



RESEARCH CENTER
Nancy - Grand Est

FIELD

Activity Report 2015

Section Partnerships and Cooperations

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ALICE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CPER (2014-2020)

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

8.1.2. PIC (2015-2017)

150 k€. The PIC project (Polymères Innovants Composites) is a collaboration between Inria, Institut Jean Lamour and Ateliers Cini, funded by Région Lorraine. The goal is to develop a new additive manufacturing process using 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

The SHAPEFORGE project (ERC Starting Grant, FP7, 2012–2017) aims at developing new methods for creating objects from examples, with 3D printers. The main challenge with this project is combining approaches that are very different in nature: algorithms from computer graphics which are used to build forms and textures using examples are combined with digital optimization methods which make sure that the real object complies with the function it is assigned. Thus, to produce a Louis XV bench, on the basis of a Louis XV chair, you need to not only capture the appearance of the example but also formalize the characteristics of a bench as well as its mechanical properties to ensure that it is solid enough. You then need to find, from among all the shapes that can be produced from a single example, the one that best complies with the various criteria. The project is led by Sylvain Lefebvre.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

We have continued our informal collaboration with Wenping Wang and Li-Yi Wei from Hong Kong University, both on geometry processing and by-example techniques. We published two joint papers this year [7], [12].

Bruno Lévy and Nicolas Ray collaborated with Gilles-Philippe Paillé, Pierre Poulin (U. Montréal, Canada) and Alla Sheffer (UBC). The result of this collaboration was published in Transactions on Graphics [17].

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

Connelly Barnes visited our team for four weeks in June 2015. We initiated a collaboration on 3D printing, which is ongoing.

Gilles-Philippe Paillé (U. Montréal, Canada) visited us (2 months) to develop "dihedral angle-based maps")

Wenping Wang (Hong-Kong U.) visited us (2 days) to discuss/launch new cooperation projects on Voronoi diagrams and on 3D printing.

8.5.1.1. Internships

Bolun Zhang is an undergraduate student from the mechanical engineering department of Hong Kong University. He visited us for three months as a summer intern, and worked on FEM simulation of infilling patterns within 3D printed parts. He was co-supervised by Jonas Martínez Bayona and Sylvain Lefebvre.

BIGS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

- *PhotoBrain* (2015-17), AGuIX® theranostic nanoparticles for vascular-targeted interstitial photodynamic therapy of brain tumors, Funding organism: EuroNanoMed II, Leader: M. Barberi-Heyob (CRAN), Thierry Bastogne
- (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. International Research Visitors

9.2.1. Visits of International Scientists

S. Roelly, University of Postdam visited P. Vallois in 2015 September.

9.2.1.1. Internships

A. Gégout-Petit and P. Vallois supervised an internship of a master IMOI student at the startup SD-Innovation, <http://www.sd-innovation.fr/>. The subject was the parametrization of curves issued from the aggregation of cells.

9.2.2. Visits to International Teams

9.2.2.1. Research stays abroad

- P. Vallois visited S. Roelly in Postdam (Germany), March 2015
- P. Vallois visited P. Salminien in Turku (Turkey), March 2015
- P. Vallois visited the Finance department in New York, April 2015

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 ⁰. 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 ALF, 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
- Intel, Santa Clara, CA, USA
- UPMARC, University of Uppsala, Sweden
- University of Batna, Algeria
- Ohio State University, Columbus, USA
- Louisiana State University, Baton Rouge, USA
- Indian Institute of Science (IIS) Bangalore, India
- University of Delaware, DE, USA

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Professor P. Sadayappan from Ohio State University, USA, has been visiting the CAMUS team from November the 4th to November the 7th. He took part of Aravind Sukumaran-Rajam’s PhD jury as a reviewer and made several presentations of his research work.

⁰<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

Participants: Marie-Dominique Devignes [contact person], Jérémie Bourseau.

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. IFB

Participant: Marie-Dominique Devignes [contact person].

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.

8.2.2.2. 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 choc HSP90 protein as a target for new drugs against paracoccidioidomycose*; Partner: Brasília University, Brasil; Funding: CNPq.

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

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Doctoral Students

In the frame of a collaboration with the University of Brasilia, Dr. A. Abadio and three doctoral students (A. Souza, J. Ribeiro, P. Alves) visited in July 2015.

CAMEL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

In the context of the research grant “CPER Cyberentreprises”, involving the French ministry of research, Région Lorraine, Inria, CNRS, and the European fund FEDER, we solicited and obtained funding for a new computer equipment dedicated to the computation of large polynomial systems. The corresponding machine has been delivered in November 2015, and will be put into service in the first weeks of 2016.

9.2. National Initiatives

The team participates in the “Calcul formel, arithmétique, protection de l’information” research pole of the GDR-IM (CNRS Research Group on Mathematical Computer Science). The team is a member of the “Arithmétique”, “Calcul formel” and “Codage et Cryptographie” working groups.

9.2.1. ANR CATREL (*Cribles: Améliorations Théoriques et Résolution Effective du Logarithme discret*)

Participants: Cyril Bouvier, Nicholas Coxon, Jérémie Detrey, Pierrick Gaudry, Laurent Grémy, Hamza Jeljeli, Emmanuel Thomé [contact], Marion Videau, Paul Zimmermann.

The CATREL proposal has been accepted in ANR “programme Blanc” in 2012. This project involves CAMEL as a leading team, in cooperation with two other partners which are INRIA project-team GRACE (INRIA Saclay, LIX, École Polytechnique), and the ARITH team of the LIRMM Laboratory (Montpellier). The project targets algorithms for solving the discrete logarithm problem in finite fields, using the Number Field Sieve and the Function Field Sieve algorithms. Actual work on the CATREL project started in January 2013. According to the schedule, the project ended on Dec. 31st, 2015. Two project meetings were held in 2015: in Nancy on January 13-14, 2015, and in Palaiseau on October 1-2, 2015. The last project meeting was attached to an international workshop which brought together international experts on the Discrete Logarithm Problem to discuss the massive advances on this topic during the last years. A mid-term project review of the CATREL project was conducted by ANR in March 2015. The review outcome was very positive.

9.2.2. PEPS JCJC INSII RiCoRé (*Résolution de systèmes polynomiaux pour les codes correcteurs et la robotique*)

Participant: Pierre-Jean Spaenlehauer.

The RiCoRé proposal has been accepted in the PEPS JCJC INSII program in 2015. This project is coordinated by Romain Lebreton (Maître de Conférence, Univ. Montpellier). The other participants are Salih Abdelaziz (Maître de Conférence, Univ. Montpellier) and Eleonora Guerrini (Maître de Conférence, Univ. Montpellier). The aim of this project is to study the interactions of symbolic algorithms for polynomial system solving with some problems arising in coding theory and robotics.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Masahiro Ishii, a PhD student from the Nara Institute of Science and Technology, Nara (Japan), visited us from February 2014 until February 2015. His PhD supervisors are Atsuo Inomata and Kazutoshi Fujikawa. Locally, he was supervised by Jérémie Detrey and Pierrick Gaudry.

During his stay here, he worked on implementing the elliptic curve factorization method (ECM) on the Kalray MPPA-256 manycore processor. A paper is currently in progress.

- Nadia Heninger, Assistant Professor at the University of Pennsylvania, visited us from June 22 to June 26.

CARTE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Simon Perdrix is the principal investigator of the project “measurement-based quantum computing” funded by Région Lorraine and Université de Lorraine.

8.2. National Initiatives

8.2.1. 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.
- The team is a funding partner in ANR Binsec (2013-2017), whose aim is to fill part of the gap between formal methods over executable code, and binary-level security analyses currently used in the security industry. Two main applicative domains are targeted: vulnerability analysis and virus detection. Two other closely related applications will also be investigated: crash analysis and program deobfuscation.

8.3. International Initiatives

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

- Submission of an Inria associate team proposal ACRA (Applications of Complexity to Resource Analysis) in collaboration with Computer Science and Engineering department, State University New York, Buffalo. The french principal investigator is Romain Péchoux, the US principal investigator is Marco Gaboardi.

8.3.2. 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 study topics such as parallelism, probabilistic systems, isomorphisms, etc. 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Walid Gomaa, associate professor at Alexandria E-Just University, was invited during two months (April and November) in the team.
- Daniel Leivant, professor at Indiana University in Bloomington, was invited in June and July.
- Mizuhito Ogawa was invited in the group to discuss about models of self-modifying code based on pushdown automata. He came back in October for further collaboration.

CASSIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR SEQUOIA *Security properties, process equivalences and automated verification*, duration: 4 years, starting in 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.

9.1.2. 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, it is a question 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 Cassis (leader), Orpailleur and Fondation Maif.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- ProSecure (2011-2016)⁰— ERC Starting Grant Project on Provably secure systems: foundations, design, and modularity. This long-term project aims at developing 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, we foresee three main tasks. First, we plan to 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 will consider the cryptographic part of the primitives that are used in such protocols (encryption, signatures, ...), obtaining higher security guarantees. Third, we aim at proposing modular results both for the analysis and design of protocols. Véronique Cortier is the leader of the project.
- SPOOC (2015–2020)⁰— ERC Consolidator Grant on Automated Security Proofs of Cryptographic Protocols: Privacy, Untrusted Platforms and Applications to E-voting Protocols.

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

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

⁰<http://www.loria.fr/~cortier/ProSecure.html>

⁰<http://www.loria.fr/~skremer/spooc/index.html>

Steve Kremer is the leader of the project.

9.3. International Initiatives

9.3.1. Inria International Partners

- 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 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

COAST Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. FSN OpenPaaS (2012–2015)

Participants: Olivier Perrin [contact], Ahmed Bouchami.

Partners: SAMOVAR team (Telecom SudParis), COAST project-team (Université de Lorraine, LORIA), ARMINES (Ecole des Mines d'Albi), Brake France, Linagora.

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

The OpenPaaS project aims at developing a PaaS (Platform as a Service) technology dedicated to enterprise collaborative applications deployed on hybrid clouds (private/public). OpenPaaS is a platform that allows to design and deploy applications based on proven technologies provided by partners such as collaborative messaging systems, integration and workflow technologies that will be extended in order to address Cloud Computing requirements. Available as an open-source Enterprise Social Network, the OpenPaaS project innovates both at the collaborative level and by its capacity to leverage heterogeneous cloud technologies at the IaaS level (Infrastructure as a Service). This project is funded under the French FSN umbrella (Fond National pour la société Numérique).

7.1.2. OpenPaas NG (2015–2018)

Participants: Claudia-Lavinia Ignat, François Charoy [contact], Gérald Oster, Olivier Perrin.

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 Enterprise Social Network concept 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.

7.1.3. Inria ADT PLM (2014-2016)

Participants: Gérald Oster [contact], Matthieu Nicolas.

Partners: COAST project-team, VERIDIS 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.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. 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 its 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 will be explored by the SyncFree project. <http://syncfree.lip6.fr/>

7.3. International Initiatives

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

7.3.1.1. USCOAST

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

Wright State University (USA) - Department of Psychology - Valerie Shalin

Start year: 2013

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

USCoast has as main objective the validation of trustworthy collaborative systems using experimental user studies. This type of validation requires the expertise of both computer scientists that designed the systems and social scientists for conceptualizing and measuring human behaviour in collaborative work. The project focuses on the real-time requirements and trust policies in collaborative editing, resulting in a theory for the effect of real-time constraints in collaborative editing and awareness management for the coordination of work in the presence of conflict and disruption. The project also proposes light security mechanisms for decentralised collaboration, based on measures of voluntary compliance with data sharing restrictions. New methods will be developed for the cost-effective evaluation of collaborative work to compensate for otherwise unrealistic sample sizes and costly engineering, using game theory to inspire task analogues and simulated users along with human users.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Valerie Shalin

Date: October 10, 2015 - November 5, 2015

Institution: Wright State University (USA)

Valerie Shalin worked on the validation of trust-based collaboration, specifically on the design and analysis of the experiments with users on the trust game.

7.4.2. Visits to International Teams

7.4.2.1. Research stays abroad

François Charoy spend 7 weeks at Wright State University, OH, in the Knoesis Team lead by Prof. Amit Sheth as part of the USCOAST associated team.

LARSEN Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. AME Satelor

Participants: François Charpillat, Maxime Rio, Nicolas Beaufort, Xuan Son Nguyen, Thomas Moinel, Mélanie Lelaure, Théo Biasutto-Lervat.

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.

9.1.2. PEPS PsyPhINE: Cogito Ergo Es

Participant: Amine Boumaza.

PEPS site Mirabelle (CNRS & University of Lorraine) gathering researchers from the following institutes: MSH Lorraine (USR3261), InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Inria Bordeaux Sud-Ouest, Loria (UMR7503). Refer to sec. 7.2.2.1 for further information.

9.2. National Initiatives

9.2.1. PIA LAR Living Assistant Robot

Participants: François Charpillat, Abdallah Dib.

Partners : Crédit Agricole, Diatelic, Robosoft

LAR project has the objective to designing an assistant robot to improve the autonomy and quality of life for elderly and fragile persons. The project started at the beginning of the year. 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 dynamic environment. Another issue is for the robot to be able to behave with acceptable social skills.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. RESIBOTS

Participants: Jean-Baptiste Mouret, Dorian Goepf, Konstantinos Chatzilygeroudis, Vassilis Vassiliades, Federico Allocati.

Title: Robots with animal-like resilience

Program: H2020

Type: ERC

Duration: May 2015 - May 2020

Coordinator: Inria

Inria contact: Jean-Baptiste Mouret

Abstract: Despite over 50 years of research in robotics, most existing robots are far from being as resilient as the simplest animals: they are fragile machines that easily stop functioning in difficult conditions. The goal of this proposal is to radically change this situation by providing the algorithmic foundations for low-cost robots that can autonomously recover from unforeseen damages in a few minutes. The current approach to fault tolerance is inherited from safety-critical systems (e.g., spaceships or nuclear plants). It is inappropriate for low-cost autonomous robots because it relies on diagnostic procedures, which require expensive proprioceptive sensors, and contingency plans, which cannot cover all the possible situations that an autonomous robot can encounter. It is here contended that trial-and-error learning algorithms provide an alternate approach that does not require diagnostic, nor pre-defined contingency plans. In this project, we will develop and study a novel family of such learning algorithms that make it possible for autonomous robots to quickly discover compensatory behaviors. We will thus shed a new light on one of the most fundamental questions of robotics: how can a robot be as adaptive as an animal? The techniques developed in this project will substantially increase the lifespan of robots without increasing their cost and open new research avenues for adaptive machines.

9.3.1.2. 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 about robust, goal-directed whole-body motion interaction with multiple contacts. CoDyCo will go beyond traditional approaches: (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) was 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.

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. PHC MUROTEX

Participant: François Charpillet.

Program: Hubert Curien Partnerships

Project acronym: MUROTEX

Project title: Multi-agent coordination in robotics exploration and reconnaissance missions

Duration: Jan. 2014 – Dec. 2015

Coordinator: O. Simonin (INSA LYON)

Other partners: Jan Faigl at the Czech Technical University in Prague

Abstract: The main objective of the project is to develop a distributed planning framework for efficient task-allocation planning in exploration and reconnaissance missions by a group of mobile robots operating in an unknown environment with considering communication constraints and uncertainty in localization of the individual team members. One main challenge is to decentralize the decision, in order to scaling up with large fleet of robots (existing solutions are centralized or depend on full communication).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

- Valerio Modugno, PhD student at the Robotics Lab, DIAG, Sapienza (Rome, Italy), visited LARSEN for 9 months (Apr. 2015 – Dec. 2015) to work on learning of task priorities for a robotic arm.

MADYNES Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. 6PO Research Region Lorraine and UL project

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

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

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

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

This led to common publications, notably on the subjects of control of a fleet of UAV (with or without leader, using particle swarm optimisation [25] and [24]) and the organisation of a Federation Charles Hermite research day in may 2015.

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

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

9.1.2. Hydradrone FEDER Région Lorraine project

Participants: Adrien Guenard, Laurent Ciarletta [contact].

Funded by the Region Lorraine under the R&D program.

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 form 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 first year has been dedicated to the development of :

- a couple of small scale hydradrones / proofs of concept (the UxV) for both hardware and software (embedded / remote)
- a larger 1:1 scale hydradrone for heavy sensor payload
- evaluation of the needed sensor payload, and the requirements to turn them into "cyber physical" components.

9.1.3. *Satelor AME Lorraine regional project*

Participants: Mandar Harshe, 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 2016). 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 keeping 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) [28]. 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 [38]. 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.

9.2. National Initiatives

9.2.1. *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.: NDN) 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 emerging networks functions or protocols in a virtualized networking environment; (2) the monitoring and security of virtually deployed networking architectures.

This year, we mainly worked on the WP1 which goal is to define the global architecture of DOCTOR and select the most relevant technologies solutions [66], [27]. We focused on performance of different virtualization solutions. We also contributed to WP4, dedicated to the testbed infrastructure [71]. We also provided a routing scheme for NDN based on a softwarization approach (Software-Defined Networking, SDN) [22], [21].

9.2.2. PIA LAR

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

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 year we have intensively tested the S-CoSenS MAC protocol under RIOT OS by using ARM Cortex-M3 motes of IoT-LAB (Grenoble) and especially contributed to the improvement of the robustness (see section 7.7.1). Another achievement is the connection of our MPIGate-based sensor data collect system to the application server, by the mean of properly defined JSON message formats.

9.2.3. 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 Interministeriel) jointly by the BPI (Banque Publique d'Investissement) and the Région Lorraine. It has been approved by two competitive clusters: Systematic and Imaginove. The consortium is composed of three academic (ICube, Citi, Inria) and five industrial (Airbus Defence and Space, Intrinsec, Oberthur, Wallix, Sydo) partners. The leader is Intrinsec.

This project started in September 2015 and 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. Academic partners will be mainly focused on defining those techniques while industrial partners will build an experimental platform to design a testing platform and data collectors.

9.2.4. Inria-Orange Joint Lab

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

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.

9.2.5. Technological Development Action (ADT)

9.2.5.1. ADT Métroscope

This ADT is linked to the consortium Metroscope <http://metroscope.eu/>, whose goal is to understand the behavior of the Internet and its uses within a mobile environment. Through this ADT, funded by Inria, an engineer (Mohammad-Irfan Khan) was hired for 2 years (2013-2015). He is participating in the design and deployment of a distributed platform. This platform is composed of a services providing measurement tools that collect a set of data and interact with probes located at various points of the network.

9.2.5.2. ADT SEA

The goal of this ADT is to provide an novel security solution for Android platforms where the users will be able to evaluate the security level of their devices. The solution relies on the analysis and collection of logs and network activities of running Android applications to detect malicious activities and also the detection of vulnerable configurations of the device using an OVAL-based approach. Through this ADT, funded by Inria an engineer (Eric Finickel) was hired for 2 years (2013-2015). The work was focused on the development of Android devices embedded probes to export logs and network activities, and also the design and setup of collector and analysis applications using a Hadoop based framework. The resulting platform from this ADT is currently deployed in the High Security Lab and it will be extended during the year 2016.

9.2.5.3. ADT R2D2

The goal of this ADT is to provide assistance in developing the Aetournos platform. Through this ADT, funded by Inria, Ceilidh Hoffmann stayed until february 2015 and then Raphaël Cherfan was hired for the rest of the year (2015). They both have been helping maintaining the Aetournos platform, coordinating students work on the platform and tutoring the Aetournos team for the 2014 and 2016 Outback Joe Search and Rescue / Medical Express Challenge.

9.2.5.4. ADT LAPLACE

This ADT started on 2014 and will end on 2016. The Madynes project is a major partner funded at the level of 120k€. ADT LAPLACE builds upon the foundations of the Grid'5000 testbed 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.

9.2.5.5. ADT COSETTE

This ADT started on 2013 and will end 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.

9.2.5.6. ADT RIOT

RIOT ADT is a multi-site project with Infine and Madynes teams, which started in December 2015 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 www.riot-os.org and 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.

Specific objectives of Madynes team include (a) implementation, on RIOT, of new MAC protocols issuing from the latest research, as well as the design of the MAC layer interfaces both with the upper network layer and directly with applications (API), (b) RIOT drivers development to allow efficiently interfacing with both radio transceivers and sensors (via UART, SPI, I2C, GPIO, ...), according to the chosen hardware platforms (e.g., Zolertia Z1, AVR, ARM Cortex), (c) implementation of the previous solutions in a smart home environment, (d) development of an MCU emulator, (e) integration of the developed MCU emulator into a network simulation tool (e.g. Cooja).

9.2.6. Other Initiative

Participants: Ciarletta Laurent, Gurriet Thomas, Xu Yang, Amza Catalin, Guenard Adrien, Nataf Emmanuel [contact].

Alerion is an "e-falconry" startup created by a member of Madynes in June 2015. Its goal is to provide novel solutions and services in the field of UxV (Unmanned Air, Ground, Surface ... Vehicles) and in moving and interacting objects of the "Internet of Things". The concept is to enhance such existing systems or design new ones by combining well-designed (i.e with regards to efficiency, safety, ease of use) components and containers seen as Cyber Physical bricks. This has also given some publications [53], [52] and [30]. The Alerion project is also actively supporting the international UAV Challenge team that is participating to the "Medical Express", the new "Outback Joe Challenge".

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Flamingo

Title: Management of the Future Internet

Programm: FP7

Duration: November 2012 - October 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 2015, our activities of Flamingo have been focused on automated configuration using service function chaining for mobile device (section 7.2.3), sensor network monitoring to counter-fight attacks in cooperation with the Jacobs University Bremen (§7.1.4), leading the standardization activities of the project (WP leader), enhancing our flow-based monitoring specification to be standardized at the IETF in a close future (§6.3) and Online training material on network management (§10.2.1).

9.4. International Initiatives

9.4.1. Inria International Labs

- LIRIMA (*Laboratoire international de recherche en informatique et mathématiques appliquées*): Madynes is associated with the MASECNESS research team of the Yaoundé University, Cameroun. The collaboration is about wireless sensors networks and was the support for funding student mobility (4 months this year). The LIRIMA has also supported the purchase of thirty sensors used in our common work. Some results have been presented this year at the scientific workshop of the LIRIMA held in St-Louis of Senegal.
- Since September 2015, Thomas Silverston is on leave at JFLI (*délégation CNRS*), an international joint-laboratory between CNRS, Inria, UPMC, Univ. Paris Sud, Keio University, NII and the University of Tokyo located in Tokyo, Japan. He is currently hosted at the University of Tokyo. His main research objectives are on virtualization on new network architecture (e.g.: ICN/NDN) through the use of software-defined networking or Network Function Virtualization.

Dash Kondo, a PhD student from Madynes, is currently doing an internship at JFLI at the University of Tokyo with Prof. Asami Tohru and Thomas Silverston, on virtualization and security in NDN.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- University of Luxembourg: Jérôme François is a Fellow at SnT (Interdisciplinary Center for Security, Reliability and Trust) to empower our collaboration with the University of Luxembourg. This collaboration is now focused on network virtualization, which also includes the co-advising of S. Signorello.
- University of Waterloo: we pursue our collaboration with the team of Prof. Raouf Boutaba especially on using SDN for scheduling flows generated by *Big Data* applications. This work lead to a a survey [55].

9.4.3. Participation In other International Programs

9.4.3.1. STIC-AmSud AKD Project

Participants: Remi 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 started in January 2015 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.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

Nesrine Khelifi, 18/06/2015-18/09/2015, Université de Manouba - Tunisie. See §7.4.1

Seetaraman Savita, 10/07/2015-31/10/2015, University of Trento (Italy), Benchmarking of virtualized network functions [62]

9.5.1.2. Scientific visits

Dr. Jian Li, associate professor at Shanghai Jiaotong University (China) visited the team for two weeks in December and given a talk on the recent research results of his group on network virtualization and cloud applications.

9.5.2. Visits to International Teams

9.5.2.1. Research stays abroad

Thomas Silverston is currently on leave (Delegation CNRS) at the University of Tokyo within JFLI, an international joint-lab between CNRS, Inria, UPMC, Univ. Paris Sud, Keio University, NII and the University of Tokyo. Daishi Kondo, co-advised with Prof. Olivier Perrin (UL) and Thomas Silverston, is also doing an internship at the JFLI from September 2015 to February 2016.

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 Guevara 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. ANR

- ANR IDeaS (2012-2015)
Participants: R. Anxionnat, M.-O. Berger, E. Kerrien.
The IDeaS Young Researcher ANR grant explores the potential of Image Driven Simulation (IDS) applied to interventional neuroradiology. IDS recognizes the current, and maybe essential, incapacity of interactive simulations to exactly superimpose onto actual data. Reasons are various: physical models are often inherently approximations of reality, simplifications must be made to reach interactive rates of computation, (bio-)mechanical parameters of the organs and surgical devices cannot but be known with uncertainty, data are noisy. This project investigates filtering techniques to fuse simulated and real data. MAGRIT team is in particular responsible for image processing and filtering techniques development, as well as validation.

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 and AEN SOFA

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 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 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 Research Visitors

8.3.1. Visits to International Teams

8.3.1.1. Research stays abroad

Pierre-Frédéric Villard is spending one year and a half as a visiting professor in the Harvard Biorobotics Lab (<http://biorobotics.harvard.edu>) led by Professor Robert D. Howe in Harvard University, Cambridge (USA). The first year (Sept 2014-Aug 2015) was funded by the CNRS and the last semester (Sept 2015-Jan 2016) is funded by Inria. The research is on individual-specific heart mitral valve simulation with biomechanical models.

MIMESIS Team

8. Partnerships and Cooperations

8.1. National projects

8.1.1. ADT (*Aide au Développement Technologique, Inria*) - *DynMesh*

The objectives of this ADT are the coupling of SOFA, the physical simulation platform supported by Inria, and CGoGN, the mesh management library developed within the ICube lab at Strasbourg. It aims at extending 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.

8.1.2. ADT - *Sofa*

SOFA Large Scale Development Initiative (ADT) : the SOFA project is an international, multi-institution, collaborative initiative, aimed at developing a flexible and open source framework for interactive simulations. This will eventually establish new grounds for a widely usable standard system for long-term research and product prototyping, ultimately shared by academic and industrial sites. The SOFA project involves 4 Inria teams: ASCLEPIOS, DEFROST, IMAGINE and MIMESIS. The development program of the ADT started in 2007. This ADT ended in September 2015 and the associated contract of our SOFA engineer Marc Legendre ended at the same time.

8.1.3. ADT - *SofaOR*

In December 2014, a new ADT national initiative started. The objective of this ADT is twofold: first, we aim 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 is 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.

8.1.4. ANR - *IDEFI*

In the IDEFI ANR, the MIMESIS team is involved in the EVEREST project which aims to develop a new generation on-line training platforms, dedicated to the theory and practice of image-guided minimally invasive surgery. A central objective is to develop a framework for the integration and the rapid spread of numerical interactive simulation systems, associated with online assessment methodologies. The IHU Strasbourg is the ANR project leader and we collaborate on the topic of virtual simulations.

8.1.5. ANR - *RESET*

At the end of 2014, the team has been awarded a new ANR project: RESET. This project started in March 2015. 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).

8.1.6. IDEX - CNRS

The aim of the project CONECT (Couplage de la rObotique et de la simulatioN mEdicale pour des proCédures auTomatisées) is to develop a robotic system for needle insertion in deformable tissues which is entirely controlled and driven by a numerical simulation. The results of this work could be extremely beneficial for medical applications, such as brachytherapy or biopsy, given the accuracy and the precision required in this kind of procedures. A first demonstration is currently under development where the needle will be inserted in a silicone gel samples. Given a non-straight predefined trajectory, our goal is to control a Mitsubishi MRV1 robot that will automatically insert a needle along the predefined path, taking into account the deformation of both the environment and the needle. The deformation of the gel is tracked with camera using the Optitrack system. The simulation is based on real time finite element models. Based on inverse simulations, we are developing a control model that provides the kinematics of the robot such that the needle remains on the trajectory during the insertion. The activities carried out already allowed a first publication at IROS (2015) "Haptic Rendering of Hyperelastic Models with Friction" and the presentation of a poster at the conference DD23 in South Korea in July 2015 "Domain Decomposition for FE Simulation for Needle Insertion".

8.1.7. REBOAsim, Department of Defense USA

REBOA stands for Resuscitative Endovascular Balloon Occlusion of the Aorta. The objective of the REBOAsim project is to develop a low-cost miniaturized tracking and haptic interface for catheters and guidewires, meeting requirements for training and intraoperative guidance of Resuscitative Endovascular Balloon Occlusion of the Aorta (and other catheterization procedures). The second aspect of the project is the development of a computer-based simulation of REBOA procedures, allowing the training of medical personnel. This project was accepted in late 2015. In this context, we collaborate with the American Department of Defense.

8.1.8. IHU, Strasbourg

Our team has been selected to be part of the IHU of Strasbourg. This institute, for which funding (67M€) has just been announced, is a very strong innovative project of research dedicated to future surgery of the abdomen. It will be dedicated to minimally invasive therapies, 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). Our group and SOFA have an important place in the project. Since September 2011 a part of our team is located within the IHU, to develop a number of activities in close collaboration with clinicians.

8.2. National collaborations

At the national level, the MIMESIS team collaborates with:

ICube 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 IGG team: we have two active collaborations, one with Dr. Caroline Essert on trajectory planning (in the context of Deep Brain Stimulation) and the group involved in research on dynamic topologies. These collaborations are supported by two IHU projects: BILIKIMO and HAYSTACK.

IHU Strasbourg: as mentioned in 8.1.8, our team is one of the principal partners of the IHU Strasbourg. We developed a number of projects in close collaboration with clinicians and members of IHU.

LML Lille: is a French research laboratory (UMR CNRS 8107) part of the Carnot institute ARTS. With more than two hundreds researchers, LML focuses on the following research area : mechanical reliability and Tribology, fluid mechanics, civil engineering and soil mechanics. In 2105, Mathias Brieu from LML visited our team.

Nouvel Hôpital 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 with started in March 2015. We also collaborate with Prof. Patrick Pessaux, a surgeon who helps us in the context of the SOFA-OR project.

R&D team at IRCAD: the computer science group at IRCAD has been involved in segmentation, 3D reconstruction and augmented reality for abdominal surgery since the 2000. An important activity on simulation also took place and led to the creation of a start-up company, Digital Trainers. Currently, the main activities are centered around augmented reality, registration, and medical imaging.

TIMC, 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 this 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,

8.3. Inria collaborations

Within Inria, the MIMESIS team collaborates with:

ASCLEPIOS: although the core activities of team are in the field of medical image analysis, it also has a strong expertise in physics-based simulation of the heart. We collaborated on the development of an electro-mechanical model of the heart, and on some core components of SOFA. We collaborate with the ASCLEPIOS team on the development of the SOFA framework and on the development of a simulation system for radio-frequency ablation in the case of cardiac arrhythmia,

DEFROST: the team imagines future robots which don't need to be "rigid" but made of complex deformable structures, composed of stiff and soft regions, close to organic materials that can be found in nature. Soft robotics opens very attractive perspectives in terms of new applications, reduction of manufacturing costs, robustness, efficiency and security. It could constitute a great jump in robotics in the following years. We continue to interact with the team in Lille given our common research background. A joint article of constraint-based haptic modeling has already been submitted.

IMAGINE: the team has a general focus on animation and simulation of natural objects. We essentially collaborate with Prof. François Faure on real-time finite element techniques, collision detection and contact response (which led to a SIGGRAPH paper) and the development of SOFA,

MAGRIT: their research field is computer vision, with a focus on augmented reality applications. The team is also fairly involved in computer-based solutions for the planning or the simulation of interventional radiology procedures, with a strong collaboration with the CHU in Nancy. We collaborate with the MAGRIT team in the area of interventional radiology and augmented reality. A common PhD thesis, whose subject was to develop implicit representations of anatomical structures such as blood vessels or aneurysms, was defended in 2013. Another joint PhD thesis was defended in January 2015 on the topic of non-rigid augmented reality and combined the computer vision expertise of MAGRIT with our expertise on real-time simulation and biomechanical modeling.

8.4. European Initiatives

8.4.1. RASimAs

2015 was the second year of the RASimAs project (STREP project funded under FP7) during which we developed new models of the biomechanics of the leg and arm, as well as the simulation of the insertion of the anaesthesiology needle. Regional anaesthesia has been used increasingly during the past four decades. This is due to the perceived advantages of reduced postoperative pain, earlier mobility, shorter hospital stay, and significantly lower costs. Current training methods for teaching regional anaesthesia include cadavers, video teaching, ultrasound guidance, and simple virtual patient modeling. These techniques have limited capabilities

and do not consider individual anatomy. The goal of this project is to increase the application, the effectiveness and the success rates of RA and furthermore the diffusion of the method through the development VPH models for anaesthesia. The goal of the MIMESIS team is to provide the computational infrastructure for the physics-based simulation and to propose new methods for patient-specific modeling and simulation of soft tissues and their interaction with the needle, including its effect on nerve physiology.

See <http://rasimas.imib.rwth-aachen.de> for more details.

In the context of the RASimAS project, we collaborate with the company:

- **SenseGraphics:** develops next generation medical simulator software for a wide range of surgical procedures. It is used in simulators for training surgeons in various fields such as robotic surgery, eye surgery, dentistry, ultrasound interpretation and anesthesia. The simulators combine the latest technologies in real-time graphics rendering as well as advanced force feedback to allow the surgeons to have an experience that is as close to reality as possible.

With the RASimAS project, we also collaborate with: the University Hospital Aachen, RWTH Aachen University, 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.

8.5. International Initiatives

8.5.1. Inria International Partners

At the international scale, the MIMESIS team collaborates with:

CIMIT, Boston: we are restarting our interactions on interventional radiology simulation, in particular the design and development of a hardware interface for tracking catheters and guidewires. A joint proposal to the DoD has been submitted to this end.

Harvard Biorobotics lab, Cambridge: this group focuses on the role of sensing and mechanical design in motor control, in both robots and humans. This work draws upon diverse disciplines, including biomechanics, systems analysis, and physiology. We started a collaboration on inverse problems for identifying optimal areas of cardiac ablation using our work on electro-mechanical modeling of the heart. Other areas of collaboration are planned, such as cardiac valve interactions with blood flow.

Humanoid and Intelligence Systems Lab, Karlsruhe Institute of Technology: we started a collaboration with Dr Stefanie Speidel and Dr. Stefan Suwelack on the topics of real-time soft tissue modeling and laparoscopic augmented reality.

Institute of Computer Science, Masaryk University, Czech Republic: we have an extensive collaboration with Igor Peterlik at the ICS, leading to 7 publications over that past 18 months. This collaboration covers the fields of non-rigid registration, augmented reality and haptics.

Interactive Graphics and Simulation, Innsbruck: the IGS group in Innsbruck is a continuation of a group led at ETH by Matthias Harders. Its scientific focus is on physically-based simulation, computer haptics, and to a limited extent, augmented reality. The main application area is the medical domain.

Surgical Planning Lab, Boston: this research laboratory at Brigham and Women's Hospital has a large expertise in the analysis of diagnostic data using computational image analysis. We know this group very well, in particular in the field of Deep Brain Stimulation and through their work on Open Source solutions for computer aided surgery. We are regularly interacting with them on the development of a version of SOFA dedicated to the operating room.

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).

Team Legato, University of Luxembourg: since last year we have active discussions with Prof. Stéphane Bordas on real-time soft tissue cutting simulation. This has already led to a journal article in Media [33] and a co-supervision of a post-doctoral fellow.

8.6. International Research Visitors

8.6.1. Visitors

In 2015, MIMESIS invited several visitors:

- Jim Ueltschi (founder of the HelpMeSee non-profit organization)
- Karol Miller (Winthrop Professor, School of Mechanical and Chemical Engineering, The University of Western Australia)
- Stéphane Bordas (LEGATO team, Luxembourg)
- Karel van Gelder (Product manager, MOOG, Amsterdam)
- Alexandre Krupa (Inria, Rennes)
- Mathias Brieu (Laboratoire de Mécanique, Ecole Centrale Lille)

8.6.2. Internships

In 2015, the MIMESIS welcomed two international interns (for 6 months):

Santiago Camacho, Universidad de Buenos Aires, worked on "Improvement of Visualization Tools for Augmented Reality Applications"

Sabrina Izcovich, Universidad de Buenos Aires, worked on "Quadratic Tetrahedron Element for FEM simulations".

8.6.3. Visits to International Teams

8.6.3.1. Explorer programme

This year, Hugo Talbot obtained an Inria Explorer grant in the context of a partnership with the Harvard BioRobotics Laboratory from Harvard, Cambridge. The Explorer programme covered the one-month visit (June 2015). This visit allowed to discuss about our respective work around simulation, especially concerning simulation in the field of cardiology. This was also the opportunity to establish several academic and industrial contacts in the United States. Hugo Talbot namely visited:

- **Thermedical:** is a company developing a new generation of radio-frequency catheters.
- **Center of Medical Simulation:** is a simulation center focusing on training based on mannequins.
- **SimQuest:** is a company developing simulation technologies for medicine, very close to the research topic of our team.
- **Surgical Planning Laboratory** (Brigham and Womens' Hospital) is a research center very close to the clinics and working mainly on medical imaging, but also interested in the medical simulation.
- **CIMIT:** is a research center developing mannequins for training.

MULTISPEECH Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. EQUIPEX ORTOLANG

Project acronym: ORTOLANG ⁰

Project title: Open Resources and TOols for LANGuage

Duration: September 2012 - May 2016 (phase I, signed in January 2013)

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 is 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 text-speech alignment and speech visualization tools.

9.1.2. ANR-DFG IFCASL

Project acronym: IFCASL

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

Duration: March 2013 - February 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.

The work involved the design and recording of a French-German learner corpus. 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.

⁰<http://www.ortolang.fr>

9.1.3. ANR ContNomina

Project acronym: ContNomina

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

Duration: February 2013 - July 2016

Coordinator: Irina Illina, MULTISPEECH

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).

9.1.4. ANR DYCI2

Project acronym: DYCI2⁰

Project title: Creative Dynamics of Improvised Interaction

Duration: March 2015 - February 2018 (signed in October 2014)

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.

9.1.5. ANR JCJC KAMoulox

Project acronym: KAMoulox

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

Duration: January 2016 - January 2019 (signed in October 2015)

Coordinator: Antoine Liutkus, MULTISPEECH

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.

9.1.6. ANR ORFEO

Project acronym: ORFEO⁰

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.

⁰<http://repmus.ircam.fr/dyci2/>

⁰[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)

In this project, we are 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).

9.1.7. FUI RAPSODIE

Project acronym: RAPSODIE ⁰

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

Duration: March 2012 - February 2016 (signed in December 2012)

Coordinator: eRocca (Mieussy, Haute-Savoie)

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

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

In this project, MULTISPEECH is involved for optimizing the speech recognition models for the envisaged task, and contributes also to 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.

9.1.8. 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.

9.1.9. ADT Plavis

Project acronym: Plavis

Project title: Platform for acquisition and audiovisual speech synthesis

Duration: January 2015 - December 2016

Coordinator: Vincent Colotte, MULTISPEECH

Abstract: The objective of this project is to develop a platform acquisition and audiovisual synthesis system (3D animation of the face synchronously with audio). The main purpose is to build a comprehensive platform for acquisition and processing of audio-visual corpus (selection, acquisition and acoustic processing, 3D visual processing and linguistic processing). The acquisition is performed using a motion capture system (Kinect-like) or from Vicon system or EMA system. We also propose to develop a 3D audiovisual synthesis system text to audio and 3D information of a talking head. The system will incorporate an animation module of the talking head to reconstruct the face animated with audio. During the first year of the project, we are setting up and testing the acquisition techniques that will be used. We have developed several tools to acquire the audiovisual data and to process it. A synchronization step was developed.

⁰<http://erocca.com/rapsodie>

9.1.10. ADT VisArtico

Project acronym: VisArtico

Project title: Software for Processing, analysis and articulatory data visualization

Duration: November 2013 - October 2015

Coordinator: Slim Ouni, MULTISPEECH

Abstract: The Technological Development Action (ADT) Inria Visartico aims at developing and improving VisArtico, an articulatory visualization software (see 6.5). In addition to improving the basic functionalities, several articulatory analysis and processing tools are being integrated.

9.1.11. 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: S. Ouni, MULTISPEECH

Cofunded by Inria and Région Lorraine

Abstract: The main objective of this project is 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 signal). The main purpose is to acquire, process and analyze the corpus and to study the expressiveness; the results will be used for the expressive audiovisual speech synthesis system.

9.1.12. LORIA exploratory project

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

Duration: June 2015 - May 2016

Coordinator: S. Ouni, MULTISPEECH

Abstract : The aim of this project is the study of the various mechanisms involved in multimodal human communication that can be oral, visual, gestural and tactile. This project focuses 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. We will set up and integrate hardware and software acquisition. Thereafter, we will acquire and structure the multimodal data.

9.2. European Initiatives

9.2.1. Collaborations with major european organizations

Jon Barker: University of Sheffield (UK)

Robust speech recognition [25].

9.3. International Initiatives

9.3.1. Inria international partners

9.3.1.1. Informal international partners

Nobutaka Ono: National Institute for Informatics (NII, Tokyo, Japan)

Machine learning and source separation [14], [58], [69] (former Inria associate team).

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

Source separation [19], [21], [24].

Bryan Pardo, Northwestern University (Evanston, IL, USA)

Audio source separation [52].

Derry Fitzgerald, Nimbus Center, Cork Institute of Technology (Ireland)

Audio source separation [43], [67].

Taylan Cemgil, Bosphorus University (Istanbul, Turkey)

Multimodal data analysis [44] and source separation [16].

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

Robust speaker recognition [53], [54].

9.3.2. Participation in other international programs

9.3.2.1. 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

National Coordinators: Juan Carlos GÓMEZ (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.

9.3.2.2. 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 Nouredine Ellouze (Tunisia).

Abstract: Development of an HMM-based speech synthesis system for the Arabic language. This includes the development of an Arabic corpora, 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.

9.4. International Research Visitors

9.4.1. Visits of international scientists

9.4.1.1. Internships

Liu Jen-Yu

Date: Apr 2015 - Sep 2015

Institution: NTU (Taiwan)

NEUROSYS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

In the *Contrat de Plan 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

- Inria Technological development action (ADT): OpenViBE-NT
This is a three-year multi-site project (2012–2015) to develop OpenViBE further on several fronts such as usability, new algorithms and scope of applicability. Teams of the ADT are Hybrid(Rennes), Athena (Sophia), Potioc (Bordeaux) and Neurosys. Coordinator is Laurent Bougrain.
- Multidisciplinary Exploratory Project (PEPS 2014) Bio-Maths-Info (BMI): *Characterising the laminar profile of motor cortical oscillatory synchronization during visuomotor behavior with new analysis tools.*

Oscillations are omnipresent in the brain, but their function is still disputed. In motor cortex, beta and gamma oscillations are often observed, but their proposed roles in sensorimotor behavior are largely overlapping. While much is known on the laminar distribution of oscillations in sensory areas, the very sparse data on the laminar profile of motor cortical oscillations largely limits their functional interpretations. The 2-years project studies the layer specificity of monkey motor cortical oscillations and oscillatory interactions between the primary motor cortex (M1) and the dorsal premotor cortex (PMd) during visuomotor behavior. Extending conventional tools, such as coherency analysis, Neurosys develops a new method to quantify short-lasting partial amplitude and phase synchronization in single-trial data, based on wavelets, exploiting the predefined vicinity of contacts on the laminar probes. The application of this new method to the data recorded in Marseille will reveal instantaneous amplitude and phase synchronization between cortical layers and between the brain areas *M1* and *PMd*, providing novel insights into the functional roles of beta and gamma oscillations in visuomotor behavior. The experimental partner at the *Institut de Neurosciences de la Timone* in Marseille is Bjork Kilavik. The contact in Neurosys is Axel Hutt.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The ITN-project *Neural Engineering Transformative Technologies (NETT)*⁰ (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 next 4 years. Neural Engineering brings together engineering, physics, neuroscience and mathematics to design and develop brain-computer interface systems, cognitive computers and neural prosthetics. Neurosys organized a NETTworkshop about *Neural Engineering in Medicine and related fields* in Nancy, 2-3 July 2015. Neurosys hosted a PhD-student, Maciej Jedynak, from Pompeu Fabra university (Spain) for one month in fall 2015. Contact is Axel Hutt.

⁰<http://www.neural-engineering.eu/>

9.3.2. Collaborations in European Programs, except FP7 & H2020

Program: ERC Starting Grant

Project acronym: MATHANA

Project title: Mathematical Modeling of Anaesthesia

Duration: January 2011 – October 2015

Coordinator: Axel Hutt

Abstract: MATHANA aims to study mathematically spatially extended neural systems and reveal their spatio-temporal dynamics during general anaesthesia.

9.3.3. Collaborations with Major European Organizations

Lifestyle Research Association (LIRA): Philips (Netherlands), Fraunhofer (Germany), Inria

Sleep is an essential part of a healthy life, but many people have trouble getting enough uninterrupted sleep. Special sensors installed in a mobile phone or bed can analyze activities, stress patterns and sleep sequences and provide ideas for new strategies and, eventually, products that support a healthier night's sleep. NEUROSYS has a Post-doc project running merging all sensor signals in a single data analysis technique to improve existing sleep monitors.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- We collaborate with Jamie Sleight (University of Auckland, New Zealand), who provides us with experimental EEG-data obtained in humans during anaesthesia (A. Hutt).
- In the collaboration with Flavio Frohlich (University of North Carolina - Chapel Hill), we receive experimental data measured intracranially in ferrets and analyse them on spectral properties (A. Hutt).
- In the collaboration with Jérémy Lefebvre (University of Lausanne), we have been working out together a stochastic delayed neural field analysis leading to new insights into the effects of additive noise (A. Hutt).
- The collaboration with Peter beim Graben (Humboldt University Berlin) on recurrence data analysis has led to analysis techniques to detect meta-stable states in EEG-signals (A. Hutt).
- We have an ongoing collaboration with Pr. 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 Pr. 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

- We have hosted Peter beim Graben (Humboldt University Berlin) in April and May on recurrence data analysis has led to analysis techniques to detect meta-stable states in EEG-signals.
- Jérémy Lefebvre, 10 days, Scientist at Toronto Western Research Institute, University Health Network, and Assistant Professor at Department of Mathematics, University of Toronto: *Shaping oscillations in the damaged brain.*
- Fatiha Hendel, three weeks, Assistant professor at Université des Sciences et de la Technologie d'Oran :

9.5.1.1. Internships

- Kanishka Basnayake, first year master student (July 5th 2015-September 6th 2015): EPFL summer Internship. *Modelling of gamma oscillation in networks of adaptive exponential integrate-and-fire neurons.*

ORPAILLEUR Project-Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Inria International Labs: SNOWFLAKE

Participants: Adrien Coulet [contact person], Malika Smaïl-Tabbone.

Inria@SiliconValley

Associate Team involved in the International Lab: SNOWFLAKE

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

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

Snowflake (<http://snowflake.loria.fr/>) 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 LOD (Linked Open Data). Such a connection would 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. The considered use case is related to pharmacogenomics drugs, i.e., drugs known to cause variable effects depending on the genetic profile of patients. Data associated with pharmacogenomics drugs and their mechanisms are available in LOD and, once connected to EHRs, they can be used to classify drugs and then patients showing a specific reaction profile to a given group of drugs.

8.1.2. Participation In other International Programs: *Ciência Sem Fronteiras*

Participant: Amedeo Napoli [contact person].

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.

8.1.3. *STIC AmSud: Autonomic Knowledge Discovery (AKD)*

Participants: Victor Codocedo, Amedeo Napoli [contact person].

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 projects targets 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.

8.1.4. *Miscellaneous*

Participants: Mehwish Alam, Aleksey Buzmakov, Victor Codocedo, Adrien Coulet, Amedeo Napoli [contact person], Chedy Raïssi, Jean-Sébastien Sereni, Mario Valencia.

- An on-going collaboration involves the Orpailleur team and Sergei Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory several times (with the support of HSE) while Sergei Kuznetsov visited Inria Nancy Grand Est several times too. The collaboration is materialized by the joint supervision of the thesis of Aleksey Buzmakov and the organization of scientific events, and in particular the workshop FCA4AI whose fifth edition should take place this year in August at ECAI 2016 (see <http://www.fca4ai.hse.ru>).
- 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.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. HEREDIA

Participant: Jean-Sébastien Sereni [contact person].

HEREDIA (<http://www.liafa.univ-paris-diderot.fr/~sereni/Heredia/>) is an ANR JCJC (“Jeunes Chercheurs”) focusing on hereditary properties of graphs, which provide a general perspective to study graph properties. Several important general theorems are known and the approach offers an elegant way of unifying notions and proof techniques. Further, hereditary classes of graphs play a central role in graph theory. Besides their theoretical appeal, they are also particularly relevant from an algorithmic point of view. With Jean-Sébastien Sereni, the HEREDIA project involves Pierre Charbit (LIAFA, Paris), Louis Esperet (G-SCOP, Grenoble) and Nicolas Trotignon (LIP, Lyon).

8.2.1.2. *Hybride*

Participants: Adrien Coulet, Luis-Felipe Melo, Amedeo Napoli, Matthieu Osmuk, Chedy Raïssi, My Thao Tang, Mohsen Sayed, Yannick Toussaint [contact person].

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 and 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).

8.2.1.3. *ISTEX*

Participants: Luis-Felipe Melo, Amedeo Napoli, Yannick Toussaint [contact person].

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. Thus ISTEX is in concern with a massive acquisition of documentation 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 the ATILF laboratory and the INIST Institute (both in Nancy). ISTEX-R aims at developing new tools for querying full-text documentation, analyzing content and extracting information. A platform is currently under development to provide robust NLP tools for text processing, as well as methods in text mining and domain conceptualization.

8.2.1.4. *Termith*

Participants: Luis-Felipe Melo, Yannick Toussaint [contact person].

Termith (<http://www.atilf.fr/ressources/termith/>) is an ANR Project which involves the following laboratories: ATILF, LIDILEM, LINA, INIST, Inria Saclay and Inria Nancy Grand Est. 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.

8.2.2. *FUI PoQemon*

Participants: Matthieu Osmuk, Chedy Raïssi [Contact Person], Mickaël Zehren.

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 trade-off 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 ρ -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 ρ -uncertainty pattern mining approach with novel data visualization techniques.

The PoQemon research project involves the following partners: Altran, DataPublica, GenyMobile, HEC, IP-Label, Next Interactive Media, Orange and Université Paris-Est Créteil, along with Inria Nancy Grand Est.

8.2.3. *PEPS*

8.2.3.1. *PEPS Appropre*

Participants: Mehwish Alam, Quentin Brabant, Aleksey Buzmakov, Victor Codocedo, Miguel Couceiro [Contact Person], Adrien Coulet, Esther Galbrun, Amedeo Napoli, Chedy Raïssi, Yannick Toussaint.

This PEPS Appropre research project (see <http://www.cnrs.fr/ins2i/spip.php?article1183>) is aimed at setting a framework for characterizing the mining of preferences in massive data. Such a unified framework for the mining of qualitative preferences is not yet existing and can be related to recent studies in decision theory (aggregation models and consensus), machine learning and data mining. A particular focus will be done on the aggregation model of Sugeno integral which can be applied on a symbolic representation of preferences for two main operations, reduction of dimensionality (feature selection) and prediction.

8.2.3.2. *PEPS Confocal*

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 planning to adapt 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*

Participants: Mehwish Alam, Quentin Brabant, Aleksey Buzmakov, Victor Codocedo, Adrien Coulet, Miguel Couceiro [Contact Person], Esther Galbrun, Amedeo Napoli, Chedy Raïssi, 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. For leading such a process, which actually is a loop, an analyst who is most of the time an expert of the data domain, is present. This materializes the fact that the KD process requires interaction and iteration. However, it appears that until recently the most important progress were made on the second step of the KD process, i.e. data mining, and especially from the algorithmic point of view. This gave birth to a variety of efficient and fast algorithms. This second step is in between the two other steps whose importance is now becoming very clear as the analyst is facing very large amounts of data and even larger amounts of resulting patterns. Actually, KDDK is one possible way of tackling such a problem as the principle is to push domain knowledge for improving 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 some original and generic pattern which can be considered as a reference for going farther and to search the pattern space w.r.t. this original pattern linked to some preferences of the analyst. In this way, the interesting pattern space is much more concise and of much lower size. Moreover, the PEPS Prefute project contributes also to consolidate the place of the analyst in the KD process. In particular this means that more studies have to be carried out on the possible interactions with the analyst and on the importance of preferences and domain knowledge in this interaction. In addition, visualization tools associated to KD systems have to be improved for being able to work with the actual large amounts of data and patterns as well (see <https://www.greyc.fr/fr/node/2207>).

8.3. Regional Initiatives

8.3.1. *PEPS Mirabelle EXPLOD-Biomed*

Participants: Adrien Coulet [contact person], Malika Smaïl-Tabbone.

This project has initiated a collaboration with geneticists from the Hospital of Nancy, namely Philippe Jonveaux and Céline Bonnet. The aim of the EXPLOD-Biomed project is to propose novel knowledge discovery methods applied to Linked Open Data for discovering gene that could be responsible for intellectual deficiencies. Linked Open Data are available on-line, interconnected and encoded in a format which can be straightforwardly mapped to ontologies. Thus they offer novel opportunities for knowledge discovery in biomedical data. Here, geneticists play the role of experts and guide the knowledge discovery process at different steps.

8.3.2. *Hydreos*

Participant: Jean-François Mari [contact person].

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 (see § 6.2.2) 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>). Currently, various display tools are under study and implementation for providing the agronomy expert an easier interpretation of the clustering outputs <http://www.loria.fr/~jfmari/App/Arpentage/Yar.avi>.

8.3.3. *PEPS Truffinet*

Participant: Chedy Raïssi [contact person].

The Truffinet PEPS project aims at developing new graph mining methods and tools to support knowledge discovery from the truffle’s complex network of interactions happening in the soil between different bacterias and the subterranean Ascomycete fungus. This work uses Log-Linear Analysis (LogLA) which is a well established statistical technique for finding associations between discrete variables in data. The general objective of LogLA is to select a model that satisfactorily explains the observed frequencies of a given categorical dataset. General approaches to LogLA are exponential with respect to the number of variables. Recently, new approaches based on multiplicative log-linear models and using notions from graph theory have been developed. We applied successfully these methods in the case of the truffle bacterial environment to discover new associations in our data.

The Truffinet PEPS project involves several partners among which Intitut Elie Cartan de Lorraine (IECL), Intitut National de Recherche en Agronomie (INRA) and Centre de Recherche en Automatique de Nancy (CRAN) along with Inria Nancy Grand Est.

SEMAGRAMME Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

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

SLAM: Schizophrenia and Language, Analysis and Modeling

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 SLAM project starts for three years at the Maison des Sciences de l'Homme de Lorraine (MSH-Lorraine, USR 3261). While this year work was dedicated to the test protocol definition, the coming years will be devoted to building an open-access corpus of pathological uses of language.

The first transcriptions of pathological interviews are analyses. The management chain was implemented for disfluencies and POS. Moreover, we have focused on implementing the treatment of lexicography issues and proposed an interface for SDRT-annotations.

Other participants are: Denis Apotheloz (ATILF, Université de Lorraine), Valérie Aucouturier (Centre Léo Apostel, Université Libre de Bruxelles), Katarina Bartkova (ATILF, Université de Lorraine), Fethi Bretel (CHS Le Rouvray, Rouen), Michel Musiol (InterPSY, Université de Lorraine), Manuel Rebuschi (Archives Poincaré, Université de Lorraine).

The SLAM project was supported by the MSH-Lorraine, USR 3261, and won a PEPS project HuMaIn (mission pour l'interdisciplinarité du CNRS). The CNRS part of the budget allowed the organization of the third workshop which gathers linguists, psychologists and computer scientists in December: <http://discours.loria.fr>.

The SLAM project was chosen for the bi-annual report of the CNRS MI as a major illustration.

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].

POLYMNIE⁰ is a research project funded by the French national research agency (ANR). 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.

⁰<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) CAuLD⁰.

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.

The complexity of the phenomena, of their formal description, and of their interactions, require to set up a testing and development environment for linguistic modeling. It will consist in extending and stabilizing a software implementing the functionalities of the ACG framework. It will provide a tool for experimentation and validation of the approach.

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.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Sabbatical programme

Pogodalla Sylvain

Date: Aug 2014 - Jul 2015

Institution: **HHU** (Germany)

The objective of the research project dealt with studying the syntax-semantics interface. It was relying on two alternative approaches of this interface for mCSG: a unification based approach for Lexicalized Tree Adjoining Grammars (LTAG) [48], [49] as proposed in [44], [51], and a type-theoretic approach using Abstract Categorical Grammars (ACG) [6], [72], [73].

On the semantic side, the project focused on the modeling of quantification in Frame Semantics [40], [31], [59]. We proposed to use Hybrid Logic (HL) [27]. We developed a syntax-semantics interface with ACG to model scope ambiguity [18], as well as a syntax-semantics interface in LTAG for iterative events [23].

⁰<http://www.loria.fr/~pogodall/cauld/>

SPHINX 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 Programme of the French National Research Agency (ANR) :

Project Acronym : iproblems

Project Title : Inverse Problems

Duration : 48 months (2013-2017)

Abstract: Inverse problems is a field in full expansion as shown by the numerous resident programs hosted in the different research institutes throughout the world, several striking breakthroughs achieved in the recent years and the flow of PhD students attracted by the subject. Strong groups and schools have appeared in Finland, the United States and Japan. In spite of its history in Analysis and Partial differential equations (in particular in microlocal analysis and control theory, both fields having strong interactions with Inverse Problems), the emergence of an organised group of mathematicians interested in the theoretical aspects of inverse problems has not yet occurred in France. The ambition of this proposal is to structure a core of analysts with a strong interest in this field, to help them investigate several central questions related to geometric and analytic inverse problems, and to favor interactions between them, as well as with foreign partners and experts in the field.

Inverse problems deal with the recovery of an unknown quantity, typically a coefficient in a partial differential equation, from knowledge of specific measurements, for instance the Cauchy data on the solutions of the given equation. They are motivated by applications to Physical Sciences but give rise to many interesting and challenging mathematical problems which lie at the crossroad of analysis (partial differential equations, harmonic and microlocal analysis, control theory, etc.) and geometry (Riemannian and Lorentzian geometries). This project mainly focuses on Calderón's inverse conductivity problem and other closely related geometric and analytic problems. In particular, it aims at investigating identifiability issues for anisotropic problems, but also in the case where only partial data is available, as well as stability issues for those problems. It will also consider injectivity problems on geodesic ray transforms.

- 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

Duration: 36 months (starting on may 1st, 2014)

URL: <http://www-sop.inria.fr/nachos/projects/tecseser/index.php/Main/HomePage>

- Xavier Antoine is member of the project BoND.

Project Acronym: BoND

Project Title: Boundaries, Numerics and Dispersion.

Coordinator: Sylvie Benzoni

Duration: 48 months (starting on october 15th, 2013)

URL: <http://bond.math.cnrs.fr>

9.2. International Initiatives

9.2.1. Informal International Partners

Most of the SPHINX members are involved in long term cooperation with international partners. The most important one at this time is our informal partnership with Université de Liège (Belgium). In particular, the recently released software program **GetDDM**, is based on the paper [25] co-authored by Xaver Antoine and Christophe Geuzaine.

TONUS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

9.2. National Initiatives

9.2.1. ANR

- ANR project GYPSI (2010-2015), <https://sites.google.com/site/anrgypsi/>: coordinator Philippe Ghendrih (CEA Cadarache), other participants, University of Marseille, Universities of Strasbourg and Nancy (CALVI and then TONUS project-team). The aim is to understand the physics of turbulence in magnetically confined plasma using numerical simulation
Participants: Philippe Helluy [local coordinator], Michel Mehrenberger.
- ANR project "PEPPSI" in Programme Blanc SIMI 9 – Sciences de l'ingénierie (Edition 2012) started in 2013.
Participants: Giovanni Manfredi [coordinator], Sever Adrian Hirstoaga.

9.2.2. IPL FRATRES

The TONUS project belongs to the IPL FRATRES and there was an annual meeting, on 15-16 October 2015, with talks of Emmanuel Franck, Philippe Helluy, Sever Adrian Hirstoaga, Michel Mehrenberger.

9.2.3. IPL C2S@*exa*

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

9.2.4. Competitvity clusters

- GENCI projet : t2015067387 "Simulation numérique des plasmas par des méthodes semi-lagrangiennes et eulériennes adaptées" 800 000 scalar computing hours on CURIE_standard (January 2015-February 2016); use: 300 000 heures.
Participants: Sever Adrian Hirstoaga, Guillaume Latu, Michel Mehrenberger [coordinator], Thi Nhung Pham, Christophe Steiner.
- GENCI projet : t2016067580 "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

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. EUROfusion 2015-2017

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

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Michel Mehrenberger has a collaboration with Bedros Afeyan (Pleasanton, USA) to work on KEEN wave simulations.

9.4.2. Participation In other International Programs

Participants: 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 objective 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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, 2014–2018) coordinated by F. Hamel (Univ. Aix-Marseille).
- A. Lejay is member of the ANR H2MNO4 (Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology, ANR Cosinus, 2012–2015) coordinated by Joceyline Erhel (IRISA, Rennes).
- E. Tanré is member of the ANR SloFaDyBio (Slow Fast Dynamics in Biology, ANR-14-CE25-0019, 2015-2017) coordinated by M. Desroches (EPI NEUROMATHCOMP, Inria Sophia Antipolis).

9.1.2. Contract with ADEME

Participants: Mireille Bossy, Sélim Kraria.

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

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

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

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

9.3. International Initiatives

9.3.1. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

9.3.1.1. ANESTOC-TOSCA

Title: Stochastic modelling of biology and renewable energies

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2014

See also: http://www.anestoc.cl/es/?page_id=1112

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

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

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

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

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

9.4.1.1. Internships

CHIKHAOUI Maroua

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

Date: May 2015 - Sept. 2015

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

CORMIER Quentin

Subject: Réseaux de neurones à décharge avec phénomènes de plasticité

Date: Oct. 2015 - Feb. 2016

Institution: ENS Lyon.

EVANGELISTA Roberta

Subject: A stochastic model of gamma phase modulated orientation selectivity

Date: May 2015 - Sept. 2015

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

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

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

VEGAS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. 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 will end in march 2016. It is coordinated by Xavier Goaoc who moved from the Vegas team to Marne-la-Vallée university in 2013.

Project website: <http://webloria.loria.fr/~moroz/ANR-Presage>.

7.1.2. 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.

In 2015, the project funded the postdoc position of Rémi Imbach.

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

7.2. International Research Visitors

7.2.1. Visits to International Teams

Monique Teillaud was invited at the Workshop on Computational Geometric and Algebraic Topology, *Mathematisches Forschungsinstitut Oberwolfach*, where she presented **CGAL**, the Computational Geometry Algorithms Library. https://www.mfo.de/occasion/1542/www_view

VERIDIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Participants: Pablo Dobal, Pascal Fontaine.

The PhD thesis of Pablo Federico Dobal was jointly funded by Région Lorraine and the ANR-DFG project SMArT (section 9.2) between September 2014 and August 2015.

9.2. National Initiatives

9.2.1. ANR-DFG Project SMArT

Participants: Haniel Barbosa, David Déharbe, Pablo Dobal, Pascal Fontaine, Maximilian Jaroschek, 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 partners are both the French and German parts of VeriDis 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. Arithmetic reasoning is one strong direction of research at MPI, and the state-of-the-art tool Redlog (section 6.1) is mainly developed by Thomas Sturm. The SMT solver veriT (section 6.4), developed in Nancy, serves as an experimentation platform for theories, techniques and methods designed within this project.

In September 2014, Pablo Federico Dobal was hired as a PhD student in joint supervision with Saarland University, co-funded by the SMArT project and the Région Lorraine. For personal reasons, his thesis has been put on hold in September 2015.

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

9.2.2. ANR Project IMPEX

Participants: Manamiary Andriamiarina, Souad Kherroubi, Dominique Méry.

The ANR Project IMPEX is an INS ANR project that 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 [28], 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 [13] is to offer rigorous mechanisms for handling domain knowledge in design models.

9.2.3. 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, will be integrated in various proof assistants, including Isabelle, Coq, and the TLA⁺ Proof System. The project is coordinated by Jasmin Blanchette and also involves Inria Saclay (EPI Toccata) and Inria Rennes (EPI Celtique), among others. Simon Cruanes was hired in October 2015 and has started the development of Nunchaku, whereas Blanchette has developed a preliminary version of the Isabelle frontend. We expect a first release in early 2016.

9.2.3.1. Inria ADT PLM (2014-2016)

Participants: Martin Quinson, Matthieu Nicolas.

Joint work with Gérald Oster (project-team Coast, Inria Nancy – Grand Est).

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 heavily refactored the software into a web application, to grow the user community amongst learners and thus gather more learning analytics. We also added the ability to solve PLM exercises by assembling code blocks as in Scratch. Finally, we started working on an integrated exercise editor in the hope of growing the user community amongst teachers that will be able to propose their own exercises on top of PLM.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. MEALS

Title: Mobility between Europe and Argentina applying Logics to Systems

Programm: FP7

Duration: October 2011 – September 2015

Coordinator: Université de la sarre

Partners:

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

Rheinisch-Westfälische Technische Hochschule Aachen (Germany)

Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Dresden (Germany)

University of Leicester (United Kingdom)

Universität des Saarlandes (Germany)

Universidad de Buenos Aires (Argentina)

Universidad Nacional de Córdoba (Argentina)

Universidad Nacional de Rio Cuarto (Argentina)

Instituto Tecnológico Buenos Aires (Argentina)

Inria contact: Castuscia Palamidessi

The MEALS project funds staff exchanges between institutions in Europe and Argentina. It is structured in five work packages (Quantitative Analysis of Concurrent Program Behaviour, Reasoning Tasks for Specification and Verification, Security and Information Flow Properties, Synthesis in Model-based Systems Engineering, Foundations for the Elaboration and Analysis of Requirements Specifications). Our team mainly cooperates with the group led by Carlos Areces in Córdoba within work package 2. In 2015, the project funded visits by Raúl Fervari and Guillaume Hoffmann in Nancy.

9.3.2. Collaborations with Major European Organizations

9.3.2.1. Cooperation with EPFL

Participants: Haniel Barbosa, Jasmin Christian Blanchette, Simon Cruanes, Pascal Fontaine.

We cooperate with Andrew Reynolds from the École polytechnique fédérale de Lausanne, Switzerland, on improving SMT solvers and bridging the gap between SMT solvers and proof assistants. This cooperation started in 2014 between Blanchette and Reynolds and has been pursued in 2015, with mutual one-week visits. The outcomes are manifold:

- We developed a decision procedure that combines reasoning about datatypes and codatatypes and implemented it in the SMT solver CVC4 [31]. This procedure is useful both for proving theorems and for model finding (counterexample generation).
- We designed an encoding of recursive and corecursive function definitions on datatypes and codatatypes that makes it possible to employ finite model finding techniques on functions with infinite domains, as long as they satisfy a wide, semantic criterion [36]. We started the development of a model finder for higher-order logic, called Nunchaku, based on this idea.
- We started work on a general framework for handling quantified formulas in SMT solving. Its focus is on the derivation of instances conflicting with a ground context, redefining the approach introduced by Reynolds et al. [68]. We enhanced the classical congruence closure algorithm so that it can handle free variables [34]. We expect the fruits of this research to be implemented in veriT and CVC4.

9.3.2.2. Cooperation with NUI Maynooth, Ireland

Participant: Dominique Méry.

The project *Building Reliable Systems: Software Refinement meets Software Verification* was a one-year project funded by PHC Ulysses. The academic Irish partner is Rosemary Monahan of NUI Maynooth. The verification of software requires the specification of preconditions and postconditions as well as other properties of the code. These properties are expressed as annotations and provide a detailed understanding of how the software is implemented. In program verification, the annotation process is often done *a posteriori*, with verification tools used to check that annotations are sound according to the semantics of the program. Determining the correct annotations to provide a complete specification is difficult, especially when specifying invariant properties of the code. *A priori* techniques for developing correct software are based on the correct-by-construction paradigm. The refinement-based approach is such a technique, providing for the construction of a correct program through the step-by-step refinement of an initial high-level model of the software. In this way, the program specification is developed alongside the code, discharging the conditions that need to be proved. We focus on combining these two software engineering techniques, to benefit from the strengths of both. We have proposed a framework for integrating the *a posteriori* paradigm Spec# and the *a priori* paradigm Event-B. This integration induces a methodology that bridges the gap between software modeling and program verification in the software development life cycle. For validating this methodology, we have designed the Rodin plugin **EB2RC** that implements transformations of Event-B models into algorithms.

9.4. International Initiatives

9.4.1. Participation In other International Programs

9.4.1.1. STIC AmSud MISMT

Participants: Haniel Barbosa, David Déharbe, Pablo Dobal, Pascal Fontaine, Stephan Merz.

VeriDis has a close working relationship with two South American teams at Universidade Federal do Rio Grande de Norte (UFRN), Brazil (more specifically with Prof. David Déharbe), and at Universidad Nacional de Córdoba, Argentina (more specifically with Prof. Carlos Areces). The STIC AmSud MISMT project, including both teams and VeriDis, started in 2014. It complements the MEALS project (section 9.3) and extends it to cooperation with UFRN.

The project is centered around Satisfiability Modulo Theories, with a focus on applications to Modal Logic [37]. Notably, the project supports the development of the veriT solver (section 6.4), of which David Déharbe and Pascal Fontaine are the main developers.

The project helped fund the stay of Haniel Barbosa in Natal (PhD in joint supervision between Nancy and Natal) from October to December, 2015. The project has been terminated prematurely due to funding problems.

9.4.1.2. Cooperation with NASA Ames Research Center, U.S.A.

Participant: Dominique Méry.

Joint work with Didier Fass of LORIA, Nancy.

Didier Fass and Dominique Méry have started a close working relationship with Brian Gore and his colleagues at the NASA Ames Research Center, Human Systems Integration Division (HSI). It is anticipated that collaboration among the researchers at NASA Ames and LORIA will lead to more formal understanding of the methods required to optimize human-systems integration issues in the design of complex human-automation systems.