



RESEARCH CENTER  
Sophia Antipolis - Méditerranée

FIELD

Activity Report 2014

# Section Partnerships and Cooperations

Edition: 2015-06-01



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## **AOSTE Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

### **8.1.1. CIM PACA Design Platform**

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

This ambitious regional initiative is intended to foster collaborations between local PACA industry and academia partners on the topics of microelectronic design, though mutualization of equipments, resources and R&D concerns. We are active in the **Design Platform** (one of three platforms), of which Inria is a founding member. This provides opportunities for interactions with local companies, leading indirectly to more formal collaborations at times. Phase 3 of the CIM PACA programme should be launched in 2015, and was subject of extensive preparation at the end of 2014.

The ANR HOPE project **8.2.1.1** is conducted under the auspices of the CIM PACA Design Platform, which also hosts prototype and commercial software products contributed by project members (Synopsys, Docea Power, and Magillem, see **8.2.1.1** ). Similarly, the CLISTINE FUI project was labeled by the platform as microelectronic branch of the SCS competitiveness cluster.

## **8.2. National Initiatives**

### **8.2.1. ANR**

#### **8.2.1.1. 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 FDL'2014, reflecting Ameni Khecharem ongoing PhD work.

#### **8.2.1.2. 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).

### **8.2.2. FUI**

#### **8.2.2.1. 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).

#### 8.2.2.2. *FUI CLISTINE*

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

This project was started in Oct 2013, aprovides 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 (konown as "Dwarfs" in teh literature), to provide benchmarks to evaluate the platform design options.

### 8.2.3. *Investissements d'Avenir*

#### 8.2.3.1. *DEPARTS*

**Participants:** Liliana Cucu-Grosjean, Adriana Gogonel, Codé Lo, Cristian Maxim.

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.

#### 8.2.3.2. *CLARITY*

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

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

#### 8.2.3.3. *Capacites*

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

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

## 8.3. European Initiatives

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

#### 8.3.1.1. ARTEMIS PRESTO

**Participants:** Frédéric Mallet, Arda Goknil, Julien Deantoni, Marie Agnès Peraldi Frati, Robert de Simone, Jean-Vivien Millo.

Type: ARTEMIS

Project title: PRESTO

Duration: April 2011 - March 2014

Coordinator: Miltech (Greece)

Others partners: TELETEL S.A. (Greece), THALES Communications (France), Rapita Systems Ltd. (United Kingdom), VTT (Finland), Softeam (France), THALES (Italy), MetaCase (Finland), Inria (France), University of L'Aquila (Italy), MILTECH HELLAS S.A (Greece), PragmaDev (France), Prismtech (United Kingdom), Sarokal Solutions (Finland).

See also: <http://www.cesarproject.eu/>

Abstract: The PRESTO project aims at improving test-based embedded systems development and validation, while considering the constraints of industrial development processes. This project is based on the integration of test traces exploitation, along with platform models and design space exploration techniques. Such traces are obtained by execution of test patterns, during the software integration design phase, meant to validate system requirements. The expected result of the project is to establish functional and performance analysis and platform optimisation at early stage of the design development. The approach of PRESTO is to model the software/hardware allocation, by the use of modelling frameworks, such as the UML profile for model-driven development of Real Time and Embedded Systems (MARTE). The analysis tools, among them timing analysis including Worst Case Execution Time (WCET) analysis, scheduling analysis and possibly more abstract system-level timing analysis techniques will receive as inputs on the one hand information from the performance modelling of the HW/SW-platform, and on the other hand behavioural information of the software design from tests results of the integration test execution.

## 8.4. International Initiatives

### 8.4.1. Inria International Labs

#### 8.4.1.1. HADES LIAMA project

This joint project is held in collaboration with ECNU Shanghai, together with the Scale Inria team, and extends in scope the Associated Team DAESD (see below). As part of this project Frédéric Mallet spends a sabbatical year at ECNU Shanghai, partly funded by an Inria delegation programme.

We attended a number of LIAMA meetings, both in France and in Beijing, most often in confcall form.

### 8.4.2. Inria Associate Teams

#### 8.4.2.1. DAESD

Title: Distributed/Asynchronous and Embedded/synchronous Systems Development

Inria principal investigator: Robert de Simone (Aoste) / Eric Madelaine (Scale)

International Partner (Institution - Laboratory - Researcher):

East China Normal University (China) - SEI-Shone - Robert De Simone

Duration: 2012 - 2014

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

The development of concurrent and parallel systems has traditionally been clearly split in two different families: distributed and asynchronous systems on one hand, now growing very fast with the recent progress of the Internet towards large scale services and clouds; embedded, reactive, or hybrid systems on the other hand, mostly of synchronous behaviour. The frontier between these families has attracted less attention, but recent trends, e.g. in industrial systems, in Cyber-Physical systems (CPS), or in the emerging Internet of Things, give a new importance to research combining them.

The aim of the DAESD associate team is to combine the expertise of the Oasis and Aoste teams at Inria, the SEI-Shone team at ECNU-Shanghai, and to build models, methods, and prototype software tools inheriting from synchronous and asynchronous models. We plan to address modelling formalisms and tools, for this combined model; to establish a method to analyze temporal and spatial consistency of embedded distributed real-time systems; to develop scheduling strategies for multiple tasks in embedded and distributed systems with mixed constraints.

A dedicated Summer School was organized this year in Shanghai (July 8-11), with participation of Julien Deantoni and Frédéric Mallet from Aoste.

DAESD is strongly linked with the LIAMA project HADES, that it supports.

## **8.5. International Research Visitors**

### ***8.5.1. Visits of International Scientists***

#### *8.5.1.1. Invited Professor*

Qingguo XU

Date: July 2014 to June 2015

Institution: Shanghai University (China)

### ***8.5.2. Visits to International Teams***

#### *8.5.2.1. Sabbatical programme*

Mallet Frédéric

Date: Sep 2014 - Aug 2015

Institution: **ECNU** (China)



## GALAAD2 Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. 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>.

### 8.1.2. 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.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. TERRIFIC

Title: Towards Enhanced Integration of Design and Production in the Factory of the Future through Isogeometric Technologies

Type: COOPERATION (ICT)

Defi: PPP FoF: Digital factories: Manufacturing design and product lifecycle manage

Instrument: Specific Targeted Research Project (STREP)

Duration: September 2011 - August 2014

Coordinator: SINTEF, Oslo (Norway)

Others partners:

Alenia Aeronautica (Italy); Inria Méditerranée (France); Jozef Kepler universitet, Linz (Austria); JOTNE, Oslo (Norway); MAGNA, Steyr (Austria); Missler Software (France); Siemens AG (Germany); Technische Universität Kaiserslautern (Germany); University of Pavia (Italy).

See also: <http://terrific-project.eu>

Abstract: The project aims at significant improvement of the interoperability of computational tools for the design, analysis and optimization of functional products. An isogeometric approach is applied for selected manufacturing application areas (cars, trains, aircrafts) and for computer-aided machining. Computer Aided Design (CAD) and numerical simulation algorithms are vital technologies in modern product development, yet they are today far from being seamlessly integrated. Their interoperability is severely disturbed by inconsistencies in the mathematical approaches used. Efficient feedback from analysis to CAD and iterative refinement of the analysis model is a feature of isogeometric analysis, and would be an essential improvement for computer-based design optimization and virtual product development. Our vision is to provide and disseminate tangible evidence of the performance of the isogeometric approach in comparison to traditional ones in four important application areas as well as addressing interoperability and other issues that necessarily arise in a large-scale industrial introduction of isogeometry.

### 8.3. International Initiatives

#### 8.3.1. 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 2013-August 2014. 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 (L. Busé).

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.

### 8.4. International Research Visitors

#### 8.4.1. Visits of International Scientists

Chandrajit Bajaj, professor at University of Austin, Texas, USA, September 14-28.

Nicolàs Botbol, researcher CONICET, University of Buenos Aires, Argentina, March 10-23.

Philippe Trébuchet, LIP6, University of Paris 6, France, May 4-11.

Nelly Villamizar, researcher at RICAM, University of Linz, Austria, February 19-26.

#### 8.4.2. Visits to International Teams

##### 8.4.2.1. Research stays abroad

Evelyne Hubert was invited to participate to the program on *Inverse Moment Problems: the Crossroads of Analysis, Algebra, Discrete Geometry and Combinatorics* at the Institute for Mathematical Science at the National University of Singapore (December 1013 - January 2014).

## GEOMETRICA Project-Team

# 8. Partnerships and Cooperations

## 8.1. Technological Development Actions

### 8.1.1. ADT PH

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

- Title: Persistent Homology
- Coordinator: Mariette Yvinec (GEOMETRICA)
- Duration: 1 year renewable once, starting date December 2012. Renewed for 1 year from January 1st 2014 to December 31st 2014
- Others Partners: Inria team ABS, Gipsa Lab (UMR 5216, Grenoble, <http://www.gipsa-lab.inpg.fr/>)
- Abstract: Geometric Inference is a rapidly emerging field that aims to analyse the structural, geometric and topological, properties of point cloud data in high dimensional spaces. The goal of the ADT PH is to make available, a robust and comprehensive set of algorithmic tools resulting from recent advances in Geometric Inference. The software will include:

tools to extract from the data sets, families of simplicial complexes,  
 data structures to handle those simplicial complexes,  
 algorithmic modules to compute the persistent homology of those complexes,  
 applications to clustering, segmentation and analysis of scalar fields such as the energy landscape of macromolecular systems.

### 8.1.2. ADT OrbiCGAL

**Participants:** Aymeric Pellé, Monique Teillaud.

- Title: OrbiCGAL
- Coordinator: Monique Teillaud (GEOMETRICA)
- Duration: 1 year renewable once, starting date September 2013.
- Abstract: OrbiCGAL is a software project supported by Inria as a Technological Development Action (ADT). It is motivated by applications ranging from infinitely small (nano-structures) to infinitely large (astronomy), through material engineering, physics of condensed matter, solid chemistry, etc

The project consists in developing or improving software packages to compute triangulations and meshes in several types of non-Euclidean spaces: sphere, 3D closed flat manifolds, hyperbolic plane.

## 8.2. Regional Initiatives

### 8.2.1. Digiteo project TOPERA

**Participants:** Frédéric Chazal, Marc Glisse, Anaïs Vergne.

TOPERA is a project that aims at developing methods from Topological Data Analysis to study covering properties and quality of cellular networks. It also involves L. Decreusefond and P. Martins from Telecom Paris.

- Starting date: December 2013
- Duration: 18 months

## 8.3. National Initiatives

### 8.3.1. ANR Présage

**Participants:** Olivier Devillers, Marc Glisse, Ross Hemsley, Monique Teillaud, Rémy Thomasse.

- Acronym: Presage.
- Type: ANR blanc.
- Title: *méthodes PRobabilistes pour l'Éfficacité des Structures et Algorithmes GÉométriques*.
- Coordinator: Xavier Goaoc.
- Duration: 31 december 2011 - 31 december 2015.
- Other partners: Inria VEGAS team, University of Rouen.
- Abstract: This project brings together computational and probabilistic geometers to tackle new probabilistic geometry problems arising from the design and analysis of geometric algorithms and data structures. We focus on properties of discrete structures induced by or underlying random continuous geometric objects. This raises questions such as:
  - What does a random geometric structure (convex hulls, tessellations, visibility regions...) look like?
  - How to analyze and optimize the behavior of classical geometric algorithms on *usual* inputs?
  - How can we generate randomly *interesting* discrete geometric structures?
- Year publications: [56], [33], [48], [52], [62], [61], [12]

### 8.3.2. ANR TOPDATA

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

- Acronym : TopData.
- Title : Topological Data Analysis: Statistical Methods and Inference.
- Type : ANR blanc
- 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>

## **8.4. European Initiatives**

### **8.4.1. FP7 & H2020 Projects**

#### *8.4.1.1. GUDHI*

Type: FP7

Instrument: ERC Advanced Grant

Duration: February 2014 - January 2019

Coordinator: Jean-Daniel Boissonnat

Inria contact: Jean-Daniel Boissonnat

Abstract: The central goal of this project is to settle the algorithmic foundations of geometry understanding in dimensions higher than 3. Geometry understanding encompasses a collection of tasks including the approximation and computer representation of geometric structures, and the inference of geometric or topological properties of sampled shapes.

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

## **8.5. International Research Visitors**

### **8.5.1. Visits of International Scientists**

Pedro Machado Manhães de Castro (Universidade Federal de Pernambuco)

Arijit Ghosh (MPII, Saarbrücken), april, november-december

Antoine Vigneron (KAUST), may

Ramsay Dyer (Johann Bernoulli Institute, University of Groningen), octobre

Kira Vyatkina (Saint Petersburg Academic University), octobre

Vissarion Fisikopoulos (Université Libre de Bruxelles), november

## MARELLE Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

In 2014, we participated to two successful applications for funding from the French national agency for research (ANR).

- 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. International Initiatives

### 8.2.1. Inria International Partners

#### 8.2.1.1. Informal International Partners

Our main partner for work on Ssreflect is Georges Gonthier, senior researcher at Microsoft Research, Cambridge.

Our team has important discussions with the team of Thierry Coquand at *Chalmers University and University of Göteborg*. This was illustrated in the past by the European project FORMATH, in the context of which we collaborated around the formalization of various aspects of Algebra (linear algebra and algebraic topology). This effort was continued in the context of the international effort around *homotopy type theory*, where Cyril Cohen is deeply involved (in particular in the implementation of a model for cubical sets). In the future, we may hope to play a continuing role in *homotopy theory* and establish more contacts with other sites involved in this topic.

We participate in the international development of the Coq community and maintain frequent contacts with the most active users around the world. In practice, this implies many contacts with several universities in the United States of America: Princeton University, University of Pennsylvania, the Massachusetts Institute of Technology, Harvard University, and Yale University.

We have intensive collaborations with IMDEA, Madrid. In particular, the software systems EasyCrypt and ZooCrypt are developed in collaboration with this institution, and several of our publications are co-authored between Inria and IMDEA.

## 8.3. International Research Visitors

### 8.3.1. Visits of International Scientists

#### 8.3.1.1. Sabbatical programme

Amy Felty, professor at University of Ottawa, was a member of our team until September 30th, on sabbatical leave from her university, and with no extra financial support from Inria.

Dough Howe, professor at Carleton University, was a member of our team until August 31st, on sabbatical leave from his university, and with no extra financial support from Inria.

## **APICS Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

### **8.1.1. Contract Provence Alpes Côte d'Azur (PACA) Region - Inria, BDO**

Contract (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**

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), respectively specialized in filters, antennas and amplifiers design. The core idea of the project is to work on the co-integration of various microwave devices in the context of GPS satellite systems in particular it provides us with an opportunity to work on matching problems (see Section 6.3.1 ).

### **8.2.2. ANR MagLune**

The ANR project MagLune (Magnétisme de la Lune) has been approved by July 2014. It involves the Cerege (Centre de Recherche et d'Enseignement de Géosciences de l'Environnement, joint laboratory between Université Aix-Marseille, CNRS and IRD), the IPGP (Institut de Physique du Globe de Paris) and ISTerre (Institut des Sciences de la Terre). Associated with Cerege are Inria (Apics team) and Irphe (Institut de Recherche sur les Phénomènes Hors Équilibre, joint laboratory between Université Aix-Marseille, CNRS and École Centrale de Marseille). The goal of this project (led by geologists) is to understand the past magnetic activity of the Moon, especially to answer the question whether it had a dynamo in the past and which mechanisms were at work to generate it. Apics will participate 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**

#### **8.4.1.1. IMPINGE**

Title: Inverse Magnetization Problems IN GEosciences.

Inria principal investigator: Laurent Baratchart

International Partner (Institution - Laboratory - Researcher):

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

Duration: 2013 - 2015

See details at : <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 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 . 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”

**Cyprus NF grant** was obtained by N. Stylianopoulos (Univ. Cyprus) to conduct joint research with L. Baratchart, E.B. Saff (Vanderbilt Univ.) and V. Totik (Univ. Szeged, Hungary). The title of the grant is: “Orthogonal polynomials in the complex plane: distribution of zeros, strong asymptotics and shape reconstruction”.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

- Doug Hardin (Vanderbilt Univ., Nashville, USA, Aug 2014)
- Benjamin Lanfer (BESA, Munich, Germany, Oct 2014)
- Eduardo A. Lima (MIT, Cambridge, USA, Mar 2014)
- Moncef Mahjoub (ENIT LAMSIN, Tunis, Tunisia, Jun 2014)
- Michael Northington (Vanderbilt Univ., Nashville, USA, Aug 2014)
- Yves Rolain (Vrije Universiteit Brussel, Belgium, June 2014)
- Maxim Yattselev (Indiana University–Purdue University, Indianapolis, USA, May 2014)

#### 8.5.1.1. Internships

- Olga Permiakova, Master 2 Computational Biology - UNSA (5 months), Inverse source problem for electromagnetic fields, with physical applications.

## 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), University of Urama-Champaign at Indianapolis (Indianapolis, USA), 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 CSF program (with University of Cyprus).



## **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 Gamma team, 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. The turn-around time must be acceptable for industrial readiness. UMRIDA will apply these methods to representative industrial configurations.

## **8.3. International Initiatives**

### **8.3.1. Inria International Labs**

Ecuador participates in the Joint Laboratory for Petascale Computing (JLPC) together with our colleagues at Argonne National Laboratory. In 2014, Ecuador was local organizer of the 11th workshop of the JLPC in Sophia-Antipolis, june 9-11, and of the PUF summer school on HPC systems, june 12-13.

## **8.4. International Research Visitors**

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

- Krishna Narayanan, from Argonne National Laboratory, visited Ecuador twice, on april 14-18 and on november 20-28
- Trond Steihaug, from University of Bergen (Norway), visited Ecuador from june 2 to june 27.
- Jan Hueckelheim, from Queen Mary University of London, did a secondment for the AboutFlow project with the Ecuador team from september 22 to november 21.

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

- Laurent Hascoët visited Argonne National Laboratory from may 13 to may 23.
- Ala Taftaf did a secondment for the AboutFlow project with Queen Mary University of London from april 7 to june 6.

## **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. IMB - Université de Bourgogne, Dijon**

The team is officially a common team with University of Nice, but also has very strong links with Université de Bourgogne and IMB (Institute of Mathematics in Burgundy). Bernard Bonnard is currently on leave from Université de Bourgogne; Jean-Baptiste Caillau collaborates actively with us; there is also an active common seminar [http://math.unice.fr/~rifford/publis/Journee\\_McTAO/J\\_McTAO.html](http://math.unice.fr/~rifford/publis/Journee_McTAO/J_McTAO.html) . A formal convention between Inria and Université de Bourgogne has been signed in 2014. It makes the IMB control team a part of McTAO as of January, 2015.

### **8.2.2. Explosys (franco-german ANR project)**

Bernard Bonnard is a memembr of this project, accepted in October, 2014. The coordinators are Dominique Sugny (Dijon) and Stefen Glaser (Munich). The budget is approximately 500 K€.

### **8.2.3. 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. International Initiatives**

There is a strong collaboration with the control group in the University of Hawaii around M. Chyba. The purpose of the collaboration is to study the aspects of the contrast problem in Nuclear Magnetic Resonance.

## 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 [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'Excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is 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], 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 projet is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

## **7.2. European Initiatives**

### **7.2.1. FP7 & H2020 Projects**

#### *7.2.1.1. DEEP-ER*

Type: FP7

Defi: Special action

Instrument: Integrated Project

Objectif: Exascale computing platforms, software and applications

Duration: October 2013 - September 2016

Coordinator: Forschungszentrum Juelich GmbH (Germany)

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

Inria contact: Stéphane Lanteri

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

## **7.3. International Initiatives**

### **7.3.1. Inria International Partners**

#### *7.3.1.1. Declared Inria International Partners*

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

### 7.3.2. Participation In other International Programs

#### 7.3.2.1. 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 Masseglia [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Marta Mattoso [COPPE/UFR], Philippe Navaux [INF/UFRG], Esther Pacitti [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Fabio Porto [LNCC], Bruno Raffin [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Pierre Ramet [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Jean-Louis Roch [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Patrick Valduriez [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Frédéric Valentin [LNCC].

Since July 2012, the team is coordinating the HOSCAR <http://www-sop.inria.fr/hoscar> Brazil-France collaborative project. 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.

## 7.4. International Research Visitors

### 7.4.1. Visits of International Scientists

Liang Li, UESTC, China, July 15-August 8

Jay Gopalakrishnan, Portland University, USA, December 8-11

Maciej Klemm, University of Bristol, UK, July 29-August 2

## **OPALE Project-Team**

# **7. Partnerships and Cooperations**

## **7.1. National Initiatives**

### **7.1.1. Project "SOKA"**

OPALE team is coordinator of the project SOKA, funded by INSEP. The objective is the optimization of the shape 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).

### **7.1.2. Project "OASIS"**

The OASIS project, Optimization of Addendum Surfaces In Stamping, is an R&D consortium (CS, Arcelor-Mittal, ErDF, Inria, UTC, EURODECISION, ESILV, NECS, DeltaCAD, SCILAB-DIGITEO) of the Pole Systemic Paris-Region dedicated to develop an optimal design framework (methods-software platforms-applications) for stamping processes. The EPI OPALE/Inria is the leader within the consortium for the Optimization work-package (one of six WP), the role of which is to develop efficient tools well adapted to Pareto front identification of the multicriteria-dependent stamping processes.

The OASIS project yields 2.4 Meuro total financial support (one Ph.D thesis, two post-doctoral positions and 12 months internship for OPALE).

## **7.2. European Initiatives**

### **7.2.1. FP7 & H2020 Projects**

#### **7.2.1.1. GRAIN 2**

Type: Cooperation

Defi: Transport (incl. Aeronautics)

Instrument: Coordination and Support Action (CSA)

Objectif: NC

Duration: October 2013 - June 2016

Coordinator: Centre Internacional de Metodes Numerics en Enginyeria, Barcelone (Spain)

Partner: Airbus (Sp), Alenia (I), EADS-IW (F), Rolls-Royce (UK), Ingenia (Sp.), Numeca (B), U. Sheffield (UK), U. Birmingham (UK), CIRA (I), VKI (B), Airbone (NL), Leitat (Sp), Cerfacs (F), U. Cranfield (UK), CAE (CN), GTE (CN), ARI (CN), FAI (CN), ASRI (CN), SAERI (CN), BIAM (CN), ACTRI (CN), BUAA (CN), NPU (CN), PKU (CN), NUAU (CN), ZIU (CN)

Inria contact: Toan Nguyen

Abstract: The main objective of GRAIN2 is to focus its greening activities following the Flight Path 2050 Vision for Aircraft en route to the very ambitious challenge "Protecting the environment and the energy supply" in three major following lines: i) greening the air vehicle, ii) greening the Air transport System and iii) Reducing the carbon foot print of aviation via sustainable alternative fuels. GRAIN2 will identify innovative R & D methods, tools and HPC environments (supercomputers and GPGPUs) in the different KGTs according to the needs of major aeronautical industries to deeper understand the mechanism of engine exhaust emissions, to improve fuel efficiency and environmental performance, to lower noise for landing gear and high lift surfaces, to introduce new materials with multiple functions, to help significantly the development of biofuels for greenhouse gas emission reduction, etc.

<http://www.cimne.com/grain2/>

#### 7.2.1.2. *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>

#### 7.2.1.3. *VELaSSCo*

Type: FP7 (Strep)

Defi: ICT, Technologies for Digital Content and Languages

Instrument: Specific Targeted Research Project

Objectif: Scalable data analytics

Duration: January 2014-December 2016

Coordinator: Centre Internacional de Metodes Numerics en Enginyeria (Spain)

Partners: JOTNE (No.), SINTEF (No.), Fraunhofer IGD (D), ATOS (SP), Univ. Edinburgh (UK)

Inria contact: Toan Nguyen

Abstract: VELaSSCo aims at developing a new concept of integrated end-user visual analysis methods with advanced management and post-processing algorithms for engineering modelling applications, scalable for real-time petabyte level simulations [59]. The interface will enable real-time interrogation of simulation data, generating key information for analysis. Main concerns have to do with handling of large amounts of data of a very specific kind intrinsically linked to geometrical properties; how to store, access, simplify and manipulate billion of records to extract the relevant information; how to represent information in a feasible and flexible way; and how to visualise and interactively inspect the huge quantity of information they produce taking into account end-user's needs. VELaSSCo achieves this by putting together experts with relevant background in Big Data handling, advanced visualisation, engineering simulations, and a User Panel including research centres, SMEs and companies from key European industrial sectors such as aerospace, household products, chemical, pharmaceutical and civil engineering.

## 7.3. International Initiatives

### 7.3.1. *Inria Associate Teams*

#### 7.3.1.1. *ORESTE*

Title: Optimal REroute Strategies for Traffic managEment

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (ÉTATS-UNIS)

Duration: 2012 - 2014

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



ORESTE is an associated team between OPALE project-team at Inria and the Mobile Millennium / Integrated Corridor Management (ICM) team at UC Berkeley focused on traffic management. With this project, we aim at processing GPS traffic data with up-to-date mathematical techniques to optimize traffic flows in corridors. More precisely, we seek for optimal reroute strategies to reduce freeway congestion employing the unused capacity of the secondary network. The project uses macroscopic traffic flow models and a discrete approach to solve the corresponding optimal control problems. The overall goal is to provide constructive results that can be implemented in practice. Both teams have actively contributed to recent advances in the subject, and we think their collaboration is now mature enough to take advantage of the associate team framework. The Inria team and its theoretical knowledge complement the Berkeley team, with its engineering knowledge anchored in practice.

### 7.3.2. Participation In other International Programs

- Inria@SILICONVALLEY :

ORESTE Associated Team with UC Berkeley takes part to the program.

- LIRIMA Team ANO 2010-2014:

The agreement governing the creation of the International Laboratory for Research in Computer Science and Applied Mathematics (LIRIMA) was signed on 24th November 2009 in Yaoundé. LIRIMA enables cooperation between Inria research teams and teams in Africa (Sub-Saharan Africa and the Maghreb) to be reinforced. It is the continuation of the major operation undertaken by the SARIMA program (2004-08 Priority Solidarity Fund created by the French Ministry of Foreign & European Affairs).

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

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

The themes investigated are biomathematics (Models for plants growth, cardiovascular and cerebral diseases, cardio image segmentation), mathematical finance (optimal portfolio, risk management, Islamic finance), multiobjective optimization in structural mechanics, and vehicle traffic and crowd motion. Refer to the website <http://www.lirima.uninet.cm/index.php/en/> for more details on the LIRIMA Africa themes and teams.

- 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. Senior Researchers*

Pr. Rinaldo M. Colombo

Subject: Conservation laws with non-local flux function.

Institution: Brescia University , Brescia (Italy)

Pr. Simone Göttlich

Subject: Optimization of traffic flows on networks.

Institution: Mannheim University , Mannheim (Germany)

Pr. Moez Kallel

Subject: Data completion for heat-elasticity systems

Institution: ENIT, Tunis al Manar University (Tunisia)

#### *7.4.1.2. Internships*

- E. Bertino from Ecole Centrale de Nantes (uncertainty quantification in traffic flow models).
- C. Fiorini from Politecnico di Milano (multiple gradient descent algorithm applied to unsteady optimization).
- S. Scialanga from Roma La Sapienza University (traffic flow models with non-local velocity)

## TOSCA Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

- N. Champagnat, J. Claisse and D. Villemonais were members of the ANR MANEGE (Modèles Aléatoires en Écologie, Génétique et Évolution, ending in April 2014) whose aim is to provide methodological and conceptual advances in the study of stochastic processes modeling ecology, population genetics and evolution of life. This work is sustained by regular exchanges with biologists from several teams in France. [http://www.cmap.polytechnique.fr/~anr-manege/index\\_en.html](http://www.cmap.polytechnique.fr/~anr-manege/index_en.html)
- N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, started in October 2014), aiming at understanding, in the greatest generality, the phenomena of propagation in non-local reaction-diffusion equations. These equations can present integral forms of diffusion operators, or speed that depend on integrals of the solution, memory effects, or long-range interactions in source terms. [http://www.agence-nationale-recherche.fr/projet-anr/?tx\\_lwmsuivibilan\\_pi2\[CODE\]=ANR-14-CE25-0013](http://www.agence-nationale-recherche.fr/projet-anr/?tx_lwmsuivibilan_pi2[CODE]=ANR-14-CE25-0013)
- A. Lejay is member of the ANR H2MNO4 (ANR Cosinus, 2012–2015) on Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology which started in November 2012 (directed by Joceyline Erhel, IRISA, Rennes).

### 8.1.2. Contract with ADEME

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

**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 have almost completed the SDM version with complex terrain description. We also improved the turbulence modelling to better take into account the shear effect near the ground.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

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

## 8.3. International Initiatives

### 8.3.1. Inria International Labs

The CIRIC Team on *Stochastic Analysis of Renewable Energies: Ocean Energy and Wind Farms; dynamics and numerics* (2012-2014) is managed by TOSCA and ANESTOC (Univ Catolica, Santiago). It is composed of three main projects.

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 improvement on wind mills modeling in the SDM software (see [28]). This modeling is based on our Lagrangian version of the actuator disc actuator line methods to take the mills into account. We evaluated and compared the case of non rotating and rotating actuator disc, and started to work on the validation of the approach by comparison with measurements.

### 8.3.2. Inria Associate Teams

#### 8.3.2.1. ANESTOC-TOSCA

Title: Stochastic modelling of biology and renewable energies

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (CHILI)

Duration: 2013 - 2016

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. In particular, a part of the Associated Team is strongly related to the CIRIC project “Stochastic Analysis of Renewable Energy”. 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 by developing and improving the Winpos software based on the downscaling methods, and waves energy potential of a site using video and developing stochastic models for the Wave Energy Converter called Oscillating Water Column.

The other part of this Associated Team is related to neurosciences, more specifically by considering applications to ion-channel dynamics through cell membranes (jointly with biophysicists of the CINV, Neuroscience Centre of Valparaíso).

### 8.3.3. Participation In other International Programs

#### 8.3.3.1. Math Amsud project SIN

**Participant:** Etienne Tanré.

It is likely that the stochastic components play an important role in the functions of the neurons and of the networks they form. We describe and study the effect of the noise at different scales of neural activity, such that the level of the ionic channels and the level of neural networks, which are responsible for conveying and processing the information coded in sequences of spikes. The most popular models of this class are leaky integrate and fire (LIF) neural networks. We study the synchronization of neurons in those networks.

The Math Amsud project SIN (Stochastic, Inference, Neuroscience) started in 2013. We worked specifically in 2014 on stochastic modelling in neuroscience.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

- M. Baar (Bonn University) has been visiting TOSCA Nancy for one week in September.
- L. Beznea (Simion Stoilow Institute of Mathematics of the Romanian Academy) has been visiting TOSCA Nancy one week in March and three weeks in July.
- The TOSCA *seminar* organized by J. Inglis in Sophia Antipolis has received the following speakers: Maxime Bonelli (TOSCA), Hector Olivero-Quinteros (Universidad de Chile), Jean-François Jabir (CIMFAV, Fac. de Ingenieria, Universidad de Valparaiso), Tony Lelièvre (École des Ponts ParisTech), Christophe Profeta (Université d’Evry-Val d’Essone), Xiaolu Tan (Ceremade, Univ. Dauphine), Pierre Patie (ORIE, Cornell University), Alexandre Richard (Inria, Regularity), Paola Cinnella (CMI, Université Aix Marseille), Caroline Bauzet (CMI, Université Aix Marseille), Laurent Mertz (Laboratoire J.A. Dieudonné, Univ. Nice – Sophia Antipolis), Charles-Edouard Bréhier (Cermics, École des Ponts).

8.4.1.1. Internships

BEDOUI Akram

Subject: Gestion du risque de portefeuille par la méthode des copules

Date: Feb 2014 - June 2014

Institution: EPT (Tunisie)

DEJAX Florian

Subject: Carbon and electricity markets

Date: from Jun 2014 until Aug 2014

Univ. Paris (France)

FOGUEN TCHUENDOM Rinel

Subject: Bayesian Inference via Markov Chain Monte Carlo methods: A financial case study

Date: March 2014 - August 2014

Institution: Université de Nice – Sophia Antipolis (France)

LALANNE Victor

Subject: Carbon and electricity markets

Date: from Jun 2014 until Aug 2014

Univ. Nice (France)

PAPIC-PONCE Alexis

Subject: Divergence of Euler numerical scheme for SDE with non Lipschitz coefficients

Date: March 2014

Institution: PUC (Chile)

PICCOLOMINI Tatiana

Subject: Probabilistic interpretation of non-linear PDEs with branching diffusion processes

Date: from March 2013 until July 2014

Institution: Universidad de Buenos Aires (Argentina)

## ABS Project-Team

## 6. Partnerships and Cooperations

### 6.1. National Initiatives

#### 6.1.1. *Projets Exploratatoires 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.

### 6.2. International Initiatives

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

F. Cazals (Inria ABS), I. Emiris (Prof., Univ. of Athens) and S. Theodoridis (Prof., Univ. of Athens) collaborate in the scope of an Inria COLOR entitled *Discriminating and classifying in high-dimensional spaces*.

The scientific goal was to study methods and algorithms in high dimensional spaces, revolving around three problems: approximate nearest neighbors, polytope volume approximations, and classification - discrimination in high high-dimensional Spaces.

The long-term plan is to examine whether the work done so far can be combined with work by other European teams targeting a European research proposal. F. Cazals and I. Emiris participate in a FET-Open STREP proposal, entitled *Exploring the Geometry of Data*, including high-dimensional geometry, machine learning, and statistical methods. More precisely, the collaborations proposed between the two groups bootstraps on the achievements of the COLOR, as they aim at exploring (i) incremental nearest neighbor methods in metric spaces, (ii) sampling methods for polytope volume approximation and high-dimensional space exploration, and (iii) applications in biophysics (protein docking and energy landscape exploration).

### 6.3. International Research Visitors

#### 6.3.1. *Visits of International Scientists*

- Fasseli Coulibaly, Monash University, September 2014.

##### 6.3.1.1. *Internships*

- R. Tetley, 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 *Bootstrap algorithms for structural alignments, with applications in structural virology*. Romain is now following-up as a PhD student.
- D. Shah, second year student from the IIT Bombay, completed a summer internship on the topic *Improving scoring functions for protein docking*.

## ASCLEPIOS Project-Team

# 7. Partnerships and Cooperations

## 7.1. European Initiatives

### 7.1.1. FP7 & H2020 Projects

#### 7.1.1.1. MD PAEDIGREE

Type: FP7

Defi: ICT for Health, Ageing Well, Inclusion and Governance

Instrument: Integrated Project

Objectif: Virtual Physiological Human

Duration: March 2013 - February 2017

Coordinator: Ospedale Pediatrico Bambino Gesu, Rome, Italy.

Partner: Siemens AG (DE), Siemens SCR (USA), Maat France (FR), MOTTEK (NL), EMP (DE), VUmc (NL), Lynkeus (IT). Universities: KU Leuven (BE), Fraunhofer (DE), UMC Utrecht (NL), TU Delft(NL), Sheffield (UK), Athens (GR), Genoa (IT), Transilvania din Brasov (RO); Hospitals: OPBG (Roma, IT), Gaslini (Genoa, IT), GOSH/UCL (London, UK), JHU (Baltimore, USA).

Inria contact: Xavier Pennec

See also: <http://www.md-paedigree.eu/>

Abstract:MD-Paedigree is a clinically-driven and strongly VPH-rooted project, where 7 world-renowned clinical centres of excellence pursue improved interoperability of paediatric biomedical information, data and knowledge by developing together a set of reusable and adaptable multi-scale models for more predictive, individualised, effective and safer paediatric healthcare, being scientifically and technologically supported by one of the leading industrial actors in medical applications in Europe operating in conjunction with highly qualified SMEs and some of the most experienced research partners in the VPH community. MD-Paedigree validates and brings to maturity patient-specific computer-based predictive models of various paediatric diseases, thus increasing their potential acceptance in the clinical and biomedical research environment by making them readily available not only in the form of sustainable models and simulations, but also as newly-defined workflows for personalised predictive medicine at the point of care. These tools can be accessed and used through an innovative model-driven infostructure powered by an established digital repository solution able to integrate multimodal health data, entirely focused on paediatrics and conceived of as a specific implementation of the VPH-Share project, planned to be fully interoperable with it and cooperating, through it, also with p-Medicine. MD-Paedigree's goals are to integrate and share highly heterogeneous biomedical information, data and knowledge, using best practices from the biomedical semantic Web; develop holistic search strategies to seamlessly navigate through and manage the integrative model-driven infostructure and digital repository; jointly develop reusable, adaptable and composable multi-scale VPH workflow models, support evidence-based translational medicine at the point of care, and ultimately facilitate collaborations within the VPH community.

#### 7.1.1.2. VP2HF

Type: FP7

Defi: ICT for Health, Ageing Well, Inclusion and Governance

Instrument: Specific Targeted Research Project

Objectif: Virtual Physiological Human

Duration: October 2013 - September 2016

Coordinator: King's College London (UK)

Partner: Philips Research Hamburg (DE), Universitat Pompeu Fabra (SP), Inria, French National Research Institute in Informatics and Mathematics (FR), Université Catholique de Louvain (BE), Caen University Hospital (FR), Philips Research Paris (FR), Simula Research Laboratory (NO), Centron Diagnostics (UK).

Inria contact: Maxime Sermesant

See also: <http://vp2hf.eu/>

Abstract: Heart failure (HF) is one of the major health issues in Europe, affecting 6 million patients and growing substantially because of the ageing population and improving survival following myocardial infarction. The poor short to medium term prognosis of these patients means that treatments such as cardiac re-synchronisation therapy and mitral valve repair can have substantial impact. However, these therapies are ineffective in up to 50% of the treated patients and involve significant morbidity and substantial cost. The primary aim of VP2HF is to bring together image and data processing tools with statistical and integrated biophysical models mainly developed in previous VPH projects, into a single clinical workflow to improve therapy selection and treatment optimisation in HF. The tools will be tested and validated in 200 patients (including 50 historical datasets) across 3 clinical sites, including a prospective clinical study in 50 patients in the last year of the project. The key innovations in VP2HF that 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 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; and 2) by utilising a decision tree stratification approach, only the appropriate parts of the tool chain, that will add maximum value to the predictions, 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 results of substantial improved efficacy of decision making over current guidelines, and 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.

#### 7.1.1.3. MedYMA

Type: FP7

Instrument: ERC Advanced Grant

Duration: April 2012 - March 2017

Coordinator: Inria (France)

Inria contact: Nicholas Ayache

Abstract: During the past decades, exceptional progress was made with in vivo medical imaging technologies for capturing the anatomical, structural and physiological properties of tissues and organs in a patient, with an ever increasing spatial and temporal resolution. The physician is 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 changes which can have a vital impact on the patient's health. To change this situation, this proposal introduces a new generation of computational models for the simulation and analysis of dynamic medical images. Thanks to their generative nature, they will allow the construction of databases of synthetic, realistic medical image sequences simulating various evolving diseases, producing an invaluable new resource for training and benchmarking. Leveraging their principled biophysical and statistical foundations, these new models will bring remarkable added clinical value after they are 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 future evolution (computer aided prognosis), and to precisely simulate and monitor an optimal and personalized therapeutic strategy (computer aided therapy). First applications will concern high impact diseases including brain tumors, Alzheimer's disease, heart failure and cardiac arrhythmia and will open new horizons in computational medical imaging.

### **7.1.2. Inria International Partners**

#### *7.1.2.1. Stanford, Statistics Department*

**France Stanford collaborative project grant (2013-2014):** *Understanding Lower Back Pain through Geometric Statistical Analysis of computed tomography (CT) Images*. Stanford, Statistics Dept & Nice Univ. Hospital. Principal investigators X. Pennec (Inria) and S. Holmes (Stanford). Collaboration on statistics on group-valued trees and geometric subspace learning.

#### *7.1.2.2. Informal International Partners*

##### *7.1.2.2.1. 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.

##### *7.1.2.2.2. 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. Matthieu Lê spent 2013 in the department of Radiation Physics at MGH.

##### *7.1.2.2.3. Other International Hospitals*

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

## **7.2. International Research Visitors**

### **7.2.1. Visits to International Teams**

#### *7.2.1.1. Research stays abroad*

- Chloé Audigier spent 3 months at Siemens, Princeton, USA from September 22, 2014 to January 30, 2015.
- Jan Margeta spent 3 months at Microsoft Research, Cambridge, UK from July 1, 2014 to September 23, 2014.

## ATHENA Project-Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

#### 8.1.1. *Projets Blancs 2014: Axe Interdisciplinaire de Recherche à l'échelle du pôle Nice - Sophia Antipolis*

##### 8.1.1.1. *Real time detection of morpho-phonological computation in the brain*

**Participants:** Maureen Clerc, Rachid Deriche, Théodore Papadopoulo, Demian Wassermann, Fabien Mathy [Université de Nice-Sophia Antipolis], Tobias Sheer [Université de Nice-Sophia Antipolis], Lucas Drevillon.

**Duration:** *June 2014 to November 2014*

The overall idea of this project is that current work [78] shows that it is possible to discriminate between morphological (i.e. concatenative) and phonological activity that is produced by the brain upon linguistic stimuli. That is, the experimental setup provides an on-line diagnostic for the presence or absence of phonological computation in the production of words.

On the neuroimaging side, the long-term challenge is to reproduce Sahin et al.'s [78] experiment with non-invasive methods (see the following section). If successful, the study will show that a processing sequence predicted on linguistic grounds is implemented in the brain in fine-grained spatiotemporally patterned activity. From the neuroimaging point of view, the development of such non-invasive methods that can accurately identify events in known regions will have an important impact on both computer science and neuroscience. Replacing deep electrode probes (implanted in the patient's brain) with algorithms to map cognitive processes onto brain activation will help developing new applications of functional neuroimaging. Note that results could also turn out to foster clinical tools in the diagnosis of patients affected by white matter abnormalities and altered structure-function relationships in the connectional anatomy of language.

This project aimed to perform a feasibility study for this research area. More precisely to investigate whether current neuroimaging technologies are able to provide the tools for the proposed linguistic analysis.

#### 8.1.2. *ARSLA-funded clinical study with Nice University Hospital*

**Participants:** Maureen Clerc, Théodore Papadopoulo, Loïc Mahé, Asya Metelkina, Violaine Guy [Nice University Hospital], Claude Desnuelle [Nice University Hospital].

We are partners of Nice University Hospital in a project funded by "Association pour la Recherche sur la Sclérose Latérale Amyotrophique" (ARSLA), thanks to which we are conducting a clinical feasibility study on a Brain Computer Interface system called the P300 speller (see section New Results on Brain Computer Interfaces).

### 8.2. National Initiatives

#### 8.2.1. ANR

##### 8.2.1.1. *ANR CO-ADAPT*

**Participants:** Maureen Clerc [coordinator], Dieter Devlaminck, Sebastian Hitziger, Loïc Mahé, Théodore Papadopoulo, Eoin Thomas, Romain Trachel.

**Duration:** *December 2009 to April 2014*

The partners of this project were the INSERM U1028 laboratory of Bron, the "laboratoire de Neurologie de la cognition" UMR6155 CNRS of Marseille, the Inria Lille Sequel project-team and the "Laboratoire d'Analyse Topologie et Probabilités" UMR6632/CNRS of Université de Provence, Marseille.

Brain Computer Interfaces (BCI) provide a direct communication channel from the brain to a computer, bypassing traditional interfaces such as keyboard or mouse, and also providing a feedback to the user, through a sensory modality (visual, auditory or haptic). A target application of BCI is to restore mobility or autonomy to severely disabled patients, but more generally BCI opens up many new opportunities for better understanding the brain at work, for enhancing Human Computer Interaction, and for developing new therapies for mental illnesses.

In BCI, new modes of perception and interaction come into play, and a new user must learn to operate a BCI, as an infant learns to explore his/her sensorimotor system. Central to BCI operation are the notions of feedback and of reward, which we believe should hold a more central position in BCI research.

The goal of this project was to study the co-adaptation between a user and a BCI system in the course of training and operation. The quality of the interface was judged according to several criteria (reliability, learning curve, error correction, bit rate). BCI were considered under a joint perspective: the user's and the system's. From the user's brain activity, features must be extracted, and translated into commands to drive the BCI system. Feature extraction from data, and classification issues, are very active research topics in BCI. However, additional markers may also be extracted to modulate the system's behavior. It is for instance possible to monitor the brain's reaction to the BCI outcome, compared to the user's expectations. This type of information we refer to as meta-data because it is not directly related to the command, and it may be qualitative rather than quantitative.

The aim of CO-ADAPT was to propose new directions for BCI design, by modeling explicitly the co-adaptation taking place between the user and the system (web site <http://coadapt.inria.fr>).

This project has led to many concrete realizations, e.g. an international BCI Challenge on detecting Error Potentials, and software (CoAdapt P300 stimulator).

#### 8.2.1.2. ANR Mosifah

**Participants:** Rachid Deriche, Maureen Clerc, Théodore Papadopoulo, Gonzalo Sanguinetti.

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

This ANR Numerical Models 2013 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.

### 8.2.1.3. ANR MULTIMODEL

**Participants:** Théodore Papadopoulo, Maureen Clerc, Sebastian Hitziger, Emmanuel Olivi.

**Duration:** December 2010 to May 2014

The MULTIMODEL project stems from a conjoint INSERM-Inria scientific initiative launched in December 2008 and ended in 2010. It involves 5 partners (Inserm U751 in Marseille, U678 in Paris, U836 in Grenoble, U642 in Rennes and Inria ATHENA project-team).

The general objectives of the MULTIMODEL project were :

- To develop computational models at the level of neuronal systems that will help interpreting neuroimaging data in terms of excitation-, inhibition- and synchronization-related processes.
- To acquire multimodal datasets, obtained in rats and humans under physiological and epileptogenic conditions, which will be used to develop the biophysical models and to test their face validity and predictability.

Specifically, the following questions were dealt with:

- How can models be integrated in order to link data from different modalities (electro/magneto-encephalography, optical imaging, functional MRI)?
- What is the influence of hidden parameters on the observed signals (e.g. ratio of excitation/inhibition and synchronization degree across regions)?
- To what extent can biophysical modelling bring valuable insights on physiological and pathological brain activity ?

We operated at the level of population of cells, i.e. at a scale compatible with the resolution of neuroimaging tools (at the level of the mm). A novel model structure was investigated, which includes astrocytes at this “mesoscopic” level and operates in networks of connected regions. Moreover, models in physiological and pathological conditions were compared, which is a step towards a better understanding of mechanisms underlying epileptic condition.

### 8.2.1.4. ANR VIBRATIONS

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

**Duration:** Early 2014 to early 2018

This Translational ANR project has just been accepted.

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.

## 8.2.2. ADT

### 8.2.2.1. ADT BOLIS

**Participants:** Théodore Papadopoulo, Juliette Leblond [APICS], Jean-Paul Marmorat [APICS].

**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.

### 8.2.2.2. 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.

### 8.2.2.3. ADT OpenViBE-NT

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

**Duration:** *October 2012 to December 2014*

OpenViBE is an opensource software which development started in 2005 with the goal of offering an open research tool for BCI and for supporting disabled people. Since its release in 2009, this software has received a lot of success (+10.000 downloads). But since 2005, new use have appeared as well as some limitations. The current software thus lacks of some features that limit its use, deployment and perennity. The goal of this ADT is to solve these problems, to improve and to extend OpenViBe One main goal was to improve the usability and the attractivity of the software and to retain a large community of users so as to ensure its sustainability. This ADT also supported the research made in four Inria teams (ATHENA, HYBRID, NEUROSYS and POTIOC) on hot topics such as adaptive or hybrid BCIs. In September 2014, the partners of this ADT organized a workshop on OpenViBE at the 6th international conference on Brain Computer Interfaces in Graz.

### 8.2.2.4. ADT MedInria-NT

**Participants:** Jaime Garcia Guevara, Loïc Cadour, Théodore Papadopoulo, Maureen Clerc, Rachid Deriche.

**Duration:** *December 2010 to December 2012, prolonged to December 2014*

The goal of this technical project, funded by Inria for 2 years, is to introduce some tools developed at ATHENA into the medInria platform. There are basically two such facilities:

- Integrate the tools developed for the statistical characterization of brain white matter fiber bundles.
- Develop an interface for M/EEG data within MedInria. This will focus on two main goals:
  - Create a facility to read and visualize M/EEG signals.
  - Integrate M/EEG forward problem tools.

## 8.3. European Initiatives

### 8.3.1. *ChildBrain ETN*

**Duration:** March 2015 to March 2019

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: mois année début - mois année fin

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.

## 8.4. International Initiatives

### 8.4.1. *Inria Associate Teams*

#### 8.4.1.1. *BRAINCONNECTIVITIES*

Title: Fusing anatomical and functional connectivity information using diffusion MRI, MEG and EEG.

International Partner (Institution - Laboratory - Researcher):

Ecole de Technologie Supérieure, Université du Québec, (CANADA)

Duration: Jan. 2012 - Dec. 2014

See also: <http://brainconnectivities.inria.fr/wordpress>

Currently brain connectivity is studied through two different lenses: 1) Anatomical connectivity aims at recovering the “wires” that connect the various brain cortical “units”, 2) Functional connectivity studies when and how cortical regions are connected. Providing tools to fuse these two complementary views is the central goal of this project. Our effort will focus on three imaging modalities: diffusion MRI (dMRI), Electroencephalography (EEG) and Magnetoencephalography (MEG). dMRI (jointly with traditional MRI) provides a detailed anatomical view of the brain. It allows the recovery of the fiber structure of the white matter: these are the electrical connexions between distant cortical areas. But dMRI does not provide any clue on: 1) on the actual use of connexions during brain activity, 2) on the way information propagates along time for a given task. On the opposite, EEG and MEG (jointly named MEEG) provide (after source reconstruction) time courses of the activity of the cortical areas. It is possible to recover some connectivity information from these time courses, but these are purely signal based and do not take account of the anatomy so there are multiple solutions that are sometimes difficult to discriminate. Furthermore source reconstructions are regularized with purely mathematical a priori taking only partially account of the actual brain structures. The main goals of this project are to provide tools: 1) To acquire diffusion data more efficiently, 2) To use the information of dMRI to define better models and regularization schemes for spatio-temporal MEEG source reconstruction, 3) To use MEEG data to better understand the task-dependent spatio-temporal structure of connectivity patterns.

## **8.4.2. Inria International Partners**

### *8.4.2.1. Informal International Partners*

- CMRR, University of Minnesota, USA (Christophe Lenglet)
- Department of CISE, the University of Florida, Gainesville, USA (Baba C. Vemuri)
- Centre for Medical Image Computing (CMIC), Dept. Computer Science, UCL, UK (D. Alexander)
- SBIA, University of Pennsylvania Medical School, USA (R. Verma).
- University Houari Boumedienne (USTHB, Algiers) (L. Boumghar) and University of Boumerdes, (D. Cherifi), Algeria.
- BESA company on EEG/MEG source localisation.

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

- Programme Samuel de Champlain - Université de Sherbrooke, Canada.

## **8.5. International Research Visitors**

### *8.5.1. Visits of International Scientists*

- Thinhinane Megherbi (USTHB, Algiers) visited ATHENA from May 30 until June 30, 2014.
- Kevin Whittingstall (Université de Sherbrooke) visited ATHENA from June 2 until June 5, 2014.
- Cristina Campi (Genoa University) visited ATHENA on March 28, 2014.

#### *8.5.1.1. Internships*

- Hughes Thomas (Queens's University, Ontario) visited ATHENA from May 5h until July 31
- Russel Taylor (Queens's University, Ontario) visited ATHENA from May 5th until July 31

## BIOCORE Project-Team

# 8. Partnerships and Cooperations

## 8.1. National initiatives

### 8.1.1. National programmes

- **ANR-GeMCo:** The objective of this project is to do model reduction, experimental validation, and control for the gene expression machinery in *E. coli*. The project is funded by ANR (2010-BLAN-0201-01) coordinated by M. Chaves, and ran through April 2014.
- **ANR-Facteur 4:** The objective of this project (2012-2015) is to propose non OGM strains 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-Purple Sun:** The objective of this project (ANR-13-BIME-004: 2013-2017) is to propose, 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 both the phenomena of photoinhibition and process overwarming.
- **ANR-Phycover:** The overall objective of the project (2014-2018) is to draw the scientific, technical and industrial contexts for an evolution of wastewater treatment plants, combining three modules: a high-rate algal pond dedicated to the treatment of municipal wastewater, an anaerobic digester, and a module aiming at enhancing the digestate valorization.
- **ANR-FunFit:** The objective of this project (2013-2017) is to develop a trait-based approach linking individual fitness of fungal plant pathogens to ecological strategies. The idea is to derive eco-epidemiological strategies from fitness optimization in colonized environments and during colonization, as well as understanding the coexistence of sibling species. This project is co-coordinated by F. 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, 2011–2015. 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 MIA, 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)
- **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), 2012–2016. 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 MIA, INRA Jouy-en-Josas.



- **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.
- **Peps BMI 2013 -J-A Sepulchre (INLN CNRS UNS) -** Projet "Pectolyse". Study of a virulence factor of a bacterium.
- **FUI-Salinalgue:** The objective of this project is to take benefit of endemic microalgae species in areas of high salinity (previously used to produce salt) to produce both biofuel (either lipid based or methane) and co-products. BIOCORE is in charge of lab scale experiments and of the modeling of the process.
- **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).

### 8.1.2. INRA funding

- **Dynamique spatiale:** INRA-SPE is funding the project "Intégration des approches comportementales et démographiques de la dynamique spatiale des populations d'insectes" in which Biocore is a partner with INRA Sophia Antipolis and Agrocampus Ouest (2012-2014).
- **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. 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.
- **Coexistence:** INRA-SPE is funding the project "Coexistence d'espèces cryptiques par différenciation temporelle de niches écologiques : de la théorie à l'application via l'exemple des oïdiums du chêne et de la vigne", which aims at understanding the co-existence of closely related plant pathogens in temperate environments. It is closely related to the FunFit ANR project.
- **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 demonstrating that the knowledge issued from the understanding of the molecular interaction between distinct avirulence genes, and mainly the discovery of non-conventional gene-for-gene interactions, can be used to develop efficient strategies for the deployment of genetic resistance in the field.
- **PRRSeval:** "An integrated approach to PRRS (Porcine Reproductive and Respiratory Syndrome)", INRA Metaprogramme GISA, 2013–2015. PRRSeval has three main objectives: to develop a live-attenuated, miRNA-controlled vaccine effective to protect from emerging PRRSV strains; to identify and prioritize relevant parameters for dynamic epidemiology of herds based on in vivo profiling of PRRSV and vaccine response; and to consolidate and empower the existing French networks and collaborations with external partners and stakeholders. BIOCORE participates in this project via MIA, INRA Jouy-en-Josas.

### 8.1.3. Networks

- **M3D:** "Mathématiques et décision pour le développement durable", supported by the RNSC (Réseau National des Systèmes Complexes) and INRA, MIA department. BIOCORE participates in the M3D network. L. Mailleret and S. Touzeau are among the network's co-leaders.
- **GDR PROBBE:** The objective of this GDR is the development of new biotechnological processes based on microorganisms producing metabolites which can be used as fuel for transportation (lipids, sugars, methane, hydrogen, ...). BIOCORE is taking part mainly in the modeling and control aspects of the processes involving anaerobic bacteria or microalgae.
- **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

- **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.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. PURE

Title: Pesticide Use-and-Risk reduction in European farming systems with Integrated Pest Management

Type: COOPERATION (ICT)

Instrument: Collaborative Project (CP)

Duration: 2011 - 2014

Coordinator: Françoise Lescourret (INRA Avignon, FR)

Other partners: **Research:** Institut National de la Recherche Agronomique - INRA (FR) Rothamsted Research - RReS (UK) Aarhus University - AU (DK) Julius Kühn Institut - JKI (DE) Stichting DLO - DLO (NL) Wageningen University - WU (NL) Consiglio Nazionale delle Ricerche - CNR (IT) Agricultural Institute of Slovenia - KIS (SLO) James Hutton Institute - JHI (UK) Fondazione Edmund Mach - FEM (IT) Instituto Valenciano de Investigaciones Agrarias - IVIA (ES) Institute of Plant Protection - IOR (PL) University of Debrecen - Centre of Agricultural Sciences - UDCAS (HU) Joint Research Centre - Institute for Prospective Technological Studies - JRC-IPTS (EU **Extension:** Knowledge Centre for Agriculture - VFL (DK) Association de Coordination Technique Agricole - ACTA (FR) **Industry:** Bayer Crop Science (DE) BIOTOP (FR) Natural Plant Protection (FR) Burkard Manufacturing Co Ltd (UK) Blgg Bv (NL) **Management:** INRA Transfert (FR)

See also: <http://www.pure-ipm.eu/project>

Abstract: The overall objective of PURE is to provide practical integrated pest management (IPM) solutions to reduce dependence on pesticides in selected major farming systems in Europe, thereby contributing to a reduction of the risks to human health and the environment and facilitating the implementation of the pesticides package legislation while ensuring continued food production of sufficient quality.

PURE will provide IPM solutions and a practical toolbox for their implementation in key European farming systems (annual arable and vegetable, perennial, and protected crops) in which reduction of pesticide use and better control of pests will have major effects. In that project, L. Mailleret develops modeling approaches dedicated to the optimization of plant protection methods relying on biological control and integrated pest management.

#### 8.2.2. Collaborations with Major European Organizations

Imperial college, Department of Chemical engineering (UK):

Modeling 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

## 8.3. International Initiatives

### 8.3.1. Inria International Labs

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.

### **8.3.2. Inria Associate Teams**

#### **8.3.2.1. GRENCORE**

Title: Modelling and control for energy producing bioprocesses

International Partner (Institution - Laboratory - Researcher):

Communication and information Research and Innovation Center (CHILI)

Duration: 01/2014 - 12/2016

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

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).

### **8.3.3. Inria International Partners**

#### **8.3.3.1. Inria informal international partners**

Universidad Técnica Federico Santa María, Departamento de Matemática, Valparaíso, Chile

Universidad de Chile, Departamento de Matemáticas, Ñuñoa Santiago, Chile

Ben-Gurion University of the Negev, Microalgal Biotechnology Laboratory, Beer Sheva, Israel

Center for Environmental Technology and Engineering, Massey University, Palmerston North, New Zealand.

## **8.4. International Research Visitors**

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

- Benoit Chachuat (Imperial College, Department of chemical engineering, UK), 1 week;
- Claude Aflalo (Ben Gurion University of the Neguev, Israel), 1 week;
- Diego Oyarzún (Imperial College London), 1 week;
- Andrei Akhmetzhanov (Université de Montpellier II, F), 1 week.

## **8.5. Project-team seminar**

BIOCORE organized a 3-day seminar in November in Saint-Etienne de Tinée. On this occasion, every member of the project-team presented his/her recent results and brainstorming sessions were organised. Alain Rapaport of the Inria MODEMIC team was invited as a guest speaker.

An additionnal 2-day seminar was dedicated to modeling and control of microalgae.

## CASTOR Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. 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.
- ANR IODISSEE : IOnospheric DIsturbanceS and SatEllite-to-Earth communications. <http://iodissee.math.cnrs.fr/project/index.html>. In this ANR project, CASTOR will address the use of data-models coupling method to identify the input model parameters (especially, the initial data for the electronic density).

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

- EUROfusion Grant agreement number 633053. Enabling Research program.
  - JOREK, BOUT++ non-linear MHD modelling of MHD instabilities and their control in existing tokamaks and ITER.
  - Synergetic numerical-experimental approach to fundamental aspects of turbulent transport in the tokamak edge. Grant agreement number 633053.
- EUROfusion WPCD (Working Package Code Development)
  - ACT1: Extended equilibrium and stability chain (participation)
  - ACT2: Free boundary equilibrium and control (participation and coordination)

## 8.3. International Initiatives

### 8.3.1. Inria Associate Teams

#### 8.3.1.1. AMOSS

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

International Partner (Institution - Laboratory - Researcher):

NCKU (TAIWAN)

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

## **8.4. International Research Visitors**

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

In the context of the AMoSS Team :

- Key-Ming Shyue of the National Taiwan University, Juilly 3 to July 13 2014, Numerical Methods: Implicit and Thinc interpolation.
- Chih-Yu Kuo, Associate Research Fellow, Research Center for Applied Sciences, Academia Sinica, Taipei, Taiwan,
- Chyan-Deng Jan, Professor, National Cheng Kung University, Tainan, Taiwan. Workshop on the Modeling of dry granular flows, CIRM Marseille: September 8 to September 13 2014.

## 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”.
- GdR EGRIN is a newly created CNRS-network, devoted to gravitational flows and natural risks; Coffee is among the members of this network.

### 7.2. International Initiatives

#### 7.2.1. Inria Associate Teams

##### 7.2.1.1. COKLYCO

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

International Partner (Institution - Laboratory - Researcher):

Kyoto (JAPON)

Duration: 2014 -

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

The team led the project CoKLyCo, a collaborative program with Kyoto University and the team Khaliffe in Lyon. 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.

#### 7.2.2. Participation In other International Programs

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” <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.

## DEMAR Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. AOI PARK DEMAR

**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.

### 7.1.2. 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.

## 7.2. National Initiatives

### 7.2.1. DEMAR / MXM Innovation Lab "SoftStim" project

**Participants:** David Guiraud, David Andreu.

Inria Innovation-Lab "SoftStim" project (2011-2014). 1 engineer (3 y.), 20keuros.

The aim of this Inria national initiative is to favor the scientific collaboration and technological transfer of the innovation between DEMAR and MXM.

Innovation Lab "SoftStim" has ended in december 2014. The aim of this project was to prototype concepts conjointly patented like stimulation unit 's embedded sequencer and processor (new set of instructions), and implantable FES controller with its dedicated software environment.

The industrial transfer has been achieved, notably through the design and realization of prototypes of neural stimulators.

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

**Participants:** Mitsuhiro Hayashibe BCI-LIFT is a large-scale 4-year research initiative (officially under peer-review evaluation) whose 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.

### 7.2.3. Cosinus ANR - SoHuSim

**Participants:** Benjamin Gilles, Mitsuhiro Hayashibe, David Guiraud, Maxime Tournier.

Project SoHuSim on modeling muscle tissue during contraction in 3D movements using SOFA software and functional modeling of the organs. 150 k€. Partners: Inria Evasion, Tecnalía, HPC, CHU Montpellier (Oct. 2010 - Oct. 2014).

### 7.2.4. 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<sup>2</sup> 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.

### 7.2.5. INTENSE project

**Participants:** David Guiraud, Olivier Rossel, Melissa Dali, Christine Azevedo-Coste, David Andreu, Jérémy Salles, Guy Cathébras, Fabien Soulier.

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.

### 7.2.6. INSEP FFS

**Participants:** Christine Azevedo Coste, Benoît Sijobert, Roger Pissard-Gibollet.

INSEP (Institut National du Sport, de l'Expertise et de la Performance) supports the project "Impact of the gaze direction on the skier trajectory" led by the Fédération Française de Ski (FFS).

## 7.3. European Initiatives

### 7.3.1. 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: École 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/>

**Participants:** David Guiraud, David Andreu, Thomas Guiho, Arthur Hiarrassarry, Christine Azevedo Coste, Pawel Maciejasz.

## 7.4. International Initiatives

### 7.4.1. Inria Associate Teams

#### 7.4.1.1. NEUROPHYS4NEUROREHAB

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

International Partner (Institution - Laboratory - Researcher):

IITH (INDE)

Duration: 2014 - 2016

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.

#### **7.4.2. 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 NTAAl-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 NTAAl-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.

##### *7.4.2.1. Informal International Partners*

Katja Mombaur, Heidelberg University (Germany). Research Group Optimization in Robotics and Biomechanics, IWR Robotics Lab.

## **7.5. International Research Visitors**

### *7.5.1. Visits of International Scientists*

Emerson Fachin Martins. Brazilian program: Science without borders (Ciências sem fronteiras) CAPES, Scholarship: BEX 3160/13-0 (Montpellier/France - December 2013 - February 2015)

#### *7.5.1.1. 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.

#### **7.5.2. Visits to International Teams**

Mitsuhiro Hayashibe was Visiting Researcher at RIKEN BSI-TOYOYA research institute and worked on "Tacit Synergetic Motor Learning for rehabilitation" (Jul.-Aug. 2014).

M. Hayashibe was invited to talk at International Workshop on Human Assistive Systems Based on Human Modeling in Tokyo, on December 14, 2014, organized by Prof. Toshiaki Tsuji, Saitama University, Prof. Yuichi Kurita, Hiroshima University

## **LEMON Team**

# **8. Partnerships and Cooperations**

## **8.1. National Initiatives**

### **8.1.1. 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

## **8.2. International Initiatives**

### **8.2.1. Inria International Labs**

Antoine ROUSSEAU visited Inria Chile in April, 2014 (2 weeks, see Associate Teams below) in order to prepare an application for a research center on marine energies in Chile.

This application is coordinated by DCNS Energies Marines and also involves Inria Chile and PUC University (Santiago).

### **8.2.2. Inria Associate Teams**

Antoine ROUSSEAU collaborates with the ANESTOC partners (TOSCA at Inria Sophia and Rolando Rebolledo at PUC, Santiago, Chile) on the stochastic analysis of renewable energies. Together with Mireille Bossy (TOSCA), AR supervises the research of two engineers in Chile: Jacques Morice and Cristián Paris.

Antoine ROUSSEAU collaborates with the DYNECOS2 partners (MODEMIC at Inria Sophia and Hector Ramirez at CMM, Santiago, Chile) on the bioremediation of natural resources.

In the framework for these two collaborations, AR visited Inria Chile in April, 2014 (2 weeks). See the TOSCA (resp. MODEMIC) project team activity report for more information on the ANESTOC (resp. DYNECOS) associate team.

### **8.2.3. Inria International Partners**

#### **8.2.3.1. 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)

Fabien MARCHE and Antoine ROUSSEAU collaborate with R. Cienfuegos (PUC University, Santiago, Chile)

## MODEMIC Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. Labex Numev

Within the Labex Numev (Solutions Numériques, Matérielles et Modélisation pour L'Environnement et le Vivant <sup>0</sup>), the team is the coordinator since 2012 of a working group on Modelling and numerical probabilities for ecology and biology with Univ. Montpellier II, Univ. Montpellier I and CNRS ISEM.

A one day workshop on “Stochastic Models for Biology” has been organized in January with Pierre Pudlo (Univ. Montpellier II). The invited speakers were Nicolas Champagnat (Inria/Institut Élie Cartan), Jean-François Delmas (Ecole des Ponts ParisTech – CERMICS), and Michel Benaïm (Université de Neuchâtel).

### 7.1.2. Inter-teams seminar

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

A. Rapaport has been invited to participate to the “Séminaire au vert” of BIOCORE team in November 2014.

## 7.2. National Initiatives

### 7.2.1. RNSC project “MnMs”

The MnMs <sup>0</sup> (Numerical Models for Microbial ecosystems) project has been funded by the RNSC (National Network on Complex Systems) in 2013 for two years.

It aims at studying how to articulate existing models (discrete, continuous, deterministic, stochastic...) in a multi-scale framework with interactions between various scales. The team has been the coordinator and the other partners were Irstea LISC (Clermont-Ferrand) and CNRS/UMPC LPMTIC (Paris VI).

### 7.2.2. Inria Project Lab “Algae in Silico”

MODEMIC is a partner of the proposal of the Inria Project Lab *Algae in Silico* launched last year by BIOCORE Inria project-team.

### 7.2.3. INRA-CEPIA project “New perspectives for the MSCF”

The project entitled *Multi-Stage Continuous Fermentor (MSCF): Study of fermentation with disturbances, and development of a control law* has been funded in 2013 by the INRA Dept. CEPIA for two years, in which the Montpellier Units SPO and Mistea are involved.

It is the continuation of the work initiated within the former European CAFE project about the control of a wine fermentation process. The goal of this project is to study the fermentation with nitrogen addition. From a control point of view, we study how to regulate both the sugar concentration and the  $CO_2$  production rate in a series of four tanks of a MSCF, that mimics in continuous culture four important physiological states of a batch fermentation.

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

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

<sup>0</sup><http://www-sop.inria.fr/members/Fabien.Campillo/projects/mnms>

### 7.2.4. PGM0 “OPTIBIO”

*OPTIBIO* (New challenges in the optimal control of bioprocesses) 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).

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 biogas production, that were neglected in the past. It appears that mathematical problems that come from the modelization 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.

### 7.2.5. 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 this year.

## 7.3. International Initiatives

### 7.3.1. Inria International Labs

Within the BioNature<sup>0</sup> operation program of CIRIC Center (Inria Chile), the team participates to the axis *Modeling, control and optimization of waste-water treatment processes and biogas production*, and more specifically to the research lines

- automation and control of anaerobic digestion,
- innovative technologies and modeling on wastewater and residues treatment.

In this framework, the team has co-supervised the postdoctoral stay of. M. Sebbah in Chile.

### 7.3.2. Inria Associate Teams

#### 7.3.2.1. DYMECOS2

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

International Partner (Institution - Laboratory - Researcher):

Departamento de Ingeniería Matemática (DIM), Universidad de Chile

Centro de Modelamiento Matemático (CMM), UMi CNRS/ Universidad de Chile

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

<sup>0</sup><https://sites.google.com/site/reseaurem2/>

<sup>0</sup><http://www.bionature.cl>

Departamento de Matematica, Universidad Tecnica Federico Santa Maria (UTFSM), Valparaiso (Chile)

Bionature, CIRIC, Inria Chile

Duration: 2014-2016

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 outcomes of the modeling for the optimal design of waste-water treatment plants.

### 7.3.3. Inria International Partners

#### 7.3.3.1. Declared Inria International Partners

LIRIMA NuWat<sup>0</sup> 2013-... (Tlemcen, Algeria and Tunis, Tunisia). NuWat focuses on the numerical Modeling and simulation of microbial ecosystems and their application in biotechnology with a focus on solutions considered as promising for countries of the Maghreb, for instance in waste-water treatment systems and its reuse in agriculture under semi-arid climates. NuWat handles the two following related topics: (1) the elaboration of numerical hybrid models for simulation of bacterial ecosystems combining discrete models (for small size populations) and continuous models (for large size populations, substrate and environment); (2) the systematic numerical and software development for biotechnology process control. The project was initially developed in collaboration with the Univ. of Tlemcen but is now extended to the ENIT in Tunis, with an extension of the domain of application to system biology and biotechnologies.

#### 7.3.3.2. Informal International Partners

CESAME, Univ. Louvain, Belgium : D. Dochain

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

Univ. Neuchâtel, Switzerland : M. Benaim

MOMAT, Univ. Madrid, Spain : B. Ivorra

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

### 7.3.4. Participation In other International Programs

#### 7.3.4.1. 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 1 to December 31, 2014

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. It gathered about 90 participants among them very well known scientists from Theoretical Ecology (S. Allesina, D. de Angelis, P. Chesson, J. Damuth, L. Ginzburg, R. Holt...) and from Mathematics (M. Benaïm, N. Berglund, M. and F. Diener, M. Krupa, A. Lam, W.M. Ni...).

Six one-week workshops were organized (one each month) on the following topics:

<sup>0</sup><https://project.inria.fr/nuwat/>

- Non-adaptive selection: explaining macroscopic laws in ecology and evolution (Organizers: L. Ginzburg, R. Arditi, L.-F. Bersier).
- Dispersal and competition of populations and communities in spatially inhomogeneous environments (Organizer: D. DeAngelis).
- Validation of uncertain ecological models with imprecise data (Organizer : S. Ferson)
- Discrete, explicit simulations versus continuous, aggregated models (Organizers: R. Arditi, C. Lobry, Y. Tyutyunov).
- Multi-scale models, slow-fast differential equations, averaging in ecology (Organizers: M. Desroches, O. Faugeras, C. Lobry, T. Sari).
- Microbial ecology and mathematical modelling (Organizers : R. Arditi, J.J. Godon, J. Harmand, C. Lobry)

The third workshop was organized in collaboration with O. Faugeras (EPI Neuromathcomp, Sophia-Antipolis) and M. Desroches (EPI MYCENAE, Rocquencourt) and tried to find connections between neurosciences and theoretical ecology through mathematical models.

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

#### 7.3.4.2. 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 modelling, 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>

#### 7.3.4.3. 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



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).

## **7.4. International Research Visitors**

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

Imme Van Den Berg

Subject: Construction, analysis and simulation of population dynamics models

Date: until Feb. 2014

Institution: Univ. of Evorra (Portugal)

#### **7.4.1.1. Internships**

Moshen Chebbi

Subject: Stochastic modeling for membrane bioreactors

Date: from Sep 2014 until Nov 2014

Institution: ENIT, Tunis (Tunisia)

Alejandro Rojas-Palma

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

Date: from Oct 2014 until dec 2014

Institution: Univ. of Chile

Victor Riquelme

Subject: Optimal control for the preservation of exploited water resources

Date: from Nov 2014 until Jan 2015

Institution: Univ. of Chile

### **7.4.2. Visits to International Teams**

#### **7.4.2.1. Research stays abroad**

C. Lobry has spent one semester (July-December 2014) at CIB, EPFL (Lausanne, Switzerland) for the co-organization of the Bernoulli workshop on the role of mathematics and computer science in ecological theory (see [7.3.4.1](#) ).

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

## MORPHEME Project-Team

## 6. Partnerships and Cooperations

### 6.1. Regional Initiatives

- iBV, "Genetics of mouse brain development" (Michèle Studer 's group): morphological analysis of neurons within the layer V of mice cortex
- TIRO group (CEA, UNS, Lacassagne center): histopathology analysis
- TIRO group (CEA, UNS, Lacassagne center): dynamics of iodine in the stomach wall

### 6.2. National Initiatives

#### 6.2.1. 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.

#### 6.2.2. 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](#))

#### 6.2.3. 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.

#### 6.2.4. 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.

#### 6.2.5. 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.

### **6.2.6. 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.

## **6.3. International Initiatives**

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

We have obtained a CNRS/RAS project between IITP Moscow (S. Komech, E. Pechersky and E. Zhizhina ) and Morpheme team (X. Descombes, A. Razetti).

## **6.4. International Research Visitors**

### **6.4.1. Visits of International Scientists**

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

Sonia Chaibi, PhD student at Badji Mokhtar-Annaba University (Algeria) has visited the Morpheme team during two months (january-february).

#### **6.4.1.1. Internships**

Tarun Yellamraju : IIT Bombay, Bachelor. Marked point process, graph cut and attractive interactions. Supervisors: X. Descombes.

### **6.4.2. Visits to International Teams**

Xavier Descombes has visited the IITP in Moscow during one week in july within a CNRS/RAS program.

## NEUROMATHCOMP Project-Team

# 6. Partnerships and Cooperations

## 6.1. National Initiatives

### 6.1.1. ANR

#### 6.1.1.1. KEOPS

See section “International Initiatives” below.

## 6.2. European Initiatives

### 6.2.1. FP7 & H2020 Projects

#### 6.2.1.1. BRAINSCALES

Title: BrainScaleS: Brain-inspired multiscale computation in neuromorphic hybrid systems

Type: COOPERATION (ICT)

Defi: Brain-inspired multiscale computation in neuromorphic hybrid systems

Instrument: Integrated Project (IP)

Objectif: FET proactive 8: Brain Inspired ICT

Duration: January 2011 - December 2014

Coordinator: Universitaet Ruprecht- Karls Heidelberg (Germany)

Other Partners: Nederlandse Akademie van Wetenschappen, Amsterdam; Universitet For Miljo Og Biovitenskap, Aas; Universitat Pompeu Fabra, Barcelona; University of Cambridge, Cambridge; Debreceni Egyetem, Debrecen; Technische Universität Dresden, Dresden; CNRS-UNIC, Gif-sur-Yvette; CNRS-INCM, Marseille; CNRS-ISM, Marseille; TUG, Graz; Ruprecht-Karls-Universität Heidelberg, Heidelberg; Forschungszentrum Ju'lich GmbH, Jülich; EPFL LCN, Lausanne; EPFL-BBP, Lausanne; The University Of Manchester, Manchester; KTH, Stockholm; Universität Zuürich, Zuürich

See also <http://brainscales.kip.uni-heidelberg.de/>

Inria contact: Olivier Faugeras

Abstract: The BrainScaleS project aims at understanding function and interaction of multiple spatial and temporal scales in brain information processing. The fundamentally new approach of BrainScaleS lies in the in-vivo biological experimentation and computational analysis. Spatial scales range from individual neurons over larger neuron populations to entire functional brain areas. Temporal scales range from milliseconds relevant for event based plasticity mechanisms to hours or days relevant for learning and development. In the project generic theoretical principles will be extracted to enable an artificial synthesis of cortical-like cognitive skills. Both, numerical simulations on petaflop supercomputers and a fundamentally different non-von Neumann hardware architecture will be employed for this purpose. Neurobiological data from the early perceptual visual and somatosensory systems will be combined with data from specifically targeted higher cortical areas. Functional databases as well as novel project-specific experimental tools and protocols will be developed and used. New theoretical concepts and methods will be developed for understanding the computational role of the complex multi-scale dynamics of neural systems in-vivo. Innovative in-vivo experiments will be carried out to guide this analytical understanding. Multiscale architectures will be synthesized into a non-von Neumann computing device realised in custom designed electronic hardware. The proposed Hybrid Multiscale Computing Facility (HMF) combines microscopic neuromorphic

physical model circuits with numerically calculated mesoscopic and macroscopic functional units and a virtual environment providing sensory, decision-making and motor interfaces. The project also plans to employ petaflop supercomputing to obtain new insights into the specific properties of the different hardware architectures. A set of demonstration experiments will link multiscale analysis of biological systems with functionally and architecturally equivalent synthetic systems and offer the possibility for quantitative statements on the validity of theories bridging multiple scales. The demonstration experiments will also explore non-von Neumann computing outside the realm of brain-science. BrainScaleS will establish close links with the EU Brain-i-Nets and the Blue Brain project at the EPFL Lausanne. The consortium consists of a core group of 10 partners with 13 individual groups. Together with other projects and groups the BrainScaleS consortium plans to make important contributions to the preparation of a future FET flagship project. This project will address the understanding and exploitation of information processing in the human brain as one of the major intellectual challenges of humanity with vast potential applications.

This project started on January 1st, 2011 and is funded for four years.

#### 6.2.1.2. MATHEMACS

Title: Mathematics of Multilevel Anticipatory Complex Systems

Type: Collaborative project (generic) (FP7-ICT)

Defi: develop a mathematical theory of complex multilevel systems and their dynamics.

Instrument: Integrated Project (IP)

Objectif: NC

Duration: October 2012 - September 2015

Coordinator: Fatihcan Atay, Max Planck Institute for Mathematics in the Sciences, Leipzig (Germany)

Other Partners: Max Planck Institute for Mathematics in the Sciences (Leipzig, Germany), Universität Bielefeld (Germany), Chalmers University of Technology (Gothenburg, Sweden), Ca' Foscari University of Venice (Italy), Università Politecnica delle Marche (Ancona, Italy).

See also: <http://www.mathemacss.eu/description.html>

Inria contact: Olivier Faugeras

Abstract: The MATHEMACS project aims to develop a mathematical theory of complex multi-level systems and their dynamics. 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 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.

This project started on October 1st, 2012 and is funded for four years.

#### 6.2.1.3. RENVISION

Type: COOPERATION, FP7 FET (Future Emerging technology) proactive program: Neuro-Bio-Inspired Systems Call 9 Objective 9.11

Defi: Retina-inspired ENcoding for advanced VISION tasks (RENVISION)

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: March 2013 - February 2016

Coordinator: Vittorio Murino, PAVIS, IIT (Italy)

Partner: PAVIS, IIT (Italy), NBT, IIT (Italy), NAPH, IIT (Italy), The Institute of Neuroscience, Newcastle University (UK), Institute for Adaptive and Neural Computation, The University of Edinburgh (UK), Neuromathcomp project-team, Inria (France)

Inria contact: Pierre Kornprobst

Abstract: 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:

- To achieve a comprehensive understanding of how the retina encodes visual information through the different cellular layers;
- 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.

#### 6.2.1.4. HBP

Type: COOPERATION, FET Flagship' project

Defi: Understanding the brain

Instrument: FET Flagship' project

Objectif: NC

Duration: October 2013 - March 2016

Coordinator: EPFL (Switzerland)

Partner: see <http://www.humanbrainproject.eu>.

Inria contact: Olivier Faugeras

Abstract: The Human Brain Project (HBP) is supported by the European Union as a 'FET Flagship' project and the 86 institutions involved will receive one billion euro in funding over ten years. HBP should lay the technical foundations for a new model of ICT-based brain research, driving integration between data and knowledge from different disciplines, and catalysing a community effort to achieve a new understanding of the brain, new treatments for brain disease and new brain-like computing technologies. <http://www.humanbrainproject.eu>

## 6.3. International Initiatives

### 6.3.1. Participation In other International Programs

#### 6.3.1.1. ANR KEOPS

Title: Algorithms for modeling the visual system: From natural vision to numerical applications.

principal investigator: Thierry Viéville (Mnemosyne)

International Partner:

Institution: University of Valparaiso (Chile)

Laboratory: Centro Interdisciplinario de Neurociencia de Valparaiso

Researcher: Adrian PALACIOS

International Partner:

Institution: UTFSM Valparaiso (Chile)

Laboratory: Direccion General de Investigacion y Postgrado

Researcher: Maria-Jose ESCOBAR

Duration: 2011 - 2014

See also: <http://cortex.loria.fr/Research/Keops>

KEOpS attempts to study and model the non-standard behavior of retinal (ganglion cells) sensors observed in natural scenarios. KEOpS also attempts to incorporate the resulting models into real engineering applications as new dynamical early-visual modules. The retina, an accessible part of the brain, is a unique model for studying the neural coding principles for natural scenarios. A recent study proposes that some visual functions (e.g. movement, orientation, anticipatory temporal prediction, contrast), thought to be the exclusive duty of higher brain centers, are actually carried at the retina level. The anatomical and physiological segregation of visual scenes into spatial, temporal and chromatic channels begins at the retina through the action of local neural networks. However, how the precise articulation of this neural network contributes to local solutions and global perception necessary to resolve natural task remains in general a mystery. KEOpS thus attempts to study the complexity of retinal ganglion cells (the output to the brain) behaviors observed in natural scenarios<sup>2</sup> and to apply this result to artificial visual systems. We revisit both the retinal neural coding information sent to the brain, and at the same time, the development of new engineering applications inspired by the understanding of such neural encoding mechanisms. We develop an innovative formalism that takes the real (natural) complexity of retinal responses into account. We also develop new dynamical early-visual modules necessary to solve visual problems task.

## 6.4. International Research Visitors

### 6.4.1. Visits of International Scientists

- Paul Bressloff, Professor of mathematics at the University of Utah won an international chair at Inria (2013-2017).
- Michele Migliore, Research Scientist at the Institute of Biophysics, National Research Council, Palermo, Italy. Funded by the "[Axe Interdisciplinaire de Recherche de l'Université de Nice – Sophia Antipolis](#)".
- Cyan O'Donnell, Postdoc at the Computational Neurobiology Laboratory in the Salk Institute, California, from 9th July until 19th July 2014. Funded by the "[Axe Interdisciplinaire de Recherche de l'Université de Nice – Sophia Antipolis](#)".

#### 6.4.1.1. Internships

- Cesar Ravello, pHd student with A. Palacios, Centro Interdisciplinario de Neurociencia de Valparaíso, Univ de Valparaíso, Valparaíso, Chile. From May 2014 until Jun 2014
- Ruben Herzog, Master student in Valparaiso, with A. Palacios, Centro Interdisciplinario de Neurociencia de Valparaíso, Univ de Valparaíso, Valparaíso. From November, 12th 2014 until November 14th 2014.

## VIRTUAL PLANTS Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. *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 2014, we organized a two-day workshop devoted to the modeling of plant development from the cellular to the organ scale.

### 7.1.2. *MecaFruit3D*

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

Funding: Agropolis foundation (Contractor for Virtual Plants: INRA, from 2009 to 2012)

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 project relies on a previously developed computational functional-structural tomato fruit model (Cieslak et al. 2011; 2012), that predicts the transport and accumulation of water and dry matter to various fruit tissues through a complex 3D vasculature network. This architecture-based model will serve as the backbone of a new approach for studying fruit development where interactions and feedback loops between turgor driven processes and cuticle mechanical constraints will be analysed and modelled. A collection of cuticle tomato mutants available at INRA Bordeaux will be used to validate the hypotheses.

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

### 7.1.3. *RhizoScanHT*

**Participants:** Julien Diener, Frédéric Boudon, Christophe Godin, Yann Guédon, Christophe Pradal.

Funding: Labex Numev (Contractor for Virtual Plants: UM2, from 2013 to 2014)

In this project, we extend the pipeline for 2D root system reconstruction from images developed in the RhizoPolis project (Agropolis foundation) to deal with large scale and high-throughput analysis. For this we develop the project in the following directions:

1. make the analysis software more robust to various acquisition conditions using visual data mining technologies developed at Zenith.
2. Improve interoperability with other software and within the OpenAlea ecosystem.
3. Improve the reconstruction quality and its evaluation.

Partners: Zenith Inria Project Team, UMR AGAP, UMR BPMC and UMR LEPSE (Montpellier).

## 7.2. National Initiatives

### 7.2.1. ANR

#### 7.2.1.1. *Morpholeaf*

**Participants:** Christophe Godin, Maryam Aliee.



Funding: ANR (Contractor for Virtual Plants: Inria, From 2011 to 2014)

The goal of this project is to apply a systems biology approach combining biological investigation and modeling on leaf margin development to elucidate how gene networks and hormone signalling are translated into specific growth patterns and generate complex shapes. This project brings together three groups that have complementary expertises in biology, image analysis and modeling to provide new insights into the mechanisms of leaf margin development. We will specifically determine the dynamics of CUC/miR164A/auxin activities during leaf development and their interrelations, establish the contributions of cell proliferation and cell expansion to leaf serration and leaf shape and address the contribution of auxin and CUC2 to differential growth and hence to leaf serration and leaf shape.

Partners: RDP ENS-Lyon; INRA Versailles.

#### 7.2.1.2. *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 2015)

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

### 7.2.2. *Other national grants*

#### 7.2.2.1. *OpenAlea 2.0*

**Participants:** Julien Coste, Christophe Pradal, Christophe Godin, Didier Parigot [Inria, Zenith].

Funding: Inria ADT (Contractors for Virtual Plants: Inria from 2012 to 2014)

The goal of this project is to develop an integrated multi-paradigm software environment for plant modeling. This environment will allow the user to draw, model, program or combine models interactively. In a first step, the component architecture of OpenAlea1 .0 will be extended to dynamically add plugin application. In a second step, we move to a decentralized architecture, capable of distributing simulations in the cloud and share virtual experiments on the web. Finally, the modeling environment to be adapted to run in a web browser using HTML5 and WebGL technology

Partners: EPI Zenith

#### 7.2.2.2. *MARS-ALT*

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

Funding: Inria ADT (Contractors for Virtual Plants: Inria from 2012 to 2014)

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.

Partners: EPI Asclepios, RDP ENS-Lyon/INRA, PHIV CIRAD

#### 7.2.2.3. *SCOOP*

**Participants:** Pierre Fernique, Yann Guédon, Christophe Pradal, 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.

#### 7.2.2.4. *Echap*

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

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

The objective of the ECHAP project is to reduce the frequency of treatments and the doses of pesticides applied on crops by taking advantage of natural mechanisms of disease escape related to crop architecture and by optimizing interception of pesticides by plant canopies. It focuses on the development of an integrative, yet modular, modeling tool on the OpenAlea plateform that couples wheat architectural development, the interception and fate of fungicides and the dynamics of a pathogen. Various scenarios combining climate x architecture x fungicide treatment will be simulated to identify and propose efficient strategies of pesticide applications.

Partners: UMR EGC (Paris-Grignon), UMR LEPSE (Montpellier), ARVALIS (Institut du végétal, France), ALTERRA (Research Institute for the Green World, The Netherlands) , ADAS Intitute (UK), CNRS, and IRSTEA .

#### 7.2.2.5. *Morphogenetics*

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

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

#### 7.2.2.6. *Rose*

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

Funding: INRA - Projet de Pari Scientifique (From 2012 to 2014)

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

Partners: UMR SAGAH, Angers

## 7.3. International Initiatives

### 7.3.1. Inria International Partners

#### 7.3.1.1. Informal International Partners

There is currently a very active connection with the group of Malcolm Bennett, at the Centre for Plant Integrative Biology (CPIB) in Nottingham, UK. The CPIB invests in the development of OpenAlea at the tissue level. This collaboration is expressed recently through several publication, e.g. [57].

An important collaboration with the CIRAD reserach unit HortSys of et 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 [24]. 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.

### 7.3.2. Participation In other International Programs

#### 7.3.2.1. BioSensors

We propose to elucidate the basis for positional information by hormones during plant morphogenesis. While it is known that cell fate decisions require simultaneous input from multiple hormones, to-date a precise understanding of how these signals are coordinated and act together to drive morphogenesis does not exist. Our limited mechanistic understanding is largely due to the difficulty to quantify the distribution of these small molecules in space and time. To explore this fundamental question, we will exploit recent advances in synthetic biology to engineer an RNA-based biosensor platform applicable to a broad range of small molecules and in particular to hormones. Using live-imaging technologies, we will use the sensors to obtain quantitative dynamic 3D maps of hormone distributions and relate these maps to the spatio-temporal distribution of cell identities, both during normal morphogenesis and upon perturbations of hormone levels. This analysis will be done on the shoot apical meristem, one of the bestcharacterized developmental systems in higher plants. In this context, mathematical approaches will be essential to analyze and establish a predictive model for how multiple hormones influence cell fate in a spatio-temporal manner.

## 7.4. International Research Visitors

### 7.4.1. Visits of International Scientists

The team received several visitors from foreign research groups in 2014:

- Farah Ben Naoum, from Sidi Bel Abbes University, Algeria, visited the team last summer for 1 month.
- Katarina Smolenova, from University of Göttingen, Germany, visited the team last fall for 2 weeks.
- Pierre Barbier, post-doc researcher at the University of Bern visited the team for a few days in February.
- Yoan Coudert, from University of Cambridge, UK, visited the team for a few days days in April.

- Xavier Sirault, from High Resolution Plant Phenomics Centre at CSIRO, visited the team for one week.
- David Ford, Professor at the University of Washington, USA, visited the team for a few days days in December.

#### **7.4.2. Visits to International Teams**

##### *7.4.2.1. Research stays abroad*

- During the year, Frédéric Boudon visited Frédéric Normand of the UR Hortsys at the CIRAD La Réunion five weeks in April.
- Sarah Cohen-Boulakia has spent one month at the University of Pennsylvania (Philadelphia, April 2014) and one week at the Humboldt University of Berlin (December 2014).

## COATI Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

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

**Participants:** Jean-Claude Bermond, David Coudert, Frédéric Havet, Luc Hogue, Ana Karolinnna Maia de Oliveira, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

The STINT projet (*ST*tructures *IN*terdités) is leaded 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 propoerties 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/>)

#### 8.1.2. GDR Actions

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

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

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

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

Action Graphes, working group of GDR IM, CNRS.

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

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. EULER

**Participants:** David Coudert, Luc Hogue, Aurélien Lancin, Bi Li, Nicolas Nisse.

Title: EULER (Experimental UpdateLess Evolutive Routing)

Type: COOPERATION (ICT)

Defi: Future Internet Experimental Facility and Experimentally-driven Research

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2010 - June 2014

Partners: Alcatel-Lucent Bell (leader) (Antwerp, Belgique), iMind (Ghent, Belgium), UCL (Louvain, Belgium), RACTI (Patras, Grece), UPC (Barcelona, Spain), UPMC (ComplexNetworks, Paris 6), Inria (COATI, GANG, CEPAGE). Coordinator: ALCATEL-LUCENT (Belgium)

STREP EULER (Experimental UpdateLess Evolutive Routing) is part of FIRE (Future Internet Research and Experimentation) objective of FP7. It aims at finding new paradigms to design, develop, and validate experimentally a distributed and dynamic routing scheme suitable for the future Internet and its evolution. COATI is the leader of WP3 on Topology Modelling and Routing scheme experimental analysis.

See also: <http://www-sop.inria.fr/mascotte/EULER/wiki/>

### 8.2.2. Collaborations with Major European Organizations

**Participants:** David Coudert, Alvinice Kodjo, Truong Khoa Phan.

Discrete Optimization group : Lehrstuhl II für Mathematik, RWTH Aachen (Germany)

Robust optimization in backbone networks for energy efficient designs, and chance-constrained programming in backhaul networks subject to link capacity variations.

### 8.2.3. COLOR Inria Sophia Antipolis-méditerranée DIT University of Athens

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

Title : Algorithms Design and Games for Location, Placement and Infrastructure Leasing (AlGa-LoP)

Duration: June 2013- September 2014

COATI and DIT University of Athens (responsible Vassilis Zissimopoulos)

## 8.3. International Initiatives

### 8.3.1. Inria Associate Teams

#### 8.3.1.1. AIDyNet

Title: Algorithm for large and Dynamic Networks

Inria principal investigator: Nicolas Nisse

International Partner (Institution - Laboratory - Researcher):

Universidad Adolfo Ibañez, Santiago, Chile

Facultad de Ingeniería y Ciencias

Karol Suchan

Duration: 2013 - 2015

See also: <http://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.

There are two main objectives:

- Find efficient localized algorithms to test certain graph properties or to prove that no such algorithms exist. We will formalize several distributed computing models and analyze which properties can and which cannot be tested in them.
- Define graph properties , computable or approximable in distributed systems , such as structures/decompositions/representations. The driving idea is to combine several well studied graph properties in order to obtain more specific structures which we hope to be more easily computable.

To verify the practical efficiency of our results, the designed algorithms will be implemented and compared to existing ones. For this purpose, a particular effort will be put to design and implement algorithms to generate graphs that satisfy properties of interest, in order to use them to test the algorithms.

The originality of the proposal is to combine powerful tools of graphs theory (e.g., FPT complexity) and of combinatorial optimization (Mixed Integer Programming) with distributed computing. One challenge here is to balance between the degree of locality of desired algorithms and the relevance of properties that may be computed.

### **8.3.2. 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 Ceara, Brasil, 2014-2016.

## **8.4. International Research Visitors**

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

#### *8.4.1.1. Professors / Researchers*

Xavier Défago

Date: until Jan 31 2014

Institution: JAIST, Japan

Michele Flammini

Date: Jun 30 - Jul 13 2014

Institution: Univ. L'aquila, Italy

Brigitte Jaumard

Date: Dec 15-21, 2014

Institution: Concordia Univ., Montréal, Canada

Mejdi Kaddour

Date: Oct 13-19 2014

Institution: Univ. Oran, Algeria

Takako Kodate

Date: Mars 21 - Apr 3 2014

Institution: Tokyo Woman's Christian Univ., Suginami-ku, Tokyo, Japan

Arie M. C. A. Koster

Date: Jun 10-13, 2014

Institution: RWTH Aachen Univ., Germany

Gianpiero Monaco

Date: Jul 9-17, 2014

Institution: Univ. L'aquila, Italy

Gabriele Muciaccia

Date: Jan 10-16, 2014

Institution: Royal Holloway, University of London, UK

Jean-Sébastien Sereni

Date: Fev 2-7, 2014

Institution: LORIA, Nancy, France

Julio-Cesar Silva Araújo

Date: Jun 23 - Jul 25 2014

Institution: Univ. Federal do Ceara, Fortaleza, Brazil

Karol Suchan

Date: Sep 7-28 2014

Institution: Univ. Adolfo Ibanez, Santiago, Chile

Joseph Yu

Date: Mar 1 - Apr 18, 2014

Institution: Abbotsford and SFU, Vancouver, Canada

Vassilis Zissimopoulos

Date: Jul 4-12 2014

Institution: NKUA, Athens, Greece

#### 8.4.1.2. *PhD students*

Marthe Bonamy

Date: Jan 27 - Feb 7, 2014

Institution: LIRMM, Montpellier, France

Akram Kout

Date: Sep 1 - Oct 25, 2014

Institution: Univ. Mentouri, Constantine, Algeria,

Esteban H. Roman Catafau

Date: May 8 - Jul 23 2014

Institution: Univ. Adolfo Ibanez, Santiago, Chile

#### 8.4.1.3. *Internships*

Claudio Carvallho

Date: Dec 2013-Feb 2014

Institution: Federal University of Ceara, Brasil

Supervisor: Frédéric Havet

Renan Dantas

Date: Dec 2013-Feb 2014

Institution: Federal University of Ceara, Brasil

Supervisor: Frédéric Havet

Doldan Juan

Date: Apr 2014 - Aug 2014

Institution: Universidad de Buenos Aires (Argentina)

Supervisor: Nicolas Nisse

### 8.4.2. *Visits to International Teams*

#### 8.4.2.1. *Research stays abroad*

Jean-Claude Bermond

Department of Informatics and Telecommunications of the National and Kapodistrian University of Athens, Greece, May 31 -June 14, 2014

David Coudert

Research Unit 1 (RU1) of the Computer Technology Institute and Press "Diophantus" (CTI), Patras, Greece, March 12-16, 2014

Department of Informatics and Telecommunications of the National and Kapodistrian University of Athens, Greece, March 16-22, 2014

Univ. Adolfo Ibañez, Santiago, Chile, November 17-30, 2014

Frédéric Giroire

LIAFA, Paris, France, March 19, 2014

PARGO, Federal University of Ceará, Fortaleza, Brazil, June 9-20, 2014

Frédéric Havet

LIP, ENS Lyon, France, December 15-17, 2014

Nicolas Nisse

JAIST, Kanazawa, Japan, July 22 - August 8, 2014

Univ. Adolfo Ibañez, Santiago, Chile, November 17 - December 12, 2014



## DIANA Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

**Plate-forme Télécom (PFT)** (2011-2014) 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, Pôle SCS, ST Ericsson, Telecom Valley. Our contribution is centred around providing a test methodology and tools for wireless networks experimentation.

## 7.2. National Initiatives

### 7.2.1. 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** (2013-2016): 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.
- **ANR REFLEXION** (2015-2016): 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.

## 7.3. European Initiatives

### 7.3.1. FP7 & H2020 Projects

Program: FP7 FIRE programme

Project acronym:

Project title: Fed4Fire

Duration: mois 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.

### 7.3.2. EIT KIC funded activities

Program: **FNS Future Networking Solutions Action Line**

Project acronym: **NFMD**

Project title: Networks for Future Media Distribution (14082)

Duration: January 2014 to December 2014

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: "Information centric networking is a novel approach of distributing content based on information rather than traditional host routing. The impact foreseen is novel content distribution networks. This is high risk but gives potentially very high impacts. Solutions for media distribution, based on caching in the network and with advanced tools for quality of experience monitoring, as well as optimization for user demand content patterns as monitored in live services, will be considered." The expected outcomes envisioned also in the application were seen over the total length of the project of 2-3 years and would give:

- Building blocks for high performance media service distribution at low cost
- Optimized caching strategies
- Information centric networking solutions
- Quality of Experience tools
- Prototypes, standardization and open source
- Greater mobility, better performance of media services and reduced cost
- Sharing of experience; increased cooperation; new or extended partnerships

Program: **FNS Future Networking Solutions Action Line**

Project acronym: **SDN**

Project title: Software Defined Networking (13153)

Duration: January 2014 to December 2014

Coordinator: Aalto University, Finland

Other partners: Helsinki University (Finland), Thales (France), Deutsche Telecom, Fraunhofer, TU München, TU Berlin (Germany).

Abstract: SDN still requires improvements to be used in mobile networks considering aspects such as security, resilience/robustness and efficient usage of resources in the mobile access. This activity addresses the design of security in mobile access networks (Distributed FW for attack detection and mitigation), Efficient resource usage in mobile access networks (redistribution of traffic based on congestion, mobility patterns) and Resilient control-plane (supporting high speed carrier mobile networks). The expected outcomes are the following:

- Security outcome: Dynamically allocate resources to countermeasure the cyber attack. Isolation of the part of the network under attack so rest is not compromised.
- Efficient resource usage in mobile access networks outcome: Optimal redirection of flows following optimized caching policy and pattern based mobility.
- Resilient control-plane outcome: Understand QoS and make that information available in routing to ensure resiliency.

## 7.4. International Initiatives

### 7.4.1. Inria International Labs

We collaborate with Javier Bustos from Inria Chile and his group on the measurements of users' quality of experience and its interpretation in terms of measurements carried on within the devices of the end-users. This collaboration comes to extend Adkintun Mobile with experience-level measurements, and to leverage the results to obtain for the analysis and calibration of users' experience new models and to develop network troubleshooting techniques in case of service degradation. This collaboration fits within our project ACQUA on predicting quality of user experience at Internet access. In 2014, we started integrating the feedback of users revealing their experience into Adkintun Mobile, and the work is currently focusing on obtaining the targeted measurements.

### 7.4.2. Inria Associate Teams

#### 7.4.2.1. SIMULBED

Title: SIMULBED: Large-Scale Simulation Testbed for Realistic Evaluation of Network Protocols and Architectures

International Partner (Institution - Laboratory - Researcher):

NICT and University of Tokyo (Japan), Hitoshi Asaeda and Yuji Sekiya.

Duration: 2012 - 2014

Participants from Inria in 2014: Walid Dabbous, Emilio Mancini, Alina Quereilhac, Hardik Soni, Julien Tribino and Thierry Turetli.

Participants from NICT in 2014: Hitoshi Asaeda, Ruidong Li and Kazuhisa Matsuzono.

Participants from University of Tokyo in 2014: Yuji Sekiya and Hajime Tazaki.

Web site: <http://planete.inria.fr/Simulbed/>

Abstract: Simulators and experimental testbeds are two different approaches for the evaluation of network protocols and they provide a varying degree of repeatability, scalability, instrumentation and realism. Network simulators allow fine grained control of experimentation parameters, easy instrumentation and good scalability, but they usually lack realism. However, there is a growing need to conduct realistic experiments involving complex cross-layer interactions between many layers of the communication stack and this has led network researchers to evaluate network protocols on experimental testbeds.

The use of both simulators and testbeds to conduct experiments grants a better insight on the behavior of the evaluated network protocols and applications. In this project, we focus on the design of SIMULBED, an experimentation platform that aims at providing the best of both worlds. Our project builds on the following state-of-the-art tools and platforms: the open source ns-3 network simulator and the PlanetLab testbed. ns-3 is the first network simulator that includes a mechanism to execute directly within the simulator existing real-world Linux protocol implementations and applications. Furthermore, it can be used as a real-time emulator for mixed (simulation-experimentation) network scenarios. PlanetLab is the well-known international experimental testbed that supports the development and the evaluation of new network services. It is composed of nodes connected to the Internet across the world, and uses container-based virtualization to allow multiple experiments running independently on the same node while sharing its resources.

The overall objective of the project is to make available to networking research community, the SIMULBED platform that will: (1) allow to conduct easily mixed simulation-experimentation evaluation of networking protocols and (2) scale up the size of the PlanetLab experimental testbed, while maintaining a high degree of realism and increasing controllability and reproducibility. We will use the NEPI unified programming environment recently developed in the Planète project-team to help in simplifying the configuration, deployment and run of network scenarios on the platform. See the 2014 Update on the Simulbed web site.

#### 7.4.2.2. Community

Title: COMMUNITY: Message delivery in heterogeneous networks

International Partner (Institution - Laboratory - Researcher):

University of California Santa Cruz (United States) - School of Engineering - Katia Obraczka

Duration: 2009 - 2014

Participants from Inria in 2014: Thierry Turletti, Chadi Barakat, Damien Saucez, Xuan Nam Nguyen, Hardik Soni and Bruno Nunes.

Participants from USCS in 2014: Katia Obraczka and Mateus Santos, PhD Student, USP (research intern at UCSC in 2014).

Participants from USP in 2014: Cintia Borges Margi.

Web site: <http://inrg.cse.ucsc.edu/community/>

Abstract: This Inria - UC Santa Cruz Team investigates a number of research challenges raised by message delivery in environments consisting of heterogeneous networks that may be subject to episodic connectivity.

During the first three years of the COMMUNITY associate team, we have explored solutions to enable efficient delivery mechanisms for disruption-prone and heterogeneous networks (i.e. challenged networks). In particular, we have designed the MeDeHa framework along with the Henna naming scheme, which allow communication in infrastructure and infrastructure-less networks with varying degrees of connectivity. We have also proposed efficient routing strategies adapted to environment with episodic connectivity that take into account the utility of nodes to relay messages. The various solutions have been evaluated using both simulations and real experimentations in testbeds located at Inria and UCSC. These solutions have demonstrated good performance in challenged networks.

However, the ossification of the Internet prevents the deployment of such solutions in large scale. So, in 2012 we decided to extend our collaboration in two research directions: (1) The exploration of the software-defined networking paradigm to facilitate the implementation and large scale deployment of new network architectures to infrastructure-less network environments, and (2) the design of innovative information-centric communication mechanisms adapted to challenged networks. In particular, we are designing mechanisms to provide flexible, efficient, and secure capacity sharing solutions by leveraging SDN in hybrid networked environments, i.e., environments that consist of infrastructure-based as well as infrastructureless networks. We are also investigating solutions to optimize caching in infrastructure and infrastructureless networks using SDN. We have also designed a content-optimal delivery algorithm, called CODA, for distributing named data over challenged networks. See the [2014 Update](#) on the Community web site.

## 7.5. International Research Visitors

### 7.5.1. Visits of International Scientists

#### 7.5.1.1. Visiting PhDs

PhD Student: Sahar Hoteit  
Date: from May 12th 2014 until May 21st 2014  
Subject: On ICN Cache Allocation to Content Providers  
Institution: LIP6, University of Pierre and Marie Curie

#### 7.5.1.2. Internships

Student: Salim Afra  
Date: from March 2014 until August 2014  
Institution: Polytech Nice Sophia, Ubinet Master

Student: Nicolas Aguilera Miranda  
Date: from October 2014 February 2015  
Subject: Measurements of users' quality of experience over Adkintun Mobile  
Institution: University of Chile

Student: Lelio Renard-Lavaud  
Date: from April 2014 until July 2014  
Subject: Popularity and placement of content in Delay Tolerant Networks  
Institution: Ecole Polytechnique - Palaiseau

Student: Hardik Soni  
Date: from March 2014 until August 2014  
Subject: On managing wireless mesh networks using an SDN architecture  
Institution: Polytech Nice Sophia, Ubinet Master

Student: Mahdi Shoja  
Date: from March 2014 until August 2014  
Subject: Evaluation of network protocols with Direct Code Execution  
Institution: Polytech Nice Sophia, Ubinet Master

Student: Phuong Tran Huu  
Date: from May 2014 until October 2014  
Subject: A Future Internet Technologies benchmark  
Institution: Polytech Nice Sophia

### 7.5.2. Visits to International Teams

Bruno Astuto A. Nunes and Thierry Turletti, visited UCSC in March in the context of the Community associated team.

Hardik Soni and Thierry Turletti, visited NICT and Univ. of Tokyo in november in the context of the Simulbed associated team.

## FOCUS Project-Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

- AEOLUS (Mastering the Cloud Complexity) is an ANR-ARPEGE project started on December 2010 that finished on December 2014. AEOLUS studies the problem of installation, maintenance and update of package-based software distributions in cloud-based distributed systems. The problem consists of representing the dependencies of packages and the inter-relationships among the services, in such a way that starting from a declarative description of the application to be deployed on the cloud, it is possible to automatically compute the resources (ie. virtual machines) to be acquired, and the allocation of such resources to the software services needed to run the application. Main persons involved: Gabbrielli, Lienhardt, Mauro, Zavattaro.
- REVER (Programming Reversible Recoverable Systems) is an ANR project that started on 1st December 2011 and with a 48-month 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.

## 7.2. European Initiatives

### 7.2.1. 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.

### 7.2.2. Collaborations in European Programs, except FP7

- The ICT COST Action BETTY (Behavioural Types for Reliable Large-Scale Software Systems), initiated in October 2012 and with a four-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 choreography. Main persons involved: Bravetti, Giachino, Hirschhoff, Lanese, Laneve, Mauro, Sangiorgi, Zavattaro.

### 7.2.3. 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. One joint PhD supervision (Michele Alberti).
- 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 2014.
- 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.

## 7.3. International Research Visitors

### 7.3.1. 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.

- Luca Padovani (Turin) "Deadlock and lock freedom in the linear pi-calculus".
- Jean-Bernard Stefani (Inria Grenoble), "Strong isolation in actor systems".
- Mauro Caporuscio (Milan): "Prime: A middleware support for fluid distributed systems".

- Fabrizio Montesi (Copenhagen): "Choreographic Programming".
- Marco Carbone (Copenhagen): "Behavioural types for adaptable service composition".
- Sandro Etalle (Eindhoven), "Signature-Less Network Intrusion Detection: from the research table to the production environments."
- Wolf Zimmermann (Halle, Germany), "Automatic Protocol Conformance Checking in Component-Based and Service-Oriented Systems."
- Lars Kotthoff (Cork, Ireland), "Towards an algorithm selection standard: data format and tools."
- Herbert Wiklicky (London), "Quantitative Aspects in Program Synthesis."
- Naoki Kobayashi (Tokyo), "Model checking higher-order programs".
- Benoit Valiron and Claudia Faggian (Paris), "Geometry of Synchronization"
- Marc Bagnol (Marseille), "On the Resolution Semiring"
- Irek Ulidowski (Leicester), on the topic of reversibility.

#### *7.3.1.1. Internships*

Raphaëlle Crubille, from ENS Lyon, has begun a stage in Focus during 2014, under the supervision of Ugo Dal Lago.



## INDES Project-Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

### 7.1.1. ANR DEFIS PWD

The PWD project (Programmation du Web diffus) has been funded by the ANR Défis programme for 4 years, starting November 2009. The partners of this project are the teams INDES (coordinator), LIP6 at University Pierre et Marie Curie and PPS at University Denis Diderot. The PWD project has been elected as one the projects "phare" by the ANR.

### 7.1.2. 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.

### 7.1.3. FUI X-Data

Broadly available big and open data open new perspectives in terms of use and applications. The X-Data project aims at validating this claim by using actual data sets for building realistic applications. The goal is to combine a large variety of data sets coming from different partners (Data Publica, Orange, EDF, La Poste, social networks, ...) to build innovative applications. The Indes team designs and implements new programming language constructs that help programming these applications. Our contribution to this project ended in November 2014.

### 7.1.4. 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. RAPP

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

Title: Robot App Store

Collaborator: Inria Hephaistos

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.

#### 7.2.1.2. MEALS

Type: FP7

Title: Mobility between Europe and Argentina applying Logics to Systems

Instrument: International Research Staff Exchange Scheme

Duration: October 2011 - September 2015

Coordinator: Pedro D'Argenio

Partner: University of Córdoba, University of Buenos Aires, University of Twente

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>.

### **7.2.2. 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: 10/12/2014 - 10/03/2015

Institution: Max Planck Institute (MPI), Germany

Collaborator: Tamara Rezk

#### *7.3.1.2. Research stays abroad*

Atuya Okudaira

Date: 1/1/2014 - 31/08/2014

Institution: International University of Kagoshima, Japan

Collaborator: Manuel Serrano

## MAESTRO Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. 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 - December 2016

Coordinator: Alain Jean Marie (Inria)

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

Abstract: ANRMARMOTE aims 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>

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. CONGAS

**Participants:** Eitan Altman, Konstantin Avrachenkov, Ilaria Brunetti, Yonathan Portilla, Alexandre Reiffers, Vikas Singh.

Project title: Dynamics and coevolution in multi level strategic interaction games

Type: FP7

Challenge: Future and Emerging Technologies

Instrument: Specific Targeted Research Project

Objective: FET Proactive: Dynamics of Multi-Level Complex Systems (DyM-CS)

Duration: October 2012 - September 2015

Coordinator: Francesco De Pellegrini (CREATE-NET)

Scientific Coordinator: Eitan Altman (Inria)

Other partners: Center for Research and Telecommunication Experimentation for Network Communities (Italy), Univ. d'Avignon et des Pays de Vaucluse (France), Technische Univ. Delft (The Netherlands), Imperial College of Science, Technology and Medicine (United Kingdom), Univ. di Pisa (Italy) and Technion - Israel Institute of Technology (Israel)

Inria contact: Konstantin Avrachenkov

Abstract: CONGAS will develop new mathematical models and tools, rooted in game theory, for the analysis, prediction and control of dynamical processes in complex systems. It will provide a coherent theoretical framework for understanding the emergence of structure and patterns in these systems, accounting for interactions spanning various scales in time and space, and acting at different structural and aggregation levels.

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/>

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

Program: 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

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.

Keywords: Service oriented internet, cloud services, autonomous control, reliability, pricing.

Website: <http://www.cost-across.nl/>

### 8.2.3. Collaborations with Major European Organizations

European Space Operations Centre: European Space Agency, Darmstadt (Germany)

Application of a BitTorrent-like data distribution model to mission operations. In the framework of this project with ESA we cooperate with Thales-Alenia Space (France) and with Teletel S.A. (Greece).

## 8.3. International Initiatives

### 8.3.1. Inria Associate Teams

#### 8.3.1.1. THANES

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

Title: THeory and Application of NEtwork Science

Inria principal investigator: Giovanni Neglia

International Partner (Institution - Laboratory - Researcher):

Univ. Federal do Rio de Janeiro (Brazil) - Department of Computer and Systems Engineering - Daniel Ratton Figueiredo

Duration: 2014 - 2016

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.

### 8.3.1.2. *GANESH*

**Participants:** Eitan Altman, Konstantin Avrachenkov.

Title: GAMES, Optimization and Analysis of NETWORKS Theory and Applications

Inria principal investigator: Eitan Altman

International Partners (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Electrical Communication Engineering - Anurag Kumar

IIT Mumbai (India) - Department of Electrical Engineering - Vivek Borkar

IIT Madras (India) - Electrical Engineering - Venkatesh Ramaiyan

Duration: 2012 - 2014

See also: <http://www-sop.inria.fr/members/Eitan.Altman/Ganesh/Home.html>

This project aims at producing outstanding contributions to the foundations of the theory of networks, in game theory, team theory, optimization and analysis. Three areas in networking will be used to apply these: (1) economy of networks and network neutrality, (2) scheduling in wireless networks, and (3) distributed optimization issues in ad-hoc networks.

### 8.3.2. *Inria International Partners*

#### 8.3.2.1. *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 Palermo (Italy), and Univ. of Twente (The Netherlands); Petrozavodsk State Univ. (Russia); Ghent Univ. (Belgium); see Sections 8.4.1.1 and 8.4.2.

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

E. Altman, I. Brunetti, M. Haddad, G. Neglia, A. Reiffers and J. K. Sreedharan participated in the CEFIPRA workshop on “New Avenues for Network Models” (13-15 January 2014) and the IFCAM workshop on Social Networks (16 January 2014). CEFIPRA and IFCAM organized these workshops to celebrate 6 years of successful collaboration between Inria and Indian institutions. The travel and accommodation expenses were supported by CEFIPRA and IFCAM.

## 8.4. International Research Visitors

### 8.4.1. *Visits of International Scientists*

#### 8.4.1.1. *Professors / Researchers*

Vivek Borkar

Date: 17 November 2014 - 6 December 2014

Institution: IIT Bombay (India)

Pavel Chebotarev

Date: 19-26 September 2014

Institution: RAS Institute of Control Problems (Russia)

Mohamed Shaheen ElGamel

Date: 7-10 October 2014

Institution: AAST Alexandria (Egypt)

Fabio Fagnani

Date: 28-31 January 2014

Institution: Politecnico di Torino (Italy)

Daniel Figueiredo

Date: 20-29 November 2014

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

Anurag Kumar

Date: 27 May 2014 - 4 June 2014

Institution: IISc Bangalore (India)

Joy Kuri

Date: 18-24 May 2014

Institution: IISc Bangalore (India)

Evsey Morozov

Date: 20-24 October 2014

Institution: Petrozavodsk State Univ. (Russia)

Alexey Piunovskiy

Date: 19-24 May 2014

Institution: Univ. of Liverpool (UK)

Shanmugasundaram Ravikumar

Date: 25-30 April 2014

Institution: Google (USA)

Bruno Ribeiro

Date: 6-15 July 2014, 24-28 November 2014

Institution: Carnegie Mellon Univ. (USA)

Rajesh Sundaresan

Date: 17 November 2014 - 6 December 2014

Institution: IISc Bangalore (India)

Don Towsley

Date: 18-21 February 2014

Institution: Univ. of Massachusetts, Amherst (USA)

Sulan Wong

Date: 9 December 2013 - 15 January 2014

Institution: Univ. of A Coruña (Spain)

Uri Yechiali

Date: 21 April 2014 - 4 May 2014

Institution: Tel Aviv Univ. (Israel)

Yi Zhang

Date: 19-24 May 2014

Institution: Univ. of Liverpool (UK)

#### *8.4.1.2. Ph.D. students*

Giuseppe Di Bella

Date: 1 May 2014 - 30 September 2014

Institution: Univ. of Palermo (Italy)

Arnob Ghosh

Date: 1 June 2014 - 31 August 2014

Institution: Univ. of Pennsylvania (USA)

Cristina Rottondi

Date: 1 April 2014 - 30 May 2014

Institution: Politecnico di Milano (Italy)

#### 8.4.1.3. Internships

Aditya Aradhye

Date: 9 June 2014 - 11 July 2014

Institution: Madras Univ. (India)

Dalel Khalladi

Date: 1 March 2014 - 31 August 2014

Institution: Univ. Avignon (France)

Najmeddine Majed

Date: 1 May 2014 - 31 October 2014

Institution: SupCom Tunis (Tunisia)

Nedko Nedkov

Date: 1 April 2014 - 31 July 2014

Institution: National and Kapodistrian Univ. of Athens (Greece)

Shanay Shah

Date: 15 May 2014 - 14 July 2014

Institution: IIT Bombay (India)

Anastasiia Varava

Date: 1 March 2014 - 31 August 2014

Institution: Univ. of Nice Sophia Antipolis (France)

### 8.4.2. Visits to International Teams

#### 8.4.2.1. Research stays abroad

MAESTRO members have visited (the)

- Create-Net, Italy in the period 14-19 April 2014 (**A. Reiffers**);
- Eurandom, The Netherlands in the period 20-24 January 2014 (**K. Avrachenkov**);
- Federal Univ. Of Rio de Janeiro, Brazil in the periods 30 July - 5 August 2014 (**E. Altman**) and 21-31 August 2014 (**G. Neglia** and **A. Reiffers**);
- Ghent Univ., Belgium in the period 15-16 December 2014 (**K. Avrachenkov**);
- Indian Institute of Science and Indian Institute of Technology (Mumbai), India in the period 11-23 January 2014 (**E. Altman**);
- National Univ. of Rosario, Argentina in the period 29 November - 16 December 2014 (**A. Jean-Marie**);
- Technion - Israel Institute of Technology, Tel Aviv, Israel in the periods 2-16 February 2014, 19 April - 3 May 2014 and 15-24 October 2014 (**E. Altman**) and 20 October - 17 December 2014 (**A. Reiffers**);
- Univ. of Bamberg, Germany in the period 19-21 March 2014 (**K. Avrachenkov**);
- Univ. of Delft, The Netherlands in the period 12-14 October 2014 (**E. Altman**);
- Univ. of Florence, Italy in the periods 14-18 July 2014 and 10-13 November 2014 (**G. Neglia**);
- Univ. of Illinois at Urbana-Champaign, USA in the period 1 October 2013 - 31 January 2014 (**M. El Chamie**);
- Univ. of Liverpool, UK in the period 30 March - 3 April 2014 (**K. Avrachenkov**);
- Univ. of Massachusetts at Amherst, USA in the periods 15 April - 16 May 2014 (**P. Nain**);
- Univ. of Waterloo, Canada in the period 16-19 July 2014 (**E. Altman**).

## 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 - May 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. FI-WARE

Type: COOPERATION

Defi: PPP FI: Technology Foundation: Future Internet Core Platform

Instrument: Integrated Project

Objectif: PPP FI: Technology Foundation:Future Internet Core Platform

Duration: September 2011 - May 2014

Coordinator: Telefonica (Spain)

Others partners: Thales, SAP, Inria

Inria contact: Olivier Festor

See also: <http://www.fi-ware.eu/>

Abstract: FI-WARE will deliver a novel service infrastructure, building upon elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors. This infrastructure will bring significant and quantifiable improvements in the performance, reliability, and production costs linked to Internet applications, building a true foundation for the future Internet.

#### 8.2.1.2. 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), CESCO 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 ICTLabs

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

Project title: EIT ICT Labs Data Science Master

Duration: submitted in 2014, funded from 2014 onwards

Coordinator: Martin Klabbers, 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 aims to create a new major for the ICT Labs master 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 SCADA associated team with the Universidad de Chile (UdC). We have had some contacts with a software company in Santiago, and starting exploring some possible collaboration in the area of formal specification of distributed applications for Android systems, and generation of “safe by construction” android code. But the effective involvement of CIRIC manpower in this activity has not yet started.

#### 8.3.1.2. LIAMA Shanghai

Liama project: HADES

Inria principal investigator: Robert de Simone

Oasis researchers involved: Eric Madelaine, Ludovic Henrio

Duration: 2013 - 2016

Modern computing architectures are becoming increasingly parallel, at all levels. Meanwhile, typical applications also display increasing concurrency aspects, specially streaming applications involving data and task parallelism. Cyber physical system interactions also add extra-functional requirements to this high degree of concurrency. The goal of best fitting applications onto architectures becomes a crucial problem, which must be tackled from any possible angle. Our position in the HADES LIAMA project is to consider modeling of applications using formal models of concurrent computation, and specialized model-driven engineering approaches to embody the design flow for such models (analysis, verification, mapping allocation, representation of non-functional properties and constraints). We build on various previous domains of expertise : synchronous languages for embedded system design, asynchronous languages for high-performance cloud computing, and real-time specification languages for cyber-physical interaction aspects.

### 8.3.2. Inria Associate Teams

#### 8.3.2.1. DAESD

Title: Distributed/Asynchronous, Embedded/synchronous System Development

Inria principal investigator: Eric Madelaine

International Partner (Institution - Laboratory - Researcher):

East China Normal University (ECNU) Shanghai - SEI - Yixiang Chen

Duration: 2012 - 2014

See also: <http://team.inria.fr/DAESD>

The development of concurrent and parallel systems has traditionally been clearly split in two different families; distributed and asynchronous systems on one hand, now growing very fast with the recent progress of the Internet towards large scale services and clouds; embedded, reactive, or hybrid systems on the other hand, mostly of synchronous behaviour. The frontier between these families has attracted less attention, but recent trends, e.g. in industrial systems, in “Cyber-Physical systems”, or in the emerging “Internet of Things”, give a new importance to research combining them.

The aim of the DAESD associate team is to combine the expertise of the Oasis/Scale and Aoste teams at Inria, the SEI-Shone team at ECNU-Shanghai, and to build models, methods, and prototype tools inheriting from synchronous and asynchronous models. We plan to address modelling formalisms and tools, for this combined model; to establish a method to analyze temporal and spatial consistency of embedded distributed real-time systems; to develop scheduling strategies for multiple tasks in embedded and distributed systems with mixed constraints.

In 2014, the DAESD associated team co-organized a “Summer School” at ECNU Shanghai.

#### 8.3.2.2. SCADA

Title: Safe Composition of Autonomic Distributed Applications

Inria principal investigator: Ludovic Henrio

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - NIC Chile Research Labs - Javier Bustos

Duration: 2012 - 2014

See also: <http://team.inria.fr/scada>

The SCADA project aims at promoting the collaboration between NIC LABS (Santiago - Chile) and OASIS team, now SCALE (Inria Sophia Antipolis - France) in the domain of the safe composition of applications. More precisely the project will extend existing composition patterns dedicated to parallel or distributed computing to ease the reliable composition of applications. The strong interactions between formal aspects and practical implementation are a key feature of that project, where formal methods, and language theory will contribute to the practical implementation of execution platforms, development and debugging tools, and verification environments. The composition models we focus on are algorithmic skeletons, and distributed components; and we will particularly focus on the programming and verification of non-functional features. Overall, from formal specification and proofs, this project should lead to the implementation of tools for the design and execution of distributed and parallel applications with a guaranteed behavior.

### 8.3.3. Inria International Partners

#### 8.3.3.1. Informal International Partners

- Florian Kammuller, Middlesex University.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

- Min Zhang, ECNU Shanghai, from Sep. 25th to Nov. 9th

*8.4.1.1. Internships*

- Siqi Li, ECNU Shanghai, master internship, from Oct. 15 to Dec. 15th.

**8.4.2. Visits to International Teams**

- Eric Madelaine visited ECNU Shanghai July. 6-12th.
- Ludovic Henrio, Oleksandra Kulankhina, and Eric Madelaine visited ECNU Shanghai from Nov. 29th to Dec. 6th.

*8.4.2.1. Research stays abroad*

- Damian Vicino, ARS Laboratory at Carleton University, Ottawa, Canada, January 2014-December 2014 (12 months)

## AYIN Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

- Seong-Gyun Jeong, Nazre Batool, Yuliya Tarabalka and Josiane Zerubia have been in contact with Didier Zugaj, image processing expert 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 Prof. Bahadoran from CHU Nice/Inserm (Faculty of Medicine, Dermatology department, at l'Archet 2 hospital in Nice) and Dr 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.

## 7.2. European Initiatives

### 7.2.1. Collaborations with Major European Organizations

LIRA consortium

Partners: Philips R&D (Eindhoven), CWI (Amsterdam), Fraunhofer Institutes (Berlin, Stuttgart, Darmstadt), Inria-SAM

Skincare image and signal processing: analysis, modeling and characterization of the condition of human skin.

## 7.3. International Initiatives

### 7.3.1. Informal International Partners

Qiyin Fang and Samir Sahli.

Subject: New optical sensors for skin imaging and their biomedical applications.

Institution: McMaster University (Canada).

Stuart Jones and Jochen Einbeck.

Subject: Shape modelling applied to subterranean sand bodies.

Institution: Department of Earth Sciences and Department of Mathematical Sciences, Durham University (UK).

Zoltan Kato, Tamas Sziranyi and Csaba Benedek.

Subjects: Multi-layer Markovian models for change detection in aerial and satellite images. Random field models of shape.

Institution: Szeged University and MTA SZTAKI (Hungary).

Gabriele Moser and Sebastiano Serpico.

Subject: Hierarchical Markov random fields for multi-temporal and multi-resolution classification in remote sensing.

Institution: Genoa University (Italy).

Anuj Srivastava.

Subject: Statistical shape analysis of functions, curves, and surfaces.

Institution: Florida State University (USA).

## 7.4. International Research Visitors

### 7.4.1. Visits of International Scientists

- Csaba Benedek (MTA SZTAKI, Hungary, one week in January 2014).
- Qiyin Fang (McMaster University, Canada, one week in May 2014).
- Joseph Francos (Ben-Gurion University, Israel, one week in July 2014).
- Zoltan Kato (Szeged University, Hungary, one month, from mid-July till mid-August 2014).
- Vladimir Krylov (Genoa University, Italy, one week in September 2014).
- Zhao Liu (University of Manchester, one week in Dec 2014).
- Gabriele Moser (Genoa University, Italy, one week in July 2014).
- Samir Sahli (McMaster University, Canada, one week in September 2014).
- Thomai Tsiftsi (Durham University, UK, one week in March 2014).

#### 7.4.1.1. Internships

Emmanuel Maggiori (from May until November 2014)

Subject: Optimizing partition trees for multi-class segmentation with shape prior.

Institution: Universidad Nacional del Centro de la Provincia de Buenos Aires and Inria.

Shu-Chi Yeh (from May until August 2014)

Subject: Hyperspectral skin image processing.

Institution: McMaster University, Canada.

### 7.4.2. Visits to International Teams

- Josiane Zerubia was invited in June to visit several laboratories in Israel: Electrical Eng. and Remote Sensing Departements at BGU in Beer Sheva, Computer Science Department at HUJI in Jerusalem, Computer Science Department at Haifa University, Multimedia Department at IDC University in Herzlyia, as well as 2 industrial research centers at Herzlyia (General Motors and Superdimension/Covidian). She also visited 2 start-up companies working in image processing: ORCAM in Jerusalem and GIVIEW in Ramat Gan. Finally she attended the Israel Computer Graphics day 2014 at Weizmann Institute in Rehovot.
- Josiane Zerubia visited in August the Computer Vision and Geometric Modeling lab at the University of Montreal, the Biophotonics lab at the Dept. of Engineering Physics of Mc Master University, as well as the Juravinski cancer research center in Hamilton, and two laboratories working in medical imaging and biological sciences at Sunnybrook Research Institute in Toronto.
- Josiane Zerubia was invited by University of Szeged and the Hungarian Academy of Sciences in December to visit the research group on visual computation at the Informatics Department, as well as the BIOMAG research group of the Synthetic and Systems Biology Unit, located both at Szeged University. She also visited 3 laboratories related to remote sensing, image processing and computer graphics in MTA SZTAKI in Budapest.

## GRAPHIK Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

#### 8.1.1.1. 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 6.2 for this year's results (Extensions of the Framework).*

#### 8.1.1.2. Pagoda

**Participants:** Jean-François Baget, Marie-Laure Mugnier, Mélanie König, Swan Rocher, Michaël Thomazo.

Pagoda (Practical Algorithms for Ontology-based Data Access) is an ANR JCJC (young researchers) project that started in Jan. 2013 (duration: 4 years). The project coordinator is Meghyn Bienvenu (LRI). 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 6.2 for this year's results.*

#### 8.1.1.3. Qualinca

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

Qualinca is an ANR Contint project that started in Apr. 2012 (duration: 4 years). 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 6.4 for this year's results.*

#### 8.1.1.4. 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 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.

### 8.1.2. Competitiveness Clusters

We are taking part in the Laboratory of Excellence (“labex”) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences), led by University of Montpellier 2 in partnership with CNRS, University of Montpellier 1 and Inria. This project aims at developing information and communication technologies for environmental and life sciences. We are participating to one of the four axis, namely “Scientific Data: processing, integration and security”.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. EcoBioCap

**Participants:** Patrice Buche, Madalina Croitoru, Jérôme Fortin, Patricio Mosse.

EcoBioCap is a FP7-KBEE project that started in March 2011 (duration: 4 years). It is led by INRA (and scientifically managed by Montpellier IATE laboratory). It involves sixteen partners among which Cork University (Ireland), CSIC (Spain), Roma University La Sapienza (Italy), SIK (Sweden). The objective of EcoBioCAP is 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 is managed by IATE team.

- See Section 6.3 for this year's results.

### 8.2.2. Collaborations with Major European Organizations

*Richard Booth:* University of Luxembourg, Interdisciplinary Centre for Security, Reliability and Trust (Luxembourg)

Souhila Kaci collaborates with Richard Booth on abstract argumentation. Madalina Croitoru collaborates with Richard Booth on argumentation labelling distances.

*Leon van der Torre:* University of Luxembourg, Computer Science and Communications Research Unit (Luxembourg)

Souhila Kaci collaborates with Leon van der Torre on argumentation aspects. They co-supervised a PhD student (Tjitze Rienstra) from 2010 to 2014.

*Sebastian Rudolph and Michaël Thomazo:* TU Dresden (Germany)

Jean-François Baget and Marie-Laure Mugnier collaborate with Sebastian Rudolph and Michaël Thomazo on existential rules.

*Markus Krötzsch:* TU Dresden (Germany)

Jean-François Baget, Marie-Laure Mugnier and Clément Sipieter collaborate with Markus Krötzsch who is associated with the ADT QUASAR (Section 5.2), as an expert in the Semantic Web.

*Ricardo Rodriguez:* University of Buenos-Aires (Argentina)



Madalina Croitoru collaborates with Ricardo Rodriguez on axiomatization of consistent query answering semantics inspired from axiomatization of belief revision operators.

*Milos Stoiakovitch*: University of Novi Sad (Serbia)

Madalina Croitoru collaborates with Milos Stoiakovitch on properties of positional games in argumentation.

## 8.3. International Research Visitors

### 8.3.1. Visits to the GraphIK team

- January 2014: Camille Pradel, IRIT. He gave a talk presenting his PhD results *D'un langage de haut niveau à des requêtes graphes permettant d'interroger le web sémantique*. <http://thesesups.ups-tlse.fr/2237/1/2013TOU30261.pdf>
- January 2014: Florent Domenach, Nicosia University, Chypre. He gave a talk *Analyse formelle de concepts, application à l'analyse d'annotations sémantiques*.
- February 2014: Aymeric Ledorze, LERIA Aymeric Ledorze (LERIA). He gave a talk presenting his PhD results *Validation, synthèse et paramétrage des cartes cognitives*. <https://tel.archives-ouvertes.fr/tel-00956983/document>
- February 2014: Pierre Bisquert, IRIT. He gave a talk presenting his PhD results on *Étude du changement en argumentation*. <http://thesesups.ups-tlse.fr/2272/1/2013TOU30302.pdf>
- February 2014: Lakhdar Saïs, CRIL. He gave a talk on *Approches déclaratives pour la fouille de données*. <http://www.cril.univ-artois.fr/decMining/pdf/slidesSeminaireLirimm.pdf>
- April 2014: Meghyn Bienvenu, LRI, One week work on query rewriting as part of the Pagoda project (see 8.1).
- April 2014: Federico Ulliana, Inria Grenoble. He gave a talk on *Deductive RDF Triplestores : domain-specific applications and bounded-size module extraction*.
- June 2014: Slawek Staworko, Inria Lille. He gave a talk on *Prioritized Repairing and Consistent Query Answering in Relational Database*. <http://researchers.lille.inria.fr/~staworko/research/talk-montpellier14.pdf>
- September 2014: Jérôme Lang, LAMSADE. He gave a talk on *Introduction au choix social computationnel*. [http://www.afia.asso.fr/tiki-download\\_wiki\\_attachment.php?attId=83](http://www.afia.asso.fr/tiki-download_wiki_attachment.php?attId=83)
- October 2014: Bernardo Cuenca Grau, Department of Computer Science, Oxford. Work on algorithms for reasoning with existential rules.
- October 2014: Meghyn Bienvenu, LRI, One week work on query rewriting as part of the Pagoda project (see 8.1).

### 8.3.2. Visits to International Teams

- January 2014: Madalina Croitoru was invited by the Universitat Autònoma de Barcelona (UAB). Work with Lluís Godo Lacasa (Artificial Intelligence Research Institute, IIIA) and Ricardo Rodriguez (University of Buenos Aires) on the axiomatisation of consistent query answering via belief revision (see 6.2).

## HEPHAISTOS Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. *SyReMuse project: recommender for museum and exhibit visitors*

**Participant:** Bernard Senach [correspondant].

The goal of the SyReMuse Project is to design and implement a recommender system for Museum and exhibits visitors. The project brings together a cluster of research labs from Inria and from University of Avignon mixing computer scientists and Human Science researchers (Laboratoire d'informatique d'Avignon, -Centre Norbert Elias, Wimmics, Hephaistos, ICT usage labs) . The project has been submitted to an ANR Call and, though not successful is still going on with a restricted objective focusing on modeling visitor's expectations and experience (individual and group).

### 7.1.2. *Gnothi Seauton project : Evaluation of communicating objects*

**Participants:** Yves Papegay, Bernard Senach [correspondant], Jean-Pierre Merlet.

In collaboration with a rehabilitation center, we are setting up an experiment of self-quantification devices based on actimetrics (measurement and analysis of motor activities of a subject ). The goal of the study is to assess utility and usability of these devices in the context of mobility rehabilitation. The study will take place at Vallauris' Centre Heliomarin with physical therapists and patients with mobility impairments.

## 7.2. European Initiatives

### 7.2.1. *FP7 & H2020 Projects*

#### 7.2.1.1. *CABLEBOT*

- Type: COOPERATION
- Instrument: Specific Targeted Research Project
- Objective: to develop a new generation of modular and reconfigurable robots able to perform many different steps in the post-production of large-scale structures.
- Duration: November 2011 - October 2014
- Coordinator: Ms. Mariola Rodríguez (TECNALIA, Spain)
- Partner: TECNALIA (Spain), CNRS-LIRMM, FRAUNHOFFER-IPA, UDE, Inria, EADS, ACCIONA, VICINAY
- Inria contact: Jean-Pierre Merlet
- Abstract: The CABLEBOT project<sup>0</sup> deals with a novel methodology for designing, developing and evaluating cable robots customized for the automation in large-scale auxiliary processes. Parallel cable robots extend the payloads and workspace of conventional industrial robots by more than two orders of magnitude. The main objective is to develop a new generation of modular and reconfigurable robots able to perform many different steps in the post-production of large-scale structures. Three key technologies will be developed: a) Design of Cable Robot: Software tools to design the layout and geometry of cable robots, b) Industrial Process Planning: Simulation of cable robots to verify the operation of cable robots in environments with large-scale structures c) Control Algorithms and Systems: Distributed control and kinematic transformation to operate modular cable

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<sup>0</sup><http://www.cablebot.eu/>

robots. Two application examples are targeted in close cooperation to industry: aeronautical applications of maintenance and the handling of construction beams. In both cases existing automation can hardly be used due to maneuverability of heavy and big parts and the risk associated. The results are feasible for many other fields including large-workspace movements of products, with impact in logistics, transport, and warehousing. The exploitation and commercialization of CABLEBOT are driven by VICINAY CEMVISA, the application of industrial scenarios, two end-users of different sectors - EADS and ACCIONA - will automate their currently manual post-production. TECNALIA provides the technology for simulation in terms of productivity, cost, safety and robustness, whereas the design of the robots is in charge of LIRMM and Inria. IPA and UDE are in charge of the control algorithms, on distributed and force control of redundant systems. Benefits include an increase of production efficiency, a wider range of products, light and reconfigurable structure mechanisms and adaptable and more flexible operator assistance systems.

### 7.2.1.2. 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: s 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.

### 7.2.2. Collaborations with Major European Organizations

Our collaboration are described in the figure 1 .

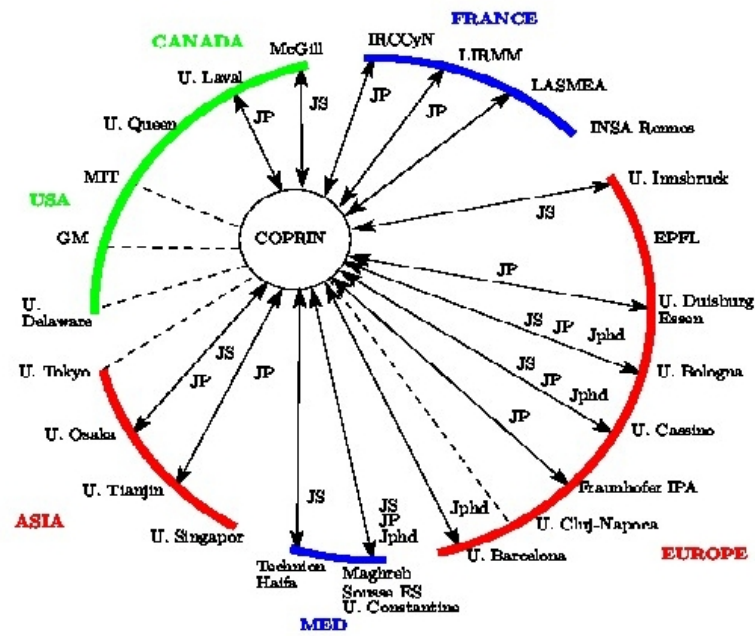


Figure 1. COPRIN collaboration. JP: joint project, JS: joint stay, Jphd: joint PhD students

## LAGADIC Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. Oseo Apash project

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

*no Insa Rennes 2012-230, duration: 24 months.*

Started in September 2012 and finished in July 2014, the Apash project was supported by the Images & Réseaux cluster. It involved three laboratories connected to INSA Rennes, namely Irisa/Inria, IETR and LGCGM. One industrial partner took part into this project: Ergovie. This project aimed at designing a driving assistance for electrical wheelchair towards the autonomy and security of disabled people. The work realized within this project is described in Section 6.2.1 .

### 8.1.2. 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 6.2.1 ) 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 2015. We expect that this technology should be helpful for many handicapped people. In particular, 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.

### 8.1.3. 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 of a humanoid robot (see Section 8.2.4 ).

### 8.1.4. "Équipement mi-lourd Rennes Métropoles"

**Participant:** Paolo Robuffo Giordano.

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

A grant from "Rennes Métropole" has been obtained in June 2014 and will support the activities related to the use of drones (quadrotor UAVs). The platform described in Section 5.4.5 has been purchased thanks to this grant.

## 8.2. National Initiatives

### 8.2.1. ANR P2N Nanorobust

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

*no. UR1 11FA310-06D, duration: 48 months.*

This project started in November 2011. 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). Our goal is to provide visual servoing techniques for positioning and manipulation tasks with a nanometer precision.

### **8.2.2. ANR Contint Visioland**

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

*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.

### **8.2.3. PEA Decsa**

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

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

This project started in November 2011. It is 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 is devoted to the development of navigation and perception algorithms for small drones in urban environment.

### **8.2.4. Oseo Romeo 2**

**Participants:** Nicolas Cazy, Suman Raj Bista, Fabien Spindler, Paolo Robuffo Giordano, 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 to develop advanced control and perception functionalities to a humanoid robot. It supports in part Suman Raj Bista’s Ph.D. about visual navigation of a humanoid robot, as well as Nicolas Cazy’s Ph.D. about model-based predictive control for visual servoing.

### **8.2.5. 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 a near future, we plan to buy a humanoid robot, Romeo, by Aldebaran Robotics.

### **8.2.6. Inria large scale initiative action PAL**

**Participants:** Panagiotis Papadakis, François Pasteau, Vishnu Karakkat Narayanan, Erwan Demairy, Marie Babel, Patrick Rives, François Chaumette.

Lagadic participates in the large-scale initiative action PAL (Personally Assisted Living) to develop technologies and services to improve the autonomy and quality of life for elderly and fragile persons. PAL started in September 2009 for 5 years. The purpose of PAL is to provide an experimental infrastructure, in order to facilitate the development of models, tools, technologies and concept demonstrations. Using the skills and objectives of the involved teams, four research themes have been defined: a) assessing the degree of frailty of the elderly, b) mobility of people, c) rehabilitation, transfer and assistance in walking, and d) social interaction. Lagadic is currently involved in the themes "mobility of people" and "assistance in walking" through collaborations with the EPI e-Motion (Grenoble), EPI Coprin (Sophia-Antipolis), and Handibio (Toulon). See Sections 6.2.1 , 6.2.2 and 6.1.4 , as well as [55].

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. FP7 Space RemoveDEBRIS

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

Instrument: Specific Targeted Research Project

Duration: from October 2013 till September 2016

Coordinator: University of Surrey (United Kingdom)

Partner: 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 the model-based tracking algorithms developed during Antoine Petit's Ph.D. (see Section 6.3.1) on images acquired during an actual space debris removal mission.

#### 8.3.1.2. FP7 Regpot Across

**Participant:** François Chaumette.

Program: Regpot

Project acronym: Across

Project title: Center of Research Excellence for Advanced Cooperative Systems

Duration: from September 2011 till March 2015

Coordinator: Prof. Ivan Petrovic from University of Zagreb (Croatia)

Other partners: KTH (Sweden), ETHZ (Switzerland), TUM (Germany), University of Manchester (UK), Vienna University of Technology (Austria), Politecnico di Milano (Italy), University of Sevilla (Spain), Eindhoven University of Technology (The Netherlands), University of Athens (Greece), etc.

Abstract: the goal of this project is to enhance collaborations with the University of Zagreb.

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

**Participant:** Marie Babel.

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.

#### *8.4.1.1. 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), a new Ph.D. student, Renato José Martins, joined the team in Sophia Antipolis thanks to a grant from the CNPq (2013-2017). He is co-directed by Patrick Rives and Samuel Siqueira Bueno from “Divisão de Robótica e Visão 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 PhD in Malaga by September 2014, is currently on a Postdoctoral position in Sophia Antipolis.

## **8.5. International Research Visitors**

### *8.5.1. Visits of International Scientists*

- Hideaki Uchiyama, associate professor at Kyushu University, Japan, visited the group in Rennes for 3 weeks in December 2014 to work on augmented reality.
- Ivan Markovic, postdoctoral researcher at the University of Zagreb, spent a three-month visit in Rennes in the scope of the FP7 Regpot Across project (see Section [8.3.1.2](#) and [6.2.4](#) ).

### *8.5.2. Visits to International Teams*

- Pierre Chatelain spent 2 one-week visits in Nassir Navab’s lab at TUM, Germany, in the scope of his Ph.D.



## REVES Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. 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, and the development of the new global illumination algorithm described in Sec. 6.2.5 .

### 8.1.2. 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. Sandilas) 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 will be to observe how people draw with existing tools. To do so we will conduct 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 will deduce 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 will combine computer vision and computer graphics techniques to estimate geometric information from sketches. We will then use this information to guide rendering algorithms that generate plausible depictions of material and lighting over the drawing. In the third part of the project, we plan to develop computer-assisted drawing lessons to teach amateurs how to draw from photographs and 3D models. We will apply 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 is 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 two publications this year on 3D modeling from sketches [17] and on vectorization of photographs [16].

### 8.1.3. 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.

## 8.2. European Initiatives

### 8.2.1. VERVE

Title: VERVE

Type: COOPERATION (ICT)

Defi: Services to promote E-inclusion using socially realistic virtual environments

Instrument: Integrated Project (IP)

Duration: October 2011 - September 2014

Coordinator: Trinity College - Dublin (Ireland)

Others partners: DFKI (Germany), CNRS-ParisTech (France), CNRS-IRCAM (France), U. of Zaragoza (Spain), Testaluna (IT), KAINOS (UK)

See also: <http://www.verveconsortium.eu/>

Abstract

Social exclusion has many causes, but major factors are the fear and apathy that often accompany a disability. The European e-Inclusion policy stresses the importance of ICT in improving the quality of life in potentially disadvantaged groups, including older people and persons with disabilities. In this project, we will develop ICT tools to support the treatment of people who are at risk of social exclusion due to fear and/or apathy associated with a disability. These tools will be in the form of personalised VR scenarios and serious games specifically designed for therapeutic targets and made broadly available via a novel integration of interactive 3D environments directly into Web browsers. We will perform cutting edge research into rendering and simulating personalised and populated VR environments, 3D web graphics, and serious games. These technical efforts will be underpinned by our clinical/laboratory and industry partners, who will be fully involved throughout in the requirements, design and evaluation of VERVE, and liaison with the stakeholders (i.e., participants, carers/family, and health professionals). They will implement the VERVE interventions in three use-cases, each targeting a different group of participants: fear of falling, apathy related to cognitive decline and behavioural disturbances, and other emotional disturbances linked to anxiety. While developing clinical assessment methods and interventions for the first two patient groups is our primary focus, our results will be applicable to a much wider range of potentially disadvantaged individuals.

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

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, with whom we have a solid working

relationship from our previous VERVE project (see above). 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 UCL on video-based rendering, which will continue in 2015.

## 8.3. International Initiatives

### 8.3.1. Inria Associate Teams

#### 8.3.1.1. CRISP2

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

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley

Duration: 2011 - Present

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

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

After a very productive year in 2013, we continued our work on drawing and manipulating materials in vector graphics in 2014. This work was published in the Computer Graphics Forum journal and presented at the Eurographics Symposium on Rendering (EGSR) [16]. We are currently working on two collaborative projects in the context of CRISP. One project is on light transport simulation (with Ravi Ramamoorthi, now at UC San Diego), the other project is on appearance transfer between photographs (with Alyosha Efros, who recently joined UC Berkeley). We also have several project ideas to start with Martin S. Banks (Human Vision Science).

### 8.3.2. Informal International Partners

#### 8.3.2.1. France-USA

**Participants:** Gaurav Chaurasia, Emmanuel Iarussi, Adrien Bousseau, George Drettakis.

Beyond the CRISP associate team, we have an ongoing collaboration with Adobe Research (Sylvain Paris) and MIT (Fredo Durand) on parallel image-processing languages and global illumination (Fredo Durand). We also have another collaboration with Adobe Research (Wilmot Li) on jewelry design. Emmanuel Iarussi did a 3-months visit at Adobe in the context of this collaboration.

#### 8.3.2.2. France-Canada

**Participant:** Adrien Bousseau.

We collaborate with K. Singh (University of Toronto) and Alla Scheffer (U. British Columbia, Vancouver), on sketching techniques for designers (see Sec. 6.4.4).

#### 8.3.2.3. France-Greece

**Participant:** George Drettakis.

We are collaborating with the Technical University of Crete on visual attention, in the context of the Ph.D. of George Koulieris, supervised by Prof. Katerina Mania and the Un. of Cottburg (D. Cunningham) (see Sec. 6.3.2 and 6.3.1).

## **8.4. International Research Visitors**

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

#### *8.4.1.1. Visitors*

We hosted several researchers this year:

- Gordon Wetzstein (MIT), in January
- Wendy McKay and Theophanis Tsandilas in February
- Kenneth Vanhoey (Univ. de Strasbourg), in February
- Fredo Durand (MIT), in February
- Jean Ponce (ENS), in February
- Marcus Magnor (TU Braunschweig), in February
- Christian Theobalt (Max Planck Institut), in February
- Markus Gross (ETH Zurich), in April
- Abdelaziz Djelouah (Inria Grenoble), in May
- Indira Thouvenin (UT Compiègne), in June
- Josef Sivic (Inria and ENS), in July
- Wenzel Jakob (ETH Zurich), in September
- Marty Banks (Berkeley part of EA CRISP), in June and November
- Gaurav Chaurasia (MIT), in November

#### *8.4.1.2. Internships*

Arora Rahul

Date: May 2014 - July 2014

Institution: IITK (India)

Ayush Tewari

Date: June 2014 - Aug 2014

Institution: IIIT

Uditha Kasthuriarachchi

Date: April 2014 - Sept 2014

Institution: UNSA

## STARS Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

#### 8.1.1.1. 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.

#### 8.1.1.2. 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.

### 8.1.2. Investment of Future

#### 8.1.2.1. Az@GAME

Program: DGCIS

Project acronym: Az@GAME

Project title: 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 behavioural disturbances, most particularly for the stimulation of apathy.

### 8.1.3. Large Scale Inria Initiative

#### 8.1.3.1. PAL

Program: Inria

Project acronym: PAL

Project title: Personally Assisted Living

Duration: 2010 -2014

Coordinator: COPRIN team

Other partners: AROBAS, DEMAR, E-MOTION, STARS, PRIMA, MAIA, TRIO, and LAGADIC Inria teams

See also: <http://www-sop.inria.fr/coprin/aen/>

Abstract: The objective of this project is to create a research infrastructure that will enable experiments with technologies for improving the quality of life for persons who have suffered a loss of autonomy through age, illness or accident. In particular, the project seeks to enable development of technologies that can provide services for elderly and fragile persons, as well as their immediate family, caregivers and social groups.

#### 8.1.4. Other Collaborations

- G. Charpiat works with Yann Ollivier and Jamal Atif (TAO team) as well as Rémi Peyre (École des Mines de Nancy / Institut Élie Cartan) on the topic of image compression.
- G. Charpiat works with Giacomo Nardi, Gabriel Peyré and François-Xavier Vialard (Ceremade, Paris-Dauphine University) on the generalization of gradient flows to non-standard metrics.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. CENTAUR

Type: FP7

Defi: Computer vision

Instrument: Industry-Academia Partnerships and Pathway

Objective: a network of scientific excellence addressing research topics in computer vision

Duration: January 2013 - December 2016

Coordinator: Honeywell (CZE)

Partner: Neovison (CZE), Inria Sophia-Antipolis (CZE), Queen Mary University of London (UK) and EPFL in Lausanne (CH).

Inria contact: François Brémond

Abstract: CENTAUR aims at developing 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. Three thrusts identified will enable the monitoring of crowded scenes: (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.

#### 8.2.1.2. PANORAMA

Type: FP7

Defi: Computer vision

Instrument: Industry-Academia Partnerships and Pathway

Objective: techniques and architectures for imaging applications

Duration: April 2012 - March 2015

Coordinator: Philips Healthcare (NL)

Partner :Medisys (FR), Grass Valley (NL), Bosch Security Systems (NL), STMicroelectronics (FR), Thales Angenieux (FR), CapnaDST (UK), CMOSIS (BE), CycloMedia (Netherlands), Q-Free (Netherlands), TU Eindhoven (NL) , University of Leeds (UK), University of Catania (IT), Inria(France), ARMINES (France), IBBT (Belgium).

Inria contact: François Brémond

Abstract: 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 set-up 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 (see also: <http://www.panorama-project.eu/>).

#### 8.2.1.3. SUPPORT

Title: Security UPgrade for PORTs

Type: FP7

Defi: Port Security

Instrument: Industry-Academia Partnerships and Pathway

Objective: secure European ports

Duration: July 2010 - June 2014

Coordinator: BMT Group (UK)

Other partners: Inria Sophia-Antipolis (FR); Swedish Defence Research Agency (SE); Securitas (SE); Technical Research Centre of Finland (FI); MARLO (NO); INLECOM Systems (UK).

Inria contact: François Brémond

Abstract: SUPPORT is addressing potential threats on passenger life and the potential for crippling economic damage arising from intentional unlawful attacks on port facilities, by engaging representative stakeholders to guide the development of next generation solutions for upgraded preventive and remedial security capabilities in European ports. The overall benefit will be the secure and efficient operation of European ports enabling uninterrupted flows of cargos and passengers while suppressing attacks on high value port facilities, illegal immigration and trafficking of drugs, weapons and illicit substances all in line with the efforts of FRONTEX and EU member states.

#### 8.2.1.4. *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, behaviour, 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.

## 8.3. International Initiatives

### 8.3.1. *Inria International Partners*

#### 8.3.1.1. *Informal International Partners*

##### 8.3.1.1.1. 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.

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

Stars collaborates with the University of Southern California.

##### 8.3.1.1.3. Collaboration with Europe:

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



### 8.3.2. Participation in Other International Programs

- The ANR SafEE (see section 8.1.1.2) collaborates with international partners as Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW) and BDE (TW).

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

#### 8.4.1.1. Internships

ABDALLA OMAR

Date: from Apr 2014 until Sep 2014

Institution: Université Française du Caire (Egypt)

BOUATIRA Mohamed

Date: from Mar 2014 until Sep 2014

Institution: Ecole Mohammadia d'Ingénieurs (Marocco)

CAVERZASI Augustin

Date: until Feb 2014

Institution: Universidad Nacional de Córdoba, Facultad de Ciencias Exactas Físicas y Naturales, Argentina

GOMEZ URIA COVELLA Alvaro

Date: from Mar 2014 until Dec 2014

Institution: National University of Rosario, Argentina

MARTINS DE MELO Filipe

Date: from Apr 2014 until Sep 2014

Institution: Federal University of Pernambuco, Brazil

NEGIN Farood

Date: from Apr 2014 until Nov 2014

Institution: Sabanci University, Turkey

NGUYEN Thi Lan Anh

Date: from Mar 2014 until Oct 2014

Institution: Dhai Nguyen University of Information and Communication Technology, Vietnam

PHAM Ngoc Hai

Date: from May 2014 until Nov 2014

Institution: Science and Technology University of Hanoi, Vietnam

PUSIOL Pablo Daniel

Date: from Apr 2014 until Sep 2014

Institution: National University of Cordoba, Argentina

SARRAY Ines

Date: Apr 2014 - Oct 2014

Institution: ESPRIT (Ecole d'ingénieurs Tunis) (Tunisia)

STRUMIA Carola

Date: from Oct 2014

Institution: University of Genova, Italy

SUBRAMANIAN Kartick

Date: until August 2014

Institution: Nanyang Technological University, Singapore

ZHOU Kouhua

Date: from Jul 2014 until Sep 2014

Institution: Polytech University of Dalan, China

## TITANE Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. *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 rupture 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 widespread practice. Culture 3D Clouds project aims to give back the caption to 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/>.

## 8.2. European Initiatives

### 8.2.1. *FP7 & H2020 Projects*

#### 8.2.1.1. *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 will draw from and bridge 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.

## 8.3. International Research Visitors

### 8.3.1. *Visits of International Scientists*

Prof. Mathieu Desbrun, head of the Information Sciences and Mathematics Department of Caltech, obtained an Inria international Chair. We are collaborating on robust surface reconstruction, optimal transport and variational meshing.

## **WIMMICS Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

### **8.1.1. *GéoIncertitude***

**Participant:** Andrea Tettamanzi.

We participate in the CNRS PEPS *GéoIncertitude*, with researchers of the UMR 7300 ESPACE de Nice and of the IRIT of Toulouse on the modeling of uncertainty in Geography using fuzzy logic and possibility theory.

### **8.1.2. *HCI Group of GLC I3S Laboratory***

**Participant:** Alain Giboin.

This work is done in collaboration with Philippe Renevier-Gonin, Christian Brel, Anne-Marie Déry (I3S Rainbow team).

The HCI Group brings together researchers from GLC teams conducting or wishing to conduct research related to HCI. The group specifically addresses the issues of how to conduct user experiments to evaluate the UIs of the software developed in GLC. The group establishes collaborations between researchers in the design and implementation of experiments. Last year a collaboration was initiated between the teams Rainbow and Wimmics on the assessment of (1) an application composition process driven by the composition of UIs, and (2) the prototype *OntoCompo* supporting this process.

This year, too, a collaboration started to design visualization services assisting caregivers in their night watch tasks.

### **8.1.3. *FUI PadDOC***

**Participant:** Alain Giboin.

This work is done in collaboration with Karima Boudaoud and Marc Arnaert (I3S Rainbow team).

*PadDOC* goal is to contribute to accelerating the digital transition of citizen, local and regional authorities, administrations and enterprises, by : (1) developing an open standard and innovative software and hardware resources to facilitate nearby or distant administrative formalities and procedures; (2) improving the security of the holder's personal data by putting these data under the exclusive control of the holder; (3) by exploiting unmarked communicating supports (such as smartphones or tablets) for all chain actors. *PadDOC* partners are: Docapost BPO, Anyces, ABC SmartCard and the teams Rainbow, Media-Coding and Wimmics. 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.

### **8.1.4. *SyReMuse Project: collaboration Agorantic-Inria***

**Participants:** Alain Giboin, Isabelle Mirbel, Serena Villata.

This work is done in collaboration with Bernard Senach (Hephaistos, Inria), Brigitte Trousse (Focus Lab, Inria), with Agorantic partners.

Started last year, the collaboration continued this year with ITCS and HSS teams from the Agorantic Federative Structure for Research of the Université d'Avignon et des Pays du Vaucluse. Distant and face-to-face meetings were organized to refine the so-called *SyReMuse* project, the goal of which is to analyze, design, and evaluate a system recommending visit tours to museum visitors (individuals and groups).

### 8.1.5. *MSHS: Axis-2 ICT, Usage and Communities*

**Participants:** Alain Giboin, Alexandre Monnin, Fabien Gandon.

This work is done in collaboration with Lise Arena and Bernard Conein (Gredeg).

Axis-2 of the "Maison des Sciences Humaines et Sociales (MSHS) du Sud-Est (Nice)" is interested in the relationships between ICT, Practices and Communities. Axis-2 objective is to make explicit two aspects of the relationship between digital technology and community building: (1) networks and (2) artifacts. Two Axis-2 groups-projects address these aspects: (1) the group-project "Social networks and digital networks" and the group-project "Artifacts and coordination".

The first group-project examines how the Internet allows reconstructing the dynamics of interaction networks by making explicit interaction phenomena that could not be observed and treated before the event of Big Data. The second group-project studies the impact of cognitive technologies on the social and cognitive coordination between individuals in organizational and community contexts. Wimmics was mainly involved in the second group-project. In this context, we co-organized the COOP 2014 conference and the COOP 2014 workshop on "The role of artefacts in social coordination".

## 8.2. National Initiatives

### 8.2.1. *BPI funded project : AZKAR*

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.

### 8.2.2. *ANR LabCom SMILK*

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*

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 projects 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.

Web site: <http://wimmics.inria.fr/projects/dbpedia>

#### 8.2.4. *Ministry of Culture*

**Participant:** Alexandre Monnin.

We organized a joint project between Inria and the Ministry of Culture from September 2013 to November 2014. The goal of this project was to discuss the Semantic Web with a special emphasis on cultural project. We organized three conference. The first, to get some feedback from the main projects that were launched the previous years (DBPedia, HDA-Lab and Joconde-Lab, Data.bnf.fr, Centre Pompidou Virtuel, MIMO, Hadoc, etc.), together with the feedback gathered from a major player in the field, the BBC. The second conference took place inside the Ministry of Culture. It raised the question of trust on the Web following Snowden's revelations and Tim Berners-Lee's campaign to re-decentralize the Web. Finally, the last session of the cycle, at Inria Sophia Antipolis, discussed the future of the Web, and presented the Semantic Web/Linked Data as providing some of the solutions that are currently needed to maintain the Web open, decentralized, trustful and safe.

#### 8.2.5. *Ministry of Culture: Group Cultural Metadata and Web 3.0 transition*

**Participant:** Alain Giboin.

In order to develop a Transition-to-Web-3.0 cultural policy, the French Ministry of Culture and Communication defined 9 operational actions allowing cultural sector to take into account opportunities and challenges offered by Web 3.0 (also called "Semantic Web", or "Web of Data"), and set up 9 working groups for these actions. Wimmics contributed to the Working Group 5 "Cultural metadata and Transition to Web 3.0: Exploring the interaction modes with audiences using Web 3.0 potentialities".

#### 8.2.6. *ANR Kolflow*

Kolflow is an ANR project (2011-2014), it proposes to extend collective intelligence with smart agents relying on automated reasoning. Smart agents can significantly reduce the overhead of communities in the process of continuously building knowledge. Consequently, continuous knowledge building is much more efficient. Kolflow aims at building a social semantic space where humans collaborate with smart agents in order to produce knowledge understandable by humans and machines.

Partners: Inria Orpailleur & Wimmics, Silex U. Claude Bernard Lyon, GDD U. of Nantes

Web site: <http://kolflow.univ-nantes.fr>

#### 8.2.7. *ANR OCKTOPUS*

OCKTOPUS is an ANR project (2012-2015). 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>

### 8.2.8. CNRS Mastodons CrEDIBLE

**Participants:** Olivier Corby, Catherine Faron Zucker, Alban Gaignard.

We participate to the CrEDIBLE research project funded by the MASTODONS program of the interdisciplinary mission of CNRS which objective is to bring together scientists from all disciplines involved in the implementation of systems sharing of distributed and heterogeneous medical imaging, provide an overview of this area and to evaluate methods of state of the art and technology that affect this area. In this framework, we participated to the organization of a 3-days workshop and we worked with members of the I3S Modalis team (Johan Montagnat) on the distribution of algorithms in the Corese/KGRAM engine.

Catherine Faron Zucker was chairman of one of its session and worked with members of the I3S Modalis team on a survey of existing approaches for the translation of relational data to RDF data.

Web site: <https://credible.i3s.unice.fr>

### 8.2.9. GDRI Zoomathia

**Participants:** Olivier Corby, Catherine Faron Zucker, Alexandre Monnin.

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.

### 8.2.10. Inria Large Scale Initiative Action PAL (*Personally Assisted Living*)

**Participants:** Alain Giboin, Célia Ormea.

This work is done in collaboration with David Daney and Jean-Pierre Merlet (Coprin/Hephaistos), Patrick Rives (Lagadic).

Last year, Wimmics was involved in a socio-ergonomic field study to inform the design of a device (such as a robotic shopping trolley) assisting elderly and frail persons to do their shopping autonomously. This year this work was synthesized and published in [61].

Web site: <http://pal.inria.fr>

### 8.2.11. Carnot Project

**Participants:** Elena Cabrio, Serena Villata.

This project was just accepted this year on the topic of *Natural Language Argumentation on Twitter: Retrieval of Argumentative Structures and Reasoning*.

Partner : Vigiglobe.

## 8.3. European Initiatives

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

Program: CHIST-ERA

Project acronym: ALOOF

Project title: Autonomous Learning of the Meaning of Objects

Duration: October 2014 - October 2017

Coordinator: University of Rome La Sapienza Italy

Other partners: University of Birmingham United Kingdom, Technische Universität Wien Austria.

Abstract: The goal of ALOOF is to enable robots to tap into 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. By searching the Web, robots will be able to learn about new objects, their specific properties, where they might be stored and so forth. To achieve this, robots need a mechanism for translating between the representations used in their real-world experience and those on the Web. We propose a meta-modal representation, composed of meta-modal entities and relations between them. A single entity is composed of modal features extracted from sensors or the Web. A modal completion supports perception in the absence of a complete set of features. The combined features link to the semantic properties associated to each entity. All entities are organized into a structured ontology, supporting formal reasoning. This is complemented with methods for detecting gaps in the knowledge of the robot, for planning where to effectively obtain the knowledge, and for extracting relevant knowledge from Web resources. By situating meta-modal representations into the perception and action capabilities of robots, we will achieve a powerful mix of Web-supported and physical-interaction-based open-ended learning. Our scenario consists of a home setting where robots have to find/retrieve objects while understanding their meaning and relevance in the assigned task. Our measure of progress will be how many gaps, i.e. incomplete information about objects, can be resolved autonomously given specific prior knowledge. We will integrate results on different mobile robot platforms ranging from smaller mobile platforms, over Metralabs Scitos to a home service robot HOBBIT.

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

Program: International Initiatives

SEEMPAD

Social Exchanges and Emotions in Mediated Polemics - Analysis and Data

International Partner (Institution - Laboratory - Researcher):

University of Montréal, Heron Lab (Canada)

Duration: 2014 - 2017

See also: <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.

During the first year, we have defined the protocol for the first experimental setting, which will represent the first stage of the proof-of-concept. The goal of the first experiment is to address a feasibility study of the annotation of a corpus of natural language arguments with emotions. The experiment involved a group of 20 participants, recruited by the Heron Lab. In particular, the first experiment has considered the following steps:

- Starting from an issue to be discussed provided by the animators, the aim of the experiment is to collect the arguments proposed by the participants.
- These arguments are then associated with the emotional component detected through apposite devices of the Heron Lab. More precisely, the workload/engagement emotional states and the facial emotions of the participants are extracted during the debate, using an EEG headset and a Face Emotion Recognition tool respectively.

- In a post-processing phase on the collected data, we have synchronized the arguments put forward at instant  $t$  with the emotional indexes we retrieved.
- The output of this post-processing phase (ongoing) will result in an argumentation graph representing each discussion addressed by the discussion groups. These argumentation graphs connect the arguments to each other by a support or an attack relation, and they will be labeled with the source that has proposed the argument, and the emotional state of the source itself and of the other participants at the time when the argument has been put on the table.

#### 8.4.1.1. *Declared Inria International Partners*

Fabien Gandon acts as Inria representative at W3C.

We participate to W3C Data Shape WG, Linked Data Platform WG and Semantic Web Interfaces Community Group.

#### 8.4.1.2. *Informal International Partners*

Software Engineering Laboratory (Head: Pierre Robillard), Polytechnique Montréal, Canada.

Topic of the collaboration: Modeling of software development processes and teams for quality assessment purposes.

#### 8.4.2. *Inria International Labs*

We participate to the LIRIMA where we have a long term collaboration with University Gaston Berger at Saint-Louis, Senegal, with Moussa Lo. We host two PhD students in collaboration with UBG: Papa Fary Diallo and Oumy Seye.

### 8.5. International Research Visitors

#### 8.5.1. *Visits of International Scientists*

**Faten Ayachi** is professor, director of Computer Science dept. at SUPCOM Engineering School in Tunis, Tunisia. Visit: august 25-31. *New security policies in RDBMS: retro-conception algorithms*.

**Pr Liam J. Bannon** (University of Limerick, Ireland), gave a talk about *Towards a More Human-centred Informatics? Examining the Role of HCI and CSCW in Computing*. It was an invited talk co-organized with the MSHS Project "Artefacts, coordination et communautés numériques", October 16th.

##### 8.5.1.1. *Internships*

**Cristian Adrián Cardellino**

June – 2014

Universidad Nacional de Córdoba (Argentina)

*Design and development of a data licensing framework for Linked Data*



## ZENITH Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. Labex NUMEV, Montpellier

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

We are participating in the Laboratory of Excellence (labex) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences) headed by University of Montpellier 2 in partnership with CNRS, University of Montpellier 1, and Inria. NUMEV seeks to harmonize the approaches of hard sciences and life and environmental sciences in order to pave the way for an emerging interdisciplinary group with an international profile. The NUMEV project is decomposed in four complementary research themes: Modeling, Algorithms and computation, Scientific data (processing, integration, security), Model-Systems and measurements. Florent Masseglia co-heads (with Pascal Poncelet) the theme on scientific data.

### 8.1.2. 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 (“Investissements d’Avenir” 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.

## 8.2. National Initiatives

### 8.2.1. PIA

#### 8.2.1.1. Datascale (2013-2015), 250Keuros

**Participants:** Reza Akbarinia, Florent Masseglia, Saber Salah, Patrick Valduriez.

The Datascale project is a “projet investissements d’avenir” 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.

#### 8.2.1.2. Xdata (2013-2015), 125Keuros

**Participants:** Emmanuel Castanier, Julien Diener, Patrick Valduriez.

The X-data project is a “projet investissements d’avenir” on big data with Data Publica (leader), Orange, La Poste, EDF, Cinequant, Hurence and Inria (Indes, 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.

### 8.2.2. Others

#### 8.2.2.1. RTRA Pl@ntNet (2009-2014), 1Meuros

**Participants:** Alexis Joly, Hervé Goëau, Julien Champ.

The PI@ntNet project <http://www.plantnet-project.org/> was launched in 2009 by a large international consortium headed by three groups with complementary skills (UMR AMAP <sup>0</sup>, IMEDIA project team at Inria, and the French botanical network TelaBotanica <sup>0</sup>), with financial support from the Agropolis Foundation. Due to the departure of Nozha Boujemaa from the head of IMEDIA and the mobility of Alexis Joly in 2011, Zenith has been entrusted with the Inria's management and scientific coordination of the project in spring 2012. The objectives of the project are (i) to develop cutting-edge transdisciplinary research at the frontier between integrative botany and computational sciences, based on the use of large datasets and expertise in plant morphology, anatomy, agronomy, taxonomy, ecology, biogeography and practical uses (ii) provide free, easy-access software tools and methods for plant identification and for the aggregation, management, sharing and utilization of plant-related data (iii) promote citizen science as a powerful means to enrich databases with new information on plants and to meet the need for capacity building in agronomy, botany and ecology.

#### 8.2.2.2. 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 notably in distributed environments.

#### 8.2.2.3. CNRS INS2I Mastodons (2013-2014), 60Keuros

**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.

## 8.3. European Initiatives

### 8.3.1. FP7 Projects

#### 8.3.1.1. CoherentPaaS

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 an SQL-like query language to query multiple databases (SQL, NoSQL) in a cloud and implementing a compiler/optimizer and query engine for that language.

<sup>0</sup><http://amap.cirad.fr/en/>

<sup>0</sup><http://www.tela-botanica.org/>

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

#### 8.4.1.1. MUSIC

Title: MUltiSite Cloud (MUSIC) data management

Inria principal investigator: Esther Pacitti

International Partner (Institution - Laboratory - Researcher):

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 Educa cao 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.

#### 8.4.1.2. 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).

### 8.4.2. Inria International Partners

#### 8.4.2.1. Informal International Partners

We have regular scientific relationships with research laboratories in

- North America: Univ. of Waterloo (Tamer Özsu), Mc Gill, Montreal (Bettina Kemme).
- Asia: National Univ. of Singapore (Beng Chin Ooi, Stéphane Bressan), Wonkwang University, Korea (Kwangjin Park)
- Europe: Univ. of Amsterdam (Naser Ayat, Hamideh Afsarmanesh), Univ. of Madrid (Ricardo Jiménez-Periz), UPC Barcelona (Josep Lluís Larriba Pey, Victor Muñoz)
- North Africa: Univ. of Tunis (Sadok Ben-Yahia)

### **8.4.3. Inria International Labs**

The Bigdatanet associated team takes part of the Inria@SiliconValley lab.

### **8.4.4. 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.

## **8.5. International Research Visitors**

### **8.5.1. Visits of International Scientists**

Ruiming Tang (National University of Singapore) gave a seminar on “Quality and Price of Data” in January.

Xiao Bai (Yahoo Labs Barcelona) gave a seminar on “Improving the Efficiency of Multi-site Web Search Engines” in January.

Philippe Bonnet (IT University of Copenhagen) gave a seminar on CLyDE Mid-Flight: What we have learnt so far about the SSD-Based IO Stack in May.

Antoine Chambille and Romain Colle (QuartetFS, Paris) gave a seminar on “In-Memory Analytics: Accelerating Business Performance” in June.

Divy Agrawal and Amr El Abbadi (UCSB, USA) gave keynote talks on “Emerging Technologies for Big Data Management and Analytics” and “Consistent, Elastic and Fault-Tolerant Management of Big Data in the Cloud”, respectively, in the Mastodons International Workshop on “Big Data Management and Crowd Sourcing towards Scientific Data” in Montpellier in June.

Bettina Kemme (McGill Univ., Canada) gave a seminar on “Multiplayer Games: a complex application in need for scalable replica management” in december.

Sihem Amer-Yahia (LIG) gave a seminar on “Task Assignment Optimization in Crowdsourci” in December.

### **8.5.2. Visits to International Teams**

Patrick Valduriez visited the Inria-Chile center in Santiago in october, where he gave several talks.

Mohamed Reda Bouadjenek visited UCSB in november-december, in the context of the Bigdatanet associated team.