data analysis. The resulting architecture will enable scalable data management infrastructures that can be used to host a variety of scientific applications that benefit from computing, storage, and networking resources that span multiple data-centers.

#### 9.4.1.2. BIGDATANET

Title: A hybrid P2P/cloud for big data

Inria principal investigator: Patrick Valduriez

International Partner : University of California at Santa Barbara (USA) - Amr El Abbadi and Divy Agrawal

Duration: 2013 - 2015

See also: <https://team.inria.fr/zenith/projects/international-projects/bigdatanet/>

The main objective of this research and scientific collaboration is to develop a hybrid architecture of a computational platform that leverages the cloud computing and the P2P computing paradigms. The resulting architecture will enable scalable data management and data analysis infrastructures that can be used to host a variety of next-generation applications that benefit from computing, storage, and networking resources that exist not only at the network core (i.e., data-centers) but also at the network edge (i.e., machines at the user level as well as machines available in CDNs – content distribution networks hosted in ISPs).

## **9.4.2. Inria International Partners**

### **9.4.2.1. Informal International Partners**

We have regular scientific relationships with research laboratories in

- North America: Univ. of Waterloo (Tamer Özsu).
- Asia: National Univ. of Singapore (Beng Chin Ooi, Stéphane Bressan), Wonkwang University, Korea (Kwangjin Park)
- Europe: Univ. of Amsterdam (Hamideh Afsarmanesh), Univ. of Madrid (Ricardo Jiménez-Periz), UPC Barcelona (Josep Lluís Larriba Pey), HES-SO (Henning Müller), University of Catania (Concetto Spampinato), The Open University (Stefan Rüger)
- North Africa: Univ. of Tunis (Sadok Ben-Yahia)

### **9.4.3. Inria International Labs**

The Bigdatanet associated team takes part of the Inria@SiliconValley lab.

### **9.4.4. Participation In other International Programs**

We are involved in the following international actions:

- CNPq-Inria project Hoscar (HPC and data management, 2012-2015) with LNCC (Fabio Porto), UFC, UFRGS (Philippe Navaux), UFRJ (Alvaro Coutinho, Marta Mattoso) to work on data management in high performance computing environments.

## **9.5. International Research Visitors**

### **9.5.1. Visits of International Scientists**

Marta Mattoso (UFRJ, Brazil) gave a seminar on “Exploratory Analysis of Raw Data Files through Dataflows” in March.

### **9.5.2. Visits to International Teams**

Maximilien Servajean visited UCSB in June, in the context of the Bigdatanet associated team.