



RESEARCH CENTER  
Nancy - Grand Est

FIELD

Activity Report 2016

# Section Partnerships and Cooperations

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## ALICE Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

CPER (2014-2020) 50 k€. Sylvain Lefebvre coordinates a work package for the CPER 2014-2020. It involves several members of ALICE as well as laboratories within the Nancy area (Institut Jean Lamour, LRGP, ERPI). Our goal is to consider the interaction between software and material in the additive manufacturing process, with a focus on filament-based printers.

PIC (2015-2017) 150 k€. The PIC project (Polymères Innovants Composites) is a collaboration between Inria, Institut Jean Lamour and Ateliers Cini, funded by Région Lorraine. The goal is to develop a new additive manufacturing process using filament of composite materials with applications in mechanical engineering and the medical domain. Our goal in the project is to provide novel ways to deposit the filament that is better suited to the considered materials and improves the quality of the final parts.

## 8.2. National Initiatives

### 8.2.1. ANR BECASIM (2013 – 2016)

890 k€. X. Antoine heads the second partner, which includes Bruno Lévy. Budget for Nancy: 170 k€ of which 100 k€ are for IECL (team CORIDA). This project is managed by Inria. Becasim is a thematic "Numerical Models" ANR project granted by the French Agence Nationale de la Recherche for years 2013-2016. The acronym Becasim is related to Bose-Einstein Condensates: Advanced SIMulation Deterministic and Stochastic Computational Models, HPC Implementation, Simulation of Experiments. The members of the ANR Project Becasim belong to 10 different laboratories.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. SHAPEFORGE

Title: ShapeForge: By-Example Synthesis for Fabrication

Programm: FP7

Duration: December 2012 - November 2017

Coordinator: Inria

Inria contact: Sylvain Lefebvre

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

view on the problem of 'by-example' shape synthesis, formulating it as the joint optimization of 'by-example' objectives, semantic descriptions of the content, as well as structural and fabrication objectives. Throughout the project, we will consider the full creation pipeline, from modeling to the actual fabrication of objects on a 3D printer. We will test our results on printed parts, verifying that they can be fabricated and exhibit the requested structural properties in terms of stability and resistance.

## **8.4. International Initiatives**

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

#### *8.4.1.1. PREPRINT3D*

Title: Model Preparation for 3D Printing

International Partner (Institution - Laboratory - Researcher):

University of Hong Kong, Computer science department, with Li-Yi Wei and Wenping Wang

Start year: 2014

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

### ***8.4.2. Inria International Partners***

#### *8.4.2.1. Informal International Partners*

We have on-going collaborations with Marc Alexa (TU Berlin) regarding slicing algorithms for additive manufacturing and Niloy Mitra (University College London) on minimal wastage design of furniture.

## **8.5. International Research Visitors**

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

#### *8.5.1.1. Internships*

Denis Salem (CESI-EXIA), 6-months intern started in September 2016, working on point distributions along surfaces using GPU algorithms. Théo Poisson (CESI-EXIA) was an intern from February to May 2016, working on quality testing and improvements to our software IceSL. Yuexin Ma, PhD student with Wenping Wang (HKU), 1 month visit in the context of the PrePrint3D associated team.

## BIGS Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

- *PEPS AMIES* (2016), Apprentissage supervisé pour l'aide au diagnostic, Collaboration Institut Elie Cartan avec la StartUp SD Innovation Frouard. Participants: A. Gégout-Petit, P. Vallois
- *Popart* (2016-2017) In the framework of collaboration with A. Deveau of Inra Nancy, A. Gégout-Petit and A. Muller-Gueudin are included in the Inra "Microbial Ecosystems & Metaomics, Call 2016" Project "Popart" for "Regulation of the Poplar microbiome by its host: is the immune system involved ? ". The aim is to develop methodology for the inference of regulation network between micro-organisms around Poplar. The specificity of the data is the inflation of zeros that has to be taken into account.
- *Intérêt des antiangiogènes dans la potentialisation des thérapies par rayonnement dans le cas des glioblastomes* (2016). Funding organism: Ligue contre le Cancer (CCIR-GE). Leader: N. Thomas (CRAN, U. Lorraine). Participants : C. Lacaux and A. Muller-Gueudin
- (2014-16), A library of Near-InfraRed absorbing photosensitizers: tailoring and assessing photo-physical and synergetic photodynamic properties, Funding organism: PHC Bosphore - Campus France, Leader: M. Barberi-Heyob (CRAN), Thierry Bastogne
- GDR 3475 Analyse Multifractale, Funding organism: CNRS, Leader: S. Jaffard (Université Paris-Est), Céline Lacaux
- GDR 3477 Géométrie stochastique, Funding organism: CNRS, Leader: P. Calka (Université Rouen), Céline Lacaux
- FHU CARTAGE (Fédération Hospitalo Universitaire Cardial and ARTERial AGEing ; leader : Pr Athanase BENETOS), Jean-Marie Monnez
- RHU Fight HF (Fighting Heart Failure ; leader : Pr Patrick ROSSIGNOL), located at the University Hospital of Nancy, Jean-Marie Monnez
- Project "Handle your heart", team responsible for the creation of a drug prescription support software for the treatment of heart failure, head: Jean-Marie Monnez

## 9.2. European Initiatives

### 9.2.1. Collaborations in European Programs, Except FP7 & H2020

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

## CAMUS Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

Philippe Clauss, Alain Ketterlin, Cédric Bastoul and Vincent Loechner are involved in the Inria Project Lab entitled “Large scale multicore virtualization for performance scaling and portability” and regrouping several french researchers in compilers, parallel computing and program optimization <sup>0</sup>. The project started officially in January 2013. In this context and since January 2013, Philippe Clauss is co-advising with Erven Rohou of the Inria team PACAP, Nabil Hallou’s PhD thesis focusing on dynamic optimization of binary code.

## 9.2. International Initiatives

### 9.2.1. Inria International Partners

#### 9.2.1.1. Informal International Partners

The CAMUS team maintains regular contacts with the following entities:

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

## 9.3. International Research Visitors

### 9.3.1. Visits of International Scientists

#### 9.3.1.1. Researchers

Rachid Seghir

Date: April 30 - May 14

Institution: University of Batna, Algeria

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<sup>0</sup><https://team.inria.fr/multicore>

## CAPSID Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. PEPS

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

The team is involved in the inter-disciplinary “MODEL-ICE” project led by Nicolas Soler (DynAMic lab, UMR 1128, INRA / Univ. Lorraine). The aim is to investigate protein-protein interactions required for initiating the transfer of an ICE (Integrated Conjugative Element) from one bacterial cell to another one.

## 8.2. National Initiatives

### 8.2.1. FEDER

#### 8.2.1.1. LBS

**Participant:** Marie-Dominique Devignes [contact person].

The project “LBS” (Le Bois Santé) is a consortium funded by the European Regional Development Fund (FEDER) and the French “Fonds Unique Interministériel” (FUI). The project is coordinated by Harmonic Pharma SAS. The aim of LBS is to exploit wood products in the pharmaceutical and nutrition domains. Our contribution has been in data management and knowledge discovery for new therapeutic applications.

### 8.2.2. ANR

#### 8.2.2.1. Fight-HF

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

This “Investissements d’Avenir” project aims to discover novel mechanisms for heart failure and to propose decision support for precision medicine. The project has been granted € 9M, and involves many participants from Nancy University Hospital’s Federation “CARTAGE” (<http://www.fhu-cartage.com/>). In collaboration with the Orpailleur Team, Marie-Dominique Devignes is coordinating a work-package on network-based science and drug discovery for this project.

#### 8.2.2.2. IFB

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

The Capsid team is a research node of the IFB (Institut Français de Bioinformatique), the French national network of bioinformatics platforms (<http://www.france-bioinformatique.fr>). The principal aim is to make bioinformatics skills and resources more accessible to French biology laboratories.

#### 8.2.2.3. PEPSI

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

The PEPSI (“Polynomial Expansions of Protein Structures and Interactions”) project is a collaboration with Sergei Grudinin at Inria Grenoble – Rhône Alpes (project Nano-D) and Valentin Gordeliy at the Institut de Biologie Structurale (IBS) in Grenoble. This project funded by the ANR “Modèles Numériques” program involves developing computational protein modeling and docking techniques and using them to help solve the structures of large molecular systems experimentally.



## 8.3. International Initiatives

### 8.3.1. Participation in Other International Programs

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

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

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

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

## 8.4. International Research Visitors

### 8.4.1. Visits to International Teams

#### 8.4.1.1. Research Stays Abroad

Gabin Personeni visited the Biomedical Informatics Research Laboratory of Prof. Michel Dumontier at Stanford University for 3 months (Nov 2015 – Feb 2016).

Seyed Ziaeddin Alborzi visited the UniProt development team of Maria Martin at the European Bioinformatics Institute (EBI), Hinxton UK, for 3 months (Oct – Dec 2016) in partial fulfilment of the requirements for a European PhD.

## **CARAMBA Project-Team**

# **9. Partnerships and Cooperations**

## **9.1. National Initiatives**

### ***9.1.1. PEPS JCJC INS2I SPICE***

The SPICE proposal (“Systèmes Polynomiaux et calcul d’Indice sur les Courbes Elliptiques : indicateurs de complexité en petite caractéristique”) has been accepted in the PEPS JCJC INS2I program in 2016. It involves Pierre-Jean Spaenlehauer (CARAMBA) and Vanessa Vitse (Université Joseph Fourier). This project is coordinated by Vanessa Vitse.

## CARTE Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

We participate in a PEPS project “Jeux quantiques sans probabilités”. The partners are Mehdi Mhalla (CR CNRS, LIG, coordinator), Pablo Arrighi (Prof. Aix-Marseille), Paul Dorbec (MdC, U. Bordeaux), Frédéric Magniez (DR CNRS, IRIF), Simon Perdrix (CR CNRS, CARTE).

### 7.1.1. ANR

- The team is a funding partner in ANR Elica (2014-2019), "Elargir les idées logistiques pour l'analyse de complexité". The CARTE team is well-known for its expertise in implicit computational complexity.

## 7.2. European Initiatives

### 7.2.1. FP7 & H2020 Projects

Mathieu Hoyrup participates in the Marie-Curie RISE project *Computing with Infinite Data* coordinated by Dieter Spreen (Univ. Siegen) that has been accepted and will start in April 2017.

## 7.3. International Initiatives

### 7.3.1. Participation in Other International Programs

- An Hubert Curien Partnership (PHC) PHC Imhotep from the French Ministry of Foreign Affairs and with the support of the French Ministry of National Education and Ministry of Higher Education and Research holds between members of EPC CARTE and Alexandria E-Just University.
- Foundations of Quantum Computation: Syntax and Semantics (FoQCoSS), Regional Program STIC-AmSud. This 2-year project has been accepted in late 2015. The Argentinian-Brazilian-French consortium consists of: Pablo ARRIGHI (Université Aix-Marseille, France), Alejandro DIAZ-CARO (Universidad Nacional de Quilmes, Argentina), Gilles DOWEK (Inria, France), Juliana KAIZER VIZZOTTO (Universidade Federal de Santa Maria, Brazil), Simon PERDRIX (CNRS/CARTE, France) and Benoît VALIRON (CentraleSupélec – LRI, France). The ultimate goal of this project is to study the foundations of quantum programming languages and related formalisms. With this goal in mind, we will need to study topics such as parallelism, probabilistic systems, isomorphisms, etc., which constitute subjects of study by themselves. The interest goes beyond having a working programming language for quantum computing; we are interested, on one hand, in its individual characteristics and its consequences for classical systems, and, on the other hand, in its implications for the foundations of quantum physics.

## 7.4. International Research Visitors

### 7.4.1. Visits of International Scientists

- Walid Gomaa, associate professor at Alexandria E-Just University, was invited during two months (March and May) in the team in the PHC Imhotep.

#### 7.4.1.1. Internships

Arinta Auza (ENS Cachan / Indonesie)

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

### *7.4.2.1. Research Stays Abroad*

Nazim Fatès was invited for a short stay at the Technische Universität Dresden, in the Centre for Information Services and High Performance Computing (ZIH), in the team of Andreas Deutsch, head of Department for Innovative Methods of Computing. He gave a talk at the monthly ZIH colloquium.

Simon Perdrix spent one month at the Simons Institute for Theoretical Computer Science at Berkeley, University of California, as an invited researcher during the semester of Logic and Computation (mid-November to Mid-December 2016)

## COAST Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. Region Lorraine TV Paint (2016–2017)

**Participants:** Claudia-Lavinia Ignat [contact], Gérald Oster, Quang Vinh Dang, Matthieu Nicolas.

Partners: TVPaint Development, Inria COAST project-team

Website: <https://www.tvpaint.com/>

This is a project in collaboration with TVPaint Development financed by Region Lorraine. The goal is to contribute to the creation of a collaborative system dedicated to animation movies, that allows to manipulate high quantities of digital artifacts in a collaborative way.

## 7.2. National Initiatives

### 7.2.1. OpenPaas NG (2015–2018)

**Participants:** Claudia-Lavinia Ignat, François Charoy [contact], Gérald Oster, Olivier Perrin, Jean-Philippe Eisenbarth, Phillippe Kalitine, Matthieu Nicolas, Mohammed Riyadh Abdmeziem, Kahina Bessai, Victorien Elvinger, Quentin Laporte Chabasse, Hoai Le Nguyen, Hoang Long Nguyen.

Partners: Linagora, XWiki SAS, Nexedi, COAST project-team (Université de Lorraine, LORIA), DaScim team (LIX).

Website: <http://www.open-paas.org/>

This project is financed by BpiFrance and involves French industrial leaders in open-source software development (Linagora, Nexedi, XWiki) and academic partners in collaborative work (COAST team) and recommender systems (DaScim team, LIX). The goal of the project is to develop next generation cloud enabled virtual desktop based on an Enterprise Social Network to provide advanced collaborative and recommendation services. COAST team is responsible of the work package dedicated to the design of the peer-to-peer collaborative middleware. In this context, we bring our expertise on data replication for collaborative data in peer-to-peer environments and on trust and access control and identity management in distributed collaborative information systems.

### 7.2.2. Inria ADT PLM (2014-2016)

**Participants:** Gérald Oster [contact], Matthieu Nicolas.

Partners: COAST project-team, MYRIADS project-team.

Website: <https://github.com/BuggleInc/plm/>

This work is performed jointly with Martin Quison (previously member of project-team VERIDIS, now Professor at ENS Rennes).

The Programmer's Learning Machine (PLM) is a software platform dedicated to computer programming education. This generic platform offers support to teachers for creating programming microworlds suitable to teaching courses. It features an integrated and graphical environment, providing a short feedback loop to students in order to improve the effectiveness of the autonomous learning process.

This project aims at establishing an experimental platform for studying the teaching of basic programming and a research instrument to design new collaborative learning environments.

## 7.3. European Initiatives

### 7.3.1. FP7 & H2020 Projects

#### 7.3.1.1. SyncFree (2013-2016)

**Participants:** Pascal Urso [contact], Jordi Martori Adrian.

Program: FP7-ICT-2013-10

Project acronym: SyncFree

Project title: Large-scale computation without synchronisation

Duration : October 2013 - September 2016

Coordinator: Marc Shapiro, Inria

Other Partners: REGAL project-team (Inria Paris - Rocquencourt / LIP6, coordinator), Basho Technologies Limited (United Kingdom), Trifork AS (Denmark), Rovio Entertainment OY (Finland), Faculdade de Ciências e Tecnologia (Universidade Nova de Lisboa, Portugal), Université Catholique de Louvain (Belgium), Koç University (Turkey), Technische Universität Kaiserslautern (Germany) and COAST project-team.

Large-scale on-line services including social networks and multiplayer games handle huge quantities of frequently changing shared data. Maintaining their consistency is relatively simple in a centralised cloud, but no longer possible due to increased scalability requirements. Instead, data must be replicated across several distributed data centres, requiring new principled approaches to consistency that have been explored by the SyncFree project. <http://syncfree.lip6.fr/>

## 7.4. International Initiatives

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

#### 7.4.1.1. USCOAST2

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

Wright State University (United States) - Department of Psychology, Knoesis - Valerie Shalin

Start year: 2016

See also: <http://uscoast.loria.fr>

The proposed project addresses the perception of trust by users, the appropriateness of a trust-based security approach and the role of trust metrics in the management of distributed work. The main challenge of this project is how to measure trust based on user behaviour and to verify by means of experimental studies with users that the trust-based mechanism is acceptable by users. We plan to apply this trust-based mechanism for two types of applications. The first one is collaborative editing where user trust will be computed based on the quality of user contributions for a document or project. The second type of application is in the management of work over a large group of people in order to conduct efficient, high-yield, high-density real time crowdsourcing activities.

Partners of USCOAST2 project have complementary expertise. Coast provides expertise in collaborative methods, systems and related technologies. Coast will propose algorithms that track and manipulate trust metrics. Kno.e.sis provides expertise on the analysis of human work-related behavior, including methods of data collection and data analysis, as well as a theoretical foundation for the evaluation of human performance. Knoesis will analyse trust from a psychological phenomenon point of view.

## **7.5. International Research Visitors**

### ***7.5.1. Visits to International Teams***

#### *7.5.1.1. Research Stays Abroad*

- Claudia-Lavinia Ignat visited the Department of Computer Science & Knoesis, Wright State University for 1 month in the period June–July 2016 in the context of the associated team USCOAST2
- Gérald Oster visited the Department of Computer Science & Knoesis, Wright State University for 1 month in the period June–July 2016 in the context of the associated team USCOAST2

## LARSEN Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. *Project PsyPhINe: Cogitamus ergo sumus*

**Participant:** Amine Boumaza.

This project is financed for two years by the MSH Lorraine (USR3261) gathering researchers from the following institutes: , InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Inria Bordeaux Sud-Ouest, Loria (UMR7503). Refer to sec. 7.1.1 for further information.

### 8.1.2. *AME Satelor*

**Participants:** François Charpillat, Xuan Son Nguyen, Thomas Moinel, Mélanie Lelaure.

Economic mobilisation agency in Lorraine has launched a new project Satelor providing it with 2.5 million Euros of funding over 3 years, out of an estimated total of 4.7 million. The leader of the project is Pharmagest-Diatelic. Pharmagest, in Nancy, is the French leader in computer systems for pharmacies, with a 43.5 % share of the market, 9,800 clients and more than 700 employees. Recently, the Pharmagest Group expanded its activities into e-health and the development of telemedicine applications. The Satelor project will accompany the partners of the project in developing services for maintaining safely elderly people with loss of autonomy at home or people with a chronic illness. Larsen team will play an important role for bringing some research results such as:

- developing a low cost environmental sensor for monitoring the daily activities of elderly people at home
- developing a low cost sensor for fall detection
- developing a low cost companion robot able to interact with people and monitoring their activities while detecting emergency situations.
- developing a general toolbox for data-fusion: Bayesian approach.

## 8.2. National Initiatives

### 8.2.1. *PIA LAR Living Assistant Robot*

**Participants:** François Charpillat, Abdallah Dib.

Partners : Crédit Agricole, Diatelic, Robosoft

The LAR project has the objective to design an assistant robot to improve the autonomy and quality of life for elderly and fragile persons. The project started at the beginning of 2015. The role of the Larsen Team is to develop a simultaneous localisation and mapping algorithm using a RGB-D camera. The main issue is to develop an algorithm able to deal with a dynamic environment. Another issue is for the robot to be able to behave with acceptable social skills.



## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. RESIBOTS

Title: Robots with animal-like resilience

Programm: H2020

Type: ERC

Duration: May 2015 - April 2020

Coordinator: Inria

Inria contact: Jean Baptiste Mouret

Despite over 50 years of research in robotics, most existing robots are far from being as resilient as the simplest animals: they are fragile machines that easily stop functioning in difficult conditions. The goal of this proposal is to radically change this situation by providing the algorithmic foundations for low-cost robots that can autonomously recover from unforeseen damage in a few minutes. The current approach to fault tolerance is inherited from safety-critical systems (e.g. spaceships or nuclear plants). It is inappropriate for low-cost autonomous robots because it relies on diagnostic procedures, which require expensive proprioceptive sensors and contingency plans, which cannot cover all the possible situations that an autonomous robot can encounter. It is here contended that trial-and-error learning algorithms provide an alternate approach that does not require diagnostic or pre-defined contingency plans. In this project, we will develop and study a novel family of such learning algorithms that make it possible for autonomous robots to quickly discover compensatory behaviors. We will thus shed a new light on one of the most fundamental questions of robotics: how can a robot be as adaptive as an animal? The techniques developed in this project will substantially increase the lifespan of robots without increasing their cost, and will open new research avenues for adaptive machines.

#### 8.3.1.2. CoDyCo

**Participants:** Serena Ivaldi, Valerio Modugno, Oriane Dermy.

Title: Whole-body Compliant Dynamical Contacts in Cognitive Humanoids

Program: FP7

Instrument: STREP

Objective: Cognitive Systems and Robotics (b)

Duration: March 2013 - February 2017 (4 years)

Coordinator: Francesco Nori (Italian Institute of Technology)

Partners: TU Darmstadt (Germany), Université Pierre et Marie Curie (France), Josef Stefan Institute (Slovenia), University of Birmingham (UK)

Inria contact: Serena Ivaldi

**Abstract:** The aim of CoDyCo is to advance the current control and cognitive understanding of robust, goal-directed whole-body motion interaction with multiple contacts. CoDyCo will go beyond traditional approaches by: (1) proposing methodologies for performing coordinated interaction tasks with complex systems; (2) combining planning and compliance to deal with predictable and unpredictable events and contacts; (3) validating theoretical advances in real-world interaction scenarios. First, CoDyCo will advance the state-of-the-art in the way robots coordinate physical interaction and physical mobility. Traditional industrial applications involve robots with limited mobility. Consequently, interaction (e.g., manipulation) has been treated separately from whole-body posture (e.g., balancing), assuming the robot firmly connected to the ground. Foreseen applications involve robots with augmented autonomy and physical mobility. Within this novel context, physical interaction influences stability and balance. To allow robots to surpass barriers between interaction

and posture control, CoDyCo will be grounded in principles governing whole-body coordination with contact dynamics. Second, CoDyCo will go beyond traditional approaches in dealing with all perceptual and motor aspects of physical interaction, unpredictability included. Recent developments in compliant actuation and touch sensing allow safe and robust physical interaction from unexpected contact including humans. The next advancement for cognitive robots, however, is the ability not only to cope with unpredictable contact, but also to exploit predictable contact in ways that will assist in goal achievement. Third, the achievement of the project objectives will be validated in real-world scenarios with the iCub humanoid robot engaged in whole-body goal-directed tasks. The evaluations will show the iCub exploiting rigid supportive contacts, learning to compensate for compliant contacts, and utilizing assistive physical interaction.

## **8.4. International Initiatives**

### ***8.4.1. Participation in Other International Programs***

Serena Ivaldi, in collaboration with Prof. Dana Kulić of University of Waterloo, obtained a MITACS-Inria grant for the master student Jamie Waugh for the project “learning gait models”.

## **8.5. International Research Visitors**

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

- Francesco Nori, researcher at the Italian Institute of Technology, and coordinator of the European Project CoDyCo (where we are partners), visited our team for one month. During this visit, we wrote together a proposal for a H2020 project that was submitted in April 2016 and was subsequently accepted: the project, AnDy, will start in January 2017.
- John Rieffel, Associate Professor at Union College (NY, USA), visited our team for a month. During his visit, we used Bayesian optimization to learn gaits for a soft tensegrity robot. A paper has been submitted.

#### ***8.5.1.1. Internships***

- Jamie Waugh, master student of University of Waterloo, visited our team for 3 months (from September to December) thanks to a MITACS-Inria grant.

## MADYNES Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. 6PO Research Region Lorraine and UL project

**Participants:** Emmanuel Nataf, Ye-Qiong Song, Laurent Ciarletta [contact].

*Funded by Region Lorraine and Université de Lorraine since 2013. Adel Belkadi (CRAN & LORIA) is co-directed by L. Ciarletta and Didier Theilliol (CRAN correspondant).*

6PO (“Systèmes Cyber-Physiques et Commande Coopérative Sûre de Fonctionnement pour une Flotte de Véhicules sans Pilote”) is a joint research project between the Loria and CRAN laboratories. As a part of the Aetournos ecosystem, it also aims at researching solutions for safe formation flying of collaborative UAVs seen as part of a collection of Cyber Physical Systems mixing computer science and automation solutions.

It is reinforced by a PhD grant from this federation that started in october 2014 (*Conception de méthodes de diagnostic et de tolérance aux fautes des systèmes multi-agents: Application à une flotte de véhicules autonomes*, Adel Belkadi).

This led to common publications, notably on the subjects of the robust control of a fleet or flock of UAVs (with or without leader, using agents paradigms and particle swarm optimisation [12] and [36]).

The project provides common use cases and scientific challenges that serve as catalysts for collaboration between teams from different research topics :

- Cyber Physical Systems, Real Time, Quality of service, Performance and Energy in Wireless Sensors and Activator Networks
- Collaborative, communicating autonomous systems and Unmanned Vehicles
- Safety, Dependability, Reliability, Diagnosis, Fault-Tolerance

### 8.1.2. Hydradrone FEDER Région Lorraine project

**Participants:** Adrien Guenard, Zhixiang Liu, Laurent Ciarletta [contact].

*Feder funding*

The Madynes team has been working on the Hydradrone project since July 2014. It started as a collaborative R&D initiative funded by *Région Lorraine* and is now FEDER funded. This project started as a joint work between Madynes and PEMA (*Pedon Environnement et Milieux Aquatiques*), an SME/VSE (small and medium size Enterprise, PME/TPE). The consortium now includes Alerion another VSE, spinoff from Loria.

It consists in developing a new solution for the surveillance of aquatic environment, the Hydradrone:

- starting with an actual need for automated and remote operation of environmental sensing expressed by PEMA
- based on an hybrid UxV (Unmanned Air, Surface... Vehicle),
- some Cyber Physical bricks in coherence with the Alerion’s concepts (ease of use, safety, autonomy)
- and an integration in the Information System of the company

PEMA, as an environmental company, is providing the use cases and terrain (and business) validation, while Alerion is working on the integration and engineering of the solution.

This second year has been dedicated to the development of the initial controllers for the Hydradrones (small and large one), and the beginning of the integration of the environmental sensors.

### 8.1.3. Satelor AME Lorraine regional project

**Participants:** François Despaux, Lei Mo, Mohamed Tlig, Bernardetta Addis, Evangelia Tsiontsiou, Ye-Qiong Song [contact].

The Madynes team is involved in Satelor, a regional research and development project funded by the AME (Agence de Mobilisation Economique) of Lorraine (October 2013 – September 2017). The consortium includes academic (Univ. of Lorraine, Inria), medical (OHS) and industrial (Diatelic-Pharmagest (lead), ACS, Kapelse, Salendra, Neolinks) partners. It aims at developing innovative and easily deployable ambient assisted living solutions for their effective use in the tele-homecare systems. The Madynes team is mainly involved in the data collection system development based on wireless sensors networks and IoT technology. The first topic consists in defining the basic functions of the future SATEBOX – a gateway box for interconnecting in-home sensors to the medical datacenter, based on our previously developed MPIGate software. A beta-version prototype of the future Satebox gateway has been released. It now includes Zigbee wireless sensors, EnOcean battery-free sensors and Bluetooth Low Energy sensors. It provides a low-cost and easily deployable solution for the daily activity monitoring. After its first real-world deployment at a OHS hospital room, a second prototype testbed has been prepared for a further test deployment including several rooms. The second topic is related to improving the data transfer reliability while still keep minimum energy consumption. This has led us to focus on the multi-hop mesh network topology with multi-constrained QoS routing problem (PhD thesis of Evangelia Tsiontsiou) [33]. The third topic is related to the wireless charging of sensor nodes (PhD work of Lei MO) in order to keeping sensors in perpetual working state. A new direction has been also investigated which consists in using the CSI (channel signal information) of the omnipresent WiFi (IEEE802.11n) as a new generation of contactless sensors. A first test bed of using CSI to measure the respiration rate has been set up.

## 8.2. National Initiatives

### 8.2.1. ANR BottleNet

**Participants:** Isabelle Chrisment [contact], Thibault Cholez, Vassili Rivron, Paul Andrey, Quentin Rouy.

The Quality of Experience (QoE) when accessing the Internet, on which more and more human activities depend, is a key factor for today's society. The complexity of Internet services and of user's local connectivity has grown dramatically in the last years with the proliferation of proxies and caches at the core and access technologies at the edge (home wireless and 3G/4G access), making it difficult to diagnose the root cause of performance bottlenecks. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure end-to-end Internet QoE and to diagnose the cause of experienced issues. The result can then be used by users, network and service operators or regulators to improve the QoE.

The ANR BottleNet project (<https://project.inria.fr/bottlenet>) started this year with a kick-off on the 1st of February 2016. It involves many partners in the field of computer networks and QoE: Inria Muse and Diana teams, Lille1 University, Telecom Sud-Paris, Orange, IP-Label. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet QoE and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users' devices. We plan to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

Our first research question was to evaluate the impact of web advertisement on users' QoE. An interdisciplinary approach was developed at MADYNES, by which we extend the common notion of "quality of information" on free news websites (usually based on journalistic content) to a notion of quality of experience for the user, that takes into account the degraded delivery of information by the multiplication of third party contents. We implemented a measurement tool as a web browser extension and made a dataset by browsing many news websites accessed with and without ad-blockers. The first statistical results retrieved from the

dataset show that web-advertisement has a huge negative impact on QoE, for example multiplying the mean page load time by more than one order of magnitude and increasing the variance even more, while adblockers' profiles show faster and more uniform performances. These results have to be further refined but already show that web-advertisement, and more generally third-party content provider, play a huge role in poor Internet QoE and that it is a key parameter to investigate in the project. This study is leading to a structural analysis of the ad regulation mechanisms in the field of web journalism. Adblockers not only upgrades the QoE of visitors, but also contributes to define what "acceptable ads" should be.

This year the following task have been completed:

- Development of a platform to collect QoS & QoE on french news websites (Quentin Rouy, Telecom Nancy student). The first exploratory data collecting campaign measured the impact of Web Advertisement on client QoS, using FatHom plugin for Firefox (a tool from MUSE/Inria, partner of the BottleNet ANR project).
- Implementation of statistical treatment schemes (Paul Andrey, ENSAE student) to correlate QoS, economic models and adblocking effects on news websites.
- Preparation of a systematized measurement campaign on french and international news sites, in order to publish to a large audience.

### 8.2.2. ANR Doctor

**Participants:** Thibault Cholez [contact], Thomas Silverston [contact], Xavier Marchal, Cédric Enclos, Elian Aubry, Daishi Kondo, Olivier Festor.

The DOCTOR project <http://www.doctor-project.org> is an applied research project funded by the French National Research Agency (ANR), grant <ANR-14-CE28-000>, and supported by the French Systematic cluster. The project started on December 2014 for three years. It involves five partners specialized in network monitoring and security: Orange Labs (lead), Thales, Montimage, Université de technologie de Troyes and LORIA/CNRS. The DOCTOR project advocates the use of virtualized network equipment (Network Functions Virtualization), to enable the co-existence of new Information-Centric Networking stacks (e.g.: Named-Data Networking) with IP, and the progressive migration of traffic from one stack to the other while guaranteeing the good security and manageability of the network. Therefore in DOCTOR, the main goals of the project are: (1) the efficient deployment of NDN as a virtualized networking environment; (2) the monitoring and security of this virtualized NDN stack.

We presented the whole project at the IRTF Information-Centric Networking Research Group (ICNRG) in January.

This year, we made contributions in three critical points for the deployment of virtualized NDN network: security, performances and interoperability. First, we identified a critical vulnerability in the NDN protocol design that allows an attacker to perform efficient DoS attacks [46] by either self-answering to his own requests or answering to clients before the server. We proposed several remediation strategies to this problem.

On the performance topic, we designed and implemented a tool similar to Iperf, Ndnperf [22]<sup>0</sup>, that can measure the maximum throughput of a program serving NDN Data. We identified critical limitations that can harm real-time services (live streaming, VOIP, etc.), and proposed several recommendations and improvements that can increase the throughput up to 8 times when combined together.

Finally, we also designed and implemented an HTTP/NDN gateway that can be used to transport web content on an NDN network, thus benefiting from its caching and multicast properties while being totally transparent for the client and the server [47]. Those three contributions were published and demonstrated in the main conference of the domain: ACM ICN.

### 8.2.3. PIA LAR

**Participants:** Kévin Roussel, Ye-Qiong Song [contact].

<sup>0</sup>[http://madyne.loria.fr/software/ndnperf\\_cpp.zip](http://madyne.loria.fr/software/ndnperf_cpp.zip)

LAR (Living Assistant Robot) is a PIA (Projet investissement d'avenir) national project getting together Inria (MAIA and MADYNES projects), *Crédit Agricole* (lead), Diatelic and Robotsoft. The aim is to develop an ambient assisted living system for elderly including both sensors and assistant robots. The task of Madynes team is the development of a WSN-based system integrating both sensors of the environment and sensors and actuators embedded on a mobile robot. The research issues include the QoS, energy and mobility management.

This project has ended in March 2016. Some new results are obtained including the use of Cooja simulator for RIOT OS based WSN simulation and an in-depth analysis of some timing inaccuracy problems introduced by MSPSim which is an emulator of MSP430 MCU [27]. A synthesis of our achievements on LAR project is reported in the PhD thesis of Kévin Roussel (<http://www.theses.fr/196570603>).

#### 8.2.4. FUI HUMA

**Participants:** Jonathan Arnault, Giulia de Santis, Pierre-Olivier Brissaud, Jérôme François [contact], Abdelkader Lahmadi, Isabelle Chrisment.

The HUMA project (*L'Humain au cœur de l'analyse de données MAssives pour la sécurité*) is funded under the national FUI Framework (Fonds Unique Interministerial) jointly by the BPI (Banque Publique d'Investissement) and the Région Lorraine. It has been approved by two competitive clusters: Systematic and Imaginove. The consortium is composed of three academic (ICube, Citi, Inria) and five industrial (Airbus Defence and Space, Intrinsec, Oberthur, Wallix, Sydo) partners. The leader is Intrinsec.

This project targets the analysis of Advanced Persistent Threat. APT are long and complex attacks which thus cannot be captured with standard techniques focused on short time windows and few data sources. Indeed, APTs may be several months long and involve multiple steps with different types of attacks and approaches. The project will address such an issue by leveraging data analytics and visualization techniques to guide human experts, which are the only one able to analyze APT today, rather than targeting a fully automated approach.

In 2016, our contribution focused on defining a clustering technique in order to group individual events into a common one. We applied our technique to darknet data as shown in section 6.2.1. In addition, we also start the modeling of an attacker process by considering the first phase of APT, *i.e.* the reconnaissance phase by analyzing scanning activities using Hidden Markov Model in section 6.2.1. We also technically contribute to the definition of APT scenarios by providing a very stealthy scanning approach (Wiscan described in 6.1.2). Finally, from a project management point of view, Inria is in charge of leading the work-package related to data analytics technique for analyzing security probe events.

#### 8.2.5. Inria-Orange Joint Lab

**Participants:** Jérôme François [contact], Rémi Badonnel, Olivier Festor, Maxime Compastié, Paul Chaignon.

The challenges addressed by the Inria-Orange joint lab relate to the virtualization of communication networks, the convergence between cloud computing and communication networks, and the underlying software-defined infrastructures. This lab aims at specifying and developing a GlobalOS (Global Operating System) approach as a platform or a software infrastructure for all the network and computing resources required by the Orange network operator. Our work, started in November 2015, concerns in particular monitoring methods for software-defined infrastructures, and management strategies for supporting software-defined security in multi-tenant cloud environments.

#### 8.2.6. CNRS-INS2I PEPS NEFAE

**Participants:** Thibault Cholez [contact], Wazen Shbair, Isabelle Chrisment, Jérôme François.

The need to monitor the increasing proportion of HTTPS traffic while preserving the privacy of users led us to propose a privacy-preserving monitoring framework that allows efficient identification of encrypted traffic (based on full TLS sessions), without relying on any decryption (no HTTPS proxy). It is based on a new set of well-tuned network features to characterise the service inside the encrypted traffic and on machine learning algorithms. The CNRS PEPS founded NEFAE project aims to specifically address the practical challenges toward real time identification of encrypted traffic by developing a next-generation firewall prototype.

This year we first built and made publicly available a new HTTPS dataset<sup>0</sup> (with complete raw data) so that researchers can compare their identification algorithms. We also improved our HTTPS monitoring framework to allow real-time identification of HTTPS services with only a few data packets instead of the full TLS session. We show better performances than the related work in all dimensions: better accuracy, earlier decision and more fine-grained identification). A running prototype is also under development to evaluate the scalability and overhead of our solution.

### 8.2.7. CNRS-INS2I PEPS SURF

**Participants:** Abdelkader Lahmadi [contact], Jérôme François, Isabelle Chrisment.

The SURF project, funded by the CNRS PEPS program, addresses the challenge of developing a methodology for the joint modelling and the analysis of the Cyber security and the safety of industrial systems in the context of the factory of the future. The project involves partners from the Heudiasyc Laboratory of the University of Technology of Compiègne (UTC), the CRAN laboratory and the Inria Madynes team. The goal of the project is to make a joint effort from safety and cyber security communities to address the challenges of a joint modelling of industrial systems while including attacks, vulnerabilities and failures. During the year 2016, with the partners of the project, we have mainly identified the key challenges regarding this issue where we identified the common models, metrics and analysis methods that should be built. We have also organized a scientific day (<http://surf.loria.fr>) with many industrials (EDF, PSA and Sentryo) and academic to share with them our work and clearly identify the requirement and experience regarding this issue. This short term project is ended by this year, however a consortium is established for further long term projects (ANR, FUI or H2020) to address the identified challenge of a joint analysis of the cyber security and the safety of industrial control systems.

### 8.2.8. ANR FLIRT

**Participants:** Olivier Festor [contact], Rémi Badonnel, Thibault Cholez, Jérôme François, Abdelkader Lahmadi, Laurent Andrey.

FLIRT (Formations Libres et Innovantes Réseaux & Télécom) is an applied research project led by the Institut Mines-Télécom, for a duration of 4 years. It includes 14 academic partners (engineering schools including Telecom Nancy), 3 industrial partners (Airbus, Nokia Group and Orange), 2 innovative startups (the MOOC agency, and Isograd), as well as 3 professional or scientific societies (Syntec Numérique, Unetel, SEE). The project objective is to build a collection of 10 MOOCs (Massive Open Online Courses) in the area of networks and telecommunications, 3 training programmes based on this collection, as well as several innovations related to pedagogical efficiency (such as virtualization of practical labs, management of student cohorts, and adaptive assessment). The Madynes team is leading a working group dedicated to the building of a MOOC on network and service management. This MOOC will cover the fundamental concepts, architectures and protocols of the domain, as well as their evolution in the context of future Internet, and will include practical labs and exercises using widely-used tools and technologies.

### 8.2.9. Technological Development Action (ADT)

#### 8.2.9.1. ADT UASS

The goal of this ADT is while still providing assistance in developing the Aetournos platform to help in the UAV Challenge Medical Express. Through this ADT, funded by Inria, Raphaël Cherfan has coordinated students work on the platform and tutoring the Aetournos team for the 2016 Outback Joe Search and Rescue / Medical Express Challenge, and help in the design and building of a novel Hybrid UAV.

#### 8.2.9.2. ADT VERTEX

This ADT started on 2016 and will end on 2018. The Madynes project is a major partner funded at the level of 120k€. ADT VERTEX built upon the foundations of the Grid'5000 testbed aims to reinforce and extend it towards new use cases and scientific challenges. Several directions are being explored: networks and Software Defined Networking, Big Data, HPC, and production computation needs. Already developed prototypes are also being consolidated, and the necessary improvements to user management and tracking are also being performed.

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<sup>0</sup><http://betternet.lhs.loria.fr/datasets/https/>



### 8.2.9.3. ADT COSETTE

This ADT started on 2013 and is ending on 2016. The Madynes project is the only partner funded at the level of 120k€. ADT COSETTE, for *COherent SET of Tools for Experimentation* aims at developing or improving a tool suite for experimentation at large scale on testbeds such as Grid'5000. Specifically, we will work on (1) the development of Ruby-CUTE, a library gathering features useful when performing such experiments; (2) the porting of Kadeploy, Distem and XPFlow on top of Ruby-CUTE; (3) the release of XPFlow, developed in the context of Tomasz Buchert's PhD; (4) the improvement of the Distem emulator to address new scientific challenges in Cloud and HPC. E. Jeanvoine (SED) is delegated in the Madynes team for the duration of this project. A subsequent project is planned to start at the end of 2016 (ADT SDT).

### 8.2.9.4. ADT RIOT

RIOT ADT is a multi-site project with Inria and Madynes teams, which started in December 2016 for a duration of two years. The high-level objective is to (1) contribute open source code, upstream, to the RIOT code base, (2) coordinate RIOT development within Inria, with other engineers and researchers using/developing RIOT, (3) coordinate RIOT development outside Inria, help maintain the RIOT community at large (see <http://www.riot-os.org> and <http://www.github.com/RIOT-OS/RIOT>) which aims to become the equivalent of Linux for IoT devices that cannot run Linux because of resource constraints.

This year MADYNES team has mainly contributed to the efficient MAC layer protocol implementation issues. We have built a general MAC protocol module (gnrc mac module) for providing critical development tools for MAC protocol developers in the RIOT community (<https://github.com/RIOT-OS/RIOT/pull/5941>; <https://github.com/RIOT-OS/RIOT/pull/5942>; <https://github.com/RIOT-OS/RIOT/pull/5949>; <https://github.com/RIOT-OS/RIOT/pull/5950>; <https://github.com/RIOT-OS/RIOT/pull/6069>; <https://github.com/RIOT-OS/RIOT/pull/6072>). Based on these generic functions, we first contributed to the functionality and performance improvement of an universal example MAC protocol (Lw-MAC) (<https://github.com/RIOT-OS/RIOT/pull/5941>). We then implemented iQueue-MAC, which is a robust, energy efficient and traffic adaptive MAC protocol (<https://github.com/RIOT-OS/RIOT/pull/5618>). Currently, we have finished to implement most of the designed features of iQueue-MAC, such as the low duty-cycle scheme, the adaptive slots allocation scheme and the multi-channel operation. Experimental results collected from samr21-Xplained-pro boards showed that iQueue-MAC is robust and has a extremely low packet drop ratio, even when interference is strong.

## 8.2.10. Inria Project Lab

### 8.2.10.1. IPL BetterNet

**Participants:** Isabelle Chrisment [contact], Thibault Cholez, Vassili Rivron.

The Inria Project Lab BetterNet (<https://project.inria.fr/betternet>) launched in October 2016. Its goal is to build and deliver a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. We will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Tools, models and algorithms will be provided to collect data that will be shared and analyzed to offer a valuable service to scientists, stakeholders and civil society.

The Madynes team leads the IPL and in particular Isabelle Chrisment who coordinates the project. Several actions have already been done over the first months:

- Organization of the Kick-Off the 19th November in Paris;
- Recruitment of a shared PhD with SPYRALS (Inria/University of Lille3) in order to develop probes and collecting platform;
- Servers installation in LHS (High Security Laboratory) for the hosting of the different BottleNet and BetterNet data collection and opendata platforms;
- Preparation of small and middle scale QoE and QoS data collection with users. Conception of incentives and rewards (value added services).



## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. Flamingo

Title: Management of the Future Internet

Programm: FP7

Duration: November 2012 - December 2016

Coordinator: University Twente

Partners:

Iminds Vzw (Belgium),  
Jacobs University Bremen Gmbh (Germany),  
University College London (United Kingdom),  
Université de Lorraine (France),  
Universitaet Der Bundeswehr Muenchen (Germany),  
Universitat Politecnica de Catalunya (Spain),  
Universiteit Twente (Netherlands),  
Universitaet Zuerich (Switzerland)

Inria contact: Jérôme François

The goals of FLAMINGO are (a) to strongly integrate the research of leading European research groups in the area of network and service management, (b) to strengthen the European and worldwide research in this area, and (c) to bridge the gap between scientific research and industrial application.

In 2016, our research activities in Flamingo have been focused on (a) the analysis and evaluation of OpenFlow message usage for security applications, in particular to enable fast deployment and reconfiguration of mitigation technique (6.2.4) in cooperation with Universitaet Der Bundeswehr Muenchen; (b) passive monitoring of Internet-of-Things using the RPL protocol in cooperation with the Jacobs University Bremen; (c) monitoring of HTTPS traffic to identify user services without necessity of decrypting (6.1.4) and (d) low-footprint Internet wide scanning using our WISCAN software developed last year.

We have pursued leading the standardization activities of the project (WP leader).

### 8.3.2. Collaborations in European Programs, Except FP7 & H2020

#### 8.3.2.1. RETINA

Program: Eurostars-2

Project acronym: RETINA

Project title: Real-Time support for heterogeneous networks in automotive applications

Duration: April 2016 - March 2018

Coordinator: TCN (Time critical networks)

Other partners: TCN (Sweden), Alkit (Sweden), Viktoria (Sweden), TNO (Netherlands), Scuola Superiore Sant'Anna (Italy), Evidence (Italy), University of Lorraine (France)

Abstract: The project will develop integrated software tools to predict, simulate, test and support real-time communication in heterogeneous vehicular networks. The tool set will allow SMEs and larger industry to design, develop and evaluate time-critical applications such as advanced safety systems and autonomous vehicles. This will put high requirements on both in-vehicle infrastructure, as well as vehicle-to-vehicle and vehicle-to-infrastructure utilizing the next generation of mobile networks for ITS.

## 8.4. International Initiatives

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

#### 8.4.1.1. IoT4D

Title: Internet of Things for Developing countries

International Partner (Institution - Laboratory - Researcher):

UY (Cameroon) - MASECNeSS - Thomas DJOTIO NDIE

Start year: 2016

We want connect wireless sensors networks to the Internet through gateways. Wireless network should have several accessible gateways (depending on the size and quality of service needed) and gateways should be used by several wireless sensors networks. This is an optimization problem in this particular context, with unreliable communications and equipments that are easily disturbed by the environment

#### 8.4.1.2. Masdin

Title: Management of Software-Defined INfrastructure

International Partner (Institution - Laboratory - Researcher):

University of Luxembourg (Luxembourg) - SnT (Interdisciplinary Centre for Security, Reliability and Trust) - Radu State

Start year: 2016

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

Networking is deeply evolving with the rise of programmability and virtualization. The concept of SDI (Software-Defined Infrastructure) has emerged from SDN (Software-Defined Networking) and NFV (Network Function Virtualization) making thus the configuration of the network highly dynamic and adaptable in real-time. However, new methods and tools have to be defined to properly monitor and configure this type of infrastructure. Current works are mainly limited to apply former approaches of traditional network but do not exploit the novel capabilities offered by these technologies. The goal of the associate team is thus to define methodologies taking benefit of them for an efficient monitoring and use of SDI resources while investigating security issues it brings.

#### 8.4.1.3. STIC-AmSud AKD Project

**Participants:** Rémi Badonnel [contact], Olivier Festor, Gaetan Hurel, Amedeo Napoli.

The AKD project, funded by the STIC-AmSud Program, addresses the challenge of autonomic knowledge discovery for security vulnerability prevention in self-governing systems. The partners include Federal University of Rio Grande do Sul (UFRGS, Brazil), Republic University of Uruguay (INCO, Uruguay), Technical University of Federico Santa Maria (UTFSM, Chile), and Inria (Orpailleur, Madynes). Computer vulnerabilities constitute one of the main entry points for security attacks, and therefore, vulnerability management mechanisms are crucial for any computer systems. However autonomic mechanisms for assessing and remediating vulnerabilities can degrade the performance of the system and might contradict existing operational policies. In that context, this project focuses on the design of solutions able to pro-actively understand the behavior of systems and networks, in order to prevent vulnerable states. For that purpose, our work concerns more specifically the exploitation and integration of knowledge discovery techniques within autonomic systems for providing intelligent self-configuration and self-protection. It also investigates the building of flexible and dynamic security management mechanisms taking benefits from software-defined methods and techniques.

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## MAGRIT Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

- Lorraine regional project about AR for liver surgery (2015-2018)  
The MAGRIT and the MIMESIS teams have been working for several years on the use of augmented reality for deformable organs and especially on liver surgery. The PhD of Jaime Garcia started in October 2015 and is funded by the Région Lorraine. It follows on from our past works and aims at improving the reliability and the robustness of AR-based clinical procedures.

## 8.2. National Initiatives

### 8.2.1. *Projet RAPID EVORA*

Participant: M.-O. Berger, V. Gaudillière, G. Simon.

This 3-year project is supported by DGA/DGE and led by the SBS-Interactive company. The objective is to develop a prototype for location and object recognition in large-scale industrial environments (factories, ships...), with the aim to enrich the operator's field of view with digital information and media. The main issues concern the size of the environment, the nature of the objects (often non textured, highly specular...) and the presence of repeated patterns. Use cases will be provided by industrial partners such as DCNS and Areva. A class of officer cadets and professors of the Merchant Marine School will also be associated to judge the pedagogical interest of such a tool. A PhD student, Vincent Gaudillière, has been recruited to work on this project and his contract started on 1st December 2016.

### 8.2.2. *Project funded by GDR ISIS in collaboration with Institut Pascal*

Participant: F. Sur.

Since June 2012, we have been engaged in a collaboration with Pr. Michel Grédiac. The aim is to give a mathematical analysis and to help improving the image processing tools used in experimental mechanics at Institut Pascal.

The TIMEX project (2014-2016) is funded by GDR ISIS ("Appel à projet exploratoire, projet interdisciplinaire"). It aims at investigating image processing tools for enhancing the metrological performances of contactless measurement systems in experimental mechanics.

### 8.2.3. *Collaboration with the MIMESIS team*

Participants: R. Anxionnat, M.-O. Berger, E. Kerrien.

The SOFA-InterMedS large-scale Inria initiative is a research-oriented collaboration across several Inria project-teams, international research groups and clinical partners. Its main objective is to leverage specific competences available in each team to further develop the multidisciplinary field of Medical Simulation research. Our action within the initiative takes place in close collaboration with both the MIMESIS team and the Department of diagnostic and therapeutic interventional neuroradiology of Nancy University Hospital. We aim at providing in-vivo models of the patient's organs, and in particular a precise geometric model of the arterial wall. Such a model is used by the MIMESIS team to simulate the coil deployment within an intracranial aneurysm. The associated medical team in Nancy, and in particular our external collaborator René Anxionnat, is in charge of validating our results. For three years, we have also been collaborating with the MIMESIS team about real-time augmentation of deformable organs.

## **8.3. International Initiatives**

### **8.3.1. Inria International Partners**

#### *8.3.1.1. Informal International Partners*

Pierre-Frederic Villard has a "Harvard Affiliate" status through his collaboration with the Harvard Biorobotics Lab led by Professor Robert D. Howe. It follows a one year and a half sabbatical years (2014-2016) that Pierre-Frederic Villard spent in Harvard University in Cambridge (USA) working on heart valve modeling.

## MIMESIS Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. *Institut Hospitalo-Universitaire de Strasbourg*

Our team has been selected to be part of the IHU of Strasbourg. This institute is a very strong innovative project of research dedicated to future surgery of the abdomen. It is dedicated to minimally invasive surgery, guided by image and simulation. Based on interdisciplinary expertise of academic partners and strong industry partnerships, the IHU aims at involving several specialized groups for doing research and developments towards hybrid surgery (gesture of the surgeon and simulation-based guidance). The MIMESIS team is an important part of the project. Since September 2011, we develop numerous experimental activities in close collaboration with clinicians.

### 7.1.2. *Other research teams*

At the regional level, the MIMESIS team also collaborates with:

**Inria Magrit team:** we closely collaborate with the Magrit team on the use of augmented reality in surgical procedures, through the PhD thesis of Jaime Garcia Guevara and the postdoctoral position of Nazim Haouchine. This collaboration leads to many publications [14].

**ICube Automatique Vision et Robotique (AVR) team:** we are currently working with the medical robotics team on percutaneous procedures, in particular robotized needle insertion (with Prof. Bernard Bayle), and needle tracking in medical images (with Elodie Breton). We are also collaborating with Jonathan Vappou on elastography.

**ICube Informatique Géométrique et Graphique (IGG) team:** the Mimesis team joined the IGG team and develops collaboration in the domain of dynamic topologies, mainly through the use of the CGoGN framework. CGoGN is a C++ library for the manipulation of meshes. It implements combinatorial maps and their multiresolution extensions and has been used in various high level application like the simulation of crowds of autonomous agents and the simulation of cuts, tears and fractures in the context of surgical simulations.

**Nouvel Hopital Civil, Strasbourg:** since 2014 we have been working with Prof. David Gaucher, an ophthalmologist surgeon, expert in retina surgery. This led to the submission of the ANR project RESET which started in March 2015. We also collaborate with Prof. Patrick Pessaux, a surgeon who helps us in the context of the SOFA-OR project.

### 7.1.3. *ADT: Aide au Développement Technologique*

The MIMESIS receives support for the development of the SOFA framework through two ADT:

**SofaOR** (Jan 2015-Dec 2016): The objective of this ADT was twofold: first, we aimed at achieving a level of quality and robustness compatible with IEC 62304 for the core of SOFA and a reduced set of components. This does not include the certification of the code itself, but rather the implementation of a comprehensive development process that will enable the certification by companies wishing to integrate this code into their systems. The second objective was to add new features specific to the needs of using intra-operative guiding tools: interoperability with equipment from the operating room, acquisition and real-time processing of full HD video streams, data assimilation and predictive filters, path planning, visualization for augmented reality, or user interfaces dedicated to the operating room.

**DynMesh** (Sep 2015-Aug 2017): The objectives of this ADT was the coupling of SOFA, the physical simulation platform supported by Inria, and CGoGN, the mesh management library developed within the ICube lab at Strasbourg. The goal is to extend the physical engine SOFA with the topological kernel of CGoGN that supports a wide variety of mesh and many local remeshing operations. The coupling of both software libraries will provide users of physical engines with new tools for the development of simulations involving topological changes like cutting, fracturing, adaptation of the resolution or improving contact management or collision detection. The impacts are numerous and will be operated directly within the MIMESIS Team, with our partners or through the establishment of new collaborations.

## 7.2. National Initiatives

### 7.2.1. ANR

MIMESIS participates to the following ANR project:

**RESET:** This project started in March 2015 and will end in May 2017. Its objective is to develop a high-fidelity training system for retinal surgery. Retina surgery is an increasingly performed procedure for the treatment of a wide spectrum of retinal pathologies. Yet, as most micro-surgical techniques, it requires long training periods before being mastered. This simulator is built upon our scientific expertise in the field of real-time simulation, and our success story for technology transfer in the field of cataract surgery simulation (MSICS simulation developed for the HelpMeSee foundation).

**Coordinator:** MIMESIS

**Partners:** the InSimo company, the AVR team of the ICube lab.

### 7.2.2. National Collaborations

At the national level, the MIMESIS team collaborates with:

**The LML laboratory (*Laboratoire de Mécanique de Lille*):** a French research laboratory (UMR CNRS 8107) part of the Carnot institute ARTS. With more than two hundred researchers, LML focuses on the following research areas: mechanical reliability and Tribology, fluid mechanics, civil engineering and soil mechanics.

**The TIMC laboratory (*Techniques de l'Ingénierie Médicale et de la Complexité*) in Grenoble:** this large research group has a strong background in computer-aided surgery, medical imaging, registration, statistical and bio-mechanical modeling. We have regular interactions with various members of this group. We are collaborating with Yohan Payan (DR CNRS) on the modeling and simulation of the brain shift. A common PhD thesis started on that topic in late 2014. Other areas of interest are in the field of advanced soft tissue modeling and computer aided surgery,

## 7.3. European Initiatives

### 7.3.1. FP7 & H2020 Projects

MIMESIS participates to the following European project:

**Program:** FP7

**Project acronym:** RASimAs

**Project title:** Regional Anaesthesia Simulator and Assistant

**Duration:** Nov 2013 - Nov 2016

**Coordinator:** Department of Medical Informatics, Uniklinik RWTH Aachen (Germany)

**Other partners:** we collaborate, among others, with: the University Hospital Aachen, RWTH Aachen, Bangor University, University College Cork, Universidad Rey Juan Carlos, Foundation for Research and Technology Hellas, Zilinska univerzita v Ziline, Katholieke Universiteit Leuven and the Stiftelsen Sintef.

**Abstract:** The goal of this project was to increase the application, the effectiveness and the success rates of regional anaesthesia and furthermore the diffusion of the method into a broader clinical use through the development of clinical tools to train new anaesthesiologists and assist them during the operation. The project combine two independent but complementary systems: one system is for training and the other one is for operational guidance. The training system consists in one medical simulator recreating RA operation for the anaesthesiologist in a virtual reality environment. The trainee is able to practise virtually the operation on various patient anatomies. The guidance system consists in assisting anaesthesiologists during the practise of RA by providing enhanced feedback on image interpretation and patient-specific anatomy. These two prototypes have been evaluated through a multi-centre clinical trial in Germany, Belgium and Ireland.

## 7.4. International Initiatives

The MIMESIS team has collaboration with the following international partners:

- **Team Legato, University of Luxembourg:** since last year we have active collaborations with Prof. Stéphane Bordas on real-time soft tissue cutting simulation. This has already led to a journal article [19] and the co-supervision of a post-doctoral fellow ;
- **Humanoid and Intelligence Systems Lab, Karlsruhe Institute of Technology:** we started a collaboration with Stefanie Speidel and Stefan Suwelack on the topics of real-time soft tissue modeling and laparoscopic augmented reality.
- **SINTEF, Norway:** we are currently collaborating with SINTEF in the context of the European project RASimAs, and also on other aspects, such as the creation of anatomically correct and accurate datasets from patient-specific data. We are also discussing future collaborations in the context of hepatic surgery simulation and augmented reality (we have jointly written a H2020 proposal on this topic).
- **Faculty of Informatics, Masaryk University, Czech Republic:** We began collaborations with Professor Ludek Matyska on biomedical simulations. The PhD thesis of Lukas Rucka on the Validation and verification of soft tissue models; takes place in this context.

## MULTISPEECH Project-Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. CORExp

Project acronym: CORExp

Project title: Acquisition, Processing and Analysis of a Corpus for the Synthesis of Expressive Audiovisual Speech

Duration: December 2014 - December 2016

Coordinator: Slim Ouni

Cofunded by Inria and Région Lorraine

Abstract: The main objective of this project was the acquisition of a bimodal corpus of a considerable size (several thousand sentences) to study the expressiveness and emotions during speech (for example, how to decode facial expressions that are merged with speech signals). The main purpose was to acquire, process and analyze the corpus and to study the expressiveness; the results will be used for the expressive audiovisual speech synthesis system.

### 9.1.2. CPER LCHN

Project acronym: CPER LCHN

Project title: CPER "Langues, Connaissances et Humanités Numériques"

Duration: 2015-2020

Coordinator: Bruno Guillaume (LORIA) & Alain Polguère (ATILF)

Abstract: The main goal of the project is related to experimental platforms for supporting research activities in the domain of languages, knowledge and numeric humanities engineering.

MULTISPEECH contributes to automatic speech recognition, speech-text alignment and prosody aspects.

### 9.1.3. CPER IT2MP

Project acronym: CPER IT2MP

Project title: CPER "Innovation Technologique Modélisation et Médecine Personnalisée"

Duration: 2015-2020

Coordinator: Faiez Zannad (Inserm-CHU-UL)

Abstract: The goal of the project is to develop innovative technologies for health, and tools and strategies for personalized medicine.

MULTISPEECH will investigate acoustic monitoring using an array of microphones.



### **9.1.4. SATT Dynalips**

Project title: Control of the movements of the lips in the context of facial animation for an intelligible lipsync.

Duration: May 2016 - December 2017

Coordinator: Slim Ouni

Abstract: We propose in this project the development of tools of lipsync which from recorded speech will provide realistic mechanisms of animating the lips. These tools will be available to be integrated into existing 3D animation software and existing game engines. One objective is that these lipsync tools fit easily into the production pipeline in the field of 3D animation and video games. The goal of this maturation is to propose a product ready to be exploited in the industry whether by the creation of a start-up or by the distribution of licenses.

## **9.2. National Initiatives**

### **9.2.1. EQUIPEX ORTOLANG**

Project acronym: ORTOLANG<sup>0</sup>

Project title: Open Resources and TOols for LANGUAGE

Duration: September 2012 - December 2016 (phase I)

Coordinator: Jean-Marie Pierrel, ATILF (Nancy)

Other partners: LPL (Aix en Provence), LORIA (Nancy), Modyco (Paris), LLL (Orléans), INIST (Nancy)

Abstract: The aim of ORTOLANG was to propose a network infrastructure offering a repository of language data (corpora, lexicons, dictionaries, etc.) and tools and their treatment that are readily available and well-documented. This will enable a real mutualization of analysis research, of modeling and automatic treatment of the French language. This will also facilitate the use and transfer of resources and tools set up within public laboratories towards industrial partners, in particular towards SME which often cannot develop such resources and tools for language treatment due to the costs of their realization. Moreover, this will promote the French language and local languages of France by sharing knowledge which has been acquired by public laboratories.

Several teams of the LORIA laboratory contribute to this Equipex, mainly with respect to providing tools for speech and language processing. MULTISPEECH contributes with text-speech alignment and speech visualization tools.

### **9.2.2. E-FRAN METAL**

Project acronym: E-FRAN METAL

Project title: Modèles Et Traces au service de l'Apprentissage des Langues

Duration: October 2016 - September 2020

Coordinator: Anne Boyer (LORIA)

Other partners: Interpsy, LISEC, ESPE de Lorraine, D@NTE (Univ. Versailles Saint Quentin), Sailendra SAS, ITOP Education, Rectorat.

Abstract: METAL aims at improving the learning of languages (both written and oral components) through the development of new tools and the analysis of numeric traces associated with students' learning, in order to adapt to the needs and rhythm of each learner.

Multispeech is concerned by oral language learning aspects.

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<sup>0</sup><http://www.ortolang.fr>

### 9.2.3. PIA2 ISITE LUE

Project acronym: ISITE LUE

Project title: Lorraine Université d'Excellence

Duration: starting in 2016

Coordinator: Univ. Lorraine

Abstract: The initiative aims at developing and densifying the initial perimeter of excellence, within the scope of the social and economic challenges, so as to build an original model for a leading global engineering university, with a strong emphasis on technological research and education through research. For this, we have designed LUE as an "engine" for the development of excellence, by stimulating an original dialogue between knowledge fields.

MULTISPEECH is mainly concerned with challenge number 6: "Knowledge engineering", i.e., engineering applied to the field of knowledge and language, which represent our immaterial wealth while being a critical factor for the consistency of future choices. In 2016, this project has funded a new PhD thesis.

### 9.2.4. ANR ContNomina

Project acronym: ContNomina

Project title: Exploitation of context for proper names recognition in diachronic audio documents

Duration: February 2013 - March 2017

Coordinator: Irina Illina

Other partners: LIA, Synalp

Abstract: The ContNomina project focuses on the problem of proper names in automatic audio processing systems by exploiting in the most efficient way the context of the processed documents. To do this, the project addresses the statistical modeling of contexts and of relationships between contexts and proper names; the contextualization of the recognition module (through the dynamic adjustment of the lexicon and of the language model in order to make them more accurate and certainly more relevant in terms of lexical coverage, particularly with respect to proper names); and the detection of proper names (on the one hand, in text documents for building lists of proper names, and on the other hand, in the output of the recognition system to identify spoken proper names in the audio/video data).

### 9.2.5. ANR ORFEO

Project acronym: ORFEO<sup>0</sup>

Project title: Outils et Ressources pour le Français Écrit et Oral

Duration: February 2013 - February 2016

Coordinator: Jeanne-Marie DEBAISIEUX (Université Paris 3)

Other partners: ATILF, CLLE-ERSS, ICAR, LIF, LORIA, LATTICE, MoDyCo

Abstract: The main objective of the ORFEO project is the constitution of a corpus for the study of contemporary French.

In this project, we were concerned by the automatic speech-text alignment at the word and phoneme levels for audio files from several corpora gathered by the project. These corpora orthographically transcribed with Transcriber contain mainly spontaneous speech, recorded under various conditions with a large SNR range and a lot of overlapping speech and anonymised speech segments. For the forced speech-text alignment phase, we applied our 2-step methodology (the first step uses a detailed acoustic model for finding the pronunciation variants; then, in the second step a more compact model is used to provide more temporally accurate boundaries).

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<sup>0</sup>[http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx\\_lwmsuivibilan\\_pi2\[CODE\]=ANR-12-CORP-0005](http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx_lwmsuivibilan_pi2[CODE]=ANR-12-CORP-0005)

### **9.2.6. ANR-DFG IFCASL**

Project acronym: IFCASL

Project title: Individualized feedback in computer-assisted spoken language learning

Duration: March 2013 - December 2016

Coordinator: Jürgen Trouvain (Saarland University)

Other partners: Saarland University (COLI department)

Abstract: The main objective of IFCASL is to investigate learning of oral French by German speakers, and oral German by French speakers at the phonetic level.

A French-German learner corpus was designed and recorded. French speakers were recorded in Nancy, whereas German speakers were recorded in Saarbrücken. An automatic speech-text alignment process was applied on all the data. Then, the French speech data (native and non-native) were manually checked and annotated in France, and the German speech data (native and non-native) were manually checked and annotated in Germany. The corpora are currently used for analyzing non-native pronunciations, and studying feedback procedures.

### **9.2.7. ANR DYCI2**

Project acronym: DYCI2<sup>0</sup>

Project title: Creative Dynamics of Improvised Interaction

Duration: March 2015 - February 2018

Coordinator: Ircam (Paris)

Other partners: Inria (Nancy), University of La Rochelle

Abstract: The goal of this project is to design a music improvisation system which will be able to listen to the other musicians, improvise in their style, and modify its improvisation according to their feedback in real time.

### **9.2.8. ANR JCJC KAMoulox**

Project acronym: KAMoulox

Project title: Kernel additive modelling for the unmixing of large audio archives

Duration: January 2016 - January 2019

Coordinator: Antoine Liutkus

Abstract: Develop the theoretical and applied tools required to embed audio denoising and separation tools in web-based audio archives. The applicative scenario is to deal with large audio archives, and more precisely with the notorious "Archives du CNRS — Musée de l'homme", gathering about 50,000 recordings dating back to the early 1900s.

### **9.2.9. ANR ArtSpeech**

Project acronym: ArtSpeech

Project title: Synthèse articulatoire phonétique

Duration: October 2015 - March 2019

Coordinator: Yves Laprie

Other partners: Gipsa-Lab (Grenoble), IADI (Nancy), LPP (Paris)

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<sup>0</sup><http://repmus.ircam.fr/dyici2/>

Abstract: The objective is to synthesize speech from text via the numerical simulation of the human speech production processes, i.e. the articulatory, aerodynamic and acoustic aspects. Corpus based approaches have taken a hegemonic place in text to speech synthesis. They exploit very good acoustic quality speech databases while covering a high number of expressions and of phonetic contexts. This is sufficient to produce intelligible speech. However, these approaches face almost insurmountable obstacles as soon as parameters intimately related to the physical process of speech production have to be modified. On the contrary, an approach which rests on the simulation of the physical speech production process makes explicit use of source parameters, anatomy and geometry of the vocal tract, and of a temporal supervision strategy. It thus offers direct control on the nature of the synthetic speech.

Measurements of glottis opening during the production of fricatives via EPGG (ElectroPhotoGlottography), the design of acoustic experiments with a replica of the vocal tract and the design of dynamic acquisition with MRI were the main activities of this first year.

### **9.2.10. FUI RAPSODIE**

Project acronym: RAPSODIE

Project title: Automatic Speech Recognition for Hard of Hearing or Handicapped People

Duration: March 2012 - February 2016

Coordinator: eRocca (Mieussy, Haute-Savoie)

Other partners: CEA (Grenoble), Inria (Nancy), CASTORAMA (France)

Abstract: The goal of the project was to realize a portable device to help a hard-of-hearing person to communicate with other people. To achieve this goal the portable device needs to access a speech recognition system, adapted to this task. Another application of the device is environment vocal control for handicapped persons.

In this project, MULTISPEECH was involved in optimizing the speech recognition models for the envisaged task, and in finding the best way of presenting the speech recognition results in order to maximize the communication efficiency between the hard-of-hearing person and the speaking person.

### **9.2.11. FUI VoiceHome**

Project acronym: VoiceHome

Duration: February 2015 - July 2017

Coordinator: onMobile

Other partners: Orange, Delta Dore, Technicolor Connected Home, eSoftThings, Inria (Nancy), IRISA, LOUSTIC

Abstract: The goal of this project is to design a robust voice control system for smart home and multimedia applications. We are responsible for the robust automatic speech recognition brick.

### **9.2.12. ADT Plavis**

Project acronym: Plavis

Project title: Platform for acquisition and audiovisual speech synthesis

Duration: January 2015 - December 2016

Coordinator: Vincent Colotte

Abstract: The objective of this project was to develop a platform acquisition and audiovisual synthesis system (3D animation of the face synchronously with audio). The main purpose was to build a comprehensive platform for acquisition and processing of audiovisual corpus (selection, acquisition and acoustic processing, 3D visual processing and linguistic processing). The acquisition was performed using a motion-capture system (Kinect-like), a Vicon system, and an electromagnetic articulography (EMA) system.

### 9.2.13. LORIA exploratory project

Project title: Acquisition and processing of multimodal corpus in the context of interactive human communication

Duration: June 2015 - May 2016

Coordinator: Slim Ouni

Abstract: The aim of this project was the study of the various mechanisms involved in multimodal human communication that can be oral, visual, gestural and tactile. This project focused on the identification and acquisition of a very large corpus of multimodal data from multiple information sources and acquired in the context of interaction and communication between two people or more.

### 9.2.14. SYNABE

Project acronym: SYNABE

Project title: Articulatory data synchronization for studying stuttering

Duration: January 2016 - December 2016

Coordinator: Fabrice Hirsch (Praxiling, UMR 5267, Montpellier)

Other partners: S. Ouni

Funding: CNRS DEFI Instrumentation aux limites

Abstract: The objective of this project is to use simultaneously three hardware allowing having information on the subglottic (respiratory belt), glottic (electroglottograph) and supraglottic (articulograph) levels during the production of the speech in order to know the timing of the gestures during speech. This system will be used to study the motor coordination between the three levels mentioned in the stuttering and normo-fluent words. We will propose a new typology of normal and pathological disfluencies.

Our main contribution concerned the articulatory data acquisition using the articulograph AG501.

## 9.3. European Initiatives

### 9.3.1. Collaborations with Major European Organizations

Jon Barker: University of Sheffield (UK)

Robust speech recognition [11], [55]

## 9.4. International Initiatives

### 9.4.1. Inria International Partners

#### 9.4.1.1. Informal International Partners

Jonathan Le Roux, Shinji Watanabe, John R. Hershey: Mitsubishi Electric Research Labs (MERL, Boston, USA)

Robust speech recognition [11], [55]

Dayana Ribas Gonzalez, Ramón J. Calvo: CENATAV (Habana, Cuba)

Robust speaker recognition [42]

### 9.4.2. Participation in Other International Programs

#### 9.4.2.1. STIC-AmSud - multimodal communication corpus

STIC-AmSud: MCC - Multimodal Communication Corpus. A collaboration: Argentina, Chile and France (01/2015-12/2016)

Project acronym: MCC

Project title: Multimodal Communication Corpus

Duration: January 2015 - December 2016

International Coordinator: S. Ouni

National Coordinators: Nancy Hitschfeld (Depto. de Ciencias de la Computación (DCC), Universidad de Chile) - Chile; and, Juan Carlos Gomez (Centro Internacional Franco Argentino de Ciencias de la Información y de Sistemas (CIFASIS), UNR, CONICET) - Argentina

Abstract: The project aims to collect a multimodal speech corpus containing synchronized audio-visual data recorded from talking individuals. The corpus will incorporate several communication modes which appear in the communication among humans, such as the acoustic signal, facial movements and body gestures during speech. During 2016, a complete corpus of 8 speakers (4 French and 4 Spanish) has been acquired and processed. The corpus will be distributed using the Ortolang platform.

#### *9.4.2.2. PHC UTIQUE - HMM-based Arabic speech synthesis*

PHC UTIQUE - HMM-based Arabic speech synthesis, with ENIT (Engineer school at Tunis-Tunisia)

Duration: 2015 - 2018.

Coordinators: Vincent Colotte (France) and Noureddine Ellouze (Tunisia).

Abstract: Development of an HMM-based speech synthesis system for the Arabic language. This includes the development of an Arabic speech corpus, the selection of linguistic features relevant to Arabic HMM-based speech synthesis, as well as improving the quality of the speech signal generated by the system.

## **9.5. International Research Visitors**

### *9.5.1. Visits of International Scientists*

Sebastian Gonzales Mora

Date: Jan 2016

Faculty de Cs. Físicas y Matemáticas, University of Chile

Benjamin Martinez Elizalde

Date: May 2016 - Aug 2016

Institution: Carnegie Mellon University (USA)

Dayana Ribas Gonzalez

Date: Sep 2016 - Dec 2016

Institution: CENATAV (Cuba)

Ziteng Wang

Date: Sep 2016 - Sep 2017

Institution: Institute of Acoustics, Chinese Academy of Sciences (China)

## NEUROSYS Project-Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

In the *Contrat de Projet État Région (CPER) IT2MP 2015-2020 on Technological innovations, modeling and Personalized Medicine*, we are contributing on platform SCARAT (*cognitive stimulation, Ambient Intelligence, Robotic assistance" and Telemedicine*). Contact in Neurosys is Laurent Bougrain.

## 9.2. National Initiatives

PEPS JCJC INS2I 2016 Modeling and simulation of the oscillatory activity of the memory system during sleep and under general anesthesia (L. Buhry, L. Bougrain).

In order to better understand the mechanisms of amnesia under anesthesia, we propose, on the one hand, to carry out a comparative study, to model and simulate the hippocampal oscillatory activity under general anesthesia and during sleep (tasks 1 and 2). Deep SEEG recordings in epileptic patients during seizures will serve as a reference for modeling and simulation. On the other hand, on the basis of data recorded during sleep, we wish (tasks 3 and 4) to analyze and model the interactions between two structures involved in memory, the hippocampus and the prefrontal cortex, and (tasks 5) propose an automated method to reveal markers of the hippocampal activity characteristics of the sleep stages making use of sole surface recordings. \*As it is widely acknowledged that the consolidation of memory occurs mostly during the deep sleep stages, this should make it possible to distinguish the parts of the signal corresponding to periods of consolidation and to propose, through mathematical modeling and simulation, mechanisms explaining the effects of amnesia, or even the absence of memory formation under general anesthesia.

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

The ITN-project *Neural Engineering Transformative Technologies (NETT)*<sup>0</sup> (2012-2016) is a Europe-wide consortium of 18 universities, research institutes and private companies which together hosts 17 PhD students and 3 postdoctoral researchers over the past 4 years. Neural Engineering brings together engineering, physics, neuroscience and mathematics to design and develop brain-computer interface systems, cognitive computers and neural prosthetics. Contact is L. Bougrain.

## 9.4. International Initiatives

### 9.4.1. Inria International Partners

#### 9.4.1.1. Informal International Partners

- + We have an ongoing collaboration with Prof. Motoharu Yoshida at the Ruhr University Bochum, Germany, aiming to study the role of persistent firing neurons in memory and more specifically in neural network synchronization. M. Yoshida provides us with biological data that we combine with simulations to test hypotheses on memory formation (L. Buhry).
- + We also collaborate with Prof. LieJune Shiau (University of Houston, Texas, USA) on more theoretical approaches concerning the role of intrinsic neuronal dynamics in network synchronization and brain oscillations (L. Buhry).

## 9.5. International Research Visitors

### 9.5.1. Visits of International Scientists

Prof. LieJune Shiau, University of Houston, June 2016. (collab. with L. Buhry)

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<sup>0</sup><http://www.neural-engineering.eu/>

## ORPAILLEUR Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. *Hydreos*

**Participant:** Jean-François Mari.

Hydreos is a state organization –actually a so-called “Pôle de compétitivité”– aimed at evaluating the delivering and the quality of water (<http://www.hydreos.fr/fr>). Actually, data about water resources rely on many agronomic variables, including land use successions. The data to be analyzed are obtained by surveys or by satellite images and describe the land use at the level of the agricultural parcel. Then there is a search for detecting changes in land use and for correlating these changes to groundwater quality. Accordingly, one main challenge in our participation in Hydreos is to process and analyze space-time data for reaching a better understanding of the changes in the organization of a territory. The systems ARPEnTage and CarottAge (see § 6.2.1 ) are used in this context, especially by agronomists of INRA (ASTER Mirecourt <http://www6.nancy.inra.fr/sad-aster>).

## 8.2. National Initiatives

### 8.2.1. *ANR*

#### 8.2.1.1. *Hybride (2011-2016)*

**Participants:** Adrien Coulet, Amedeo Napoli, Chedy Raïssi, My Thao Tang, Mohsen Sayed, Yannick Toussaint.

The Hybride research project (<http://hybride.loria.fr/>) aims at combining Natural Language Processing (NLP) and Knowledge Discovery in Databases (KDD) for text mining. A key idea is to design an interacting and convergent process where NLP methods are used for guiding text mining while KDD methods are used for guiding the analysis of textual documents. NLP methods are mainly based on text analysis and extraction of general and temporal information. KDD methods are based on pattern mining, e.g. patterns and sequences, formal concept analysis and graph mining. In this way, NLP methods applied to texts extract “textual information” that can be used by KDD methods as constraints for focusing the mining of textual data. By contrast, KDD methods extract patterns and sequences to be used for guiding information extraction from texts and text analysis. Experimental and validation parts associated with the Hybride project are provided by an application to the documentation of rare diseases in the context of Orphanet.

The partners of the Hybride consortium are the GREYC Caen laboratory (pattern mining, NLP, text mining), the MoDyCo Paris laboratory (NLP, linguistics), the INSERM Paris laboratory (Orphanet, ontology design), and the Orpailleur team at Inria NGE (FCA, knowledge representation, pattern mining, text mining). The Hybride project ended on 30th November 2016.

#### 8.2.1.2. *ISTEX (2014–2016)*

**Participant:** Yannick Toussaint.

ISTEX is a so-called “Initiative d’excellence” managed by CNRS and DIST (“Direction de l’Information Scientifique et Technique”). ISTEX aims at giving to the research and teaching community an on-line access to scientific publications in all the domains (<http://www.istex.fr/istex-excellence-initiative-of-scientific-and-technical-information/>). Thus ISTEX requires a massive acquisition of documents such as journals, proceedings, corpus, databases...ISTEX-R is one research project within ISTEX in which the Orpailleur team is involved, with two other partners, namely ATILF laboratory and INIST Institute (both located in Nancy). ISTEX-R aims at developing new tools for querying full-text documentation, analyzing content and extracting information. A platform is under development to provide robust NLP tools for text processing, as well as methods in text mining and domain conceptualization.



#### 8.2.1.3. *PractiKPharma (2016–2020)*

**Participants:** Adrien Coulet, Joël Legrand, Pierre Monnin, Amedeo Napoli, Malika Smaïl-Tabbone, Yannick Toussaint.

The ANR project PractiKPharma (<http://praktikpharma.loria.fr/>) is interested in the validation of domain knowledge in pharmacogenomics. The originality of PractiKPharma is to use “Electronic Health Records” (EHRs) to constitute cohorts of patients, cohorts which are then mined for validating extracted pharmacogenomics knowledge units after validation w.r.t. literature knowledge. This project involves two other labs, namely LIRMM at Montpellier and CRC Paris.

#### 8.2.1.4. *Termith (2014–2016)*

**Participant:** Yannick Toussaint.

Termith (<http://www.atilf.fr/ressources/termith/>) is an ANR Project involving a series of laboratories, namely ATILF, INIST, Inria Nancy Grand Est, Inria Saclay, LIDILEM, and LINA. It aims at indexing documents belonging to different domain of Humanities. Thus, the project focuses on extracting candidate terms (information extraction) and on disambiguation.

In the Orpailleur team, we are mainly concerned by information extraction using Formal Concept Analysis techniques, but also pattern and sequence mining. The objective is to define contexts introducing terms, i.e. finding textual environments allowing a system to decide whether a textual element is actually a candidate term and its corresponding environment. This disambiguation process was described and published at LREC 2016 [35]. The Termith project ended in April 2016.

### 8.2.2. *FUI POQEMON (2014-2016)*

**Participants:** Chedy Raïssi, Mickaël Zehren.

The publication of transaction data, such as market basket data, medical records, and query logs, serves the public benefit. Mining such data allows the derivation of association rules that connect certain items to others with measurable confidence. Still, this type of data analysis poses a privacy threat; an adversary having partial information on a person’s behavior may confidently associate that person to an item deemed to be sensitive. Ideally, an anonymization of such data should lead to an inference-proof version that prevents the association of individuals to sensitive items, while otherwise allowing truthful associations to be derived. The POQEMON project aims at developing new pattern mining methods and tools for supporting privacy preserving knowledge discovery from monitoring purposes on mobile phone networks. The main idea is to develop sound approaches that handle the tradeoff between privacy of data and the power of analysis. Original approaches to this problem were based on value perturbation, damaging data integrity. Recently, value generalization has been proposed as an alternative; still, approaches based on it have assumed either that all items are equally sensitive, or that some are sensitive and can be known to an adversary only by association, while others are non-sensitive and can be known directly. Yet in reality there is a distinction between sensitive and non-sensitive items, but an adversary may possess information on any of them. Most critically, no antecedent method aims at a clear inference-proof privacy guarantee. In this project, we integrated the  $\rho$ -uncertainty privacy concept that inherently safeguards against sensitive associations without constraining the nature of an adversary’s knowledge and without falsifying data. The project integrates the  $\rho$ -uncertainty pattern mining approach with novel data visualization techniques.

The POQEMON research project (<https://members.loria.fr/poqemon/>) involves the following partners: Altran, DataPublica, GenyMobile, HEC, IP-Label, Next Interactive Media, Orange and Université Paris-Est Créteil, and Inria Nancy Grand Est.

### 8.2.3. *CNRS PEPS and Mastodons projects*

#### 8.2.3.1. *Mastodons HyQual (2016–2018)*

**Participants:** Miguel Couceiro, Esther Galbrun, Dhouha Grissa, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

The HyQual project was proposed and initiated this year in the framework of the Mastodons CNRS Call about data quality in data mining (see <http://www.cnrs.fr/mi/spip.php?article819&lang=fr>). This project is interested in the mining of nutritional data for discovering predictive biomarkers of diabetes and metabolic syndrome in elder populations. The data mining methods which are considered here are hybrid, combining symbolic and numerical methods, and are applied to complex and noisy metabolic data [39]. In the HyQual project, we are mainly interested by the quality of the data at hand and the patterns that can be discovered. In particular, we check whether we can find possible definitions within the data (actually double implications) and redescrptions (under the form of different descriptions of the same data). In this way, we can study the definitional power of the data and as well the incompleteness of the data, leading to two original ways of considering data quality. The project involves researchers from the Orpailleur Team, with researchers from LIRIS Lyon, ICube Strasbourg, and INRA Clermont-Ferrand.

#### 8.2.3.2. *PEPS Confocal (2015–2016)*

**Participants:** Adrien Coulet, Amedeo Napoli, Chedy Raïssi, Malika Smaïl-Tabbone.

The Confocal Project (see <http://www.cnrs.fr/ins2i/spip.php?article1183>) is interested in the design of new methods in bioinformatics for analyzing and classifying heterogeneous omics data w.r.t. biological domain knowledge. We are working on the adaption of FCA and pattern structures for discovering patterns and associations in gene data with the help of domain ontologies. One important objective of the project is to check whether such a line of research could be reused on so-called “discrete models in molecular biology”.

#### 8.2.3.3. *PEPS Prefute (2015–2016)*

**Participants:** Quentin Brabant, Adrien Coulet, Miguel Couceiro, Esther Galbrun, Amedeo Napoli, Chedy Raïssi, Justine Reynaud, Mohsen Sayed, Malika Smaïl-Tabbone, My Thao Tang, Yannick Toussaint.

The PEPS Prefute project is mainly interested in interaction and iteration in the knowledge discovery (KD) process. Usually the KD process is organized around three main steps which are (i) selection and preparation of the data, (ii) data mining, and (iii) interpretation of (selected) resulting patterns. An analyst, most of the time an expert of the data domain, is present for leading the KD process. Accordingly, the PEPS Prefute project is interested in the study of interactions between the analyst and the KD process, i.e. pushing constraints, preferences and domain knowledge, for guiding and improving the KD process. One possible way is to discover initial patterns acting as seeds for searching farther the pattern space w.r.t. this initial seeds possibly linked to preferences of the analyst. In this way, the interesting pattern space is much more concise and of much lower size.

Then, the importance of preferences and domain knowledge in interaction with KD, and as well, visualization tools, have to be improved for allowing work with large and complex datasets (see <https://www.greyc.fr/fr/node/2207>).

## 8.3. European Initiatives

### 8.3.1. *FP7 & H2020 Projects*

#### 8.3.1.1. *CrossCult (H2020 Project, 2016-2020)*

**Participants:** Miguel Couceiro, Nyoman Juniarta, Amedeo Napoli, Chedy Raïssi.

CrossCult (<http://www.crosscult.eu/>) aims to make reflective history a reality in the European cultural context, by enabling the re-interpretation of European (hi)stories through cross-border interconnections among cultural digital resources, citizen viewpoints and physical venues. The project has two main goals. The first goal is to lower cultural EU barriers and create unique cross-border perspectives, by connecting existing digital historical resources and by creating new ones through the participation of the public. The second goal is to provide long-lasting experiences of social learning and entertainment that will help towards the better understanding and re-interpretation of European history. To achieve these goals, CrossCult will use cutting-edge technology to connect existing digital cultural assets and to combine them with interactive experiences that all together are intended to increase retention, stimulate reflection and help European citizens appreciate their past and present in a holistic manner. CrossCult will be implemented on 4 real-world flagship pilots involving a total of 8 sites across Europe.

The role of the Orpailleur Team (in conjunction with the Kiwi Team of LORIA) is mainly to work on the recommendation aspects, with a focus on defining an extended profile of the users and connecting these profiles with domain knowledge for leading the recommendation process [42].

The partners of the Orpailleur team in the CrossCult project are the following: Luxembourg Institute for Science and Technology and Centre Virtuel de la Connaissance sur l'Europe (Luxembourg, leader of the project), University College London (England), University of Malta (Malta), University of Peloponnese and Technological Educational Institute of Athens (Greece), Università degli Studi di Padova (Italy), University of Vigo (Spain), National Gallery (London, England), and GVAM Guías Interactivas (Spain).

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams: SNOWFLAKE

#### 8.4.1.1. SNOWFLAKE

**Participants:** Adrien Coulet, Joël Legrand, Pierre Monnin, Malika Smail-Tabbone.

Title: Knowledge Discovery from Linked Data and Clinical Notes

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Medicine, Stanford Center for Biomedical Informatics Research (BMIR) - Nigam Shah

Start year: 2014

Web site: <http://snowflake.loria.fr/>

Snowflake is an Inria Associate Team which started in 2014. It is aimed at facilitating the collaboration between researchers from the Inria Orpailleur team and the Stanford Center for Biomedical Informatics Research, Stanford University, USA. The main objective of Snowflake is to improve biomedical knowledge discovery by connecting Electronic Health Records (EHRs) with domain knowledge either in the form of ontologies or of Linked Open Data (LOD). Such a connection should help to complete domain knowledge w.r.t. EHRs. The initial focus of Snowflake is the identification and characterization of groups of patients w.r.t. (adverse) reactions to drugs. Identified features associated with such groups of patients could be used as predictors of over- or under-reactions to some drugs.

### 8.4.2. Participation in Other International Programs

#### 8.4.2.1. A stay at NASA Frontier Development Lab

**Participant:** Chedy Raïssi.

In 2013, NASA presented the “Asteroid Grand Challenge”, a White House supported initiative to supplement the NEO (Near-Earth Object) Program, with a mission: “Find all asteroid threats to human populations and to know what to do about them.” There remain a number of unresolved gaps in this challenge, both in terms of discovery, characterization and eventual mitigation strategies, should a potentially hazardous asteroid (PHA) be discovered. By bringing new approaches in computer science, such as deep learning and data mining to tackle specific parts of the problem, solutions may be revealed that, combined with existing processes, significantly benefit the community as a whole.

In July 2016, Chedy Raïssi visited NASA Ames and SETI Institute as part of the Frontier Development Lab. He worked there on developing meaningful research opportunities, as well as support the work of the planetary defense community and show the potential of this kind of applied research methodology to deliver breakthrough of significant value. The work was over a period of six weeks, focusing on Delay-Doppler radar imaging. Delay-Doppler radar imaging is a powerful technique to characterize the trajectories, shapes, and spin states of near-Earth asteroids and has yielded detailed models of dozens of objects. Since the 1990s, Delay-Doppler data has been analyzed using the SHAPE software developed originally by Steven J. Ostro. SHAPE performs sequential single-parameter fitting, and requires considerable computation runtime and human intervention. Reconstructing asteroid shapes and spins from Delay-Doppler data is, like many inverse problems, computationally intensive and requires extensive human oversight of the shape modeling process. Chedy Raïssi has explored two new techniques to better automate Delay-Doppler shape modeling: Bayesian optimization and deep generative models.

#### 8.4.2.2. *Ciência Sem Fronteiras (2014–2016)*

**Participant:** Amedeo Napoli.

Program “Ciência Sem Fronteiras” is a Brazilian research fellowship which provides a funding for the stay of a visiting French researcher in Brazil at Universidade Federal Pernambuco Recife for three years. The on-going project is called “Formal Concept Analysis as a Support for Knowledge Discovery” and is aimed at combining FCA methods with numerical clustering methods used by Brazilian colleagues. This project is supervised in Brazil by Professor Francisco de A.T. de Carvalho (CIn/UFPE).

The project aims at developing and comparing classification and clustering algorithms for complex data (especially interval and multi-valued data). Two families of algorithms are studied, namely “clustering algorithms” based on the use of a similarity or a distance for comparing the objects, and “classification algorithms in Formal Concept Analysis (FCA)” based on attribute sharing between objects. The objectives here are to combine the facilities of both families of algorithms for improving the potential of each family in dealing with more complex and voluminous datasets.

#### 8.4.2.3. *STIC AmSud: Autonomic Knowledge Discovery (AKD, 2015–2016)*

**Participants:** Miguel Couceiro, Esther Galbrun, Amedeo Napoli, Chedy Raïssi.

This research project involves researchers with different specialties, from Brazil (Universidade Federal Rio Grande do Sul), from Chile (UFSM Santiago and Valparaiso), from Uruguay (Universidad de la República), and the Orpailleur Team. The project is interested in the design of solutions able to proactively understand the behavior of systems and networks in order to prevent vulnerable states. Accordingly, we aim at integrating knowledge discovery techniques within autonomic systems in order to provide intelligent self-configuration and self-protection mechanisms. The results of this project may not only benefit to end-users but also highly contribute to the scientific community by providing solid foundations for the development of more secure, scalable, and reliable management approaches.

#### 8.4.2.4. *LEA STRUCO*

**Participant:** Jean-Sébastien Sereni.

LEA STRUCO is an “Associated International Laboratory” of CNRS between IÚUK, Prague, and LIAFA, Paris. It focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work. Jean-Sébastien Sereni is the contact person for LEA STRUCO which was initiated when Jean-Sébastien was a member of LIAFA.

#### 8.4.2.5. *Research Collaboration with HSE Moscow*

**Participants:** Miguel Couceiro, Adrien Coulet, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

An on-going collaboration involves the Orpailleur team and Sergei O. Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory several times while Sergei O. Kuznetsov visited Inria Nancy Grand Est several times too. The collaboration is materialized by the joint supervision of students (such as for example the thesis of Aleksey Buzmakov defended at the end of 2015), and the organization of scientific events, as in particular the workshop FCA4AI whose fifth edition was organized this year in August at ECAI 2016 (see <http://www.fca4ai.hse.ru>) [53]. A special session about Knowledge Discovery and Formal Concept Analysis will be supervised by Sergei O. Kuznetsov and Amedeo Napoli at the next ISMIS Conference in Warsaw (Poland) next June 2017 ([http://ismis2017.i.i.pw.edu.pl/s\\_kd\\_fca.php](http://ismis2017.i.i.pw.edu.pl/s_kd_fca.php)).

## PESTO Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. CNRS

- CNRS PEPS JCJC INS2I 2016 project VESPA *Verifying Equivalence Security in Protocols: Tools and Algorithms*, duration: 1 year, leader: Jannik Dreier, participant: Vincent Cheval.

Privacy-related notions such as unlinkability and anonymity are usually expressed as equivalence properties, which are notoriously difficult to prove. Due to the complexity of the protocols and the properties, tool support is a must, yet currently rather limited. Notably, there is currently no tool that can verify unlinkability of the electronic passport for an unbounded number of sessions, or anonymity in certain classic electronic cash protocols. The goal of this project is to enable the proofs for these and similar protocols using two complementary approaches: (1) by significantly advancing the state of the art of the algorithms used inside the tools to improve handling of branching and cryptographic primitives, and (2) by providing new reduction results that simplify the tools' inputs.

- CNRS PEPS INS2I 2016 project ASSI *Analyse de Sécurité de Systèmes Industriels*, duration: 1 year, leader: Pascal Lafourcade (Université Clermont-Ferrand), participant PESTO: Jannik Dreier, other participants: Marie-Laure Potet, Maxime Puys (University Grenoble-Alpes).

The goal of the project is to develop an approach to verify protocols used in industrial control (SCADA) systems using tools such as *TAMARIN* or ProVerif. These protocols have specific security requirements such as flow integrity, going beyond the classical authentication and secrecy properties. The project also aims at analyzing different intruder models matching the particularities of industrial systems, and to develop specific modeling and verification techniques.

### 9.1.2. ANR

- ANR SEQUOIA *Security properties, process equivalences and automated verification*, duration: 4 years, since October 2014, leader: Steve Kremer. Most protocol analysis tools are restricted to analyzing reachability properties while many security properties need to be expressed in terms of some process equivalence. The increasing use of observational equivalence as a modeling tool shows the need for new tools and techniques that are able to analyze such equivalence properties. The aims of this project are (i) to investigate which process equivalences – among the plethora of existing ones – are appropriate for a given security property, system assumptions and attacker capabilities; (ii) to advance the state-of-the-art of automated verification for process equivalences, allowing for instance support for more cryptographic primitives, relevant for case studies; (iii) to study protocols that use low-entropy secrets expressed using process equivalences; (iv) to apply these results to case studies from electronic voting.

### 9.1.3. Fondation MAIF

Project *Protection de l'information personnelle sur les réseaux sociaux*, duration: 3 years, started in October 2014. The goal of the project is to lay the foundation for a risk verification environment on privacy in social networks. Given social relations, this environment will rely on the study of metrics to characterize the security level for a user. Next, by combining symbolic and statistical techniques, an objective is to synthesize a model of risk behavior as a rule base. Finally, a verifier à la model-checking will be developed to assess the security level of user. Partners are Pesto (leader), Orpailleur and Fondation Maif.

## 9.2. European Initiatives

### 9.2.1. FP7 & H2020 Projects

- ProSecure (2011-2016)<sup>0</sup>— ERC Starting Grant Project on Provably secure systems: foundations, design, and modularity. The long-term aim of the project is to develop provably secure systems such as security protocols. The goal is to propose foundations for a careful analysis and design of large classes of up-to-date protocols. To achieve this goal, the project is structured in three main tasks. First, we develop general verification techniques for new classes of protocols that are of primary interest in nowadays life like e-voting protocols, routing protocols or security APIs. Second, we consider the cryptographic part of the primitives that are used in such protocols (encryption, signatures, ...), obtaining higher security guarantees. Third, we propose modular results both for the analysis and design of protocols. Véronique Cortier is the leader of the project.
- SPOOC (2015–2020)<sup>0</sup>— ERC Consolidator Grant on Automated Security Proofs of Cryptographic Protocols: Privacy, Untrusted Platforms and Applications to E-voting Protocols.

The goals of the SpooC project are to develop solid foundations and practical tools to analyze and formally prove security properties that ensure the privacy of users as well as techniques for executing protocols on untrusted platforms. We will

- develop foundations and practical tools for specifying and formally verifying new security properties, in particular privacy properties;
- develop techniques for the design and automated analysis of protocols that have to be executed on untrusted platforms;
- apply these methods in particular to novel e-voting protocols, which aim at guaranteeing strong security guarantees without need to trust the voter client software.

Steve Kremer is the leader of the project.

## 9.3. International Initiatives

### 9.3.1. Inria International Partners

- Collaboration with David Basin, Ralf Sasse and Lara Schmid (ETH Zurich), Cas Cremers (University of Oxford), and Sasa Radomirovic (University of Dundee) on the improvement of the *TAMARIN* prover and the elaboration of a user manual.
- Collaboration with Bogdan Warinschi (Bristol University) on defining game-based privacy for e-voting protocols and isolated execution environments.
- Collaboration with Myrto Arapinis (University of Edinburgh) on simplification results for the formal analysis of e-voting protocols.
- Collaboration with Matteo Maffei (CISPA, Germany) on type systems for e-voting systems.
- Collaboration with Michael Backes and Robert Künnemann (CISPA, Germany) on automated verification of security protocols.
- Collaboration with Paliath Narendran's group (SUNY Albany) on automated deduction.
- Collaboration with Hanifa Boucheneb's group (Ecole Polytechnique de Montréal) on model-checking of collaborative systems.
- Collaboration with John Mullins's group (Ecole Polytechnique de Montréal) on information hiding.

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

- Carlos Castro (UTSM Valparaíso, Chile), July 2015 - June 2016, partly funded as Inria invited researcher
- David Galindo (University of Birmingham), April 2016
- Bogdan Warinschi (University of Bristol), November 2016

<sup>0</sup><http://prosecure.loria.fr>

<sup>0</sup><https://members.loria.fr/SKremer/files/spooc/index.html>



## SEMAGRAMME Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. Projets Région

#### 7.1.1.1. SLAM

**Participants:** Maxime Amblard [coordinator], Philippe de Groote, Sylvain Pogodalla.

Schizophrenia is well-known among mental illnesses for the strength of the thought disorders it involves, and for their widespread and spectacular manifestations: from deviant social behavior to delusion, not to speak about affective and sensitive distortions. It aims at exploring a specific manifestation, namely disorders in conversational speech. This is an interdisciplinary research, both empirical and theoretical from several domains, namely psychology, philosophy, linguistic and computer science.

The first transcriptions of pathological interviews are analyses. The management chain was implemented for disfluences and POS. Moreover, we have focused on implementing the treatment of lexicography issues and proposed an interface for SDRT-annotations. This year, we have developed a new interaction with the Centre Médical d'Aix-en-Provence in order to collect new interviews. The protocol started at the very end of the year. Moreover we have started the reimplementing of the tool SLAMtk.

The SLAM project was supported by the MSH-Lorraine, USR 3261, the region Grand-Est and the University of Lorraine. We organise the fourth workshop (In)Coherence of Discourse which gather linguists, psychologists and computer scientists in march 2017 : <http://discours.loria.fr>.

#### 7.1.2. CPER

##### 7.1.2.1. ITL-DI-Oeil

**Participant:** Maxime Amblard.

*Interrelation troubles du langage, discours et processus oculomoteurs*

This project is part of another research project about eye-tracking of schizophrenics. It is really close to the SLAM project. One of the main issue is how to collect the data. In order to simplify this clue, the two projects share the same corpus. SLAM is concerned by the transcription of the interviews whereas ITL-DI-Oeil analyses the eye-tracking records.

## 7.2. National Initiatives

### 7.2.1. ANR

#### 7.2.1.1. Polymnie: Parsing and synthesis with abstract categorial grammars. From lexicon to discourse

**Participants:** Maxime Amblard, Philippe de Groote, Aleksandre Maskharashvili, Sylvain Pogodalla [coordinator].

POLYMNIE<sup>0</sup> is a research project funded by the French national research agency (ANR) from September 2012 to February 2016. It relies on the grammatical framework of Abstract Categorial Grammars (ACG). A feature of this formalism is to provide the same mathematical perspective both on the surface forms and on the more abstract forms the latter correspond to. As a consequence:

- ACG allows for the encoding of a large variety of grammatical formalisms such as context-free grammars, Tree Adjoining grammars (TAG), etc.
- ACG defines two languages: an abstract language for the abstract forms, and an object language for the surface forms.

<sup>0</sup><http://semagramme.loria.fr/doku.php?id=projects:polymnie>

Importantly, the notions of object language and abstract language are relative to each other. If we can naturally see surface forms as strings for instance and abstract forms as the associated syntactic trees, we can also consider to associate this abstract form to a first order logical formula as surface (object) form. This property is central in our project as it offers a unified approach to text analysis and text generation, in particular considering the underlying algorithms and their complexity.

ACG definition uses type-theory and lambda-calculus. From this point of view, they smoothly integrate formal semantics models issuing from Montague's proposal. Theories that extend to the discourse level such as Discourse Representation Theory (DRT) and Dynamic Predicate Logic (DPL) were not initially formulated using lambda-calculus. But such formulations have been proposed. In particular, a formulation based on continuation semantics allows them to be expressed quite naturally in the ACG architecture. Dynamic effects of discourse, in particular those related to anaphora resolution or rhetorical relation inference, have then to be expressed by lexical semantics or computed from the syntactic rules as studied in the Inria Collaborative Research Project (ARC) CAuLD<sup>0</sup>.

It has been shown that the discourse structure of texts plays a key role in their understanding. This is the case for both human readers and automatic processing systems. For instance, it can enhance text transformation systems such as the ones performing automatic summarization.

POLYMNIE focuses on studying and implementing the modeling of sentences and discourses in a compositional paradigm that takes into account their dynamics and their structures, both in parsing and in generation. To that end, we rely on the ACG framework. The kind of processing we are interested in relates to the automatic construction of summaries or to text simplification. This has to be considered in the limits of the modeling of the linguistic processes (as opposed to inferential processes for instance) these tasks involve.

Partners:

- Sémagramme people,
- Alpage (Paris 7 university & Inria Paris-Rocquencourt): Laurence Danlos (local coordinator), C. Braud, C. Roze, Éric Villemonte de la Clergerie,
- MELODI (IRIT, CNRS): Stergos Afantenos, Nicholas Asher (local coordinator), Juliette Conrath, Philippe Muller,
- Signes (LaBRI, CNRS): Jérôme Kirman, Richard Moot, Christian Retoré (local coordinator), Sylvain Salvati, Noémie-Fleur Sandillon-Rezer.

The project has been presented during the *journées du numérique de l'ANR* [23]. A demonstration of the ACGtk software has been given during the TALN conference 2016 [22].

## 7.2.2. DGLFLF (*Délégation générale à la langue française et aux langues de France*)

### 7.2.2.1. ZombiLingo

**Participants:** Bruno Guillaume [coordinator], Nicolas Lefebvre.

The goal of the ZombiLingo project is to develop an online GWAP (Game With A Purpose) to help the construction of linguistic resources. See 6.3.1 for more information.

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<sup>0</sup><https://members.loria.fr/SPogodalla/files/cauld>



## SPHINX Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. ANR

- David Dos Santos Ferreira is the coordinator (PI) of a Young Researcher Program of the French National Research Agency (ANR) :  
**Project Acronym** : iproblems  
**Project Title** : Inverse Problems  
**Coordinator** : David Dos Santos Ferreira  
**Duration** : 48 months (2013-2017)
- Takéo Takahashi is the coordinator (PI) of a Researcher Program of the French National Research Agency (ANR) :  
**Project Acronym** : IFSMACS  
**Project Title** : Fluid-Structure Interaction: Modeling, Analysis, Control and Simulation  
**Coordinator**: Takéo Takahashi  
**Duration** : 48 months (starting on October 1st, 2016)  
**URL**: <http://ifsmacs.iecl.univ-lorraine.fr/>
- Xavier Antoine is member of the project TECSER funded by the French armament procurement agency in the framework of the Specific Support for Research Works and Innovation Defense (ASTRID 2013 program) operated by the French National Research Agency.  
**Project Acronym**: TECSER  
**Project Title** : Nouvelles techniques de résolution adaptées à la simulation haute performance pour le calcul SER  
**Coordinator**: Stéphane Lanteri (Inria, NACHOS project-team)  
**Duration**: 36 months (starting on May 1st, 2014)  
**URL**: <http://www-sop.inria.fr/nachos/projects/tecser/index.php/Main/HomePage>
- Xavier Antoine is member of the project BoND.  
**Project Acronym**: BoND  
**Project Title**: Boundaries, Numerics and Dispersion.  
**Coordinator**: Sylvie Benzoni (Institut Camille Jordan, Lyon, France)  
**Duration**: 48 months (starting on October 15th, 2013)  
**URL**: <http://bond.math.cnrs.fr>
- Xavier Antoine is the local coordinator of the ANR project BECASIM.  
**Project acronym**: BECASIM  
**Project Title**: Bose-Einstein Condensates: Advanced SIMulation Deterministic and Stochastic Computational Models, HPC Implementation, Simulation of Experiments.  
**Coordinator**: Ionut Danaïla (Université de Rouen, France)  
**Duration**: 48 months (plus an extension of 12 months, until November 2017)  
**URL**: <http://becasim.math.cnrs.fr>

### 9.1.2. CNRS

Thomas Chambrion is the coordinator of the Research Project from CNRS Inphynity "DISQUO" (5300 euros, 2016).

## **9.2. International Initiatives**

### ***9.2.1. Participation in Other International Programs***

Within the PHC Utique programme, a project of French-Tunisian collaboration involving some members of our team has been selected by Campus France. The exact amount of the budget is not known yet and will be comprised between 9000 and 16000 euros.

## **9.3. International Research Visitors**

### ***9.3.1. Visits to International Teams***

Xavier ANTOINE has been a visitor of the Beijing CSRC for 4 weeks during the summer 2016.

## TONUS Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

The thesis of Pierre Gerhard devoted to numerical simulation of room acoustics is supported by the Alsace region. It is a joint project with CEREMA (*Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement*) in Strasbourg.

### 8.2. National Initiatives

#### 8.2.1. ANR

ANR project PEPPSI (models for edge plasma physic in Tokamak) in *Programme Blanc* SIMI 9, started in 2013. Participants, G. Manfredi (coordinator), S. Hirstoaga, D. Coulette.

**Participants:** Giovanni Manfredi [coordinator], Sever Adrian Hirstoaga.

#### 8.2.2. IPL FRATRES

The TONUS project belongs to the IPL FRATRES (models and numerical methods for Tokamak). The annual meeting has been organized in Strasbourg by Emmanuel Franck and Philippe Helluy.

#### 8.2.3. IPL C2S@exa

The TONUS and HIEPACS projects have obtained the financial support for the PhD thesis of Nicolas Bouzat thanks to the IPL C2S@exa (computational sciences at exascale). Nicolas Bouzat works at CEA Cadarache and is supervised locally by Guillaume Latu; the PhD advisors are Michel Mehrenberger and Jean Roman.

#### 8.2.4. Competitivity clusters

GENCI projet : "*Simulation numérique des plasmas par des méthodes semi-lagrangiennes et PIC adaptées*". 450 000 scalar computing hours on CURIE\_standard (January 2016-January 2017); coordinator: Michel Mehrenberger

**Participants:** Sever Adrian Hirstoaga, Guillaume Latu, Michel Mehrenberger, Thi Nhung Pham, Christophe Steiner, Yann Barzhamian.

### 8.3. European Initiatives

#### 8.3.1. FP7 & H2020 Projects

##### 8.3.1.1. EUROfusion 2015-2017

Eurofusion Enabling Research Project ER15-IPP01 (1/2015-12/2017) "Verification and development of new algorithms for gyrokinetic codes" (Principal Investigator: Eric Sonnendrücker, Max-Planck Institute for Plasma Physics, Garching).

**Participants:** Philippe Helluy, Sever Adrian Hirstoaga, Michel Mehrenberger.

Eurofusion Enabling Research Project ER15-IPP05 (1/2015-12/2017) "Global non-linear MHD modeling in toroidal geometry of disruptions, edge localized modes, and techniques for their mitigation and suppression" (Principal Investigator: Matthias Hoelzl, Max-Planck Institute for Plasma Physics, Garching).

**Participant:** Emmanuel Franck.

### 8.4. International Initiatives

#### 8.4.1. Inria International Partners

##### 8.4.1.1. Informal International Partners

Michel Mehrenberger collaborates with Bedros Afeyan (Pleasanton, USA) on KEEN wave simulations.

Emmanuel Franck collaborates with E. Sonnendruecker (IPP Garching) and S. Serra Capizzano (University of Como, Italy) on preconditioning for IGA methods.

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

**Participants:** Conrad Hillairet, David Coulette, Emmanuel Franck, Philippe Helluy [local coordinator].

ANR/SPPEXA "EXAMAG" is a joint French-German-Japanese project. Its goal is to develop efficient parallel MHD solvers for future exascale architectures. With our partners, we plan to apply highly parallelized and hybrid solvers for plasma physics. One of our objectives is to develop Lattice-Boltzmann MHD solvers based on high-order implicit Discontinuous Galerkin methods, using SCHNAPS and runtime systems such as StarPU.

## TOSCA Project-Team

## 8. Partnerships and Cooperations

### 8.1. National Initiatives

#### 8.1.1. ANR

- N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, 2014–2018) coordinated by F. Hamel (Univ. Aix-Marseille).
- E. Tanré is member of the ANR SloFaDyBio (Slow Fast Dynamics in Biology, ANR-14-CE25-0019, 2015-2017) coordinated by M. Desroches (EPI MATHNEURO, Inria Sophia Antipolis).

### 8.2. International Initiatives

#### 8.2.1. Inria International Labs

##### **Inria Chile**

Associate Team involved in the International Lab:

##### 8.2.1.1. ANESTOC-TOSCA

Title: Stochastic modelling of biology and renewable energies

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2014

See also: <http://www.incidechile.cl/anestoc/teams-involved/>

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, this 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 and waves energy potential of a site using video.

#### 8.2.2. Participation in Other International Programs

##### 8.2.2.1. International Initiatives

##### **ECOS Discretlongmem**

Title: On discretization procedures in Non-Gaussian long memory processes with applications in non parametric statistics and time series analysis

International Partner (Institution - Laboratory - Researcher):

Universidad de Valparaiso (Chile) - CIMFAV – Facultad de Ingeniería

PI: E. Tanré (France), S. Torrès (Chile)

Duration: 2016 - 2018

Start year: 2016

Keywords: Approximations of non-Gaussian long-memory processes. Fractional Poisson processes (fPp). Skew Fractional Process (SfP).

## 8.3. International Research Visitors

### 8.3.1. Visits of International Scientists

- L. Beznea (Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucarest) has been visiting TOSCA Nancy for 11 days in July.
- O. Lupaşcu (Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucarest) has been visiting TOSCA Nancy for one week in October.
- The TOSCA seminar organized by A. Richard in Sophia Antipolis has received the following speakers: Pierre-Emmanuel Jabin (University of Maryland), Christophe Henry (Institute of Fluid Flow Machinery, Polish Academy of Sciences), Tony Lelièvre (ENPC), D. Alberici (University of Bologna), Nicolas Fournier (Université Pierre et Marie Curie), Philip Protter (Columbia University), Jean-François Jabir (CIMFAV – Valparaiso, Chile), Roberto Cortez Milan (CIMFAV – Valparaiso, Chile), Areski Cousin (ISFA, Lyon).

#### 8.3.1.1. Internships

BICHAT Antoine

Subject: Modélisation de populations de cellules irradiées: une approche par processus de branchement

Date: Sep. 2015 - June 2016 (projet recherche)

Institution: Écoles des Mines de Nancy.

CORMIER Quentin

Subject: Study of invariants associated to the dynamic of a neuron network subject to STDP

Date: Oct. 2015 - Feb. 2016

Institution: ENS Lyon

DUPRE Aurore

Subject: Analyse et évaluation de l'adjonction de la modélisation de phénomènes convectifs dans un modèle numérique lagrangien de la couche limite atmosphérique

Date: April 2016 - Oct. 2016

Institution: Université de Reims Champagne-Ardenne

GEORGES Thomas

Subject: Single Particle Tracking Techniques

Date: Sept. 2016 - June 2017 (research project)

Institution: Écoles des Mines de Nancy.

GUERBAB Ismail

Subject: Sums of Pareto distributions

Date: June 2016 - Aug. 2016

Institution: Écoles des Mines de Nancy.

HELSON Pascal

Subject: Spiking Neurons in interaction with Plasticity

Date: April 2016 - Aug. 2016

Institution: Ecole des Ponts et chaussées.

KANTASSI Ameni

Subject: Processus du plus récent ancêtre commun dans des arbres de Galton-Watson

Date: April 2015 - Aug. 2015

Institution: Univ. Lorraine et École Supérieure des Sciences et Technologies d'Hamam Sousse (Tunisie).

PAPIC Alexis

Subject: States Reduction on Markov Processes

Date: Mai 2016 - Aug. 2016

Institution: Univ. Pierre et Marie Curie.

### **8.3.2. Visits to International Teams**

#### *8.3.2.1. Research Stays Abroad*

- N. Champagnat and D. Villemonais spent one week in Neuchâtel (Switzerland) in September, to work with Michel Benaïm.
- P. Pigato has spent two weeks in Valparaiso and Santiago (Chile) in March, working with R. Rebolledo and S. Torres.
- P. Pigato has spent one week in Padova (Italy), in June, for a collaboration with P. Dai Pra.
- A. Richard and E. Tanré have spent one week in Valparaíso and one week in Santiago (Chile) in December within the ECOS program (PIs: E. Tanré, S. Torres, C. Tudor), working with S. Torres (Univ. of Valparaiso).
- D. Talay spent ten days at Columbia University in October.

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## VEGAS Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

We organized, with IECL, a «journée Charles Hermite» about geometry and probability. A regular working group on the topic was started in november.

## 8.2. National Initiatives

### 8.2.1. ANR PRESAGE

The white ANR grant PRESAGE brings together computational geometers (from the VEGAS and GEOMETRICA projects of Inria) and probabilistic geometers (from Universities of Rouen, Orléans and Poitiers) 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 random continuous geometric objects.

The project, with a total budget of 400k€, started on Dec. 31st, 2011 and ended in March 2016. It is coordinated by Xavier Goaoc who moved from the Vegas team to Marne-la-Vallée university in 2013.

Project website: <https://members.loria.fr/GMoroz/ANR-Presage/>.

### 8.2.2. ANR SingCAST

The objective of the young-researcher ANR grant SingCAST is to intertwine further symbolic/numeric approaches to compute efficiently solution sets of polynomial systems with topological and geometrical guarantees in singular cases. We focus on two applications: the visualization of algebraic curves and surfaces and the mechanical design of robots.

After identifying classes of problems with restricted types of singularities, we plan to develop dedicated symbolic-numerical methods that take advantage of the structure of the associated polynomial systems that cannot be handled by purely symbolic or numerical methods. Thus we plan to extend the class of manipulators that can be analyzed, and the class of algebraic curves and surfaces that can be visualized with certification.

This is a 3.5 years project, with a total budget of 100k€, that started on March 1st 2014, coordinated by Guillaume Moroz.

The project funded the postdoc position of Rémi Imbach from November 2014 until October 2016. We organized two workshops in 2016 with the OPTI team in Nantes, on certified surface continuation.

Project website: <https://project.inria.fr/singcast/>.

## 8.3. International Initiatives

### 8.3.1. Participation in Other International Programs

#### 8.3.1.1. Nancy Emerging Associate Team Astonishing

The objectives of the *ASsociate Team On Non-ISH euclIdeaN Geometry* is to study various structures and algorithms in non-Euclidean spaces, from a computational geometry viewpoint. Proposing algorithms operating in such spaces requires a prior deep study of the mathematical properties of the objects considered, which raises new fundamental and difficult questions that we want to tackle.

A key characteristic of the project is its interdisciplinarity: it gathers approaches, knowledge, and tools in mathematics and computer science. A mathematical study of the considered objects will be performed, together with the design of algorithms when applicable. Algorithms will be analyzed both in theory and in practice after prototype implementations. In the long term, implementations should be improved whenever it makes sense to target longer-term integrations into **CGAL**, in order to disseminate our results to end-users.



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The partners are the Johann Bernouilli Institute of Mathematics and Computer Science of University of Groningen, the Mathematics Research Unit of University of Luxembourg, and the Talgo team of École Normale Supérieure. The project is coordinated by Monique Teillaud and supported by Inria Nancy - Grand Est.

Project website: <https://members.loria.fr/Monique.Teillaud/collab/Astonishing/>.

## **8.4. International Research Visitors**

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

#### *8.4.1.1. Invited Professor*

Gert Vegter, Professor at University of Groningen, was awarded an invited professor position by University of Lorraine and spent one month in the group in May. He is coordinating the NEAT Astonishing on the Dutch side.

#### *8.4.1.2. PhD Visitor*

Sény Diatta, Senegalese PhD student co-advised by Guillaume Moroz, Daouda Niang Diatta (Ziguinchor) and Marie-Françoise Roy (Rennes), obtained a bourse Eiffel from Campus France, which includes a salary for 10 months to visit LORIA.

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

#### *8.4.2.1. Research Stays Abroad*

Iordan Iordanov spent one month at University of Luxembourg in June. The visit was partially supported by University of Luxembourg and by the NEAT Astonishing.

## VERIDIS Project-Team

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. ANR-DFG Project SMArT

**Participants:** Haniel Barbosa, Pascal Fontaine, Marek Košta, Stephan Merz, Thomas Sturm.

The SMArT (Satisfiability Modulo Arithmetic Theories) project is funded by *ANR-DFG Programmes blancs 2013*, a program of the Agence Nationale de la Recherche and the (German) Deutsche Forschungsgemeinschaft DFG. It started in April 2014. The project gathers members of VeriDis in Nancy and Saarbrücken, and the Systerel company. The objective of the SMArT project is to provide advanced techniques for arithmetic reasoning beyond linear arithmetic for formal system verification, and particularly for SMT. The results feed back into the implementations of Redlog (section 6.2) and veriT (section 6.5), which also serve as experimentation platforms for theories, techniques and methods designed within this project.

More information on the project can be found on <http://smart.gforge.inria.fr/>.

### 9.1.2. ANR Project IMPEX

**Participants:** Souad Kherroubi, Dominique Méry.

*The ANR Project IMPEX, within the INS program, started in December 2013 for 4 years. It is coordinated by Dominique Méry, the other partners are IRIT/ENSEIHT, Systerel, Supelec, and Telecom Sud Paris. The work reported here also included a cooperation with Pierre Castéran from LaBRI Bordeaux.*

Modeling languages provide techniques and tool support for the design, synthesis, and analysis of the models resulting from a given modeling activity, as part of a system development process. These languages quite successfully focused on the analysis of the designed system exploiting the expressed semantic power of the underlying modeling language. The semantics of this modeling languages are well understood by the system designers and the users of the modeling language, i.e. the semantics is implicit in the model. In general, modeling languages are not equipped with resources, concepts or entities handling explicitly domain engineering features and characteristics (domain knowledge) underlying the modeled systems. Indeed, the designer has to explicitly handle the knowledge resulting from an analysis of this application domain [49], i.e. explicit semantics. Nowadays, making explicit the domain knowledge inside system design models does not obey any methodological rules validated by practice. The users of modeling languages introduce these domain knowledge features through types, constraints, profiles, etc. Our claim is that ontologies are good candidates for handling explicit domain knowledge. They define domain theories and provide resources for uniquely identifying domain knowledge concepts. Therefore, allowing models to make references to ontologies is a modular solution for models to explicitly handle domain knowledge. Overcoming the absence of explicit semantics expression in the modeling languages used to specify systems models will increase the robustness of the designed system models. Indeed, the axioms and theorems resulting from the ontologies can be used to strengthen the properties of the designed models. The objective [11] is to offer rigorous mechanisms for handling domain knowledge in design models.

### 9.1.3. Inria IPL HAC SPECIS

**Participants:** Marie Duflot-Kremer, Stephan Merz.

The goal of the **HAC SPECIS** (High-performance Application and Computers: Studying PErformance and Correctness In Simulation) project is to answer methodological needs of HPC application and runtime developers and to allow studying real HPC systems with respect to both correctness and performance. To this end, this Inria Project Lab assembles experts from the HPC, formal verification, and performance evaluation communities.

HAC SPECIS started in 2016. VeriDis contributes through its expertise in formal verification techniques. In particular, our goal is to extend the functionalities of exhaustive and statistical model checking within the SimGrid platform.

#### 9.1.4. Inria Technological Development Action CUIC

**Participants:** Jasmin Christian Blanchette, Simon Cruanes.

Most “theorems” initially given to a proof assistant are incorrect, whether because of a typo, a missing assumption, or a fundamental flaw. Novices and experts alike can enter invalid formulas and find themselves wasting hours, or even days, on an impossible proof. This project, funded by Inria and running from 2015 to 2017, supports the development of a counterexample generator for higher-order logic. This new tool, called Nunchaku (cf. section 6.1), will be integrated in various proof assistants, including Isabelle, Coq, and the TLA<sup>+</sup> Proof System. The project is coordinated by Jasmin Blanchette and also involves Inria Saclay (Toccatà group) and Inria Rennes (Celtique group), among others. Simon Cruanes was hired in October 2015 and has started the development of Nunchaku, whereas Blanchette has developed an Isabelle frontend. Three releases have taken place so far, and the tool is an integral part of the Isabelle2016-1 official release. Work has started on Coq and TLAPS frontends. The tool is described in a conference publication [33] and was presented at a workshop [28].

#### 9.1.5. Inria ADT PLM (2014-2016)

**Participant:** Matthieu Nicolas.

*Joint work with Gérald Oster (project-team Coast, Inria Nancy – Grand Est) and Martin Quinson (project-team Myriads, Inria Rennes – Bretagne Atlantique)*

The goal of this project is to establish an experimental platform for studying the didactics of informatics, specifically centered on introductory programming courses.

The project builds upon a pedagogical platform for supervising programming exercises developed for our own teaching, and improves this base in several ways. We want to provide more adapted feedback to the learners, and gather more data to better understand how beginners learn programming.

This year, we finalized the web version of our framework, and submitted several project applications to pursue this work in the future. Unfortunately, none of these applications have been accepted so far. Martin Quinson invited Peter Hubwieser, professor of the Technical University of Munich (TUM) and specialist of the didactics of Computer Science, for two weeks in November. Developing the PLM and exploiting the data already gathered were central elements of this work meeting. A joint publication is currently prepared, targeting the ItiCSE’17 conference.

## 9.2. European Initiatives

### 9.2.1. FP7 & H2020 Projects

Program: H2020-FETOPEN-2015-CSA

Project acronym: SC<sup>2</sup>

Project title: Satisfiability Checking and Symbolic Computation

Duration: July 2016 – September 2018

Coordinator: James H. Davenport (U. Bath, U.K.)

Other partners: RWTH Aachen (Germany), Fondazione Bruno Kessler (Italy), Università degli Studi di Genova (Italy), MapleSoft Europe Ltd (Germany), Coventry University (U.K.), University of Oxford (U.K.), Universität Kassel (Germany), Max Planck Institut für Informatik (Germany), Universität Linz (Austria)

Abstract: Whereas symbolic computation is concerned with efficient algorithms for determining exact solutions to complex mathematical problems, more recent developments in the area of satisfiability checking tackle similar problems with different algorithmic and technological solutions. Both communities have made remarkable progress in the last decades and address practical problems of rapidly increasing size and complexity. For example, satisfiability checking is an essential backend for assuring the security and the safety of computer systems. Techniques and tools of symbolic computation are used by different scientific communities for solving large mathematical problems that are out of reach of pencil and paper developments. Currently the two communities are largely disjoint and unaware of the achievements of each other, despite strong reasons for them to discuss and collaborate, as they share many central interests. Bridges between the communities in the form of common platforms and roadmaps are necessary to initiate an exchange, and to support and to direct their interaction. This Coordination and Support Action within the FET-Open framework will initiate a wide range of activities to bring the two communities together, identify common challenges, offer global events and bilateral visits, propose standards, and so on. Combining the knowledge, experience and the technologies in these communities will lead to cross-fertilization and mutual improvements, enabling the development of radically improved software tools.

## 9.3. International Initiatives

### 9.3.1. Inria International Partners

#### 9.3.1.1. KANASA

Title: Kanazawa-Nancy for Satisfiability and Arithmetics

International Partner: Japan Advanced Institute for Science and Technology (Dept. Intelligent Robotics, Mizuhito Ogawa)

Starting year: 2016

During the last decade, there has been tremendous progress on symbolic verification techniques, spurred in particular by the development of SMT (satisfiability modulo theories) techniques and tools. Our first direction of research will be to investigate the theoretical background and the practical techniques to integrate Interval Constraint Propagation within a generic SMT framework, including other decision procedures and quantifier handling techniques. On the purely arithmetic side, we also want to study how to unite the reasoning power of all arithmetic techniques developed in the team, including simplex-based SMT-like reasoners, Virtual Substitution, and Cylindrical Algebraic Decomposition. In particular, this includes developing theory combination frameworks for linear and non-linear arithmetic. There is a strong incentive for these kind of combinations since even non-linear SMT problems contain a large proportion of linear constraints. The partnership is supported by a Memorandum of Understanding between JAIST and LORIA.

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

Ilina Stoilkovska

Date: 1 September – 31 October

Institution: TU Wien (Austria)

Host: Stephan Merz

Ilina is a PhD student at TU Wien, Austria, and works on tailored abstractions for the parameterized verification of fault-tolerant distributed algorithms. During her stay in Nancy, she worked on a formal soundness proof of her abstractions in the TLA<sup>+</sup> Proof System.

Tung Vu Xuan

Date: 1 May 2016 – 30 April 2017

Institution: JAIST

Host: Pascal Fontaine

Tung Vu Xuan is a PhD student at JAIST, Japan. He is visiting VeriDis in the context of the KANASA project. He works mainly on Interval Constraint Propagation (ICP), a heuristic but powerful method for satisfiability checking of non-linear arithmetic (NLA) constraints. During his stay, we investigate techniques to combine ICP with decision procedures for NLA within an SMT context.

#### **9.4.2. Internships**

Anders Olav Candasamy

Date: 1 March – 31 July

Institution: Université de Lorraine (Erasmus Mundus DESEM)

Host: Dominique Méry

Anders Candasamy analyzed a hemodialysis case study using Event-B. Besides developing the formal model, he also reflected on the modeling process and proposed several methodological improvements.

Matthieu Lequesne

Date: 1 March – 31 July

Institution: École Polytechnique

Host: Stephan Merz

Matthieu Lequesne worked on translating formulas in a core sublanguage of  $TLA^+$  to the input format of Nunchaku (section 6.1), with the aim of producing (counter)models for  $TLA^+$  proof obligations.

Weichung Shaw

Date: 1 March – 31 August

Institution: Université de Lorraine (Erasmus Mundus DESEM)

Host: Stephan Merz

Weichung Shaw worked on formalizing a correctness proof of the Raft consensus algorithm [50] in  $TLA^+$ . He proved several fundamental lemmas and documented several methodological issues with the use of TLAPS.