RESEARCH CENTER
Nancy - Grand Est

FIELD

Activity Report 2018

Section Partnerships and Cooperations

Edition: 2019-03-07

ALICE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. EXPLORAGRAM

Inria exploratory project EXPLORAGRAM (in cooperation with MOKAPLAN): We explored new algorithms for computational optimal transport. The project allowed us to hire a post-doc for 18 months (Erica Schwindt). She worked on the semi-discrete algorithm, and its application to the simulation of fluid-structure interactions. The project allowed to strengthen the cooperation with MOKAPLAN. It also allowed us to start exploring new cooperations, with Institut d'Astrophysique de Paris, on early universe reconstruction. The results were published in [7].

8.1.2. ANR MAGA (2016-2020)

We participate in the ANR MAGA (ANR-16-CE40-0014) on the Monge Ampere equation and computational geometry. In this ANR project, we cooperate with Quentin Merigot and other researchers of the MOKAPLAN Inria team on new computational methods for optimal transport.

8.1.3. ANR ROOT (2016-2020)

We participate in the Young Researcher ANR ROOT (ANR-16-CE23-0009) on Optimal Transport for computer graphics, with Nicolas Bonneel (CNRS Lyon) as Principal Investigator. In the context of this project, we develop a new symmetric algorithm for semi-discrete optimal transport that optimizes for both the location of the samples and their Lagrange multipliers. An ENS training period will start in Jan. 2018 (Agathe Herrou), hosted in Nancy.

8.2. International Research Visitors

8.2.1. Visits of International Scientists

Oleksandr Bondarenko (KPI, Ukraine) visited the team from 19 October 2018 to 30 October 2018. The goal of the visit was to work on pendulum stabilization.

8.2.2. Visits to International Teams

8.2.2.1. Sabbatical programme

Dmitry Sokolov visited Kuban State University (Russia) from 1 August 2018 to 31 August 2018 for his CNRS sabbatical programme. As a result, two papers are being prepared for Mechantronics 2019 submission.

BIGS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- GDR 3475 Analyse Multifractale, Funding organism: CNRS, Leader: S. Jaffard (Université Paris-Est), Céline Lacaux
- GDR 3477 Géométrie stochastic, 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
- A. Gégout-Petit, N. Sahki, S. Mézières are involved in the learning aspect of the clinical protocol "EOLEVAL" with Assistance Publique des Hopitaux de Paris (APHP)
- "ITMO Physics, mathematics applied to Cancer" (2017-2019): "Modeling ctDNA dynamics for detecting targeted therapy", Funding organisms: ITMO Cancer, ITMO Technologies pour la santé de l'alliance nationale pour les sciences de la vie et de la santé (AVIESAN), INCa, Leader: N. Champagnat (Inria TOSCA), Participants: A. Gégout-Petit, A. Muller-Gueudin, P. Vallois.
- PEPS AMIES (2018-2019), Etude Biométrique en foetopathologie et développement de l'enfant, Collaboration Institut Elie Cartan avec le CRESS INSERM, S. Ferrigno.
- Modular, multivalent and multiplexed tools for dual molecular imaging (2017-2020), Funding organism: ANR, Leader: B Kuhnast (CEA). Participant: T. Bastogne.
- Sophie Mézières belongs to GDR 720 ISIS, Funding organism: CNRS, leader: Laure Blanc-Féraud.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

T. Bastogne participates to the ASCATIM Project (project FEDER), leaded by N. Tran and J.-P. Jehl (2018-2021).

CAMUS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Idex Prim'Eau

Participant: Jens Gustedt [contact].

In the framework of the Prim'Eau project of the University of Strasbourg, we study surface runoff for hydrological periods of several days. We use an efficient domain decomposition method that we apply to a real world example of Mutterbach (Moselle) with geological and flood data from the years 1920, 1940 and 2017. As the time and memory usage for these computations is important, we aim to parallelize them.

9.1.2. ADT ASNAP

Participants: Philippe Clauss, Jens Gustedt, Maxime Mogé.

Philippe Clauss, Jens Gustedt and Maxime Mogé have been involved until August 2018 in the ADT Inria project ASNAP (Accélération des Simulations Numériques pour l'Assistance Peropératoire), in collaboration with the Inria team MIMESIS. The goal was to find opportunities in the SOFA simulation platform for applying automatic parallelization techniques developed by Camus. We have investigated two approaches. One approach uses memory behavior memoïzation to generate a parallel code made of independent threads at runtime.

9.1.3. ADT ALTO (ApoLlo TakeOff)

Participants: Philippe Clauss, Muthena Abdul Wahab.

The Apollo compilation platform [4] that is being developed in Camus, dedicated to speculative and dynamic optimization and parallelization of loop nests, is the achievement of many original advances in compilation algorithms, in extensions of the polyhedral model, in speculative parallelization and in dynamic optimization of programs. It is a library of implemented knowledge and a fertile ground for other advances and extensions : for instance, an extension of the polyhedral model for handling non-linear loops would not have been possible without Apollo. However, this software platform must continuously be maintained, improved and extended.

The ALTO project, which is a 2.5 years project started in August 2018, is devoted to strengthen Apollo's software implementation in several ways, thanks to the expert engineer who has been recruited for these goals, Matthew Wahab. The main goals are the following:

- making the programming code respecting the standard rules of open-source software;
- making Apollo more robust regarding cases where some inputs may yield extreme behaviors
- implementing required improvements and extensions, as inter-procedural analysis or memory behavior memoïzation.

9.2. National Initiatives

9.2.1. ANR AJACS

Participant: Arthur Charguéraud.

The AJACS research project is funded by the programme "Société de l'information et de la communication" of the ANR, from October 2014, until March 2019. http://ajacs.inria.fr/

The goal of the AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts implemented in JavaScript, the most widely used language for the Web. The proposal is to prove correct analyses for JavaScript programs, in particular information flow analyses that guarantee no secret information is leaked to malicious parties. The definition of sub-languages of JavaScript, with certified compilation techniques targeting them, will allow deriving more precise analyses. Another aspect of the proposal is the design and certification of security and privacy enforcement mechanisms for web applications, including the APIs used to program real-world applications. Arthur Charguéraud focuses on the description of a formal semantics for JavaScript, and the development of tools for interactively executing programs step-by-step according to the formal semantics.

Partners: team Celtique (Inria Rennes - Bretagne Atlantique), team Prosecco (Inria Paris), team Indes (Inria Sophia Antipolis - Méditerranée), and Imperial College (London).

9.2.2. ANR Vocal

Participant: Arthur Charguéraud.

The Vocal research project is funded by the programme "Société de l'information et de la communication" of the ANR, for a period of 48 months, starting on October 1st, 2015. https://vocal.lri.fr/

The goal of the Vocal project is to develop the first formally verified library of efficient general-purpose data structures and algorithms. It targets the OCaml programming language, which allows for fairly efficient code and offers a simple programming model that eases reasoning about programs. The library will be readily available to implementers of safety-critical OCaml programs, such as Coq, Astrée, or Frama-C. It will provide the essential building blocks needed to significantly decrease the cost of developing safe software. The project intends to combine the strengths of three verification tools, namely Coq, Why3, and CFML. It will use Coq to obtain a common mathematical foundation for program specifications, as well as to verify purely functional components. It will use Why3 to verify a broad range of imperative programs with a high degree of proof automation. Finally, it will use CFML for formal reasoning about effectful higher-order functions and data structures making use of pointers and sharing.

Partners: team Gallium (Inria Paris), team DCS (Verimag), TrustInSoft, and OCamlPro.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERC Deepsea

Participant: Arthur Charguéraud.

The Deepsea project is funded by ERC from June 2013 to May 2018. It aims at developing abstractions, algorithms and languages for parallelism and dynamic parallelism with applications to problems on large data sets. Umut A. Acar (affiliated to Carnegie Mellon University and Inria Paris) is the principal investigator of this ERC-funded project. The other main researchers involved are Mike Rainey (Inria, Gallium team), who is full-time on the project, and Arthur Charguéraud (Inria, Camus team), who works part time on this project. Project website: http://deepsea.inria.fr/.

9.3.2. Collaborations with Major European Organizations

Cristian Ramon-Cortes and Rosa M. Badia: Barcelona Supercomputing Center (Spain)
A Python module for automatic parallelization and distributed execution of affine loop nests

Raquel Lazcano and Eduardo Juárez Martínez: Universidad Politecnica de Madrid (Spain)
Integration of Apollo in the Cerbero dataflow framework for adaptive code generation.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

The CAMUS team maintains regular contacts with the following entities:

- Reservoir Labs, New York, NY, USA
- University of Batna, Algeria
- Ohio State University, Colombus, USA
- Louisiana State University, Baton Rouge, USA
- Colorado State University, Fort Collins, USA
- Indian Institute of Science (IIIS) Bangalore, India
- Barcelona Supercomputing Center, Barcelona, Spain

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Rachid Seghir (Maître de conférences A, University of Batna, Algeria) visited our team (June 16-23, 2018), to participate to the mid-thesis evaluation of Harenome Ranaivoarivony-Razanajato, and work with Vincent Loechner on our ongoing collaboration co-advising Toufik Baroudi.

9.5.2. Internships

Toufik Baroudi is a PhD student under the supervision of Rachid Seghir at University of Batna (Algeria). He is co-advised by Vincent Loechner, and visiting our team as an intern for one year since November 2018, founded by the Algerian *Programme National Exceptionnel (PNE)*. His PhD defense is planned at the end of 2019.

CAPSID Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CPER – IT2MP

Participants: Marie-Dominique Devignes [contact person], Malika Smaïl-Tabbone, David Ritchie.

Project title: *Innovations Technologiques, Modélisation et Médecine Personnalisée*; PI: Faiez Zannad, Univ Lorraine (Inserm-CHU-UL). Value: 14.4 M€ ("SMEC" platform – Simulation, Modélisation, Extraction de Connaissances – coordinated by Capsid and Orpailleur teams for Inria Nancy – Grand Est, with IECL and CHRU Nancy: 860 k€, approx); Duration: 2015–2020. Description: The IT2MP project encompasses four interdisciplinary platforms that support several scientific pôles of the university whose research involves human health. The SMEC platform supports research projects ranging from molecular modeling and dynamical simulation to biological data mining and patient cohort studies.

8.1.2. LUE-FEDER – CITRAM

Participants: Marie-Dominique Devignes [contact person], Isaure Chauvot de Beauchêne, Bernard Maigret, Philippe Noël, David Ritchie.

Project title: *Conception d'Inhibiteurs du Transfert de Résistances aux agents Anti-Microbiens: bio-ingénierie assistée par des approches virtuelles et numériques, et appliquée à une relaxase d'élément conjugatif intégratif*; PI: N. Leblond, Univ Lorraine (DynAMic, UMR 1128); Other partners: Chris Chipot, CNRS (SRSMSC, UMR 7565); Value: 200 k€ (Capsid: 80 k€); Duration: 2017–2018. Description: This project follows on from the 2016 PEPS project "MODEL-ICE". 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, and to develop small-molecule inhibitors of these interactions.

8.1.3. PEPS – DynaCriGalT

Participants: Isaure Chauvot de Beauchêne [contact person], Bernard Maigret, David Ritchie.

Project title: *Criblage virtuel et dynamique moléculaire pour la recherche de bio-actifs ciblant la β4GalT7, une enzyme de biosynthèse des glycosaminoglycanes*; PI: I. Chauvot de Beauchêne, Capsid (Inria Nancy – Grand Est); Partners: Sylvie Fournel-Gigleux, INSERM (IMoPA, UMR 7365); Value: 15 k€; Duration: 2017–2018. Description: The β4GalT7 glycosyltransferase initiates the biosynthesis of glycosaminoglycans (GAGs), and is a therapeutical target for small molecules which might correct a defect in the synthesis and degradation of GAGs in rare genetic diseases. Classical approaches to propose active molecules have failed for this target. The DynaCriGalT project combines molecular dynamics modelling of the GAG active site with virtual screening in order to propose a diverse set of small molecules for *in vitro* compound testing.

8.1.4. PEPS – InterANRIL

Participant: Isaure Chauvot de Beauchêne [contact person].

Project title: *TBA* Duration: 2017–2018. Description: *TBA*

Project title: *Identification et modélisation des interactions nécessaires à l'activité du long ARN non-codant ANRIL dans la régulation épigénétique des gènes*; PI: Sylvain Maenner, Univ Lorraine (IMoPA, UMR 7365); Value: 20 k€; Duration: 2017–2018. Description: ANRIL is a long non-coding RNA (lncRNA) which has been identified as an important factor in the susceptibility cardiovascular diseases. ANRIL is involved in the epigenetic regulation of the expression of a network of genes via mechanisms that are still largely unknown. This project aims to identify and model the protein-RNA and/or DNA-RNA interactions that ANRIL establishes within the eukaryotic genome.

8.1.5. GlycoEst

Participant: Isaure Chauvot de Beauchêne [contact person].

GlycoEst is an informal working group which was recently created to develop an interdisciplinary regional network of Glyco-scientists. Isaure Chauvot de Beauchêne gave a talk on her protein-GAG docking method at the first meeting of this group in March 2018.

8.2. National Initiatives

8.2.1. FEDER – SB-Server

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

Project title: *Structural bioinformatics server*; PI: David Ritchie, Capsid (Inria Nancy – Grand Est); Value: 24 k€; Duration: 2015–2020. Description: This funding provides a small high performance computing server for structural bioinformatics research at the Inria Nancy – Grand Est centre.

8.2.2. ANR

8.2.2.1. Fight-HF

Participants: Marie-Dominique Devignes [contact person], Malika Smaïl-Tabbone [contact person], Bernard Maigret, Sabeur Aridhi, Kévin Dalleau, Claire Lacomblez, David Ritchie.

Project title: *Combattre l'insuffisance cardiaque*; PI: Patrick Rossignol, Univ Lorraine (FHU-Cartage); Partners: multiple; Value: 9 m€ (Capsid and Orpailleur: 450 k€, approx); Duration: 2015–2019. Description: This "Investissements d'Avenir" project aims to discover novel mechanisms for heart failure and to propose decision support for precision medicine. The project has been granted € 9M, and involves many participants from Nancy University Hospital's Federation "CARTAGE" (http://www.fhu-cartage.com/). In collaboration with the Orpailleur Team, Marie-Dominique Devignes is coordinating a work-package on network-based science and drug discovery for this project.

8.2.2.2. IFB

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

Project title: *Institut Français de Bioinformatique*; PI: Claudine Médigue and Jacques van Helden (CNRS UMS 3601); Partners: multiple; Value: 20 M€ (Capsid: 126 k€); Duration: 2014–2021. Description: 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.

8.2.3. Collaborations with Major European Organizations

EBI: European Bioinformatics Institute, Maria Martin team (UK). We are working with the EBI team to validate and improve our graph-based approaches for protein function annotation.

8.2.4. PEPS-INS2I – ORCA 3D

Participants: Isaure Chauvot de Beauchêne [contact person], Agnibha Chandra, Rohit Roy.

Protect Title: *Oligo-RNA Combinatorial Assembly for 3D modeling of protein-RNA complexes.* PI: Isaure Chauvot de Beauchêne. Value: 8k€. Description: The project aimed at improving our fragment-based ssRNA docking method, of which we already provided a proof of principle. It mainly provided grants for two internship students to work on (i) a new ssRNA-protein scoring function and (ii) docking with constraints specific to the geometry of ssRNA in RNA loops.

8.3. International Initiatives

8.3.1. TempoGraphs

Participants: Sabeur Aridhi [contact person], Marie-Dominique Devignes, Malika Smaïl-Tabbone, David Ritchie, Bishnu Sarker, Wissem Inoubli.

Project title: *Analyzing big data with temporal graphs and machine learning: application to urban traffic analysis and protein function annotation.* PI: Sabeur Aridhi; Partners: LORIA/Inria NGE, Federal University of Ceará (UFC); Value: 20 k€; Duration: 2017–2020. Description: This project aims to investigate and propose solutions for both urban traffic-related problems and protein annotation problems. In the case of urban traffic analysis, problems such as traffic speed prediction, travel time prediction, traffic congestion identification and nearest neighbors identification will be tackled. In the case of protein annotation problem, protein graphs and/or protein–protein interaction (PPI) networks will be modeled using dynamic time-dependent graph representations.

8.3.1.1. Informal International Partners

Participant: David Ritchie; Project: *Integrative Modeling of 3D Protein Structures and Interactions;* Partner: Rocasolano Institute of Physical Chemistry, Spain. Funding: Inria Nancy – Grand Est ("Nancy Emerging Associate Team").

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, Brazil.

Participant: Bernard Maigret; Project: *Fusarium graminearum target selection;* Partner: Embrapa Recursos Geneticos e Biotecnologia, Brazil.

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

Participant: Bernard Maigret; Project: *Protein-protein interactions for the development of new drugs;* Partner: Federal University of Goias, Brazil.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Ghania Khensous from the University of Sciences and Technologies in Oman visited the team to develop a tabu-based search algorithm for flexible protein-ligand docking, under the supervision of Bernard Maigret.

Patricia Alves from the University of Brasilia is visiting the team to carry out drug repositioning on several target fungus proteins under the supervision of Bernard Maigret.

8.4.1.1. Internships

Agnibha Chandra from the Indian Institute of Engineering Science & Technology visited the team to optimize a force-field for ssRNA-protein docking, under the supervision of Isaure Chauvot de Beauchêne.

Ismail El Fadli from the Mohammed V University of Rabat visited the team to adapt our RNA-protein docking method to DNA-protein systems, under the supervision of Isaure Chauvot de Beauchêne.

Aichata Niang from the University of Paris Diderot visited the team to to apply modeling and virtual screening of a galactosyl-transferase enzyme in order to find new inhibitors, under the supervision of Isaure Chauvot de Beauchêne.

Rohit Roy from the Indian Institute of Technology at Kharagpur visited the team in order to include geometric constrains in our docking algorithm for docking RNA loops, under the supervision of Isaure Chauvot de Beauchêne.

Giammarco Mastronardi from the University of Lorraine visited the team to carry out a virtual screening study of small-molecule inhibitors of a bacterial polyketide synthase module, under the supervision of Bernard Maigret and David Ritchie.

Wissem Inoubli from the University of Tunis El Manar visited the team to work on his PhD thesis on distributed graph processing under the supervision of Sabeur Aridhi.

Damien Vantourout from the University of Lorraine visited the team to develop a tool for protein function annotation using semantic protein networks and deep neural networks under the supervision of Sabeur Aridhi.

Xavier Farchetto from the University of Lorraine visited the team to work on the segmentation of images in Crohn's disease under the supervision of Malika Smaïl-Tabbone and Chedy Raissy (Orpailleur team).

Maxime Guyot from the University of Lorraine (Telecom Nancy stage 2A) visited the team to perform statistical analyses on KBDock and to develop a scoring function for protein-protein interaction subgraphs extracted from a knowledge graph database.

CARAMBA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CPER CyberEntreprises

Program: CPER (Contrat de Plan État Région)

Project title: Cyber-Entreprises

Duration: 01/07/2015 - 31/12/2020

Coordinator: Emmanuel Thomé and Marc Jungers (CRAN)

Other partners: Inria, LORIA, CRAN, IECL, Centrale Supelec, LCFC.

Abstract: cf web site (in French only).

A high-performance computer cluster was funded by the CPER Cyber-entreprises project (Région Grand-Est, French Ministry of Research and Higher Education, Inria, CNRS). This cluster is also mentioned in 6.4 .

9.2. National Initiatives

9.2.1. FUI Industrial Partnership on Lightweight Cryptography

Program: FUI (Fonds Unique Interministériel)

Project acronym: PACLIDO

Project title: Protocoles et Algorithmes Cryptographiques Légers pour l'Internet Des Objets

Duration: 12/2017 - 12/2020

Coordinator: Airbus Cybersecurity.

Other partners: organisme, labo (pays) Airbus Cybersecurity, LORIA-CNRS, Rtone, Trusted Objects, CEA, Sophia Engineering, Université de Limoges, Saint-Quentin-en-Yvelines.

This contract is dedicated to the definition of new lightweight cryptographic primitives for the IoT. See web site for a full presentation.

Coast Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Region Grand Est TV Paint (2017–2019)

Participants: Claudia-Lavinia Ignat, Gérald Oster, Cédric Enclos.

Partners: TVPaint Development, Inria Coast project-team

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

This is a project in collaboration with TVPaint Development financed by Region Grand Est. It is a follow-up of a project in collaboration with TVPaint Development financed by Region Lorraine from 2016 to 2017. The goal is to contribute to the creation of a collaborative system dedicated to manage the production of animated movies. This system has to manipulate a large amount of data in a safe and secure manner. Based on the previously proposed architecture and prototype, this project intends to design and implement a commercial product. In the framework of this project, we bring our expertise in data management, business process management, distributed systems and collaborative systems.

8.2. National Initiatives

8.2.1. OpenPaas NG (2015–2019)

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

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

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

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

8.3. International Initiatives

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

8.3.1.1. USCoast2

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2016

See also: http://usCoast.loria.fr

The proposed project addresses the perception of trust by users, the appropriateness of a trust-based security approach and the role of trust metrics in the management of distributed work. The main challenge of this project is how to measure trust based on user behaviour and to verify by means of experimental studies with users that the trust-based mechanism is acceptable by users. We plan to apply this trust-based mechanism for two types of applications. The first one is collaborative editing where user trust will be computed based on the quality of user contributions for a document or project. The second type of application is in the management of work over a large group of people in order to conduct efficient, high-yield, high-density real time crowdsourcing activities. Partners of USCoast2 project have complementary expertise. Coast provides expertise in collaborative methods, systems and related technologies. Coast will propose algorithms that track and manipulate trust metrics.Knoesis provides expertise on the analysis of human work-related behaviour, including methods of data collection and data analysis, as well as a theoretical foundation for the evaluation of human performance. Knoesis will analyse trust from a psychological phenomenon point of view.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

As part of our work on elastic business processes execution, we started a collaboration with Professor Cesare Pautasso from the University of Lugano. We developed a benchmarking framework for business process execution in the cloud, including hot migration of process engine in a multi-tenant setting. This collaboration resulted in a framework that allows repeatable evaluation of process execution.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Weihai Yu, The Arctic University of Norway, is doing his sabbatical year in the period September 1, 2018 - August 31, 2019 in the Coast team. He is working on the formalisation of undo with CRDTs.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

- François Charoy visited Knoesis team at Wright State University, OH from the 15th of June to the 23rd of July (USCoast2). He worked with Valerie Shalin on trust in sharing data during crisis amng different organisations.
- François Charoy visited the SOC Team of Boualem Benatallah at UNSW, Sydney, Australia from the 26 of August to the 14th of September. He collaborated with Boualem Benatallah on a new project on Composition of cognitive services at a large scale.

GAMBLE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

We organized, with colleagues of the mathematics department (Institut Elie Cartan Nancy) a regular working group about geometry and probability.

9.2. National Initiatives

9.2.1. ANR SingCAST

Project title: Singular Curves and Surfaces Topology
Duration: March 2014 – August 2018
Coordinators: Guillaume Moroz 60%, and Marc Pouget 40%
Abstract: The objective of the young-researcher ANR grant SingCAST was to intertwine further symbolic/numeric approaches to compute efficiently solution sets of polynomial systems with topological and geometrical guarantees in singular cases. We focused on two applications: the visualization of algebraic curves and surfaces and the mechanical design of robots. We developed 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.

The project had a total budget of 100k€. Project website: https://project.inria.fr/singcast/.

9.2.2. ANR SoS

Project title: Structures on Surfaces
Duration: 4 years
Starting Date: April 1st, 2018
Coordinator: Monique Teillaud
Participants:

- Gamble project-team, Inria.
- LIGM (Laboratoire d'Informatique Gaspard Monge), Université Paris-Est Marne-la-Vallée. Local Coordinator: Éric Colin de Verdière.
- RMATH (Mathematics Research Unit), University of Luxembourg. National Coordinator: Hugo Parlier

SoS is co-funded by ANR (ANR-17-CE40-0033) and FNR (INTER/ANR/16/11554412/SoS) as a PRCI (Projet de Recherche Collaborative Internationale).

The central theme of this project is the study of geometric and combinatorial structures related to surfaces and their moduli. Even though they work on common themes, there is a real gap between communities working in geometric topology and computational geometry and SoS aims to create a long lasting bridge between them. Beyond a common interest, techniques from both ends are relevant and the potential gain in perspective from long-term collaborations is truly thrilling.

In particular, SoS aims to extend the scope of computational geometry, a field at the interface between mathematics and computer science that develops algorithms for geometric problems, to a variety of unexplored contexts. During the last two decades, research in computational geometry has gained wide impact through CGAL, the Computational Geometry Algorithms Library. In parallel, the needs for non-Euclidean geometries are arising, e.g., in geometric modeling, neuromathematics, or physics. Our goal is to develop computational geometry for some of these non-Euclidean spaces and make these developments readily available for users in academy and industry.

To reach this aim, SoS will follow an interdisciplinary approach, gathering researchers whose expertise cover a large range of mathematics, algorithms and software. A mathematical study of the objects considered will be performed, together with the design of algorithms when applicable. Algorithms will be analyzed both in theory and in practice after prototype implementations, which will be improved whenever it makes sense to target longer-term integration into CGAL.

Our main objects of study will be Delaunay triangulations and circle patterns on surfaces, polyhedral geometry, and systems of disjoint curves and graphs on surfaces.

Project website: https://members.loria.fr/Monique.Teillaud/collab/SoS/.

9.2.3. ANR Aspag

Project title: Analyse et Simulation Probabilistes d'Algorithmes Géométriques
Duration: 4 years
Starting date: January 1st, 2018
Coordinator: Olivier Devillers
Participants:

- Gamble project-team, Inria.
- Labri (Laboratoire Bordelais de Recherche en Informatique), Université de Bordeaux. Local Coordinator: Philippe Duchon.
- Laboratoire de Mathématiques Raphaël Salem, Université de Rouen. Local Coordinator: Pierre Calka.
- LAMA (Laboratoire d'Analyse et de Mathématiques Appliquées), Université Paris-Est Marne-la-Vallée. Local Coordinator: Matthieu Fradelizi

Abstract: ASPAG projet is funded by ANR undered number ANR-17-CE40-0017 .

The analysis and processing of geometric data has become routine in a variety of human activities ranging from computer-aided design in manufacturing to the tracking of animal trajectories in ecology or geographic information systems in GPS navigation devices. Geometric algorithms and probabilistic geometric models are crucial to the treatment of all this geometric data, yet the current available knowledge is in various ways much too limited: many models are far from matching real data, and the analyses are not always relevant in practical contexts. One of the reasons for this state of affairs is that the breadth of expertise required is spread among different scientific communities (computational geometry, analysis of algorithms and stochastic geometry) that historically had very little interaction. The Aspag project brings together experts of these communities to address the problem of geometric data. We will more specifically work on the following three interdependent directions.

(1) Dependent point sets: One of the main issues of most models is the core assumption that the data points are independent and follow the same underlying distribution. Although this may be relevant in some contexts, the independence assumption is too strong for many applications.

(2) Simulation of geometric structures: The phenomena studied in (1) involve intricate random geometric structures subject to new models or constraints. A natural first step would be to build up our understanding and identify plausible conjectures through simulation. Perhaps surprisingly, the tools for an effective simulation of such complex geometric systems still need to be developed.

(3) Understanding geometric algorithms: the analysis of algorithm is an essential step in assessing the strengths and weaknesses of algorithmic principles, and is crucial to guide the choices made when designing a complex data processing pipeline. Any analysis must strike a balance between realism and tractability; the current analyses of many geometric algorithms are notoriously unrealistic. Aside from the purely scientific objectives, one of the main goals of Aspag is to bring the communities closer in the long term. As a consequence, the funding of the project is crucial to ensure that the members of the consortium will be able to interact on a very regular basis, a necessary condition for significant progress on the above challenges.

Project website: https://members.loria.fr/Olivier.Devillers/aspag/.

9.2.4. PHC Embeds II

Embeds is a bilateral, two-year project funded by the PHC Barrande program. It is joint between various french locations (Paris Est, Grenoble and, since september 2018, Nancy) and Charles University (Prague). The PI are Xavier Goaoc and Martin Tancer. It started in 2015 for two years, and was renewed in 2017 for two more years (5kE/year on the french side to support travels).

Starting Date: January 1st, 2017.
Duration: 2 years.

9.2.5. Institut Universitaire de France

Xavier Goaoc was appointed *junior member* of the Institut Universitaire de France, a grant supporting a reduction in teaching duties and funding.

Starting Date: October 1st, 2014.
Duration: 5 years.

9.3. International Initiatives

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

9.3.1.1. TRIP

Title: Triangulation and Random Incremental Paths

International Partner: Carleton University (Canada) - Prosenjit Bose

Start year: 2018

See also: https://members.loria.fr/Olivier.Devillers/trip/

The two teams are specialists of Delaunay triangulation with a focus on computation algorithms on the French side and routing on the Canadian side. We plan to attack several problems where the two teams are complementary: - Stretch factor of the Delaunay triangulation in 3D. - Probabilistic analysis of Theta-graphs and Yao-graphs. - Smoothed analysis of a walk in Delaunay triangulation. - Walking in/on surfaces. - Routing in non-Euclidean spaces.

9.3.1.2. Astonishing

Title: ASsociate Team On Non-ISH euclIdeaN Geometry

International Partner: University of Groningen (Netherlands) - Institute of Systems Science - Gert Vegter

Start year: 2017

See also: https://members.loria.fr/Monique.Teillaud/collab/Astonishing/

Some research directions in computational geometry have hardly been explored. The spaces in which most algorithms have been designed are the Euclidean spaces $\mathbb{R}^d$. To extend further the scope of applicability of computational geometry, other spaces must be considered, as shown by the concrete needs expressed by our contacts in various fields as well as in the literature. Delaunay triangulations in non-Euclidean spaces are required, e.g., in geometric modeling, neuromathematics, or physics. Topological problems for curves and graphs on surfaces arise in various applications in computer graphics and road map design. Providing robust implementations of these results is a key towards their reusability in more applied fields. We aim at studying various structures and algorithms in other spaces than $\mathbb{R}^d$, from a computational geometry viewpoint. Proposing algorithms operating in such spaces requires a prior deep study of the mathematical properties of the objects considered, which raises new fundamental and difficult questions that we want to tackle.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Gert Vegter spent three weeks in GAMBLE in the framework of the Astonishing associate team.

Jean-Lou De Carufel and Prosenjit Bose spent one week in GAMBLE in the framework of the TRIP associate team.

Martin Tancer, Vojta Kalusza and Pavel Paták, from Charles University (Prague), spent one week each in GAMBLE. They were supported by the PHC program EMBEDS II.

9.4.2. Visits to International Teams

Olivier Devillers spent two weeks at the Computational Geometry Lab of Carleton University http://cglab.ca/about.html in the framework of the TRIP associate team.

Charles Duménil spent one month at the Computational Geometry Lab of Carleton University http://cglab.ca/about.html in the framework of the TRIP associate team.

Monique Teillaud and Iordan Iordanov spent one month at Johann Bernouilli Institute for Mathematics and Computer Science of the University of Groningen in the framework of the Astonishing associate team.

LARSEN Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Project PsyPhINe: Cogitamus ergo sumus

Title: Cogitamus ergo sumus

Program: PEPS CNRS

Duration: January 2016 - January 2018

Coordinator: MSH Lorraine (USR3261)

LARSEN member: Amine Boumaza

Psyphine is an interdisciplinary and exploratory project (see 9.1.1) between philosophers, psychologists and computer scientists. The goal of the project is related to cognition and behavior. Cognition is a set of processes that are difficult to unite in a general definition. The project aims to explore the idea of assignments of intelligence or intentionality, assuming that our intersubjectivity and our natural tendency to anthropomorphize play a central role: we project onto others parts of our own cognition. To test these hypotheses, our aim is to design a "non-verbal" Turing Test, which satisfies the definitions of our various fields (psychology, philosophy, neuroscience and computer science) using a robotic prototype. Some of the questions that we aim to answer are: is it possible to give the illusion of cognition and/or intelligence through such a technical device? How elaborate must be the control algorithms or "behaviors" of such a device so as to fool test subjects? How many degrees of freedom must it have?

Partner institutions: InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Inria Bordeaux Sud-Ouest, Loria (UMR7503) and MSH Lorraine (USR3261).

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. RESIBOTS

Title: Robots with animal-like resilience

Program: H2020

Type: ERC

Duration: May 2015 - April 2020

Coordinator: Inria

Inria contact: Jean Baptiste Mouret

Despite over 50 years of research in robotics, most existing robots are far from being as resilient as the simplest animals: they are fragile machines that easily stop functioning in difficult conditions. The goal of this proposal is to radically change this situation by providing the algorithmic foundations for low-cost robots that can autonomously recover from unforeseen damages in a few minutes. 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.

9.2.1.2. ANDY

Title: Advancing Anticipatory Behaviors in Dyadic Human-Robot Collaboration

Programme: H2020

Type: ICT RIA (No. 731540)

Duration: January 2017 - December 2020

Coordinator: IIT

PI for Inria: Serena Ivaldi

Recent technological progress permits robots to actively and safely share a common workspace with humans. Europe currently leads the robotic market for safety-certified robots, by enabling robots to react to unintentional contacts. AnDy leverages these technologies and strengthens European leadership by endowing robots with the ability to control physical collaboration through intentional interaction.

To achieve this interaction, AnDy relies on three technological and scientific breakthroughs. First, AnDy will innovate the way of measuring human whole-body motions by developing the wearable AnDySuit, which tracks motions and records forces. Second, AnDy will develop the AnDyModel, which combines ergonomic models with cognitive predictive models of human dynamic behavior in collaborative tasks, which are learned from data acquired with the AnDySuit. Third, AnDy will propose the AnDyControl, an innovative technology for assisting humans through predictive physical control, based on AnDyModel.

By measuring and modeling human whole-body dynamics, AnDy provides robots with an entirely new level of awareness about human intentions and ergonomy. By incorporating this awareness online in the robot's controllers, AnDy paves the way for novel applications of physical human-robot collaboration in manufacturing, health-care, and assisted living.

AnDy will accelerate take-up and deployment in these domains by validating its progress in several realistic scenarios. In the first validation scenario, the robot is an industrial collaborative robot, which tailors its controllers to individual workers to improve ergonomy. In the second scenario, the robot is an assistive exoskeleton which optimizes human comfort by reducing physical stress. In the third validation scenario, the robot is a humanoid, which offers assistance to a human while maintaining the balance of both.

Partners: Italian Institute of Technology (IIT, Italy, coordinator), Josef Stefan Institute (JSI, Slovenia), DLR (Germany), IMK Automotive Gmbh (Germany), XSens (Netherlands), AnyBody Technologies (Denmark)

9.3. International Initiatives

9.3.1. Lifelong Learning Machines program (DARPA) — STELLAR project

Title: STELLAR (Super Turing Evolving Lifelong Learning ARchitecture)

Coordinator: HRL laboratory (Malibu, USA)

Coordinator for Inria: Jean-Baptiste Mouret

Partners: Stanford University (USA), University of California Irvine (USA), University of Texas Austin (USA), IT University of Copenhagen (Denmark), Loughborough University (United Kingdom), Inria – Nancy Grand Est

Objective: Develop a general-purpose neural super Turing machine for lifelong learning and demonstrate supra-human performance in a simulated autonomous driving context. Our Super Turing Evolving Lifelong Learning ARchitecture (STELLAR) system will power a self-driving agent that continually improves its performance and updates its knowledge unsupervised, rapidly adapts to unforeseen contexts, and learns and consolidates new tasks without forgetting old ones. The project involves deep world models, neuroevolution, quality diversity algorithms, and plastic neural networks.

9.3.1.1. Informal International Partners

- Oxford University (Shimon Whiteson): data-efficient robot learning[22]
- Union College (John Rieffel): resilient tensegrity robots [10]
- Italian Institute of Technology (Enrico Mingo-Hoffman, Daniele Pucci, Nikos Tsagarakis): whole-body control of humanoids [11], [24], [27]
- IT University Copenhagen (Sebastian Risi): quality diversity algorithms
- Imperial College (Antoine Cully): data-efficient learning and quality diversity
- Hochschule Bonn-Rhein-Sieg (Alexander Asteroth): surrogate modelling [17], [7]
- Kyushu Institute of Technology, Japan (Sozo Inoue, Moe Matsuki): activity recognition

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Enrico Mingo Hoffman (Post-doc, Italian Institute of Technology) – from Feb 2018 to Feb 2018
- Niels Justesen (PhD student, IT University Copenhagen, Denmark) – from Sep 2018 to Dec 2018
- Marie Charbonneau (PhD student, IIT, Italy) – from May 2018 to Oct 2018
- Moe Matsuki (PhD student, Kyushu Institute of Technology, Japan) –fom sept 2018 to Dec 2018

MAGRIT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- The project *Imagerie et Robotique Médicale Grand Est (IRMGE)* started in early january 2018. Clinical and interventional imagery is a major public health issue. Teams from the Grand-Est region involved in medical imaging have thus proposed a research project to broaden and strenghten cooperation. The three axis of the project are about optic imagery, nuclear imagery and medical image processing. The Magrit team is especially involved in the third axis, with the aim to improve interventional procedures.
- 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. Projet RAPID EVORA

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

8.2.2. AEN Inria SOFA-InterMedS

Participants: R. Anxionnat (CHU Nancy), M.-O. Berger, E. Kerrien.
The SOFA-InterMedS large-scale Inria initiative is a research-oriented collaboration across several Inria project-teams, international research groups and clinical partners. Its main objective is to leverage specific competences available in each team to further develop the multidisciplinary field of Medical Simulation research. Our action within the initiative takes place in close collaboration with both the MIMESIS team and the Department of diagnostic and therapeutic interventional neuroradiology of Nancy University Hospital. Two PhD students - R. Trivisonne and J. Guarcia Guevara- are currently co-supervised by the Magrit and the MIMESIS teams.

8.3. International Initiatives

8.3.1. Inria International Labs

Inria@EastCoast
Associate Team involved in the International Lab:

8.3.1.1. CURATIVE

Title: CompUteR-based simulAtion Tool for mItral Valve rEpair

International Partner (Institution - Laboratory - Researcher):

Harvard University (United States) - Harvard Biorobotics Lab (HBL) - Robert Howe

Start year: 2017

See also: https://team.inria.fr/curative/

The mitral valve of the heart ensures one-way flow of oxygenated blood from the left atrium to the left ventricle. However, many pathologies damage the valve anatomy producing undesired backflow, or regurgitation, decreasing cardiac efficiency and potentially leading to heart failure if left untreated. Such cases could be treated by surgical repair of the valve. However, it is technically difficult and outcomes are highly dependent upon the experience of the surgeon.

One way to facilitate the repair is to simulate the mechanical behavior of the pathological valve with subject-specific data. Our main goal is to provide surgeons with a tool to study solutions of mitral valve repairs. This tool would be a computer-based model that can simulate a potential surgical repair procedure in order to evaluate its success. The surgeons would be able to customize the simulation to a patient and to a technique of valve repair. Our methodology will be to realistically simulate valve closure based on segmentation methods faithful enough to capture subject-specific anatomy and based on a biomechanical model that can accurately model the range of properties exhibited by pathological valves.

8.3.1.2. Informal International Partners

- Pierre-Frédéric Villard is a co-investigator in the INVIVE project (http://www.it.uu.se/research/scientific_computing/project/rbf/biomech) funded by the Swedish Research Council and realized within a collaboration with Uppsala University and Karolinska Institute. Within this project, he is the co-supervisor of Igor Tominec (Uppsala University) with Elisabeth Larsson (Uppsala University) as the Main advisor.
- With Gabriele Steidl (Technische Universität Kaiserslautern, Germany), we have worked about the removal of Cauchy noise in natural images. This work has led with a publication in *Journal of Mathematical Imaging and Vision* in 2018. The extension of this technique for structured data (on Riemanian variety for instance) will be considered in future works.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Pete Hammer, a senior researcher at Harvard University (http://www.childrenshospital.org/researchers/peter-e-hammer), visited the MAGRIT team from 06/04/18 to 06/10/18. He gave a talk to the Department 1 in Loria, he helped out with mechanical modeling of the mitral valve and he provided advice to Daryna Panicheva supervision during one week.
- Rob Howe, a full professor at Harvard University (http://people.seas.harvard.edu/~howe/), visited the MAGRIT team from 06/16/18 to 06/20/18. He gave a talk to the Department 1 in Loria, he helped out with science understanding of the valve and he helped Daryna Panicheva supervision during one week.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Pierre-Frederic Villard spent one month (May 2018) at Uppsala University working on the INVIVE project. His work there includes supervising PhD student Igor Tominec, meeting with a physiologist expert in respiration muscles and working on an implicit surface representation of the diaphragm.

MFX Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Project LUE

- Funding type: Lorraine Université d'Excellence.
- Title: Passive and active 3D printed orthosis: modeling, simulation and applications.
- Project Coordinator: Sylvain Lefebvre

This project is funded by *Lorraine Université d'Excellence* for three years. It is a collaboration between IJL (Jean Lamour Institute), LORIA (Lorraine Research Laboratory in Computer Science and its Applications), LRGP (Reaction and Process Engineering Laboratory), ERPI (Research Laboratory on Innovation Process), IRR Nancy (Regional Institute for Physical and Rehabilitation Medicine) and Nancy CHU (University Hospital). The project considers the creation of flexible plates with controlled elasticity for use in medical applications (orthoses, insoles). It exemplifies our approach of doing focused collaborations around application domains of our research, to ensure that our techniques answer actual practical challenges and maximize the chances that they are deployed in the near future.

The project funds a PhD student, Thibault Tricard, who started in October 2018. Thibault is co-advised by Sylvain Lefebvre and Didier Rouxel (IJL).

8.1.2. Project PIC

- Funding type: Pacte Lorraine.
- Title: Innovative Polymers and Composites
- Project Coordinator: Sylvain Lefebvre

The project PIC (*Innovative Polymers and Composites*) is a regional project between Inria, IJL (Jean Lamour Institute – materials science), ECN (surgery school) and the company *Les Ateliers Cini*. This collaboration aimed for the creation of new high performance composite materials usable in 3D printing. It began in 2016 (within ALICE) and ended in 2018 (within MFX). The project funded an engineer, Noémie Vennin.

MFX contributed on algorithm aspects of the 3D printer control. PEEK is a material that needs a strict control of temperature: it is extruded at 400 degrees, and cooling plays an important role in the final mechanical properties. During the project, we first developed the software possibilities, adding novel features to enable a finer control over deposition and temperature management. These improvements were implemented in our IceSL software and included thermal shields (see Figure 10), novel support structures, novel infill patterns and the ability to control all print parameters within the object (*e.g.*, varying temperature in different parts). This lead to a significant increase in part quality and accuracy. We also worked on improving the 3D printer jointly with other partners, upgrading the thermal capabilities with a better heating plate (+40°C) and side mounted heating patches, with a safety and control sensor.

We are now able to produce parts in PEEK material, using IceSL for generating printer instructions. For instance, we manufactured parts used by the surgery school for training sessions.

Nevertheless, despite improvements in print quality, it remains the case that parts should be designed or modified to achieve best results with PEEK filament deposition. The high temperature gradients and thermal behavior of PEEK remain very challenging and constrain the geometries that can be reliably produced.

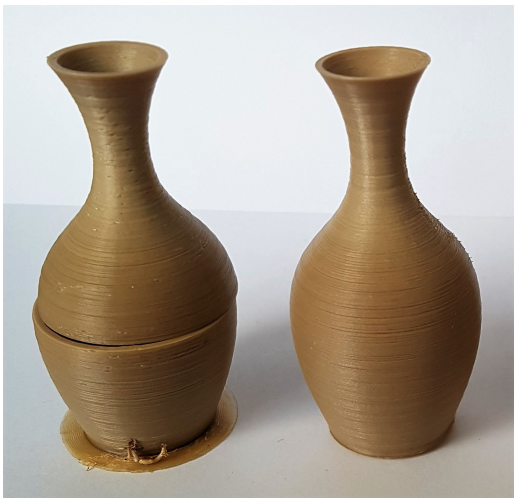

Figure 10. 3D printed vase in PEEK material. Left: Vase breaking during fabrication due to thermal stresses. Right: Adding a thermal shield (not shown) results in a correct 3D print.

8.1.3. Project Colored FDM

- Funding type: CPER and LORIA
- Title: Color fused filament deposition
- Project Coordinator: Sylvain Lefebvre

This project is funded both by the CPER Cyber-entreprise (axis *algorithms for novel materials*) and the LORIA laboratory. As part of the CPER, we work closely with the *Reaction and Process Engineering Laboratory* (LRGP) in Nancy on this topic.

8.1.4. Regional PhD Funding

- Funding type: Région Grand-Est.

We secured two half-PhD fundings from Région Grand-Est in 2018. The first is co-funding Semyon Efremov (PhD student) in the context of the ANR MuFFin. Semyon is co-advised by Jonàs Martínez and Sylvain Lefebvre, he joined the team in October 2018.

The second is co-funding Jimmy Etienne (PhD student), co-advised by Cédric Zanni and Sylvain Lefebvre. The other half-funding is provided by local support from the LORIA laboratory. Jimmy Etienne's topic focuses on curved printing for additive manufacturing, he started in September 2018.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. Project MuFFin (2018-2021)

- Funding type: ANR JCJC (ANR-17-CE10-0002).
- Title: Procedural and stochastic microstructures for functional fabrication
- Project Coordinator: Jonàs Martínez

MuFFin aims at contributing a unified pipeline for the efficient and scalable synthesis, visualization, and modeling of additively manufactured microstructures with tailored macroscopic physical behavior. In an interdisciplinary effort, MuFFin will blend together computer and material science perspectives to deliver an integrated approach that is both computationally and physically sound.

This year we hired Semyon Efremov as a PhD student, starting from October 2018. We have interdisciplinary collaborations with researchers in topology optimization (Perle Geoffroy-Donders and Grégoire Allaire at École Polytechnique), and material science in the context of aeronautics (Mohamed amin Ben Lassoued and Guilhem Michon at ISAE-SUPAREO, Annie Ross at Polytechnique Montréal).

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

In 2018 we had collaborations with TU Delft [11], continued collaborations with Connelly Barnes (Adobe) [17] and Li-Yi Wei (Adobe) [17], [10]. We have ongoing projects with Bernhard Thomaszewski (University of Montreal), Daniele Panozzo (NYU), Marc Alexa (TU-Berlin), Charlie C.L. Wang (TU-Delft), Sara McMains (University of California) and Brian Wyvill (University of Victoria).

8.4. Visits of International Scientists

Brian Wyvill, professor at the University of Victoria, is a pioneer in the field of computer graphics. He visited us on May 10-11, 2018 and gave a seminar to the department.

Jean-Baptiste Labrune, designer and researcher in 4D printing visited on November 29, 2018. We organized an open seminar within LORIA.

MIMESIS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

At the regional level, the MIMESIS team collaborates with

9.1.1. ICube Automatique Vision et Robotique (AVR)

We have been collaborating 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.

9.1.2. ICube Informatique Géométrique et Graphique (IGG)

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

9.1.3. Institute of Image-Guided Surgery (IHU) Strasbourg

We have several active projects and collaborations with IHU Strasbourg in order to collect and use medical images (such as MRI, CT, Fluoroscopy and Ultrasound) before, during and after minimally-invasive surgical procedures (percutaneous, endovascular and laparoscopic). Such images represent an essential support for the development of numerical simulations for intra-operative assistance through augmented and virtual reality. Eventually, simulations will be used for the diagnostic, treatment as well as for training and teaching in medical domain. Yet, before being used in current clinical routine, such simulations must be validated on animal models. Through our collaboration with IHU, we use CT and MRI images to retrieve the anatomical model of internal structures, whereas fluoroscopic and ultrasound images can be used to retrieve 2D images of the physiology and the navigation of surgical instruments within the anatomy. In-vivo procedures can also be performed under ethical approval of MSER (reference to ethic protocol *APAFIS #15433-2018060815283960*). We also collaborate with IHU-Strasbourg fellow surgeons, such as Pr. Mario GIMENEZ and Dr. Alain GARCIA, that provide medical and technical support for medical aspects (see Fig. 11).

- *Authors:* Raffaella Trivisonne, Stéphane Cotin

9.2. National Initiatives

9.2.1. ADT (Action de Développement Technologique)

Team MIMESIS received a support for the development of the project **LOSAR: Liver Open Surgery with Augmented Reality** that aims at developing tools for a per-operative usage of research algorithms developed in the team. Although the current trend is to move towards minimally invasive surgery, open-liver surgery remains the standard treatment for most patients. For Augmented reality purpose, open surgery raises specific constraints compared to celioscopic surgery, such as larger deformations of the liver and unavoidable occlusions of the organ. During the year 2017, the Mimesis team has developed an augmented reality prototype for open liver surgery. This prototype was developed as part of research projects and a collaboration between the team Mimesis and the CHB Paul Brousse (first service of hepatobiliary surgery in France).

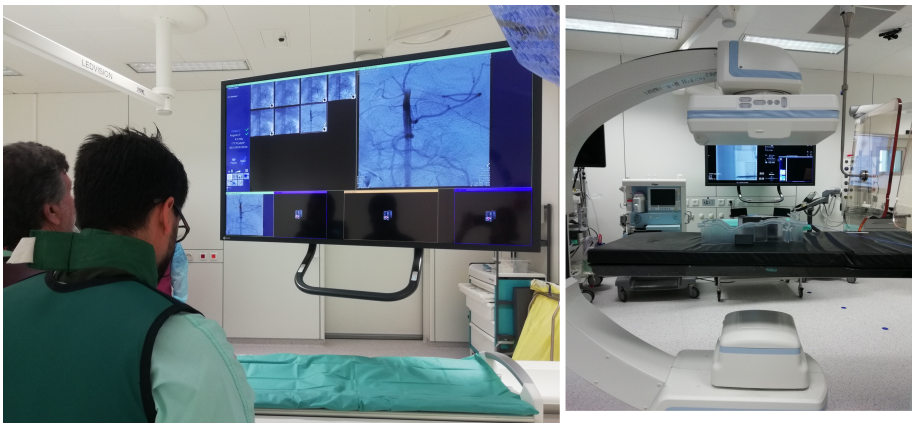

Figure 11. Environmental Set-Up for Image Acquisition. IHU-Strasbourg Platform.

Our goal is to be able to repeatedly test our method for one or more important publications in medical conferences. This type of publication requires to methodically repeat our solution on several patients. However, the steps are still insufficiently automated and the algorithm needs to be improved for greater reliability. These essential elements lie outside traditional research missions and require significant development and engineering effort. Indeed, an effort of automation and ergonomics will have to be made to make the use of the software sufficiently simple to be used in the operating room. Furthermore, the accuracy of the deformed model (anatomical distances modeled versus actual anatomical relationships) must also be verified and validated through experimentation.

9.2.2. ANR (Agence Nationale de la Recherche)

MIMESIS coordinates the ANR project entitled **SPERRY: SuPervisEd Robotic suRgerY - application to needle insertion**. Percutaneous medical procedures (using surgical needles) are among the least invasive approaches to accessing deep internal structures of organs without damaging surrounding tissues. Today, many surgical procedures rely on the use of needles allowing for complex interventions such as curie-therapies or thermoablations of tumors (cryoablation, radio frequencies). Unlike traditional open surgery, these approaches only affect a localized area around the needle reducing this way trauma and risks of complications. These treatments also offer new solutions for tumors or for metastases for which traditional methods may be contraindicated due to the age of the patient and the extent or location of the disease. Although they provide very good results, these interventions significantly increase the level of expertise required for practitioners.

In this project, we want to develop new solutions for the control of medical robots interacting with soft tissues. This work is motivated by recent advances in the field of medical simulation achieving a sufficient level of realism to help surgeons during the operation. These simulations are now used for training of surgeons, and even for visual assistance during the operation thanks to augmented reality. The maturity of these techniques now suggests the ability to use a simulation intraoperatively to control the motion of a robotic system for needle insertion. This is really a challenge, because in general, very few information can be extracted in real time from images during an intervention. We believe that even minimal knowledge of the mechanical behavior of structures, associated with the use of images can make it possible and allow a robot to reach a pre-identified target during a planning stage, without human intervention.

9.2.3. Inria Collaborations

MIMESIS is closely connected to the SOFA Consortium, created by Inria in November 2015 with the objective to support the SOFA community and encourage contributions from new SOFA users. The Consortium should

also be a way to better answer to the needs of academic or industrial partners. MIMESIS actively participates at the development of SOFA and contributed to the evolution of the framework. Moreover, MIMESIS also participates in an initiative aiming at verification and validation of codes and algorithms of SOFA.

Further, MIMESIS actively collaborates with the following Inria teams:

MAGRIT: The team at Inria Grand Est focuses on research in computer vision and is also actively 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 MAGRIT in the area of interventional radiology and augmented reality. Currently, two PhD thesis are co-supervised by researcher from Magrit: the PhD thesis of Jaime Garcia Guevara and Raffaella Trivisonne.

DEFROST: The team conducts research in soft robotics. We continue mutual interaction with DEFROST mainly in the context of contact modeling.

9.2.4. National Collaborations

At the national level, the MIMESIS team collaborates with:

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

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

Hôpital Paul-Brousse a hospital in South Paris. We collaborate with *Centre Hépato-Biliaire* via the co-supervision of the Ph.D. thesis of Nicolas Golse, MD, who is a surgeon at the center.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

- **HiPerNav** (https://hipernav.eu) is an Innovative Training Network (ITN) funded through a Marie Skłodowska-Curie grant. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 722068. There is 14 fully funded and 2 partially funded PhD's working on the project. The project aims to improve soft tissue navigation through research and development, to improve several bottleneck areas:
  - Creating effective pre-operative model(s) and planning
  - Faster and more accurate intra-operative model updates
  - Faster and more accurate model-to-patient registration
  - More intuitive user-interaction and effective workflow
  - Usage of high performance computing (e.g. GPU)

  From these 14 PhD students, two of them are from the Mimesis team: **Jean-Nicolas Brunet** and **Sergei Nikolaev**.
- **Driven** ((https://driven.uni.lu/) The overall aim of the DRIVEN project is to boost the scientific excellence and innovation capacity in data-driven simulation of the University of Luxembourg (UL) and its high-quality Twinning partners: Institut National de Recherche en Informatique et en Automatique (Inria), University of Limerick (ULIM) and University of Texas at Austin (UT Austin). To achieve this aim, the 3 year project will build upon the existing strong research and innovation base of UL and its Twinning partners. The recently established Computational Sciences

interdisciplinary group is composed of members from different research units and disciplines as diverse as Earth Sciences, Life Sciences, Physics, Mathematics and Engineering, with the common goal to set up a network among application-driven scientists which can provide interdisciplinary expertise in the field and contribute to this platform of training and knowledge exchange. To boost their scientific excellence and technology transfer capacity in data-driven simulation, the partners will implement a research and innovation strategy focused on three sub-topics:

1. Mathematical foundations for data-driven simulations – UL with UT Austin,
2. Data-driven simulations for computer-assisted therapy – UL with Inria, and
3. Data-driven simulations for functional composite materials – UL with ULIM.

9.4. International Initiatives

9.4.1. Informal International Partners

- **CAMERA group, University of Bath, UK:** Collaboration on non-rigid registration using RGB-D sensors - Antoine Petit
- **PRISMA Lab, University of Naples, Italy:** Collaboration on soft object robotic manipulation, along with DEFROST team at Inria Lille, and collaboration on visual perception for robotic surgery - Antoine Petit.
- **University of Twente, Netherlands:** Thanks to our clinical partner IHU, we collaborate with Prof. Stefano Stramigioli, head of a group at Robotics and Mechatronics laboratory.
- **Faculty of Informatics, Masaryk University, Czech Republic:** We collaborate on simulation of living cells in fluorescent microscopy.
- **Team Legato, University of Luxembourg:** We have an active collaboration with Prof. Stéphane Bordas on error estimation in real-time simulations of deformable objects.
- **ARTORG Center for Biomedical Engineering Research, Bern, Switzerland:** Collaboration in the projects related to deep learning.

9.5. International Research Visitors

9.5.1. Internships

Domenico Idone (master student from Italy) did a six month internship in the team. The aim of the training period is to investigate a novel method to track catheter shape and location during vascular interventions. We have already experimented the use of a fiber optic, equipped with Fiber Bragg Grating sensors, embedded on a flexible plate, to determine its shape. This sensing system has allowed us to track the motion of the plate undergoing a two-dimensional deformation. The objective of this internship is to expand this work to the case of a three-dimensional deformation, which requires significant improvements over the previous approach.

Renée Geraats (Twente university) did a 2 months internship. She investigated different visualization solutions for augmented reality on fluoroscopic images of the liver and its vasculature, for the 2D3D Fusion project.

Daan Kuppens (Twente university) did a 2 months internship. He provided support on the acquisition of reliable porcine CT and X-ray fluoroscopic images fluoroscopic images, on CT segmentation of the liver and its vasculature and on clinical applications, for the 2D3D Fusion project.

Pim Hendricks (Twente university) did a 2 months internship. She provided support on the acquisition of reliable porcine CT and X-ray fluoroscopic images fluoroscopic images, and on clinical applications, for the 2D3D Fusion project.

MOCQUA Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- Project acronym: ANR PRCE SoftQPro (ANR-17-CE25-0009)
  Project title: Solutions logicielles pour l'optimisation des programmes et ressources quantiques.
  Duration: Dec. 2017 - Nov. 2021
  Coordinator: Simon Perdrix
  Other partners: Atos-Bull, LRI, CEA-Saclay.
  Participants: Simon Perdrix, Emmanuel Jeandel, Emmanuel Hainry, and Romain Péchoux
  Abstract: Quantum computers can theoretically solve problems out of reach of classical computers. We aim at easing the crucial back and forth interactions between the theoretical approach to quantum computing and the technological efforts made to implement the quantum computer. Our software-based quantum program and resource optimisation (SoftQPRO) project consists in developing high level techniques based on static analysis, certification, transformations of quantum graphical languages, and optimisation techniques to obtain a compilation suite for quantum programming languages. We will target various computational model back-ends (e.g. QRAM, measurement-based quantum computations) as well as classical simulation. Classical simulation is central in the development of the quantum computer, on both ends: as a way to test quantum programs but also as a way to test quantum computer prototypes. For this reason we aim at designing sophisticated simulation techniques on classical high-performance computers (HPC).
- Project acronym: ANR PRCI VanQuTe (ANR-17-CE24-0035)
  Project title: Validation of near-future quantum technologies.
  Duration: Dec. 2017 - Nov. 2021
  Coordinator: Simon Perdrix
  Other partners: Atos-Bull, LRI, CEA-Saclay.
  Participants: Simon Perdrix, Emmanuel Jeandel, Emmanuel Hainry, and Romain Péchoux
  Abstract: Quantum computers can theoretically solve problems out of reach of classical computers. We aim at easing the crucial back and forth interactions between the theoretical approach to quantum computing and the technological efforts made to implement the quantum computer. Our software-based quantum program and resource optimisation (SoftQPRO) project consists in developing high level techniques based on static analysis, certification, transformations of quantum graphical languages, and optimisation techniques to obtain a compilation suite for quantum programming languages. We will target various computational model back-ends (e.g. QRAM, measurement-based quantum computations) as well as classical simulation. Classical simulation is central in the development of the quantum computer, on both ends: as a way to test quantum programs but also as a way to test quantum computer prototypes. For this reason we aim at designing sophisticated simulation techniques on classical high-performance computers (HPC).

8.1.2. Autres initiatives

- Quantex. Project acronym: PIA-GDN/Quantex. (initially an ITEA3 project finally funded by the *Grands défis du Numérique / Programme d'investissements d'avenir*).
  Project title: Simulation/Emulation of Quantum Computation.
  Duration: Feb. 2018 - Jan 2021.
  Coordinator: Huy-Nam Nguyen (Atos Bull).
  Other partners: Atos-Bull, LRI, CEA Grenoble.
  Participants: Simon Perdrix (WP leader), Emmanuel Jeandel
  Abstract: The lack of quantum computers leads to the development of a variety of software-based simulators to assist in the research and development of quantum algorithms. This proposal focuses on the development of a combined software-based and hardware-accelerated toolbox for quantum computation. A quantum computing stack including specification language, libraries and optimisation/execution tools will be built upon a well-defined mathematical framework mixing classical and quantum computation. Such an environment will be dedicated to support the expression of quantum algorithms for the purpose of investigation and verification.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Mathieu Hoyrup participates in the Marie-Curie RISE project Computing with Infinite Data coordinated by Dieter Spreen (Univ. Siegen) that has started in April 2017.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. IIL projects

Simon Perdrix is the WP leader in the ANR PRCI project VanQuTe (with LIP6, and the Singapore University of Technology and Design, the National University of Singapore, and the Nanyang Technological University). Emmanuel Jeandel is also a member of this project.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Victor Selivanov (Kazan University) was an Inria invited researcher in September 2018. We have worked on the computable aspects of Descriptive Set Theory.
- Cristóbal Rojas (Universidad Andres Bello, Santiago) visited us during one month in September 2018. We have worked on the computable aspects of invariant measures in dynamical systems.
- Alexander Frank (Universidad Andres Bello, Santiago) visited us during three weeks in September-October 2018. We have worked on the computable aspects of invariant measures in dynamical systems.
- Bruce Kapron (University of Victoria, Canada) visited us in October 2018. We have worked on applications of tier based type systems to characterize the class of second order functionals computable in polynomial time.
- Damiano Mazza (CNRS, Université de Paris 13) visited us in March 2018. We have worked on the adaptation of linear logic to a functional programming languages with infinite streams to characterize the class of first order functions over the real computable in polynomial time.

MULTISPEECH Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CPER LCHN

Project acronym: CPER LCHN

Project title: CPER “Langues, Connaissances et Humanités Numériques”

Duration: 2015-2020

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

Participants: Dominique Fohr, Denis Jouvet, Odile Mella, Yves Laprie

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

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

9.1.2. CPER IT2MP

Project acronym: CPER IT2MP

Project title: CPER “Innovation Technologique Modélisation et Médecine Personalisée”

Duration: 2015-2020

Coordinator: Faiez Zannad (Inserm-CHU-UL)

Participants: Romain Serizel, Emmanuel Vincent

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

MULTISPEECH will investigate acoustic monitoring using an array of microphones.

9.1.3. Dynalips

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

Duration: February 2017 - August 2018

Coordinator: Slim Ouni

Participants: Valerian Girard, Slim Ouni

Funding: SATT

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

A first prototype of the lipsync system has been developed for French. From audio and text, the system allows animating a 3D model of the face (an avatar) realistically. This work has been presented at Annecy International Animation Film Festival.

9.2. National Initiatives

9.2.1. ANR DYCI2

Project acronym: DYCI2 (http://repmus.ircam.fr/dyci2/)

Project title: Creative Dynamics of Improvised Interaction

Duration: March 2015 - February 2018

Coordinator: Ircam (Paris)

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

Participants: Ken Déguernel, Nathan Libermann, Emmanuel Vincent

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

MULTISPEECH was responsible for designing a system able to improvise on multiple musical dimensions (melody, harmony) across multiple time scales.

9.2.2. ANR ArtSpeech

Project acronym: ArtSpeech

Project title: Synthèse articulatoire phonétique

Duration: October 2015 - March 2019

Coordinator: Yves Laprie

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

Participants: Ioannis Douros, Yves Laprie, Anastasiia Tsukanova

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

Static MRI acquisition of vowels (images plus acoustic signal) have been carried out this year and their exploitation started to explore the impact of the articulatory modeling and the plane wave assumption. Manual delineations of approximately 1000 images have been done and used to generate speech signals with articulatory copy synthesis.

9.2.3. ANR JCJC KAMoulox

Project acronym: KAMoulox

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

Duration: January 2016 - September 2019

Coordinator: Antoine Liutkus (Inria Zenith)

Participants: Mathieu Fontaine, Antoine Liutkus

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

9.2.4. PIA2 ISITE LUE

Project acronym: ISITE LUE

Project title: Lorraine Université d'Excellence

Duration: starting in 2016

Coordinator: Univ. Lorraine

Participants: Ioannis Douros, Yves Laprie

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

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

9.2.5. E-FRAN METAL

Project acronym: E-FRAN METAL

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

Duration: October 2016 - September 2020

Coordinator: Anne Boyer (LORIA)

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

Participants: Theo Biasutto-Lervat, Anne Bonneau, Vincent Colotte, Dominique Fohr, Denis Jouvet, Odile Mella, Slim Ouni, Anne-Laure Piat-Marchand, Elodie Gauthier, Thomas Girod

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

MULTISPEECH is concerned by oral language learning aspects.

9.2.6. ANR VOCADOM

Project acronym: VOCADOM (http://vocadom.imag.fr/)

Project title: Robust voice command adapted to the user and to the context for ambient assisted living

Duration: January 2017 - December 2020

Coordinator: CNRS - LIG (Grenoble)

Other partners: Inria (Nancy), Univ. Lyon 2 - GREPS, THEORIS (Paris)

Participants: Dominique Fohr, Md Sahidullah, Sunit Sivasankaran, Emmanuel Vincent

Abstract: The goal of this project is to design a robust voice control system for smart home applications.

MULTISPEECH is responsible for wake-up word detection, overlapping speech separation, and speaker recognition.

9.2.7. ANR JCJC DiSCogs

Project acronym: DiSCogs

Project title: Distant speech communication with heterogeneous unconstrained microphone arrays

Duration: September 2018 – March 2022

Coordinator: Romain Serizel

Participants: Nicolas Furnon, Irina Illina, Romain Serizel, Emmanuel Vincent

Collaborators: Télécom ParisTech, 7sensing

Abstract: The objective is to solve fundamental sound processing issues in order to exploit the many devices equipped with microphones that populate our everyday life. The solution proposed is to apply machine learning methods based on deep learning to recast the problem of synchronizing devices at the signal level as a multi-view learning problem aiming at extracting complementary information from the devices at hand.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. COMPRISE

Program: H2020 ICT-29-2018 (RIA)

Project acronym: COMPRISE

Project title: Cost-effective, Multilingual, Privacy-driven voice-enabled Services

Duration: Dec 2018- Nov 2021

Coordinator: Emmanuel Vincent

Other partners: Inria Magnet, Ascora GmbH, Netfective Technology SA, Rooter Analysis SL, Tilde SIA, University of Saarland

Participants: Irina Illina, Denis Jouvet, Emmanuel Vincent

Abstract: COMPRISE will define a fully private-by-design methodology and tools that will reduce the cost and increase the inclusiveness of voice interaction technologies.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. AMIS

Program: CHIST-ERA

Project acronym: AMIS

Project title: Access Multilingual Information opinionS

Duration: Dec 2015- Nov 2018

Coordinator: Kamel Smaïli (LORIA)

Other partners: University of Avignon, University of Science and Technology Krakow, University of DEUSTO (Bilbao)

Participants: Dominique Fohr, Denis Jouvet, Odile Mella

Abstract: The idea of the project is to develop a multilingual help system of understanding without any human being intervention. This should help people understanding broadcasting news, presented in a foreign language and to compare it to a corresponding one available in the mother tongue of the user.

MULTISPEECH contributions concern mainly the speech recognition in French, English and Arabic videos.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Jon Barker: University of Sheffield (UK)

Robust speech recognition [19]

Tomi Kinnunen: University of Eastern Finland (Finland)

Speaker verification and spoofing countermeasures for voice biometrics [47], [24], [32], [26], [41], [67]

Nicholas Evans: EURECOM (France)

Spoofing countermeasures for voice biometrics [47], [24], [32]

Hamid Eghbal-Zadeh: Johannes Kepler University (Austria)

Audio event detection [40]

Shinji Watanabe, Johns Hopkins University (USA)

Robust speech recognition [19]

Junichi Yamagishi, National Institute of Informatics (Japan)

Spoofing countermeasures for voice biometrics [47], [24], [32], [26]

NEUROSYS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Within the *Contrat de Projet État Région (CPER) IT2MP* 2015-2020 on *Technological innovations, modeling and Personalized Medicine*, we are contributing on platform SCIARAT (*cognitive stimulation, Ambient Intelligence, Robotic assistance" and Telemedicine*) observing electroencephalographic activity of humans during motor tasks.

8.2. National Initiatives

8.2.1. Inria project-Lab BCI-LIFT 2015-2018 (Brain-Computer Interfaces: Learning, Interaction, Feedback, Training)

Project leader: Maureen Clerc
Partners: 7 Inria project-teams (Aramis, Athena, Demar, Hybrid, Mjolnir, Neurosys, Potioc), univ. Rouen, Dycog team at Centre de Recherche en Neurosciences de Lyon.

BCI-LIFT is a research initiative to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. With this concern of usability as our driving objective, we build non-invasive systems that benefit from advanced signal processing and machine learning methods, from smart interface design, and where the user immediately receives supportive feedback. What drives this project is the concern that a substantial proportion of human participants is currently categorized “BCI-illiterate” because of their apparent inability to communicate through BCI. Through this project we aim at making it easier for people to learn to use BCI, by implementing appropriate machine learning methods and developing user training scenarios.

8.2.2. Projet CNRS PEPS S2IH INS2I 2018 : MoveYouMind (Design and evaluation of a visual neurofeedback based on specific corticomotor areas using source localization for enhancing motor imagery)

Project leader: Laurent Bougrain
Partners: Neurosys, Cognitive and Systems Neurosciences (univ. Lorraine/CRAN), Perseus (univ. Lorraine)
This project aims at improving the functional recovery protocols of hemiplegic stroke patients by increasing the precision of the identification of the brain areas involved in a kinesthetic motor task of the upper limbs. The brain areas engaged during this rehabilitation task will be detected by specific source localization methods based on the signals obtained by an electroencephalographic acquisition system with variable geometry, which will inform and therefore guide the patient (and the nursing staff) during the functional rehabilitation by indicating to her/him if the activity which she/he produces is in the right motor area. The project aims to design and evaluate a visual neurofeedback based on active cortical areas within an existing brain-computer interface.

8.2.3. Projet CNRS PEPS S2IH INS2I 2018 : HDCHS (From Human-Human Handshaking to Human-Robot Handshaking)

Project leader: Patrick Hénaff
Partners: Neurosys, Perseus (univ. Lorraine), Cerco

This project interfaces robotics, neuroscience and experimental psychology. It is part of on-going research initiated at LORIA on the understanding of physical and cognitive phenomena that appear while two persons handshake, in order to reproduce them with a humanoid robot naturally interacting with a human. This act is studied because is a multimodal physical and social interaction, socially common but complex from a neuroscience and robotics point of view, because it involves physical, psychological and sensorimotor couplings which differ, depending on the social context. This project proposes novel handshaking experiments aiming at understanding the physical and psychological synchronization phenomena (coupling, locking, rhythmicity), best known as the « Human Dynamic Clamp » (HDC) paradigm, in order to propose models in adequation with the bio-inspired controllers developed at LORIA for the control of humanoid robots.

8.3. International Initiatives

8.3.1. Informal International Partners

- We hosted Takeshi Nishida (Kuytech, Japan) for five months and Sozo Inoue (Kuytech, Japan) for one week to prepare a collaboration on neurosciences and robotics. Laurent Bougrain visited Takeshi Nishida, Kiyohisa Natsume and Toshimasa Yamazaki in Kyutech. Asako Watanabe, a master student from Kuytech, will come for 3 weeks in the team in January 2019 to work on EEG markers of a motor task.
- We collaborate with Anton Popov (Kiev Polytechnic Institute, Ukraine) on feature extraction of brain signal and deep learning (L. Bougrain). Oleksii Avilov is a Ph.D student under a joint supervision arrangement between Kiev Polytechnic Institute and university of Lorraine.
- We also collaborate with Emel Demircan (Univ South California) to use EMG-informed Computed Muscle Control for dynamic simulations of movement available in OpenSim [0]. She stayed 3 weeks in Neurosys this year.
- We also collaborate with 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).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Takeshi Nishida, Ass. Prof, Kuytech, Japan, 5 weeks (Jun.-Jul. 2018)
- Emel Demircan, Ass. Prof, Univ South California, USA, 3 weeks (Jun.-Jul. 2018)
- Sozo Inoue, Full Prof, Kuytech, Japan, 1 week (dec. 2018)

8.4.1.1. Internships

- Sooraj Sivakumar, Student, IIT Madras, India (Jan-Mar 2018)

[0] https://opensim.stanford.edu/

ORPAILLEUR Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. AGREV-3

Participant: Jean-François Mari.

The AGREV 3 project (for "Agriculture Environment Vittel") is part of "Agrivair" –a subsidiary of Nestlé Waters– in actions to protect the natural resources of natural mineral water. We used ARPEnTAge to mine survey data about the Vittel-Contrexéville territory, which is suspected of groundwater quality risks [5]. This allowed to locate regions having the same behavior. In addition, this provided a more contrasted simulation by eliminating the influence of stable zones (forests, permanent grasslands) and a more precise definition of a "neutral" model.

8.1.2. Hydreos

Participants: Jean-François Mari, Chedy Raïssi.

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

On other aspects, we tested new deep graph convolutional learning over data provided by the SEDIF "Syndicat des eaux d'Île-de-France" to predict the likelihood of water leaks in a network of pipes and compared it with a master thesis where spatial point process techniques were used (master thesis of Nicolas Dante, M2 IMSD Nancy).

8.1.3. The Smart Knowledge Discovery Project

Participants: Jérémie Nevin, Amedeo Napoli, Chedy Raïssi.

The SKD project for "Smart Knowledge Discovery" aims at analyzing complex industrial data for troubleshooting and decision making, and is funded by "Grand Est Region". We are working on exploratory knowledge discovery with the Vize company, which is based in Nancy and specialized in visualization-based data mining. The data which are under study are provided by the Arcelor-Mittal Steel Company and are related to the monitoring of rolling mills. Data are complex time series and the problem is related to a so-called "predictive maintenance", or how to anticipate problems in the furnaces and avoid their stop. In this way, one main objective of SKD is to combine sequence mining and visualization tools for recognizing temperature problems in the furnaces, and thus preventing the occurrences of defects in the outputs of the rolling mills.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. Elker (2017–2020)

Participants: Nacira Abbas, Miguel Couceiro, Amedeo Napoli, Chedy Raïssi.

The objectives of the ELKER ANR Research Project is to study, formalize and implement the search for link keys in RDF data. Link keys generalize database keys in two independent directions, i.e. they deal with RDF data and they apply across two relation datasets. Then we study the automatic discovery of link keys and reasoning with link keys, in taking an FCA point of view. The projects relies on the competencies of Orpailleur in FCA for solving the problem using FCA and pattern structures algorithms, partition pattern structures which are related to the discovery of functional dependencies. This project involves the EPI Orpailleur at Inria Nancy Grand Est, the EPI MOEX at Inria Rhône Alpes, and LIASD at Université Paris 8.

8.2.1.2. PractiKPharma (2016–2020)

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

PractiKPharma for "Practice-based evidences for actioning Knowledge in Pharmacogenomics" is an ANR research project (http://practikpharma.loria.fr/) about the validation of domain knowledge in pharmacogenomics. Pharmacogenomics is interested in understanding how genomic variations related to patients have an impact on drug responses. Most of the available knowledge in pharmacogenomics (state of the art) lies in biomedical literature, with various levels of validation. An originality of PractiKPharma is to use Electronic Health Records (EHRs) to constitute cohorts of patients. These cohorts are then mined for extracting potential pharmacogenomics patterns to be then validated w.r.t. literature knowledge for becoming actionable knowledge units. More precisely, firstly we should extract pharmacogenomic patterns from the literature and secondly we should confirm or moderate the interpretation and validation of these units by mining EHRs. Comparing knowledge patterns extracted from the literature with facts extracted from EHRs is a complex task depending on the EHR language –literature is in English whereas EHRs are in French– and on knowledge level, as EHRs represent observations at the patient level whereas literature is related to sets of patients. The PractiKPharma involves three other laboratories, namely LIRMM in Montpellier, SSPIM in St-Etienne and CRC in Paris.

8.2.2. CNRS Mastodons Projects: HyQual, HyQualiBio and QCM-BioChem (2016–2018)

Participants: Nacira Abbas, Guilherme Alves Da Silva, Miguel Couceiro, Alain Gély, Nyoman Juniarta, Tatiana Makhalova, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

The HyQual project was proposed in 2016 in response to the Mastodons CNRS Call about data quality in data mining (see http://www.cnrs.fr/mi/spip.php?article819&lang=fr). This project is interested in the mining of nutritional data for discovering predictive biomarkers of diabetes and metabolic syndrome in elder populations. The considered data mining methods are hybrid, and they combine symbolic and numerical methods for mining complex and noisy metabolic data [77]. Regarding the mining process, we are interested in the quality of the data at hand and in the discovered patterns. In particular, we check the incompleteness of the data, the quality of the extracted rules and the possible existence of redescriptions.

Initially, the project involved researchers from the EPI Orpailleur, with researchers from LIRIS Lyon, ICube Strasbourg, and INRA Clermont-Ferrand. Then, the project was merged the other Mastodons project named QualiBioConsensus, about the "ranking of biological data using consensus ranking techniques". The joint Mastodons project was called "HyQualiBio". The year after, the project was a new time merged with the PEPS Decade project to form the new "QCM-BioChem" (https://www.lri.fr/~cohen/QCM-BioChem.html). The topics of interest for the participants are the mining of complex biological data, rankings and ties in rankings, and the search of dependencies in the web of data.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. CrossCult (H2020 Project, 2016-2020)

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

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

The role of the Orpailleur Team (in conjunction with the LORIA Kiwi Team) is to work on knowledge discovery and recommendation. The focus is on the mining of visitor trajectories for analysis purposes [32], [33] and on the definition of a visitor profile in connection with domain knowledge for recommendation [31].

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

8.4. International Initiatives

8.4.1. Inria International Labs

Inria@SiliconValley
Associate Team involved in the International Lab:

8.4.1.1. Snowball

Title: Discovering knowledge on drug response variability by mining electronic health records

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2017

See also: http://snowball.loria.fr/

Snowball (2017-2019) is an Inria Associate Team and the continuation of the preceding Associate Team called Snowflake (2014-2016). The objective of Snowball is to study drug response variability through the lens of Electronic Health Records (EHRs) data. This is motivated by the fact that many factors, genetic as well as environmental, imply different responses from people to the same drug. The mining of EHRs can bring substantial elements for understanding and explaining drug response variability.

Accordingly the objectives of Snowball are to identify in EHR repositories groups of patients which are responding differently to similar treatments, and then to characterize these groups and predict patient drug sensitivity. These objectives are complementary to those of the PractiKPharma ANR project. Moreover, it should be noticed that Adrien Coulet is continuing a two-years sabbatical stay in the lab of Nigam Shah at Stanford University since September 2017 (granted by an "Inria délégation").

Participants of the Snowball Associate Team have been awarded with a Grant Seed funded by Stanford University, to pursue their efforts in AI in Medicine. The granted project will particularly focus on the building of fair and equitable predictive models for medicine (see http://medicine.stanford.edu/news/current-news/standard-news/presenceannouncesseedgrantawardees.html).

8.4.2. Informal International Partners: Research Collaboration with HSE Moscow

Participants: Nacira Abbas, Guilherme Alves Da Silva, Miguel Couceiro, Alain Gély, Nyoman Juniarta, Tatiana Makhalova, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

An on-going collaboration involves the Orpailleur team and Sergei O. Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory several times while Sergei O. Kuznetsov visits Inria Nancy Grand Est every year. The collaboration is materialized by the joint supervision of students (such as the thesis of Aleksey Buzmakov defended in 2015 and the on-going thesis of Tatiana Makhalova), and the the organization of scientific events, as the workshop FCA4AI with six editions between 2012 and 2018 (see http://www.fca4ai.hse.ru).

This year, we participated in the writing of common publications around the thesis work of Tatiana Makhalova and the organization of one main event, namely the sixth edition of the FCA4AI workshop in July 2018 at the ECAI-IJCAI Conference which was held in Stockholm, Sweden (see http://ceur-ws.org/Vol-2149, [58]).

8.4.3. Participation in other International Programs

8.4.3.1. A stay at NASA Frontier Development Lab

In July and August 2018, Chedy Raïssi visited NASA Ames and SETI Institute as part of the Frontier Development Lab, where he worked on mentoring teams and developing meaningful research opportunities, as well as support the work of the planetary defense community and show the potential of this kind of applied research methodology to deliver breakthrough of significant value.

During the eight-week research incubator he aimed at applying cutting-edge machine-learning algorithms to challenges in the space sciences. He worked with two machine-learning students (PhD and post-doc level) that were paired with two space-science researchers (post-doc level) on the improvement of machine-learning models for exoplanet transit classification. This small team started initially from a machine-learning model that classified signals based on straightforward local and global views of the light curves that was developed by Google Brain engineer Chris Shallue. To improve upon it, the team added scientific domain knowledge –staying true to the Orpailleur idea of injecting domain knowledge– that was provided by domain experts. Using the resulting model, the team managed to classify a Kepler data set with 97.5% accuracy and 98% average precision [2].

PESTO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. CNRS

CNRS PEPS INS2I 2016-2018 project ASSI *Analyse de Sécurité de Systèmes Industriels*, duration: 2 years, leader: Pascal Lafourcade (Univ Clermont-Ferrand), participant Pesto: Jannik Dreier, other participants: Marie-Laure Potet, Maxime Puys (Univ Grenoble-Alpes).

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

9.1.2. ANR

- ANR SEQUOIA *Security properties, process equivalences and automated verification*, duration: 4 years, since October 2014, leader: Steve Kremer, other partners: ENS Cachan, Univ Luxembourg. Most protocol analysis tools are restricted to analyzing reachability properties while many security properties need to be expressed in terms of some process equivalences. 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.
- ANR TECAP *Protocol Analysis — Combining Existing Tools*, duration: 4 years, starting in 2018, leader: Vincent Cheval, other partners: ENS Cachan, Inria Paris, Inria Sophia Antipolis, IRISA, LIX. Despite the large number of automated verification tools, several cryptographic protocols (e.g. stateful protocols) still represent a real challenge for these tools and reveal their limitations. To cope with these limits, each tool focuses on different classes of protocols depending on the primitives, the security properties, etc. Moreover, the tools cannot interact with each other as they evolve in their own model with specific assumptions. The aim of this project is to get the best of all these tools, that is, to improve the theory and implementations of each individual tool towards the strengths of the others and to build bridges that allow the cooperations of the methods/tools. We will focus in this project on CryptoVerif, EasyCrypt, Scary, ProVerif, *TAMARIN*, *Akiss* and APTE. In order to validate the results obtained in this project, we will apply our results to several case studies such as the Authentication and Key Agreement protocol from the telecommunication networks, the Scytl and Helios voting protocols, and the low entropy 3D-Secure authentication protocol. These protocols have been chosen to cover many challenges that the current tools are facing.

9.1.3. Fondation MAIF

Project *Protection de l'information personnelle sur les réseaux sociaux*, from October 2014 to March 2018. 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, our objective is to synthesize a model of risk behavior as a rule base. Finally, a verifier based on model-checking will be developed to assess the security level of user. The partners are Pesto (leader), Orpailleur and Fondation MAIF.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- 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 the need to trust the voter client software.

  Steve Kremer is the leader of the project.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- Collaboration with David Basin, Ralf Sasse and Lara Schmid (ETH Zurich), Cas Cremers (Univ Oxford), and Sasa Radomirovic (Univ Dundee) on the improvement of the *TAMARIN* prover
- Collaboration with Constantin Catalin Dragan (Univ of Surrey), Francois Dupressoir (Univ of Surrey), and Bogdan Warinschi (Univ Bristol) on proving security of voting protocols with EasyCrypt.
- Collaboration with Matteo Maffei (Univ Wien) on type systems for e-voting systems
- Collaboration with Bogdan Warinschi (Univ Bristol) on defining game-based privacy for e-voting protocols
- Collaboration with Robert Künnemann (CISPA, Germany) on the development of the SAPIC tool.
- Collaboration with Paliath Narendran's group (SUNY Albany) on automated deduction
- Collaboration with Hanifa Boucheneb's group (Polytechnique Montreal) on model-checking of collaborative systems
- Collaboration with John Mullins's group (Polytechnique Montreal) on information hiding

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Bogdan Warinschi (Univ Bristol), November 2018

[0] https://members.loria.fr/SKremer/files/spooc/index.html

RESIST Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR BottleNet

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

- Acronym: BottleNet
- Title: Comprendre et diagnostiquer les dégradations des communications de bout en bout dans l'Internet
- Coordinator: Inria
- Duration: October 2015- March 2018
- Others Partners: Inria Muse, Inria Diana, Lille1 University, Telecom Sud-Paris, Orange, IP-Label.
- Abstract: The Quality of Experience (QoE) when accessing the Internet, on which more and more human activities depend on, is a key factor for today's society. The complexity of Internet services and of users' local connectivity has grown dramatically in the last years with the proliferation of proxies and caches at the core and access technologies at the edge (home wireless and 3G/4G access), making it difficult to diagnose the root causes of performance bottlenecks. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure end-to-end Internet QoE and to diagnose the cause of the experienced issues. The result can then be used by users, network and service operators or regulators to improve the QoE.

9.1.1.2. ANR Doctor

Participants: Thibault Cholez [contact], Xavier Marchal, Daishi Kondo, Olivier Festor.

- Acronym: DOCTOR
- Title: DeplOyment and seCurisaTion of new functiOnalities in virtualized networking enviRonments
- Coordinator: Orange Labs (Bertrand Matthieu)
- Duration: December 2014-December 2018
- Partners: Orange Labs, Thales, Montimage, UTT and LORIA
- Site: http://www.doctor-project.org
- Abstract: The DOCTOR project is an applied research project that advocates the use of virtualized network equipment (Network Functions Virtualization), to enable the co-existence of new Information-Centric Networking stacks (e.g.: Named-Data Networking) with IP, and the progressive migration of traffic from one stack to another while guaranteeing the good security and manageability of the network. Therefore in DOCTOR, the main goals of the project are: (1) the efficient deployment of NDN as a virtualized networking environment; (2) the monitoring and security of this virtualized NDN stack.

9.1.1.3. ANR FLIRT

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

- Acronym: FLIRT
- Title: Formations Libres et Innovantes Réseaux et Télécoms
- Coordinator: Institut Mines-Télécom (Pierre Rolin)
- Duration: January 2016-January 2020
- Others Partners: Institut Mines-Télécom, Airbus, Orange, the MOOC Agency, Isograd
- Site: http://flirtmooc.wixsite.com/flirt-mooc-telecom
- Abstract: FLIRT (Formations Libres et Innovantes Réseaux & Télécom) is an applied research project leaded by the Institut Mines-Télécom, for a duration of 4 years. It includes 14 academic partners (engineering schools including Telecom Nancy), industrial partners (Airbus, Orange), innovative startups (the MOOC agency, and Isograd), as well as professional or scientific societies (Syntec Numérique, Unetel, SEE). The project is to build a collection of 10 MOOCs (Massive Open Online Courses) in the area of networks and telecommunications, three training programmes based on this collection, as well as several innovations related to pedagogical efficiency (such as virtualization of practical labs, management of student cohorts, and adaptative assessment). The RESIST team is leading a working group dedicated to the building and operation of a MOOC on network and service management. This MOOC covers the fundamental concepts, architectures and protocols of the domain, as well as their evolution in the context of future Internet (e.g. network programming, flow monitoring). It corresponds to a training program of 5 weeks. The main targeted skills are to understand the challenges of network and service management, to know the key methods and techniques related to this area, and to get familiar with the usage and parameterization of network management solutions. We have also performed the maintenance of the different contents of the MOOC, in preparation of the second session, which will start January 2019.

9.1.1.4. Inria-Orange Joint Lab

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

- Acronym: IOLab
- Title: Inria - Orange Joint Laboratory
- Duration: September 2015 - August 2020
- Abstract: The challenges addressed by the Inria-Orange joint laboratory relate to the virtualization of communication networks, the convergence between cloud computing and communication networks, and the underlying software-defined infrastructures. Our work concerns in particular monitoring methods for software-defined infrastructures, and management strategies for supporting software-defined security in multi-tenant cloud environnements.

9.1.2. Technological Development Action (ADT)

9.1.2.1. ADT SCUBA

Participants: Abdelkader Lahmadi [Contact], Thomas Lacour, Frédéric Beck.

- Acronym: CUBA
- Duration: January 2018-January 2020
- Abstract: The goal of this ADT is to develop a tool suite to evaluate the security of industrial and general public IoT devices in their exploitation environment. The Tool suite relies on a set of security probes to collect information through passive and active scanning of a running IoT device in its exploitation environment to build its Security Knowledge Base (SKB). The knowledge base contains all relevant information of the device regarding its network communications, the enumeration of its used hardware and software, the list of its known vulnerabilities in the CVE format associated to their Common Weakness Enumeration (CWE) and Common Attack Pattern Enumeration and Classification (CAPEC) descriptions. The collected information is used to evaluate the devices associated with their usage scenarios and to identify intrusion chains in an automated way.

9.1.3. FUI

9.1.3.1. FUI PACLIDO

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

- Acronym: PACLIDO
- Title: Lightweight Cryptography Protocols and Algorithms for IoT (Protocoles et Algorithmes Cryptographiques Légers pour l'Internet des Objets)
- Coordinator: ADS (Airbus Defence and Space)
- Duration: September 2017- August 2020
- Others Partners: Sophia Conseil, Université de Limoges, Cea tech, Trusted Objects, Rtone, Saint Quentin En Yvelines.
- Abstract: The goal of PACLIDO is to propose and develop lightweight cryptography protocols and algorithms to secure IoT communications between devices and servers. The implemented algorithms and protocols will be evaluated in multiple use cases including smart home and smart city applications. PACLIDO develops in addition an advanced security monitoring layer using machine learning methods to detect anomalies and attacks while traffic is encrypted using the proposed algorithms.

9.1.3.2. FUI HUMA

Participants: Jérôme François [contact], Soline Blanc, Isabelle Chrisment, Quang Vinh Dang, Abdelkader Lahmadi, Giulia de Santis.

- Acronym: HuMa
- Title: L'HUmain au cœur de l'analyse de données MAssives pour la sécurité
- Coordinator: Intrinsec
- Duration: September 2015-March 2018
- Others Partners: ICube, Idemia, Airbus Defence and Space, Wallix, Sydo.
- Abstract: HuMa targets the analysis of Advanced Persistent Threats. 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 oned able to analyze APT today, rather than targeting a fully automated approach.

9.1.4. Inria Project Lab

9.1.4.1. IPL BetterNet

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

- Acronym: BetterNet
- Coordinator: RESIST (Isabelle Chrisment)
- Duration: October 2018-August 2023
- Others Partners: Inria MiMove, Inria Diana, Inria Spirals, Inria Dionysos, ENS-ERST and IP-Label
- Site: https://project.inria.fr/betternet
- Abstract: BetterNet's goal is to build and deliver a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. We will propose new user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Tools, models and algorithms will be provided to collect data that will be shared and analyzed to offer valuable service to scientists, stakeholders and the civil society.

9.1.4.2. IPL Discovery

Participant: Lucas Nussbaum [contact].

- Partners: Orange, RENATER
- Abstract: To accommodate the ever-increasing demand for Utility Computing (UC) resources, while taking into account both energy and economical issues, the current trend consists in building larger and larger Data Centers in a few strategic locations. Although such an approach enables UC providers to cope with the actual demand while continuing to operate UC resources through a centralized software system, it is far from delivering sustainable and efficient UC infrastructures for future needs.

  The DISCOVERY initiative aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet in order to deliver widely distributed platforms that can better match the geographical spread of users as well as the ever increasing demand. Critical to the emergence of such locality-based UC (also referred as Fog/Edge Computing) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote a new kind of Cloud Operating System (OS) that will enable the management of such a large-scale and widely distributed infrastructure in an unified and friendly manner.

9.2. European Initiatives

9.2.1. Fed4Fire+ (2017-2022)

Title: Federation for FIRE Plus

Program: H2020

Duration: January 2017 - December 2021

Coordinator: Interuniversitair Micro-Electronicacentrum Imec VZW

Partners:
Universidad de Malaga; National Technical University of Athens - NTUA; The Provost, Fellows, Foundation Scholars & the other members of board of the College of the Holy & Undivided Trinity of Queen Elizabeth Near Dublin; Ethniko Kentro Erevnas Kai Technologikis Anaptyxis; GEANT LImited; Institut Jozef Stefan; Mandat International Alias Fondation Pour la Cooperation Internationale; Universite Pierre et Marie Curie - Paris 6; Universidad De Cantabria; Fundacio Privada I2CAT, Internet I Innovacio Digital A Catalunya; EURESCOM-European Institute For Research And Strategic Studies in Telecommunications GMBH; Nordunet A/S; Technische Universitaet Berlin; Instytut Chemii Bioorganicznej Polskiej Akademii Nauk; Fraunhofer Gesellschaft zur Foerderung Der Angewandten Forschung E.V.; Universiteit Van Amsterdam; University of Southampton; Martel GMBH; Atos Spain SA; Institut National de Recherche en Informatique et automatique.

Inria contact: David Margery (for RESIST: Lucas Nussbaum)

Fed4FIRE+ is a successor project to Fed4FIRE. In Fed4FIRE+, we more directly integrate Grid'5000 into the wider eco-system of experimental platforms in Europe and beyond using results we developped in Fed4FIRE. We will also provide a generalised proxy mechanisms to allow users with Fed4FIRE identities to interact with services giving access to different testbeds but not designed to support Fed4FIRE identities. Finally, we will work on orchestration of experiments in a federation context.

9.2.2. SecureIoT

Title: Predictive Security for IoT Platforms and Networks of Smart Objects

Duration: 3 years

Coordinator: INTRASOFT International SA

Partners:
Fujitsu Technology Solutions GMBH; Atos Spain S.A; Siemens SRL; Singularlogic S.A.; IDIADA Automotive Technology SA; P@SSPORT Holland B.V.; UBITECH LIMITED; Innovation Sprint Sprl; DWF Germany Rechtsanwaltsgesellschaft mbH; LuxAI S.A.; Institut National de Recherche en Informatique et automatique; it's OWL Clustermanagement GmbH; Research and Education Laboratory in Information Technologies – Athens Information Technology (AIT).

Inria contact: Jérôme François

SecureIoT is a a joint effort of global leaders in IoT services and IoT cybersecurity to secure the next generation of dynamic, decentralized IoT systems, that span multiple IoT platforms and networks of smart objects, through implementing a range of predictive IoT security services. SecureIoT will integrate its security services in three different application scenarios in the areas of: Digital Automation in Manufacturing (Industry 4.0), Socially assistive robots for coaching and healthcare and Connected cars and Autonomous Driving.

Emerging cross-platform interactions and interactions across networks of smart objects require more dynamic, scalable, decentralized and intelligent IoT security mechanisms. Such mechanisms are highly demanded by the industry in order to secure a whole new range of IoT applications that transcend the boundaries of multiple IoT platforms, while involving autonomous interactions between intelligent CPS systems and networks of smart objects. In this direction, the main objectives of the project are to: Predict and anticipate the behavior of IoT systems, facilitate compliance to security and privacy regulations and provide APIs and tools for trustworthy IoT solutions.

9.3. International Initiatives

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

9.3.1.1. Masdin

Title: MAnagement of Software-Defined INfrastructure

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2016

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

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

9.3.1.2. NetMSS

Title: NETwork Monitoring and Service orchestration for Softwarized networks

International Partner (Institution - Laboratory - Researcher):

University of Waterloo (Canada), David R. Cheriton School of Computer Science - Raouf Boutaba

Start year: 2018

See also: https://team.inria.fr/netmss/

Evolution towards softwarized networks are greatly changing the landscape in networking. In the last years, effort was focused on how to integrate network elements in cloud-based models. This lead to the advent of network function virtualization primarily relying on regular virtualization technologies and on some advances in network programmability. Several architectural models have been proposed and, even if no full consensus has been reached yet, they highlight the major components. Among them, monitoring and orchestration are vital elements in order to ensure a proper assessment of the network conditions (network monitoring) serving as the support for the decision when deploying services (orchestration). With softwarization of networks, these elements can benefit from a higher flexibility but the latter requires new methods to be efficiently handled. For example, monitoring softwarized networks necessitates the collection of heterogeneous information, regarding the network but also cloud resources, from many locations. Targeting such a holistic monitoring will then support better decision algorithms, to be applied in a scalable and efficient manner, taking advantage of the advanced capabilities in terms of network configuration and programmability. In addition, real-time constraints in networking are very strong due to the transient nature of network traffic and are faced with high throughputs, especially in data-center networks where softwarization primarily takes place. Therefore, the associate team will promote (1) line-rate and accurate monitoring and (2) efficient resource uses for service orchestration leveraging micro-services.

9.3.2. Participation in Other International Programs

9.3.2.1. ThreatPredict

- Title: ThreatPredict, From Global Social and Technical Big Data to Cyber Threat Forecast
- Coordinator: Inria
- Duration: December 2017 - November 2020
- Others Partners: International University of Rabat (IUR), Carnegie Mellon University
- Funding: North Atlantic Treaty Organization
- Abstract: Predicting attacks can help to prevent them or at least reduce their impact. Nowadays, existing attack prediction methods make accurate predictions only hours in advance or cannot predict geo-politically motivated attacks. ThreatPredict aims to predict different attack types days in advance. It develops machine-learning algorithms that capture the spatio-temporal dynamics of cyber-attacks and global social, geo-political and technical events. Various sources of information are collected, enriched and correlated such as honeypot data, darknet, GDELT, Twitter, and vulnerability databases. In addition to warning about attacks, this project will improve our understanding of the effect of global events on cyber-security.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

- Visit of Anthony (Anthony) Ang in RESIST, Ms Student, from June 4 to August 26 2018, new scheduler for micro-service based VNF [6]
- Visit of Shihabur Chowdhury in RESIST, PhD Student, from June 4 to August 26 2018, new scheduler for micro-service based VNF [6], intelligent traffic engineering

SEMAGRAMME Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. PLURAL

- Program: Langues et Numérique 2018 (DGLFLF: Délégation générale à la langue française et aux langues de France)
- Project acronym: PLURAL
- Project title: Production LUdique de Ressources Annotées pour les Langues de France (Gamified production of annotated resources for Languages of France)
- Duration: October 2017 - June 2018
- Coordinator: Bruno Guillaume
- Other partners: Université Paris-Sorbonne (Karën Fort, Alice Millour, André Thibault) and Université de Strasbourg (Delphine Bernhard).
- Abstract: The objective of the PLURAL project is to build linguistic resources with GWAPs (Game With A Purpose) for poorly endowed languages. Unlike other languages, poorly endowed languages lack freely available raw corpora. The goal of the PLURAL project is to provide a web interface to gather corpora in poorly endowed languages of France. First target languages are Alsacian and Guadeloupean creole. The main difficulty is to take into account orthographic diversity and regional diversity for these languages.

  Nicolas Lefebvre was employed as an engineer in the PLURAL project from October 2017 to March 2018.

7.2. International Initiatives

7.2.1. Informal International Partners

Maxime Amblard continues discussing with the Centre for Linguistic Theory and Studies in Probability (CLASP, University of Gothenburg, Sweden), especially with Robin Cooper, Ellen Breitholtz and Chris Howes. The discussions are about computational treatments of dialogues modelling. We have common issues about the management corpora and models of dialogue. As for now, ongoing discussions have not yet been turned into a formal project.

7.3. International Research Visitors

7.3.1. Visits to International Teams

7.3.1.1. Explorer programme

Maxime Amblard visited Gotenborg University, Sweden, from October 21 to October 26, 2018.

SPHINX Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Lorraine Université d'Excellence

Thomas Chambrion is deputy head of working group 2 of the Deepsurf project (a project of LUE). ...

8.2. National Initiatives

8.2.1. ANR

- **Project Acronym :** IFSMACS
  Project Title : Fluid-Structure Interaction: Modeling, Analysis, Control and Simulation
  Coordinator: Takéo Takahashi
  Participants: Julien Lequeurre, Alexandre Munnier, Jean-François Scheid, Takéo Takahashi
  Duration : 48 months (starting on October 1st, 2016)
  Other partners: Institut de Mathématiques de Bordeaux, Inria Paris, Institut de Mathématiques de Toulouse
  Abstract: The aim of this project is to analyze systems composed by structures immersed in a fluid. Studies of such systems can be motivated by many applications (motion of the blood in veins, fish locomotion, design of submarines, etc.) but also by the corresponding challenging mathematical problems. Among the important difficulties inherent to these systems, one can quote nonlinearity, coupling, free-boundaries. Our objectives include asymptotic analyses of FSIS, the study of controllability and stabilizability of FSIS, the understanding of locomotion of self-propelled structures and the analyze and development of numerical tools to simulate fluid-structure system.
  URL: http://ifsmacs.iecl.univ-lorraine.fr/
- **Project Acronym:** QUACO
  Project title: use of geometrical tools for the control of quantum system and application to MRI.
  Coordinator: Thomas Chambrion
  Duration: 48 months (starting January 1st 2018).
  URL: http://www.iecl.univ-lorraine.fr/~Thomas.Chambrion/QUACO/index.html
- **Project acronym:** ISDEEC
  Project title: Interaction entre Systèmes Dynamiques, Equations d'Evolution et Contrôle
  Coordinator: Romain Joly
  Participant: Julie Valein
  Other partners: Institut Fourier, Grenoble; Département de Mathématiques d'Orsay
  Duration: 36 months (2017-2020)
  URL: http://isdeec.math.cnrs.fr/

8.2.2. CNRS

Thomas Chambrion is the coordinator of the Research Project from CNRS Inphynity "DISQUO" (5300 euros, 2017).

8.3. International Initiatives

8.3.1. Participation in International Programs

8.3.1.1. Indo-French Center of Applied Mathematics

Analysis, Control and Homogenization of Complex Systems

International Partner: TIFR CAM, Bangalore

Heads: Takéo Takahashi (France) and Mythily Ramaswamy (India).

Duration: 2018 - 2021

scientific objectives

- Study the well-posedness of models arising from either structure in the fluid or structure on the boundary of the domain containing the fluid.
- Explore Controllability, Optimal Control and Stabilization of such fluid-structure interaction problems.
- Study systems describing fluid flows in a time dependent domain with a rapidly oscillating boundary using Homogenization Theory. The rapid oscillations of the boundary takes into account, the rough character of the boundary and its movements may take into account the displacement of a deformable body into a fluid flow.
- Carry out Finite Element Analysis for such models, including elastic structures as well as rigid ones.

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

- Xavier Antoine was invited
  - to Beijing CSRC, Beijing + Department of Mechanics and Engineering Science, Beijing, July 2018 (one week);
  - to the Department of Mathematics, Sichuan University, Chengdu, Augutst 2018 (3.5 weeks);
  - to the Department of Mathematics, Sichuan University, Chengdu, January 2019 (2 weeks).
- Julie Valein staid for 10 days in Valparaiso (Chile) and gave a talk to the workshop ICoPS 2018; she staid in Santiago (2-14 December 2018) to collaborate with E. Cerpa.

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. Contracts with Industry

We are involved in a common project with the company AxesSim in Strasbourg. The objective is to help to the development of a commercial software for the numerical simulation of electromagnetic phenomena. The applications are directed towards antenna design and electromagnetic compatibility. This project was partly supported by DGA through "RAPID" funds. A CIFRE PhD has started in AxesSim on the same kinds of subjects in March 2015 (Bruno Weber). The new project is devoted to the use of runtime system in order to optimize DG solvers applied to electromagnetism [28]. The resulting software will be applied to the numerical simulation of connected devices for clothes or medicine. The project is supported by the "Banque Publique d'Investissement" (BPI) and coordinated by the Thales company.

9.2.2. National projects

- PEPS "initiative Jeunes" CNRS . E. Franck, F. Drui, C. Courtès, "Design and analysis of implicit kinetic schemes".

9.2.3. IPL FRATRES

The TONUS project belongs to the IPL FRATRES (models and numerical methods for Tokamak).
We detail the activity founded by the IPL FRATRES:

- Guillaume Morel was a post-doctoral fellow until October 2018, under the joint supervision of Nicolas Crouseilles (team IPSO, Inria Rennes) and Michel Mehrenmerger.
- Work session in Saint Etienne de Tinée with Inria CASTOR TEAM in July 2018.
- IPL Workshop in Alsace with Inria TEAM CASTOR AND MINGUS + exterior in November 2018.

9.2.4. HPC resources

- GENCI projet *Simulations 3D de plasmas deux espèces avec des méthodes particulaires et semi-lagrangiennes*: 400 000 scalar computing hours accepted in October 2017 on supercomputer OCCI-GEN. Coordinator: Sever Hirstoaga
  Participants: Yann Barsamian, Sever Hirstoaga, Michel Mehrenberger.
- PRACE project *SME HPC Adoption Programme in Europe: full simulation of an electromagnetic wave inside and outside a fully modelled human body*: 40 000 GPU computing hours accepted in October 2017 on supercomputer Piz Daint. Coordinator: Bruno Weber
  Participants: Philippe Helluy, Bruno Weber.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Eurofusion 2028

- Eurofusion Enabling Research Project ER15-IPP05 Extension (1/2018-12/2018): "Global non-linear MHD modelling 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.
- EoCoE-II (2019-2022): the European center of excellence EoCoE-II brings together 20 partners from 7 European countries around exascale computing for energy-oriented numerical models. Eurofusion project MAGYK, Mathematics and Algorithms for GYrokinetic and Kinetic models (2019-2021), led by E. Sonnendrucker.
  Participant: Michel Mehrenberger.

9.4. International Initiatives

9.4.1. Participation in International Programs

- **Participants**: David Coulette, Emmanuel Franck, Philippe Helluy [local coordinator].
  ANR/SPPEXA "EXAMAG" is a joint French-German-Japanese project. Its goal is to develop efficient parallel MHD solvers for future exascale architectures. With our partners, we plan to apply highly parallelized and hybrid solvers for plasma physics. One of our objectives is to develop Lattice-Boltzmann MHD solvers based on high-order implicit Discontinous Galerkin methods, using SCHNAPS and runtime systems such as StarPU.

9.5. International Research Visitors

9.5.1. Visits of International Teams

9.5.1.1. Research Stays Abroad

- Lukas Tannhaüser from Würzburg University was invited in February 2018.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Philippe Helluy, Emmanuel Franck and Florence Drui visited Christian Klingenberg at Würzburg University.
- Philippe has been invited to a scientific stay at the University of Tokyo in February 2018. Collaboration about Vlasov-Poisson modeling with Naoki Yoshida.
- Emmanuel Franck visited Eric Sonnendruecker at IPP Gaching twice.

TOSCA Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- A. Lejay is a member of the Executive board of LUE Impact digistrust on citizens' trust in the digital world (grant of the i-site, U. Lorraine), since 2018.

7.2. National Initiatives

7.2.1. 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).

7.2.2. GDR

A. Lejay is leader of the GdR Project TRAG on rough path. This project has been accepted in October and should start on January 1st, 2019.

7.2.3. ITMO project

N. Champagnat, C. Fritsch and D. Villemonais are involved in an ITMO Cancer project (INSERM funding) on "Modeling ctDNA dynamics for detecting targeted therapy resistance" (2017-2020), involving researchers from IECL (Institut Elie Cartan de Lorraine), the Inria teams BIGS and TOSCA, ICL (Institut de Cancérologie de Lorraine), CRAN (Centre de Recherche en Automatique de Nancy) and CHRU Strasbourg (Centre Hospitalier Régional Universitaire). This project is coordinated by N. Champagnat.

7.2.4. PEPS

D. Villemonais has obtained a "PEPS jeune chercheur" grant.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

- Mireille Bossy is involved in the VIMMP H2020 project, started in January 2018, as responsible for the partner Inria. VIMMP is a four years development for a software platform and simulation market place on the topic of complex multiscale CFD simulations.

7.4. International Initiatives

7.4.1. Participation in Other International Programs

7.4.1.1. International Initiatives

Discrelongmem (C15E05)

Title: On discretization procedures in Non-Gaussian long memory processes with applications in non parametric statistics and time series analysis (C15E05)

International Partner (Institution - Laboratory - Researcher):

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

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

Duration: 2016 - 2018

Start year: 2016

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

BRN

Title: Biostochastic Research Network

International Partner (Institution - Laboratory - Researcher):

Universidad de Valparaiso (Chile) - CIMFAV – Facultad de Ingenieria - Soledad Torres, Rolando Rebolledo

CNRS, Inria & IECL - Institut Élie Cartan de Lorraine (France) - N. Champagnat, A. Lejay, D. Villemonnais, R. Schott.

Duration: 2018 - 2022

Start year: 2018

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- A. Kohatsu-Higa (Ritsumeikan University, Japan) - 1 month, with an invited professor position.

7.5.1.1. Internships

- Walid El Wahabi

  subject: processus de fragmentation pour les avalanches

  date: sept. 2018 - june. 2019

  institution: École des Mines de Nancy

- Vincent Hass

  Subject: Modèles de diffusion et estimation des dynamiques d'ADN tumoral circulant pour la détection d'une résistance à une thérapie ciblée

  Date: April 2018 - Sept. 2018

  Institution: Université Paris Sud

- Azer Mimouni

  subject: Méthodes de signature en apprentissage statistique

  date: sept. 2018 - june. 2019

  institution: École des Mines de Nancy

7.5.1.2. Sabbatical programme

D. Villemonais has obtained a *délégation CNRS* starting in September.

VERIDIS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR International Project SYMBIONT

Project acronym: SYMBIONT.

Project title: Symbolic Methods for Biological Networks.

Duration: July 2018 – June 2021.

Coordinators: Thomas Sturm and Andreas Weber (Univ. of Bonn, Germany).

Other partners: Univ. of Lille 1, Univ. of Montpellier, Inria Saclay Île de France (Lifeware), RWTH Aachen (Department of Mathematics and Joint Research Center for Computational Biomedecine), Univ. of Kassel.

Participants: Thomas Sturm.

Abstract: SYMBIONT is an international interdisciplinary project, funded by ANR in France and by DFG in Germany under the PRCI program. It includes researchers from mathematics, computer science, systems biology, and systems medicine. Computational models in systems biology are built from molecular interaction networks and rate laws, involving parameters, resulting in large systems of differential equations. The statistical estimation of model parameters is computationally expensive and many parameters are not identifiable from experimental data. The project aims at developing novel symbolic methods, aiming at the formal deduction of principal qualitative properties of models, for complementing the currently prevailing numerical approaches. Concrete techniques include tropical geometry, real algebraic geometry, theories of singular perturbations, invariant manifolds, and symmetries of differential systems. The methods are implemented in software and validated against models from computational biology databases.

More information: https://www.symbiont-project.org/.

8.1.2. ANR Project IMPEX

Project acronym: IMPEX.

Project title: Implicit and explicit semantics integration in proof based developments of discrete systems.

Duration: December 2013 – December 2018.

Coordinator: Dominique Méry.

Other partners: ENSEEIHT/IRIT Toulouse, Supélec, Telecom Sud Paris, Systerel. Pierre Castéran from LaBRI Bordeaux also contributed to the project.

Participants: Souad Kherroubi, Dominique Méry.

Abstract: Modeling languages provide techniques and tool support for the design, synthesis, and analysis of formal models that arise during system development. The semantics of these languages is well understood by their users and is therefore implicit in the models. The languages do not provide concepts for explicitly representing characteristics (domain knowledge) resulting from an analysis of the underlying application domain [69]. We suggest that ontologies are good candidates for defining domain theories and for uniquely identifying concepts encapsulating domain knowledge. The objective [50] is to offer rigorous mechanisms for handling domain knowledge in design models. The main results of the project are summarized in [18] and show the importance of three operations over models namely annotation, dependency and refactoring [38].

8.1.3. ANR Project Formedicis

Project acronym: Formedicis.

Project title: Formal methods for the development and the engineering of critical interactive systems.

Duration: January 2017 – December 2020.

Coordinator: Bruno d'Augsbourg (Onera).

Other partners: ENSEEIHT/IRIT Toulouse, ENAC, Université de Lorraine (Veridis).

Participants: Dominique Méry.

Abstract: For the last 30 years, the aerospace domain has successfully devised rigorous methods and tools for the development of safe functionally-correct software. During this process, interactive software has received a relatively lower amount of attention. However, Human-System Interactions (HSI) are important for critical systems and especially in aeronautics: for example, the investigation into the crash of the Rio-Paris flight AF 447 in 2009 pointed out a design issue in the Flight Director interface as one of the original causes of the crash. Formedicis aims at designing a formal hub language, in which designers can express their requirements concerning the interactive behavior that must be embedded inside applications, and at developing a framework for validating, verifying, and implementing critical interactive applications expressed in that language.

More information: http://www.agence-nationale-recherche.fr/Project-ANR-16-CE25-0007.

8.1.4. ANR Project DISCONT

Project acronym: DISCONT.

Project title: Correct integration of discrete and continuous models.

Duration: March 2018 – February 2022.

Coordinator: Paul Gibson (Telecom Sud Paris).

Other partners: ENSEEIHT/IRIT Toulouse, LACL, ClearSy, Université de Lorraine (Veridis).

Participants: Dominique Méry.

Abstract: Cyber-Physical Systems (CPSs) connect the real world to software systems through a network of sensors and actuators that interact in complex ways, depending on context and involving different spatial and temporal scales. Typically, a discrete software controller interacts with its physical environment in a closed-loop schema where input from sensors is processed and output is generated and communicated to actuators. We are concerned with the verification of the correctness of such discrete controllers, which requires correct integration of discrete and continuous models. Correctness should arise from a design process based on sound abstractions (including discretizations) and models of the relevant physical laws. DISCONT aims at bridging the gap between the discrete and continuous worlds of formal methods and control theory. We will lift the level of abstraction above that found in current bridging techniques and provide associated methodologies and tools. Our concrete objectives are to develop a formal hybrid model, elaborate refinement steps for control requirements, propose a rational design method and support tools, and validate them based on use cases from a range of application domains.

More information: https://fusionforge.int-evry.fr/www/discont/.

8.1.5. ANR Project PARDI

Project acronym: PARDI.

Project title: Verification of parameterized distributed systems.

Duration: January 2017 – December 2020.

Coordinator: Philippe Quéinnec (ENSEEIHT/IRIT Toulouse).

Other partners: Université Paris Sud/LRI, Université Nanterre/LIP6, Inria Nancy Grand Est (Veridis).

Participants: Marie Duflot-Kremer, Igor Konnov, Stephan Merz.

Abstract: Distributed systems and algorithms are parameterized by the number of participating processes, the communication model, the fault model, and more generally the properties of interaction among the processes. The project aims at providing methodological and tool support for verifying parameterized systems, using combinations of model checking and theorem proving. VeriDis contributes its expertise on TLA$^+$ and its verification tools, and the integration with the Cubicle model checker is a specific goal of the project.

More information: http://pardi.enseeiht.fr/.

8.1.6. Inria IPL HAC SPECIS

Project acronym: HAC SPECIS.

Project title: High-performance application and computers: studying performance and correctness in simulation.

Duration: June 2016 – June 2020.

Coordinator: Arnaud Legrand (CNRS & Inria Grenoble Rhône Alpes, Polaris).

Other partners: Inria Grenoble Rhône Alpes (Avalon), Inria Rennes Bretagne Atlantique (Myriads), Inria Bordeaux Sud Ouest (Hiepacs, Storm), Inria Saclay Île de France (Mexico), Inria Nancy Grand Est (Veridis).

Participants: Marie Duflot-Kremer, Stephan Merz.

Abstract: The goal of HAC SPECIS is to answer methodological needs of HPC application and runtime developers and to allow the study of real HPC systems with respect to both correctness and performance. To this end, this Inria Project Lab assembles experts from the HPC, formal verification, and performance evaluation communities. VeriDis contributes its expertise in formal verification techniques. In particular, our goal is to extend the functionalities of exhaustive and statistical model checking within the SimGrid platform. Yann Duplouy joined the project in December 2018 as a post-doctoral researcher with the objective of designing and implementing a statistical model checker for SimGrid.

More information: http://hacspecis.gforge.inria.fr.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. ERC Matryoshka

Program: ERC.

Project acronym: Matryoshka.

Duration: April 2017 – March 2022.

Coordinator: Jasmin Blanchette (VU Amsterdam).

Participants: Daniel El Oraoui, Mathias Fleury, Pascal Fontaine, Hans-Jörg Schurr, Sophie Tourret, Uwe Waldmann.

Abstract: Proof assistants are increasingly used to verify hardware and software and to formalize mathematics. However, despite some success stories, they remain very laborious to use. The situation has improved with the integration of first-order automatic theorem provers – superposition provers and SMT (satisfiability modulo theories) solvers – but only so much can be done when viewing automatic provers as black boxes. We propose to deliver much higher levels of automation to users of proof assistants by fusing and extending two lines of research: automatic and interactive theorem proving. Our approach will be to enrich superposition and SMT with higher-order (HO) reasoning in

a careful manner, in order to preserve their desirable properties. With higher-order superposition and higher-order SMT in place, we will develop highly automatic provers building on modern superposition provers and SMT solvers, following a novel stratified architecture, and integrate them in proof assistants. Users stand to experience substantial productivity gains: From 2010 to 2016, the success rate of automatic provers on interactive proof obligations from a representative benchmark suite called Judgment Day has risen from 47% to 77%; with this project, we aim at 90%–95% proof automation.

More information: http://matryoshka.gforge.inria.fr/.

8.2.1.2. FET-Open CSA SC^2

Program: FET Open CSA.

Project acronym: SC^2.

Project title: Symbolic Computation and Satisfiability Checking.

Duration: July 2016 – August 2018.

Coordinator: James Davenport (U. of Bath, UK).

Other partners: see http://www.sc-square.org/CSA/welcome.html.

Participants: Pascal Fontaine, Thomas Sturm.

Abstract: The use of advanced methods for solving practical and industrially relevant problems by computers has a long history. Whereas Symbolic Computation is concerned with the algorithmic determination of exact solutions to complex mathematical problems, more recent developments in the area of Satisfiability Checking tackle similar problems but with different algorithmic and technological solutions. Before the project, the two communities were largely disjoint and unaware of the achievements of each other, despite strong reasons for them to discuss and collaborate. Researchers from the two communities rarely interacted, and also their tools lacked common, mutual interfaces for unifiying their strengths. The SC^2 project initiated a wide range of activities to bring the two communities together, identify common challenges, offer global events and bilateral visits, propose standards, and so on. Now that the project is finished, we believe that these activities will continue to foster cross-fertilization of both fields and bring mutual improvements to the techniques and the software tools developed by both communities.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

Program: Erasmus+.

Project acronym: PIAF.

Project title: Pensée Informatique et Algorithmique au Fondamental / Computational Thinking in and Algorithmic in Primary Education.

Coordinator: Université de Liège.

Other partners: Université du Luxembourg, Saarland University, ESPE Nancy.

Participant: Marie Duflot-Kremer.

Abstract: The goal of the PIAF project is threefold: creating a repository of skills related to computational and algorithmic thinking, designing activities aiming at the acquisition of these skills, and evaluating the impact of these activities on primary school children and their computational thinking capacities.

8.3. International Initiatives

8.3.1. Inria International Partners

Project acronym: KANASA.

Title: Kanazawa-Nancy Partnership for Satistifiability and Arithmetics.

International Partner: Japan Advanced Institute for Science and Technology (JAIST, Dept. Intelligent Robotics, Mizuhito Ogawa).
Start year: 2016.
During the last decade, there has been tremendous progress on symbolic verification techniques, spurred in particular by the development of SMT (satisfiability modulo theories) techniques and tools. Our first direction of research will be to investigate the theoretical background and the practical techniques to integrate Interval Constraint Propagation within a generic SMT framework, including other decision procedures and quantifier handling techniques. On the purely arithmetic side, we also want to study how to unite the reasoning power of all arithmetic techniques developed in the team, including simplex-based SMT-like reasoners, Virtual Substitution, and Cylindrical Algebraic Decomposition. In particular, this includes developing theory combination frameworks for linear and non-linear arithmetic. There is a strong incentive for these kind of combinations since even non-linear SMT problems contain a large proportion of linear constraints. The partnership is supported by a Memorandum of Understanding between JAIST and LORIA.

In 2016/17, Vu Xuan Tung, then a PhD student from JAIST, spent one year in the VeriDis team, and Pascal Fontaine was a reviewer of his PhD thesis, defended in 2018. There were mutual visits in 2018, and the joint research evolves towards applying SMT techniques for detecting malware in obfuscated code.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Cezary Kaliszyk.

Date: 17 May 2018 – 17 June 2018.
Institution: University of Innsbruck, Austria.
Host: Pascal Fontaine.

Cezary Kaliszyk is an assistant professor at the University of Innsbruck. He is an expert in and a precursor of the use of machine learning in an automated reasoning context. He is the principal investigator for the ERC Starting Grant SMART (Strong Modular Proof Assistance Reasoning Across Theories). His research interests cover machine learning for theorem proving, formalization of mathematics, logical and proof translations, automated reasoning and proof data management. During his stay in Nancy, we initiated a new direction of research for quantifier instantiation, that is, using machine learning as a means of filtering the numerous instances generated by heuristic instantiation procedures in SMT.

8.4.2. Internships

Alexis Grall

Date: 1 March 2018 – 31 August 2018
Institution: Université de Lorraine
Host: Dominique Méry

In his master thesis, Alexis Grall studied the localization of Event-B models and their tranformation into the DistAlgo programming language. The Event-B models are obtained for designing distributed algorithms such as the leader election or the sliding window protocol. The transformation is proved to be sound and to preserve the properties of the Event-B models.

Axel Palaude

Date: 1 May 2018 – 31 July 2018
Institution: ENS Rennes
Host: Igor Konnov, Stephan Merz

Axel Palaude extended the short counter-example property that underlies decidability results for the verification of threshold automata (cf. section 7.2) to the case of threshold automata with real-time constraints.