Activity Report 2019

Section Partnerships and Cooperations

<div align="center" style="color:red">CAMUS Project-Team</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *ADT SPETABARU-H*

Participants: Bérenger Bramas, Vincent Loechner, Paul Cardosi.

Duration: 2019 - 2021

The SPETABARU task-based runtime system is now being developed in CAMUS. This tool is the first runtime system build on the tasks and dependencies paradigm that supports speculative execution. It is at the same time a robust runtime system that could be used for high-performance applications, and the central component to perform research in parallelization, speculation and scheduling.

The SPETABARU-H project started in November 2019 for 2 years aims in improving SPETABARU on several aspects:

- Implement a generic speculative execution model based on the team's research;
- Implement the mechanisms to make SPETABARU supporting GPUs (and heterogeneous computing nodes in general);
- Split the management of the workers and the management of the graph of tasks to allow multiple independent graphs to be used on a single node;
- Use SPETABARU in the Complexes++ application, which is a bio-physic software for protein simulation;
- Maintain and update the code to keep it modern and up to date.

9.1.2. *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.

9.2. 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 us to derive 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, from October 2015 until October 2020 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. *Collaborations with Major European Organizations*

Benjamin Stamm and Muhammad Hassan: Université d'Aix-la-Chapelle RWTH, MATHCCES (Germany). An integral equation formulation of the N-body dielectricspheres problem.

Michael Wilczek and Cristian Lalescu: Max Planck Institute for Dynamics and Self-Organization (Germany). Pseudospectral direct numerical simulations (DNS) of the incompressible Navier-Stokes equations.

Juergen Koefinger: Max Planck Institute of Biophysics, Theoretical Biophysics (Germany). Monte-Carlo simulation for coarse grained protein models.

Pavel Kus: Czech Academy of Sciences, Institute of Mathematics (Tchequia). Direct solver for several matrices at a time.

9.4. International Initiatives

9.4.1. *Informal International Partners*

The CAMUS team has collaborated with the following entities in 2019:

- Reservoir Labs, New York, NY, USA (See subsection 7.3)
- University of Batna, Algeria (See subsection 7.16)
- Universidad Politécnica de Madrid, Spain (See subsection 7.4)
- Barcelona Supercomputing Center, Barcelona, Spain (See subsection 7.5)

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

9.5.1.1. Internships

Toufik Baroudi is a PhD student under the supervision of Rachid Seghir at the University of Batna (Algeria). He is co-advised by Vincent Loechner, and has been visiting our team as an intern for one year from Nov. 2018 to Nov. 2019, founded by the Algerian *Programme National Exceptionnel (PNE)*. His PhD defense is planned at the beginning of 2020.

Raquel Lazcano is a PhD student under the supervision of Eduardo Juárez Martínez at the University of Madrid. She is also co-advised by Philippe Clauss and has been visiting our team as an intern for three months, from February to April 2019. Her PhD defense is planned at the beginning of 2020.

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, IÉCL, 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 6.3 .

9.2. National Initiatives

9.2.1. FUI Industrial Partnership on Lightweight Cryptography

> Program: FUI (Fonds Unique Interministériel)
>
> Project acronym: PACLIDO
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> Project title: Protocoles et Algorithmes Cryptographiques Légers pour l'Internet Des Objets
>
> Duration: 12/2017 - 12/2020
>
> Coordinator: Airbus Cybersecurity
>
> Other partners: 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.

9.2.2. ANR Decrypt

The CARAMBA team coordinates this ANR Project (started in January 2019) with the 5 following partners: LORIA, LIRIS (Lyon), LIMOS (Clermont-Ferrand), IRISA (Rennes), TASC (Nantes). This project aims to propose a declarative language dedicated to cryptanalytic problems in symmetric key cryptography using constraint programming (CP) to simplify the representation of attacks, to improve existing attacks and to build new cryptographic primitives that withstand these attacks. We also want to compare the different tools that can be used to solve these problems: SAT and MILP where the constraints are homogeneous and CP where the heterogeneous constraints can allow a more complex treatment.

One of the challenges of this project will be to define global constraints dedicated to the case of symmetric cryptography.

Concerning constraint programming, this project will define new dedicated global constraints, will improve the underlying filtering and solution search algorithms, and will propose dedicated explanations generated automatically. This 4-year project started in January 2019. See web site for more information.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Diego Aranha from Aarhus University visited the team one week in May and presented his work on the Brazilian voting machines at the SSL seminar, and his work on fast pairing implementation at the team's seminar. As a result, some of the new secure pairing-friendly curves of [21], [22] are implemented in the C++ library RELIC [0] (free software).

- Santanu Sarkar from IIT Madras, Chennai, India is visiting the team from December 2019 to the end of February 2020.

9.3.1.1. Internships

- Hamid Boukerrou (Université Paris 8, from March 2019 until September 2019). Subject: cryptanalysis of LBlock.

- Félix Breton (ÉNS Paris, from June 2019 until July 2019). Félix Breton has formally proven in Coq the GNU MPFR subtraction routine in the case where all three operands (the two inputs and the result) have the same precision p, and $1 \leq p < w$, where w is the machine bit-size. This extends previous work done by Jianyang Pan in 2018 on the addition and multiplication routines.

- Émilien Failly (CPP Nancy, from April 2019 until June 2019). Émilien Failly studied the Multiple Polynomial General Number Field Sieve (MNFS). He compared the use of 2, 3, and 4 polynomials on three test numbers: a 60-digit number, a 70-digit number, and a 96-digit number. In each case, the sieving time was estimated, because Cado-NFS cannot currently fully deal with MNFS polynomials.

- Liwei Liu (Peking University, from June 2019 until September 2019). In the context of the computation of discrete logarithms in finite field extensions of small degree, using the Number Field Sieve, Liwei Liu worked on the individual logarithm step, in order to make it faster and more robust.

- Rémi Piau (ÉNS Rennes, from May 2019 until July 2019). Rémi Piau worked on the implementation in Python of our attack against ECDSA using wNAF representation. He was able to improve it by making it cleaner, and using small tricks to make it faster too.

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[0] https://github.com/relic-toolkit/relic

GAMBLE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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/.

9.1.2. 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: The ASPAG projet is funded by ANR under 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 algorithms 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/.

9.1.3. ANR MinMax

Project title: MIN-MAX
Duration: 4 years
Starting date: 2019
Coordinator: Stéphane Sabourau (Université Paris-Est Créteil)
Participants:

- Université Paris Est Créteil, Laboratoire d'Analyse et de Mathématiques Appliquées (LAMA). Local coordinator: Stéphane Sabourau
- Université de Tours, Institut Denis Poisson. Local coordinator: Laurent Mazet. This node includes two participants from Nancy, Benoît Daniel (IECL) and Xavier Goaoc (Loria, GAMBLE).

Abstract: The MinMax projet is funded by ANR under number ANR-19-CE40-0014

This collaborative research project aims to bring together researchers from various areas – namely, geometry and topology, minimal surface theory and geometric analysis, and computational geometry and algorithms – to work on a precise theme around min-max constructions and waist estimates.

9.1.4. 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.

9.2. International Initiatives

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

9.2.1.1. TRIP

Title: Triangulation and Random Incremental Paths

International Partner (Institution - Laboratory - Researcher):

Carleton University (Canada) - CGLab - 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 un non-Euclidean spaces.

9.2.1.2. Astonishing

Title: ASsociate Team On Non-ISH euclIdeaN Geometry

International Partner (Institution - Laboratory - Researcher):

University of Groningen (Netherlands) - Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence - 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.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Gert Vegter (University of Groningen, NL) spent two weeks in GAMBLE in the context of the Astonishing associate team.

Matthijs Ebbens (University of Groningen, NL) spent one week in GAMBLE in the context of the Astonishing associate team.

Hugo Parlier (University of Luxembourg) spent two days in GAMBLE in the context of the ANR project SoS.

Erin Wolf Chambers (Saint Louis University, USA) spent two days in GAMBLE

Vanessa Robins (Australian National University) spent two days in GAMBLE

Andreas Holmsen (KAIST, South Korea) and Zuzanna Patáková (IST Austria, Vienna) spent a week in GAMBLE

9.3.2. Visits to International Teams

Olivier Devillers and Monique Teilaud spent one week in June at the Computational Geometry Lab of Carleton University http://cglab.ca/ in the context of the TRIP associate team.

Vincent Despré spent a total of three week during 2019 at the Mathematical Research Unit of the University of Luxembourg in the context of the ANR SoS project.

Sylvain Lazard spent two weeks in September at the Computational Geometry Lab of Carleton University http://cglab.ca/ in the context of the TRIP associate team.

Monique Teillaud spent two weeks at Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence of the University of Groningen in the context of the Astonishing associate team.

Monique Teillaud spent two days at University of Luxembourg in the context of the ANR SoS project

Xavier Goaoc spent one week at UNAM Queretaro, in Mexico.

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 - Dec. 2022
  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: Fev. 2018 - Jan. 2022
  Coordinator: Damian Markham (Laboratoire d'informatique de Paris 6)
  Other partners: NTU (Nanyang Technological University), SUTD (Singapore University of Technology and Design), NUS (Nationl University of Singapore), LIP6 (Laboratoire d'informatique de Paris 6)
  Participants: Simon Perdrix, Emmanuel Jeandel
  Abstract: In the last few years we have seen unprecedented advances in quantum information technologies. Already quantum key distribution systems are available commercially. In the near future we will see waves of new quantum devices, offering unparalleled benefits for security, communication, computation and sensing. A key question to the success of this technology is their verification and validation.

  Quantum technologies encounter an acute verification and validation problem: On one hand, since classical computations cannot scale-up to the computational power of quantum mechanics, verifying the correctness of a quantum-mediated computation is challenging. On the other hand, the underlying quantum structure resists classical certification analysis. Members of our consortium have shown, as a proof-of-principle, that one can bootstrap a small quantum device to test a larger one. The aim of VanQuTe is to adapt our generic techniques to the specific applications and constraints of photonic systems being developed within our consortium. Our ultimate goal is to develop techniques to unambiguously verify the presence of a quantum advantage in near future quantum technologies.

8.1.2. Other 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. Participation in Other International Programs

ECOS-Sud A17C03 QuCa - 01/2018 - 12/2020. **Quantum Calculi**. Funded by MinCyT and ECOS France.
Argentine Director: A. Díaz-Caro (UNQ/CONICET), French Director: G. Dowek (Inria, LSV, ENS Paris-Saclay)
Permanent members: P. Arrighi (Aix-Marseille) - J.-Y. Marion (LORIA) - P. E. Martínez López (UNQ) - S. Perdrix - B. Valiron (CentraleSupélec).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Alonso Herrera: Universidad Andrés Bello, Chile.
- Takayuki Kihara : Nagoya University, Japan.
- Damiano Mazza, CNRS, LIPN.
- Victor Selivanov: Ershov Institute of Informatics Systems, Novosibirsk, Russia.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Simon Perdrix visited Universita Buenos Aires, Universita de Quilmes and Conicet for two weeks in November 2019. The visit was part of the QuCa Ecos Sud project and was partially funded by LIA SINFIN.

<p style="text-align:center; color:red">PESTO Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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.

9.2. 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.

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

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 (Helmholtz Center for Information Security (CISPA)), and Sasa Radomirovic (Univ Dundee) on the improvement of the *TAMARIN* prover
- Collaboration with David Basin and Lara Schmid (ETH Zurich) on the study of the security impact of the bulletin board in e-voting protocols
- Collaboration with Guillaume Girol (CEA), David Basin, Ralf Sasse (ETH Zurich), Dennis Jackson (Univ Oxford), and Cas Cremers (Helmholtz Center for Information Security (CISPA)) on a new security analysis framework for the Noise language
- Collaboration with Ravishankar Borgaonkar (Sintef), Shinjo Park, and Altaf Shaik (TU Berlin) on the study of practical privacy attacks in mobile communication
- 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 Gilles Barthe (MPI for Security and Privacy, Germany) on the automation of computer-aided cryptographic proofs
- Collaboration with Paliath Narendran's group (SUNY Albany) on automated deduction
- Collaboration with Serdar Erbatur (LMU, Germany) and Andrew Marshall (Univ Mary Washington, USA) on decision procedures for combined equational theories
- 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 and April 2019.
- Ralf Sasse (ETH Zurich), November 2019.

<p style="text-align:center; color:red">VERIDIS Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

Antoine Defourné's PhD thesis and Yann Duplouy's post-doctoral research are co-funded by Région Grand Est.

9.2. National Initiatives

9.2.1. PIA2 ISITE LUE

Project acronym: ISITE LUE - Digitrust

Project title: Lorraine Université d'Excellence, Citizen Trust in the Digital World

Duration: 2016 – 2020

Coordinator: Marine Minier

Participants: Margaux Durœulx, Stephan Merz

Abstract: Digitrust is one of the "impact" projects within the excellence funding acquired by University of Lorraine and supports research into different aspects related to the trustworthiness and security of digital systems. It funds the PhD thesis of Margaux Durœulx on the use of SAT techniques for assessing system reliability.

9.2.2. ANR International Project ProMiS

Project acronym: ProMiS.

Project title: Provable Mitigation of Side Channel through Parametric Verification

Duration: November 2019 – April 2022.

Coordinators: Étienne André and Jun Sun (Singapore Management University, Singapore).

Other partners: École Centrale Nantes, Singapore University of Technology and Design.

Participants: Étienne André.

Abstract: ProMiS is an international project, funded by ANR in France and by NRF in Singapore under the PRCI program.

The Spectre vulnerability has recently been reported, which affects most modern processors. The idea is that attackers can extract information about the private data using a timing attack. It is an example of side channel attacks, where secure information flows through side channels unintentionally. How to systematically mitigate such attacks is an important and yet challenging research problem.

We propose to automatically synthesize mitigation of side channel attacks (e.g., timing or cache) using well-developed verification techniques. The idea is to reduce this problem to the parameter synthesis problem of a given formalism (for instance, parametric timed automata). Given a program or system with design parameters which can be tuned to mitigate side channel attacks, our approach will automatically generate provably secure valuations of the parameters. We plan to deliver a toolkit which can be automatically applied to real-world systems.

9.2.3. 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, Hamid Rahkooy.

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/.

9.2.4. 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, Horatiu Cirstea.

Abstract: During 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.

9.2.5. 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), until February 2019; Dominique Méry, since March 2019.

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

Participants: Dominique Méry, Zheng Cheng.

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 and models of the relevant physical laws. The systems are generally characterized by differential equations with solutions in continuous domains; discretization steps are therefore of particular importance for assessing the correctness of CPSs. 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 step-wise 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/.

9.2.6. ANR Project PARDI

Project acronym: PARDI.

Project title: Verification of parameterized distributed systems.

Duration: January 2017 – December 2021.

Coordinator: Philippe Quéinnec (ENSEEIHT/IRIT Toulouse).

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

Participants: 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/.

9.2.7. 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 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.

9.2.8. DFG Transregional Research Center 248 CPEC

Project acronym: CPEC.

Project title: Foundations of Perspicuous Software Systems.

Duration: January 2019 – December 2022.

Coordinators: Holger Hermanns (Saarland University, Germany) and Raimund Dachselt (University of Dresden, Germany).

Other partners: Max Planck Institute for Software Systems, Saarbrücken.

Participants: Alberto Fiori, Sophie Tourret, Christoph Weidenbach.

Abstract: With cyber-physical technology increasingly impacting our lives, it is very important to ensure that humans can understand them. Systems lack support for making their behaviour plausible to their users. And even for technology experts it is nowadays virtually impossible to provide scientifically well-founded answers to questions about the exact reasons that lead to a particular decision, or about the responsibility for a malfunctioning. The root cause of the problem is that contemporary systems do not have any built-in concepts to explicate their behaviour. They calculate and propagate outcomes of computations, but are not designed to provide explanations. They are not perspicuous. The key to enable comprehension in a cyber-physical world is a science of perspicuous computing.

More information: https://www.perspicuous-computing.science/.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERC Matryoshka

Program: ERC.

Project acronym: Matryoshka.

Duration: April 2017 – March 2022.

Coordinator: Jasmin Blanchette (VU Amsterdam).

Participants: Antoine Defourné, Daniel El Oraoui, Mathias Fleury, Pascal Fontaine, Stephan Merz, 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. The purpose of Matryoshka is 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 is 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/.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: Erasmus+.

Project acronym: PIAF.

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

Program: ERASMUS+.

Project acronym: ARC.

Project title: Automated reasoning in the class.

Coordinator: West University of Timisoara (Romania).

Other partners: Johaness Kepler University Linz (Austria), RWTH Aachen University (Germany), Eszterhazy Karoly University (Hungary), Université de Lorraine.

Participant: Sorin Stratulat.

Abstract: The main objective of the project is to improve the education of computer science students in fields related to computational logic, by creating innovative and advanced learning material that uses automated reasoning and by training a large number of academic staff in using this in a modern way. Thus indirectly the project objectives include the effects of increased software reliability: virus elimination, online safety, better detection of negative online phenomena (fake news, cyberbullying, etc.), and other.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Maria Paola Bonacina.

> Date: 11 February 2019 – 16 February 2019.
> Institution: Università degli Studi di Verona, Italy.
> Host: Pascal Fontaine.

Maria Paola Bonacina is a professor at the Università degli Studi di Verona, Italy. She is well known in the community for her numerous works in the field of automated reasoning, notably in SMT, combination of theories, and procedures for first-order logic. During her one-week stay in Nancy, we particularly discussed SGGS (semantically-guided goal-sensitive theorem proving) as a means of inspiration for instantiation in SMT. We also worked on a review paper on combination of theories, published in 2019 [49].

Armin Biere.

> Date: 27 May 2019 – 29 May 2019.
> Institution: Johannes Keppler Universität, Linz, Austria.
> Host: Christoph Weidenbach.

Armin Biere is professor at the University of Linz. He is a leading researcher in the SAT community. During his stay we discussed recent developments in SAT solving. In particular, resolution based inference and reduction mechanisms beyond subsumption resolution.

9.4.1.1. Internships

Manon Blanc

    Date: 1 June 2019 – 31 July 2019

    Institution: ENS Cachan

    Host: Pascal Fontaine

In her bachelor thesis, Manon Blanc studied and experimentally evaluated two different subtropical methods for handling polynomial constraints within SMT.

Mehran Aghabozorgi

    Date: 5 August 2019 – 7 October 2019

    Institution: Isfahan University of Technology, Iran

    Host: Christoph Weidenbach

Mehran worked on algorithms enhancing SAT pre- and inprocessing. He implemented blocked clause elimination as well as a variable elimination algorithm aiming at smaller clause sets.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Thomas Sturm visited the University of Bonn (Institute of Computer Science II) for 4 weeks during 2019, and the University of Kassel (Mathematical Institute). Topics included perspectives for SMT Solving in symbolic reaction network analysis, toricity of steady state varieties, scaling methods for systems of ordinary differential equations (ODE), and logic approaches for the classification of real singularities of ODE.

SPHINX Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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: QUAntum COntrol: PDE systems and MRI
  Coordinator: Thomas Chambrion
  Duration: 48 months (starting January 1st 2018).
  URL: http://www.iecl.univ-lorraine.fr/~Thomas.Chambrion/QUACO/index.html
  Abstract The aim of the project is the use of geometrical tools for the study and the control of quantum system with application to MRI.

- **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/
  Abstract The aim of the project is to study the qualitative dynamics of various classes of PDEs and classes of ODEs with special structure. This work program requires expertise in different mathematical domains such as dynamical systems theory, PDE techniques, control theory, geometry, functional analysis... while the current trend in mathematics is for high specialisation. The purpose of this project is to create and extend interactions between experts of these various domains, in order to deepen our understanding of the dynamics of evolution equations and to explore the new challenging questions, which will emerge.

- **Project Acronym:** ODISSE
  Project title: Observer Design for Infinite-dimensional Systems
  Coordinator: Vincent Andrieu
  Local coordinator: Karim Ramdani
  Duration: 48 months (starting on October 1st 2019)
  Participants: Ludovick Gagnon, Karim Ramdani, Julie Valein and Jean-Claude Vivalda.
  Other partners: Laas, Lagepp, Inria-Saclay
  Abstract: This ANR project includes 3 work-packages

  1. Theoretical aspects of observability and identifiability.

  2. From finite dimensional systems to infinite dimensional systems : Infinite-dimensional Luenberger observers, Parametric identification and adaptive estimation algorithm, Infinite-dimensional observers for finite-dimensional systems.

  3. From infinite dimensional systems to finite dimensional systems : discretization, hierarchical reduction.

9.2. International Initiatives

9.2.1. Inria International Labs

9.2.1.1. BEC2HPC

Title: Bose-Einstein Condensates : Computation and HPC simulation

Head: Xavier Antoine

International Partner: Sichuan University, Chengdu (China) - Department of mathematics - Qinglin TANG

Start year: 2019

See also: https://team.inria.fr/bec2hpc/

All members of the associate team are experts in the mathematical modeling and numerical simulation of PDEs related to engineering and physics applications. The first objective of the associate team is to develop efficient high-order numerical methods for computing the stationary states and dynamics of Bose-Einstein Condensates (BEC) modeled by Gross-Pitaevskii Equations (GPEs). A second objective is to implement and validate these new methods in a HPC environment to simulate large scale 2D and 3D problems in quantum physics. Finally, a third objective is to provide a flexible and efficient HPC software to the quantum physics community for simulating realistic problems.

9.2.2. Participation in Other International Programs

9.2.2.1. Réseau Franco-Brésilien de mathématiques

Ludovick Gagnon collaborates with the Universidade Federal da Paraiba and Universidade Federal do Rio de Janeiro funded by the Réseau Franco-Brésilien de mathématiques.

9.2.2.2. Indo-French Center of Applied Mathematics

Title : **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.

9.3. International Research Visitors

9.3.1. Visits to International Teams

Jean-François Scheid was invited to the "École Supérieure des Sciences et Technologie d'Hammam-Sousse", Tunisia, 30 September–5 October 2019.

9.3.1.1. Research Stays Abroad

Xavier Antoine was invited to the Department of Mathematics, Sichuan University, Chengdu, January 2019 (2 weeks) + August 2019 (4.5 weeks) + November 2019 (3 weeks).

<p style="text-align:center">**TOSCA Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

- C. Henry is the coordinator of the PAIRE project, a TREMPLIN-COMPLEX project funded by University of Côte d'Azur. The project aims at creating new international and cross-sector collaborations to foster innovative solutions for particle contamination in the environment. This will be achieved by bringing together partners in a consortium to submit a research proposal to the European MSCA-RISE-2019 and MSCA-RISE-2020 calls.

- 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.

8.2. National Initiatives

8.2.1. ANR

- N. Champagnat was member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales), coordinated by F. Hamel (Univ. Aix-Marseille), which ended in October.

- C. Henry is the coordinator of the PACE project, a MRSEI project funded by the ANR to help prepare European projects. As for PAIRE, the project aims at creating new international and cross-sector collaborations to foster innovative solutions for particle contamination in the environment. This will be achieved by bringing together partners in a consortium to submit a research proposal to the European MSCA-RISE-2019 and MSCA-RISE-2020 calls.

- U. Herbach is member of the ANR SinCity (Analyses transcriptomiques sur cellules uniques dont la généalogie est identifiée au cours d'un processus de différentiation), coordinated by O. Gandrillon (ENS Lyon).

8.2.2. GDR

A. Lejay is leader of the GdR Project TRAG on rough paths founded by INSMI in 2019.

8.2.3. ITMO Cancer

N. Champagnat, C. Fritsch and U. Herbach 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.

8.2.4. PEPS

The project SECURE of C. Fritsch obtained a PEPS I3A (Intelligence Artificielle et Apprentissage Automatique).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Program: FP7

Project acronym: HBP

Project title: The Human Brain Project

Duration: April 2018 - Mars 2020 (third part)

Coordinator: EPFL

Other partners: see the webpage of the project.

Tosca contact: Etienne Tanré

Abstract: Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases. This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics, Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity. A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

M. Bossy and C. Henry are involved in the VIMMP H2020 project, started in January 2018. M. Bossy is 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.

8.4. International Initiatives

8.4.1. Participation in Other International Programs

Math AmSud SARC

Title: Stochastic and Statistics analysis for Stochastic Differential equations driven by fractional Brownian motion with non regular coefficients.

International Partner (Institution - Laboratory - Researcher):

Universidade Estadual de Campinas (Brasil)

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

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

Duration: 2019 - 2020

Start year: 2019

Keywords: Stochastic differential equations, fractional Brownian motion, Malliavin calculus, Bayesian parametric, and nonparametric statistics.

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

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- E. Horton (University of Bath) spent one week in IECL in April to work with D. Villemonais.
- E. Mordecki (U. de la República, Uruguay) spent 3 months in IECL, with an invited professor position (*poste rouge CNRS*).
- H. Olivero Quintos spent one month at Sophia Antipolis.

8.5.1.1. Internships

- Loubna Ben Allal

  subject: processus de Hawkes

  date: sept. 2019 - june 2020

  institution: École des Mines de Nancy

- Wejdene Ben Nasr

  subject: méthodes de signature pour les séries temporelles multi-variées

  date: sept. 2019 - june 2020

  institution: Master IMSD, U. Lorraine.

- Olivier Coudray

  subject: transmission de la longueur de télomères entre générations

  date: apr. 2019 - aug. 2019

  institution: École Polytechnique, Master Mathématiques de l'aléatoire

- Rémi Maréchal

  subject: processus de fragmentation pour les avalanches

  date: sept. 2019 - june 2020

  institution: École des Mines de Nancy

- Seyedafshin Shekarforush

  subject: particles in the environment: the adaptative grid generation problem in particle agglomeration and fragmentation dynamics

  date: apr. 2019 - aug. 2019

  institution: Université Nice Sophia Antipolis

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

D. Villemonais obtained a *délégation CNRS* which ended in August.

<div align="center">**BIGS Project-Team**</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Lorraine Université d'Excellence LUE, Impact Project GEENAGE (Functional **G**enomic, **E**pigenomic and **EN**vironment interplay to imptact the understanding, diagnosis and management of healthy and pathological **AGE**ing). Anne Gégout-Petit, Lionel Lenôtre, Emma Horton.

9.2. National Initiatives

- FHU CARTAGE (Fédération Hospitalo Universitaire Cardial and ARTerial AGEing ; leader : Pr Athanase Benetos), Jean-Marie Monnez, Benoît Lalloué, Anne Gégout-Petit.
- RHU Fight HF (Fighting Heart Failure ; leader : Pr Patrick Rossignol), located at the University Hospital of Nancy, Jean-Marie Monnez, Benoît Lalloué.
- 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 (2019-2020), Etude Biométrique en foetopathologie et développement de l'enfant, Collaboration between Institut Elie Cartan and the 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.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Juhyun Park from Bath University spent a week in Nancy in June 2019 to work on tests for paired distributions in the framework of functional analysis with Anne Gégout-Petit.

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, Université de 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 Noel, Dominique Mias-Lucquin, Antoine Moniot, 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, Université de Lorraine (DynAMic, UMR 1128); Other partners: Chris Chipot, CNRS (LPCT, 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. IMPACT GeenAge

Participant: Marie-Dominique Devignes [contact person].

The IMPACT project GeenAge (Lorraine Université d'Excellence) is composed of four axes dedicated to research in high-throughput molecular biology. The Capsid team is involved in a transversal axis for numerical sciences. In the frame of this project, Marie-Dominique Devignes co-supervises with Amedeo Napoli a postdoc hired by the Orpailleur team. She is also responsible with Thierry Bastogne (CRAN) and Anne Gegout-Petit (IECL) for creating a Center of Competencies in Artificial Intelligence and Health.

8.2. National Initiatives

8.2.1. FEDER – SB-Server

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

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], Emmanuel Bresso, Bernard Maigret, Sabeur Aridhi, Kévin Dalleau, Claire Lacomblez, Gabin Personeni, Philippe Noel, David Ritchie.

Project title: *Combattre l'insuffisance cardiaque : Projet de Recherche Hospitalo-Universitaire FIGHT-HF*; PI: Patrick Rossignol, Université de Lorraine (FHU-Cartage); Value: 9 m€ (Capsid and Orpailleur: 450 k€, approx); Duration: 2015–2020. 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". Marie-Dominique Devignes and Malika Smaïl-Tabbone are coordinating a work-package dedicated to network-based science, decision support 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); 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. Marie-Dominique Devignes is coordinating with Alban Gaignard the Interoperability task in the Integrative Bioinformatics Workpackage.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. H2020 ITN RNAct

Participants: Isaure Chauvot de Beauchêne [contact person], Marie-Dominique Devignes, Malika Smaïl-Tabbone, Hrishikesh Dhondge, Anna Kravchenko, David Ritchie.

Program: H2020 Innovative Training Network

Project acronym:RNAct

Project title: Enabling proteins with RNA recognition motifs for synthetic biology and bio-analytics

Duration: octobre 2018 - octobre 2022

Coordinator: Wim Vranken (Vrije University Bruxelles, Belgium)

Other partners: Loria, CNRS (France), Helmholtz Center Munich (Germany), Conseio Superior de Investigaciones Cientificas, Instituto de Biologia Molecular y Celular de Plantas (Spain), Ridgeview instruments AB (Sweden), Giotto Biotech Srl (Italy), Dynamic Biosensors GmbH (Germany).

Abstract: This project aims at designing new proteins with "RNA recognition motifs (RRM)" that target a specific RNA, for exploitation in synthetic biology and bio-analytics. It combines approaches from sequence-based and structure-based computational biology with experimental biophysics, molecular biology and systemic biology. Our scientific participation regards the creation and usage of a large database on RRMs for KDD, and the development of RNA-protein docking methods.

URL: http://rnact.eu

8.3.2. Informal European Partners

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.

ELIXIR: 3D-bioinfo Community. We participated in the creation of the new ELIXIR 3D-bioinfo community. ELIXIR Communities enable the participation of communities of practice in different areas of the life sciences in the activities of ELIXIR. The goal is to underpin the evolution of data, tools, interoperability, compute and training infrastructures for European life science informatics (see https://www.elixir-europe.org/use-cases). ELIXIR supports its formally recognised Communities by providing funding for workshops and short collaborative projects associated with the Community. More specifically, Isaure Chauvot de Beauchene is member of the sub-section "Tools to describe, analyze, annotate, and predict nucleic acid structures" of this community.

ELIXIR: Interoperability Platform Marie-Dominique Devignes is collaborating with the ELIXIR Interoperability Platform aa a member of the IFB (the ELIXIR French Node: ELIXIR FR). She coordinates and reviews projects in the field of FAIR data, Data Management Plans and Recommended Interoperability Resources (RIR).

8.4. International Initiatives

8.4.1. TempoGraphs

Project: Analyzing big data with temporal graphs and machine learning. Application to urban traffic analysis and protein function annotation.

Participants: Sabeur Aridhi (PI), Marie-Dominique Devignes, Malika Smaïl-Tabbone, Bishnu Sarker, Wissem Inoubli, Dave Ritchie.

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.

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

Project: FlexMol. Algorithms for Multiscale Macromolecular Flexibility:

Participants: Maria-Elisa Ruiz-Echartea, Dave Ritchie, Isaure Chauvot de Beauchêne.

Partners: Nano-D, ChaconLab team, Rocasolano Institute of Physical Chemistry (IQFR-CSIC), Madrid, Spain, as non-beneficiary associated lab.

Description: Developing representations of molecular flexibility at different scales, for the 3D modeling of multi-molecular assemblies.

8.4.3. Informal International Partners

Project: Characterization, expression and molecular modeling ofTRR1 and ALS3 proteins of Candida spp., as a strategy to obtain new drugs with action on yeasts involved in nosocomial infections. Participant: Bernard Maigret. Partner: State University of Maringá, Brasil. Publication: [14], [18].

Project: Fusarium graminearum target selection. Participant: Bernard Maigret. Partner: Embrapa Recursos Geneticos e Biotecnologia, Brasil. Publication: [13].

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

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

<div align="center">

MIMESIS Team

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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

MIMESIS joined the IGG team to collaborate 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)

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. We also collaborate in the field of elastic registration with X-ray images and surgical training for flexible endoscopy.

9.2. National Initiatives

9.2.1. ADT (Action de Développement Technologique)

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 registration algorithms developed in the team. 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. This project is done in collaboration with Paul Brousse Hospital in Paris.

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 thermo-ablations of tumors (cryoablation, radio frequencies). Unlike traditional open surgery, these approaches only affect a localized area around the needle, reducing 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. 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. The maturity of these techniques now suggests the ability to use a simulation intra-operatively to control the motion of a robotic system for needle insertion. This is really a challenge, because in general, 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 contributes 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. Currently, two PhD are co-supervised by researcher from Magrit: Jaime Garcia and Guevara 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 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 specialized in hepatic surgery.

> **IRMA** Research Institut on Advanced Mathematics, a research laboratory at Strasbourg university. A collaboration started in the fields of shape optimisation methods via the co-supervision of the PhD of Guillaume Mestdagh.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

- **HiPerNav** 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 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** 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 partners (Inria, University of Limerick, and University of Texas at Austin). 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:
  - Mathematical foundations for data-driven simulations – UL with UT Austin,
  - Data-driven simulations for computer-assisted therapy – UL with Inria,
  - 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
- **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.
- **University of Twente, Netherlands:** we collaborate with Prof. Stefano Stramigioli, head of a group in Robotics and Mechatronics laboratory, on the development of a low-cost training system for flexible endoscopy.
- **Verona University, Italy:** we collaborate with the ALTAIR Robotics Lab on computer-aided ultrasound guidance using real-time registration. This resulted in 2 publications this year: [19] and [23].
- **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.
- **CIMIT and Harvard Medical School:** we collaborate with members of the Center for Minimally Invasite Therapy and faculty from HMS on the development of a training system for Resuscitative endovascular balloon occlusion of the aorta (REBOA).

9.5. International Research Visitors

Eleonora Tagliabue, PhD student at the robotics laboratory of Verona University, visited the team from April to June 2019. During her stay we collaboration of the comparison of different physics-based approaches to model soft tissues. This led to a publication in the International Journal of Computer Assisted Radiology and Surgery. We also applied our deep physics network to the problem od registration of breast model onto ultrasound data. This was presented at the MICCAI workshop on Computational Biomechanics in September 2019.

9.5.1. *Visits to International Teams*

Jean-Nicolas Brunet and Sergei Nikolaev spent 2 weeks in Forchheim (Germany) to visit Siemens R&D and product development groups, as part of the H2020 HiPerNav project.

<p align="center" style="color:red">NEUROSYS Project-Team</p>

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. The acquisition of a new 64-channel EEG system has been approved.

8.2. National Initiatives

8.2.1. ANR

Program: PRCE CES 33 (interaction, robotics)

Project acronym: Grasp-IT

Project title: Design and evaluation of a tangible and haptic brain-computer interface for upper limb rehabilitation after stroke

Duration: Jan 2020 - Jan 2024

Coordinator: Laurent Bougrain (Neurosys)

Other partners: 4 research teams (UL/Perseus, Inria/Camin, Inria/Hybrid) and 3 centers or hospital departments for physical medicine and rehabilitation (IRR/CMPR Lay St Christophe, CHU Rennes, CHU Toulouse) and 1 manufacturer of 3D printers (Alchimies/OpenEdge)

Abstract: This project aims to recover upper limb control improving the kinesthetic motor imagery (KMI) generation of post-stroke patients using a tangible and haptic interface within a gamified Brain-Computer Interface (BCI) training environment. (i) This innovative KMI-based BCI will integrate complementary modalities of interactions such as tangible and haptic interactions in a 3D printable flexible orthosis. We propose to design and test usability (including efficacy towards the stimulation of the motor cortex) and acceptability of this multimodal BCI. (ii) The GRASP-IT project proposes to design and integrate a gamified non-immersive virtual environment to interact with. This multimodal solution should provide a more meaningful, engaging and compelling stroke rehabilitation training program based on KMI production. (iii) In the end, the project will integrate and evaluate neurofeedbacks, within the gamified multimodal BCI in an ambitious clinical evaluation with 75 hemiplegic patients in 3 different rehabilitation centers in France.

The GRASP-IT project represents a challenge for the industrial 3D printing field. The materials of the 3D printable orthosis, allowing the integration of haptic-tangible interfaces, will come from a joint R & D work performed by the companies Alchimies and Open Edge.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Hiroaki Wagatsuma, Ass. Prof, 11-28 Jun. 2019, Kyutech (Japan). Methodological design for integration of human EEG data with behavioral analyses into human-human/robot interactions in a real-world context.

8.3.1.1. Internships

- Asako Watanabe, Master Student, Jan-Mar 2019, Kyutech (Japan). Feature Extraction of EEG Signals Using Power Spectral Entropy.

8.3.2. Visits to International Teams

L. Bougrain, A. Aussel and S. Rimbert participated in the Kyutech-LORIA workshop organized jointly by University of Lorraine and Kyutech (4-8 March 2019).

TONUS Project-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, lamobilité et l'aménagement) in Strasbourg.

9.2. National Initiatives

9.2.1. National projects

PEPS "initiative Jeunes" CNRS. E. Franck with A. Crestetto (leader), M. Badsi, "Asymptotic scheme for multiscale problems in Plasma".

PEPS "initiative Jeunes" CNRS. C. Courtès with R. Côte (IRMA), P. A. Hervieux (IPCMS), R. Ignat (IMT), G. Manfredi (IPCMS), "Study of the influence of the temperature and the external magnetic field on the magnetization reversal".

9.2.2. HPC resources

Big Challenge GENCI: Simulation of electromagnetic interaction between connected objects and the human body. We solve the 3D Maxwell equations to compute the antena emission Bluetooth Low Energy (BLE) close to the body. The main goal is to scale the computation on the new supercomputer Jean Zay to treat a realistic test case.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Eurofusion project MAGYK, *Mathematics and Algorithms for GYrokinetic and Kinetic models* (2019-2021), led by E. Sonnendrucker.
Participants: L. Navoret

Eurofusion project *Strengthening the non-linear MHD code JOREK for application to key questions of the fusion roadmap* (2019-2021), led by M. Hoelzl.
Participants: E. Franck

<p align="center">**COAST Project-Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

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

Partners: TVPaint Development, Inria
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.

9.2. National Initiatives

9.2.1. OpenPaas NG (2015–2019)

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

Partners: Linagora, XWiki, Nexedi, Université de Lorraine, LIX.
Website: http://www.open-paas.org/

This project is funded 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 is responsible for 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.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

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

9.3.2. Research Stays Abroad

François Charoy was invited by Heiko Ludwig to spend 3 month (March-May 2019) at IBM Almaden Research Center in San Jose,CA. He worked on P2P Federated Learning. A replication protocol has been designed that is under evaluation thanks to a shared internship. It also led to an ANR submission on the topic with a french company.

François Charoy was invited by Akhil Kumar to spend 6 weeks at Penn State University to collaborate to on a long transaction protocol implementation on a permissioned blockchain. This work is based on previous work done in the Coast project-team. It is also ongoing and has led to the submission of a project to a proposal submission with a local startup.

<p style="text-align:center">**RESIST Team**</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

Olivier Festor is leading the Grand Est PACTE initiative on cyber-security. This initiative led to a total funding of 400 K€ to acquire, develop and operate the first Cyber Range in the Grand Est. This unique equipment is deployed at TELECOM Nancy and serves as the main platform for cyber-security training in the Grand Est region for both civil and military staff.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR BottleNet

Participants: Isabelle Chrisment [contact], Antoine Chemardin, Thibault Cholez.

- Acronym: BottleNet
- Title: Understanding and Diagnosing End-to-End Communication Bottlenecks of the Internet
- Coordinator: Inria
- Duration: October 2015 - extended to September 2020
- 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.

9.2.1.2. 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-Décembre 2020
- Others Partners: TELECOM Nancy, 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 an (extended) duration of 5 years. It includes 14 academic partners (engineering schools including Telecom Nancy), industrial partners (Airbus, Orange) and innovative startups (the MOOC agency, and Isograd). 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.

9.2.1.3. ANR MOSAICO

Participants: Thibault Cholez [contact], Olivier Festor.

- Acronym: MOSAICO
- Title: Multi-layer Orchestration for Secured and low lAtency applICatiOns
- Coordinator: Orange Labs
- Start: 01/12/2019
- Duration: 4 years
- Others Partners: Orange Labs, Montimage, ICD-UTT
- Abstract:

  For several years, programmability has become increasingly important in network architectures. The last trend is to finely split services into micro-services. The expected benefits relies on an easier development and maintenance, better quality, scalability and responsiveness to new scenarios than monolithic approaches, while offering more possibilities for operators and management facilities through orchestration. As a consequence, it appears that network functions, such as routing, filtering, etc. can be split in several micro-services, implemented through different means, according to the software environments, and at different topological locations, thus opening the way to fully end-to-end programmable networks. This need for multi-level and multi-technology orchestration is even more important with the emergence of new services, such as immersive services, which exhibit very strong quality of service constraints (i.e. latency cannot exceed a few milliseconds), while preserving end-to-end security. The MOSAICO project proposes to design, implement and validate a global and multi-layer orchestration solution, able to control several underlying network programmability technologies (SDN, NFV, P4) to compose micro-services forming the overall network service. To reach this objective, the project will follow an experimental research methodology in several steps including the definition of the micro-services and of the global architecture, some synthetic benchmarking, the design of orchestration rules and the evaluation against the project use-case of a low latency network application.

  The kick-off meeting of MOSAICO took place the 03/12/2019 in Orange Gardens. Our current work consists in surveying the latest technologies around NFV and Open Networking.

9.2.2. Inria joint Labs

9.2.2.1. Inria-Orange Joint Lab

Participants: Jérôme François [contact], Olivier Festor, Matthews Jose, 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.

9.2.3. *Technological Development Action (ADT)*

9.2.3.1. *ADT SCUBA*

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

- Acronym: SCUBA
- 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.

9.2.4. *FUI*

9.2.4.1. *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.

9.2.5. *Inria Project Lab*

9.2.5.1. *IPL BetterNet*

Participants: Isabelle Chrisment [contact], Antoine Chemardin, Frederic Beck, Thibault Cholez.

- Acronym: BetterNet
- Coordinator: RESIST (Isabelle Chrisment)
- Duration: October 2016-August 2020
- 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.

9.2.5.2. IPL Discovery

Participant: Lucas Nussbaum [contact].

- Coordinator: Adrien Lebre (STACK)
- End: June 2019
- Site: http://beyondtheclouds.github.io
- Others 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.

9.3. European Initiatives

9.3.1. H2020 Projects

9.3.1.1. Fed4Fire+ (2017-2022)

Title: Federation for FIRE Plus

Program: H2020

Duration: January 2017 - December 2021

Coordinator: Interuniversitair Micro-Electronica centrum 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)

Abstract: 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.

9.3.1.2. SecureIoT

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

Duration: December 2017 - December 2020

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

Url : http://secureiot.eu

Abstract: 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.

9.3.1.3. SPARTA

Title: Strategic programs for advanced research and technology in Europe

Program: H2020

Duration: February 2019 - January 2022

Coordinator: Commissariat à l'Energie Atomique et aux Energies Alternatives

Partners: see web site

Inria contact: Jérôme François

Url : http://www.sparta.eu

Abstract: Cybersecurity is an urgent and major societal challenge. In correlation with the digitization of our societies, cyberthreats are having an increasing impact on our lives: it is essential to ensure digital security and strategic autonomy of the EU by strengthening its cybersecurity capacities. This challenge will require the coordination of Europe's best competences, along with strong international cooperations, towards common research and innovation goals.

SPARTA is a novel cybersecurity competence network, with the objective to collaboratively develop and implement top-tier research and innovation actions. Strongly guided by concrete challenges forming an ambitious Cybersecurity Research & Innovation Roadmap, SPARTA will tackle hard innovation challenges, leading the way in building transformative capabilities and forming a world-leading cybersecurity competence network across the EU. Four initial research and innovation programs will push the boundaries to deliver advanced solutions to cover emerging issues, with applications from basic human needs to economic activities, technologies, and sovereignty.

9.3.1.4. CONCORDIA

Participants: Thibault Cholez [contact], Rémi Badonnel, Olivier Festor.

Acronym: CONCORDIA

Title: Cyber security cOmpeteNCe fOr Research anD InnovAtion

Program: H2020

Start: 01/01/2019

Duration: 4 years

Coordinator: Research Institute CODE (Munich, Germany)

Partners: 52 partners, 26 academic and 26 industrial, from 19 countries (please see https://www.concordia-h2020.eu/consortium)

Url : https://www.concordia-h2020.eu/

Abstract: CONCORDIA is one of the 4 pilot projects whose goal is to structure and develop a network of cybersecurity competences across Europe. CONCORDIA has a research program to develop next-generation cybersecurity solutions by taking a holistic end-to-end data-driven approach from data acquisition, data transport and data usage, and addressing device-centric, network-centric, software-centric, system-centric, data-centric and user-centric security. The solutions will be integrated in sector-specific (vertical) and cross-sector (horizontal) industrial pilots with building incubators. Vertical pilots include Telecom, Finance, e-Health, Defence and e-Mobility, while horizontal pilots are about two European-scale federated platforms that are the DDoS clearing house and the Threat Intelligence platform . CONCORDIA also develops a CONCORDIA ecosystem by providing lab infrastructures, platforms, tools as "Living Labs" as well as advanced cybersecurity courses on cyber-ranges.

The project kick-off took place in Munich the 28/01/2019. The team is mainly involved in three tasks (research, education and European dimension). On the research side, we begun our work on assessing the reliability of blockchains' networking infrastructure (see section 7.1.3). Regarding the education in cybersecurity, we set up a cyber-range at TELECOM Nancy which was officially launched the 24/09/2019 and is already used by our M1 and M2 students to be trained in cybersecurity. We worked also for the task "Liaison with stakeholders" and were in particular the main editor of the 1st year deliverable of this task.

9.4. International Initiatives

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

9.4.1.1. 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

Duration: 3 years

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.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

The team is actively involved in the international program of LUE (Lorraine Université d'Excellence):

Prof. Raouf Boutaba (University of Waterloo): Inria International Chair and Professor@Lorraine

Abir Laraba: international PhD grant in cooperation with University of Waterloo

Mehdi Zakroum: international PhD grant in cooperation with International University of Rabat

9.4.2.2. Informal International Partners

Since 2019, we have started a collaboration with Sonia Mettali from the CRISTAL Lab at the ENSI engineering school (Tunisia) on the development of reinforcement learning methods for the monitoring of IoT. The work is done in the context of the PhD of Mohamed Said Frikha, jointly co-supervised by Sonia Mettali and Abdelkader Lahmadi.

9.4.3. Participation in Other International Programs

9.4.3.1. 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.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Professor Adel Bouhoula from SUP'COM (Tunisia) from June 2019 until July 2019 in collaboration with PESTO team to develop methods for optimal and verifiable security policies for software-defined networks.

Dashi Kondo, Assistant Professor in Osaka Prefecture University for two weeks in November 2019 to develop new scientific cooperation on network security.

9.5.1.1. Internships

Anthony Samer Abou Jaoude, from March 2019 until May 2019.

Tarek Nsiri, from June 2019 until September 2019.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Abdelkader Lahmadi visited the team of Professor Raouf Boutaba in the University of Waterloo for two weeks during the month of June 2019. During this visit, he provided an IEEE seminar on the topic of Self-Driving Networks.

ALICE Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- We coordinate a work package for the CPER CyberEntreprise 2017–2020 ($\approx$ 30k euros). The application goal is to develop modelling methods, which are of interest to oil companies in order to optimize oil production.
  Program: CPER (Contrat de Plan État Région)
  Project title: Cyber-Entreprises
  Duration: 01/07/2015 – 31/12/2020
  Participants: Bruno Lévy, Dmitry Sokolov and Nicolas Ray
  Coordinator: Emmanuel Thomé and Marc Jungers (CRAN)

<p align="center" style="color:red">LARSEN Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. LUE C-Shift

Program: LUE Impact (Lorraine Université d'Excellence)

Project acronym: C-Shift

Project title: Cobots in the Service of Human activity at work In consistence with the challenges of Industry of the FuTure

Duration: October 2019 - December 2022

Coordinator: Benoit Iung (University of Lorraine)

PI for Inria/Loria: Serena Ivaldi

Abstract:

Le projet IMPACT « C-SHIFT » (Cobots in the Service of Human activity at work In consistence with the challenges of Industry of the FuTure) labélisé LUE (Lorraine Université d'Excellence) en collaboration avec les laboratoires de recherches LORIA, CRAN, CEREFIGE, PErSEUS, DevAH, LGIPM et les centres d'expertise et ressources AIPL-SMART et Ergosim et qui vise à étudier l'impact de la mise en œuvre de dispositifs collaboratifs intelligents tels que les cobots dans le cadre des défis de l'industrie du futur.

9.1.2. LUE Acceptability

Program: LUE PhD program (Lorraine Université d'Excellence)

Project title: elderly-technology interaction: accessibility and acceptability of assistive technology at home

Partners : Inria-Loria and Psychology and neuroscience lab - EA7489 (2LPN)

participants : Jérome Dinet, François Charpillet, Eloïse Zehner

Duration: October 2018 - September 2021

Abstract:

This PhD program is funded by the LUE PhD program, which among other has the objective to strength cooperation with associated institutions or companies supporting one of the six socio-economic challenges, here "Ageing and Health" challenge. This Ph.D. thesis, is aiming:

- at identifying sustainable actions to promote seniors' quality of life, intended to investigate this kind of interaction in terms of accessibility and acceptability that senior citizen experience with technological devices autonomy at home;
- at understanding more of technology use by older people. We have insight in the actual situation on older people's use and acceptance of technology, but locally and segmented, and more descriptive than explanatory. Most attention goes to the role of technology in the home with a particular focus on the interaction between people and assistive robots.

9.1.3. Project Psyphine Hors les Murs

Title: Psyphine Hors les Murs

Program: PEPS blanc 2019 de l'INS2I

Duration: January 2017 - January 2019

Coordinator: LORIA UMR (UMR 7503)

LARSEN member: Amine Boumaza

Psyphine is an interdisciplinary and exploratory project that gathers philosophers, psychologists, ethnologist, and computer scientists. The long term goal of the project is to explore the idea of assignments of intelligence or intentionality. Assuming that our intersubjectivity and our natural tendency to anthropomorphize plays a central role in this process, the project members investigate the elements that drive humans to attribute intelligence to robotic devices. Some of the questions that we aim to answer are: is it possible to give the illusion of cognition and/or intelligence through a technical device? How elaborate must be the control algorithms or "behaviors" of such a device so as to fool the observer? How many degrees of freedom must it have?

Partner institutions: InterPsy (EA 4432), ATILF (UMR 7118), Archives Henri-Poincaré (UMR7117), Inria Bordeaux Sud-Ouest, Loria (UMR7503) and MSH Lorraine (USR3261).

9.2. National Initiatives

9.2.1. ANR : The Flying Co-Worker

Program: ANR

Project acronym: Flying Co-Worker

Project title: Flying Co-Worker

Duration: October 2019 - october 2023

Coordinator: Daniel Sidobre (Laas Toulouse)

PI for Inria: François Charpillet

Abstract: Bringing together the recent progresses in physical and decisional interaction between humans and robots with the control of aerial manipulators, this project addresses the flying coworker, an aerial manipulator robot that act as a teammate of a human worker to transport a long bar or to realise complex tasks. Safety and human-aware robot abilities are at the core of the proposed research to progressively build robots capable to do cooperative handling and to assist a worker by notably delivering objects directly in a safe, efficient, pertinent and acceptable manner. The methodologies developed for ground manipulators cannot be directly used for aerial manipulator systems because of the floating base, of a limited payload, and of strong actuation and energy constraints. From the perception and the interpretation of the human activity, the objective of the project is to build an aerial manipulator capable to plan and control human aware motions to achieve collaborative tasks.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. 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.

9.3.1.2. 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)

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. HEAP

- Program: CHIST-ERA
- Project acronym: HEAP
- Project title: HEAP: Human-Guided Learning and Benchmarking of Robotic Heap Sorting
- Duration: March 2019–Feb. 2022

- Coordinator: Gerhard Neumann (Univ. of Lincoln, UK)
- PI for Inria: Serena Ivaldi
- Other partners: Italian Insitute of Technology (Italy), Technische Universitat Wien (Austria), Idiap Research Institute (Switzerland), Inria
- This project will provide scientific advancements for benchmarking, object recognition, manipulation and human-robot interaction. We focus on sorting a complex, unstructured heap of unknown objects –resembling nuclear waste consisting of a set of broken deformed bodies– as an instance of an extremely complex manipulation task. The consortium aims at building an end-to-end benchmarking framework, which includes rigorous scientific methodology and experimental tools for application in realistic scenarios. Benchmark scenarios will be developed with off-the-shelf manipulators and grippers, allowing to create an affordable setup that can be easily reproduced both physically and in simulation. We will develop benchmark scenarios with varying complexities, i.e., grasping and pushing irregular objects, grasping selected objects from the heap, identifying all object instances and sorting the objects by placing them into corresponding bins. We will provide scanned CAD models of the objects that can be used for 3D printing in order to recreate our benchmark scenarios. Benchmarks with existing grasp planners and manipulation algorithms will be implemented as baseline controllers that are easily exchangeable using ROS. The ability of robots to fully autonomously handle dense clutters or a heap of unknown objects has been very limited due to challenges in scene understanding, grasping, and decision making. Instead, we will rely on semi-autonomous approaches where a human operator can interact with the system (e.g. using tele-operation but not only) and giving high-level commands to complement the autonomous skill execution. The amount of autonomy of our system will be adapted to the complexity of the situation. We will also benchmark our semi-autonomous task execution with different human operators and quantify the gap to the current SOTA in autonomous manipulation. Building on our semi-autonomous control framework, we will develop a manipulation skill learning system that learns from demonstrations and corrections of the human operator and can therefore learn complex manipulations in a data-efficient manner. To improve object recognition and segmentation in cluttered heaps, we will develop new perception algorithms and investigate interactive perception in order to improve the robot's understanding of the scene in terms of object instances, categories and properties.

9.4. International Research Visitors

9.4.1. *Visits of International Scientists*

This year we had the visit of Professor Sozo Inoue from Kyushu Institute of Technology (https://sozolab.jp) for one week in September. He was accompanied with one PhD student and two Master students, and a Postdoc. The objective was to organise together the collection of a Dataset and propose an international challenge for testing action and activity recognition algorithms.

9.4.1.1. *Internships*

- Luan Wei (University of Osnabrück, Germany), 5 months (supervisor: Jean-Baptiste Mouret)
- Ivan Bergonzi (University of Roma — La Sapienza, Italy), 5 months (supervisor: Jean-Baptiste Mouret)
- Lorenzo Vianello (University of Roma — La Sapienza, Italy), 6 months (supervisor: Serena Ivaldi)
- Andrea Macrí (University of Roma — La Sapienza, Italy), 5 months (supervisor: Serena Ivaldi)
- Lina Achaji (University Lebanese University – Faculty of Engineering – Tripoli), 3 months (supervision: François Charpillet)
- Niyati Rawal (Rovira i Virgili University & Open University of Catalonia (Spain)), 5 months (supervision: Francis Colas, Serena Ivaldi, Vincent Thomas)
- Yang You (Cranfield University), 5 months (supervision Vincent Thomas, Olivier Buffet, François Charpillet).

9.4.2. PhD students

- Niels Justesen (IT University of Copenhagen), 3 months (supervisor: Jean-Baptiste Mouret)
- Anji Ma (Bejing Institute of Technology), 1 year (supervisor: Serena Ivaldi)
- Moe Matsuki (Kyushu Institute of Technology) 2 weeks (supervisor: François Charpillet).

<p style="color:red; text-align:center;">**MAGRIT Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

The project *Imagerie et Robotique Médicale Grand Est (IRMGE)* started in 2018. Clinical and interventional imagery is a major public health issue. Teams from the Grand-Est region involved in medical imaging (Inria, ICuve, CRESTIC) have thus proposed a research project to broaden and strenghten cooperation. The three axes 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.

8.2. National Initiatives

8.2.1. ANR JCJC ICaRes

Participant: F. Sur

This 3-year project (2019-2022) headed by B. Blaysat (Université Clermont-Auvergne), is supported by the Agence Nationale de la Recherche. It addresses residual stresses, which are introduced in the bulk of materials during processing or manufacturing. Since unintended residual stresses often initiate early failure, it is of utmost importance to correctly measure them. The goal of the ICaRes project is to improve the performance of residual stress estimation through the so-called virtual digital image correlation (DIC) which will be developed. The basic idea of virtual DIC is to mark the specimen with virtual images coming from a controlled continuous image model, instead of the standard random pattern. Virtual DIC is expected to outperform standard DIC by, first, matching real images of the materials with the virtual images, then, to run DIC on the virtual images on which strain fields are estimated, giving ultimately residual stresses.

8.2.2. Projet RAPID EVORA

(2016-2010) Participants: M.-O. Berger, V. Gaudillière, G. Simon.

This 4-years 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.

This year we have built a demonstrator to locate a camera in a factory modeled by a set of registered RGB-D panoramic images. The panoramic image closest to the current image is selected using a CNN descriptor calculated inside proposed boxes. Points and edges are then detected and matched between the current image and the selected panoramic image by using our method published at ICIP 2018 [31]. The camera pose can finally be obtained with regard to the scene by transitivity (image $\longleftrightarrow$ panoramic view $\longleftrightarrow$ scene).

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 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.

8.3.2. Inria International Partners

8.3.2.1. 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.

- Gabriele Steidl (Technische Universität Kaiserslautern, Germany) invited Fabien Pierre during two days in her team to work on convolution on Riemannian manifolds for color images. The goal of this collaboration is the design of a CNN to process images which values are on a Manifolds.

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 in July 2019. 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 during one week.

- Douglas Perrin, a senior researcher at Harvard University (http://www.childrenshospital.org/researchers/douglas-perrin), visited the MAGRIT team in September 2019. He gave a talk to the Department 1 in Loria, he worked on the segmentation of the mitral valve leaflet and he provided advice to Daryna Panicheva during one week.

- Ioana Ilea, Technical University Cluj-Napoca visited the Magrit team in October. She gave a talk entitled "Robust classification on covariance matrix space: Application to texture".

8.4.1.1. Internships

Anastasiia Onanko from Kiev Polytechnique Institute was hosted to fulfill her Master internship (Erasmus mobility program). She worked to initiate a new research line in collaboration with our partners from CHRU Nancy, who were interested in having faster, more automated, but still faithful, means of detecting

intracranial aneurysms from 3D magnetic resonance angiography (MRA) images. The deep learning approach that was followed addressed three challenges: the impossibility to use full-sized 3D MRA as input to a deep Convolutional Neural Network (CNN), the difficulty to collect annotated data, and the scarcity of aneurysms within the whole brain vasculature (about 50 voxels in a volume that counts millions of voxels). We designed two patch-based classification approaches, with roughly annotated data, and experimented with various data augmentation protocols. Results are preliminary and need to be consolidated. In particular, the current (limited) database will be expanded in the next few months.

8.4.2. *Visits to International Teams*

8.4.2.1. *Research Stays Abroad*

- Pierre-Frédéric Villard spent one month (May 2019) 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.

- Daryna Panicheva and Pierre-Frédéric Villard stayed in Harvard University in Cambridge (USA) respectively 2 weeks and 1 month in the context of the CURATIVE team. Each of them gave a talk to the Harvard Biorobotics Lab. An acquisition of a porcine mitral valve was done with 4 different amounts of pressure with a microCT scan. Biomechanical simulations on the mitral valve were also studied in term of stability and convergence.

MFX Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Project Orthosis4D (2019-2022)

- Acronym: Orthosis4D.
- Title: Passive and active 3D printed orthosis: modeling, simulation and applications.
- Duration: 2019-2022.
- Funding: Lorraine Université d'Excellence.
- Coordinator: Sylvain Lefebvre.
- Participants: SylvainLefebvre, ThibaultTricard, Pierre-AlexandreHugron, Jean-BaptisteAustruy
- Other partners: IJL, LRGP, ERPI, IRR and Nancy CHU
- Abstract: 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. On our side the project funds a PhD student, Thibault Tricard, who started in October 2018, a project manager, Jean-Baptiste Austruy, who started in May 2019 and a design engineer, Pierre-Alexandre Hugron, who started in April 2019.

  The project resulted in several publications this year [17], [11], [14]. We are also actively working with Bernhard Thomaszewski (University of Montréal) and Mélina Skouras (Inria Grenoble) within the scope of this project.

  Pierre-Alexandre Hugron started to interact with the medical partners, following the manufacturing process of orthopedic insoles at the IRR Louis Pierquin as well as producing and discussing 3D printed samples with practitioners to better understand their expectations and requirements. In particular, extensive tests have been conducted on the fabrication of different structures and density samples to mimic the current materials of insoles. Some of these samples are currently reviewed by the CHRU. These tests have resulted in an optimization of our 3D printing processes for a better accuracy and speed.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. Project MuFFin

- Acronym: MuFFin.
- Title: Procedural Stochastic Microstructures for Functional Fabrication.
- Duration: 2018-2021.
- Funding: ANR JCJC.
- Coordinator: Jonàs Martínez.
- Participants: Jonàs Martínez, Sylvain Lefebvre, Samuel Hornus, Semyon Efremov.

- Abstract:

  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.

  We have ongoing interdisciplinary collaborations with researchers in topology optimization (Perle Geoffroy-Donders and Grégoire Allaire at École Polytechnique), material science in the context of aeronautics (Mohamed amin Ben Lassoued, Ahmed Abbad, and Guilhem Michon at ISAE-SUPAREO, Annie Ross at Polytechnique Montréal), and deformable robotics (Félix Vanneste and Olivier Goury in the DEFROST Inria team).

9.2.1.2. Project IMPRIMA

- Acronym: IMPRIMA.
- Title: Implicit modeling for additive manufacturing.
- Duration: 2019-2023.
- Funding: ANR JCJC.
- Coordinator: Cédric Zanni.
- Participants: Cédric Zanni, Sylvain Lefebvre, Melike Aydinlilar.
- Abstract:

  Project IMPRIMA seek to explore novel implicit representations in order to provide a unified approach for the modeling and slicing of both macro geometry, microstructures and gradient of material. Additionally, this research aims at a complete, tight integration of both standard boundary representations and novel implicit volume representations, allowing the best choice of representation for different parts of a design.

  We have hired Melike Aydinlilar as a PhD student, starting from November 2019. We have an ongoing collaboration on skeleton-based implicit surfaces with Évelyne Hubert and Alvaro Fuentes in the AROMATH Inria team.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

We continued our informal international collaborations, in particular with Bernhard Thomaszewski (University of Montréal) on clay support structures [13] and microstructure design [14].

We are pursuing our joint research effort on slicing and curved 3D printing [11] with Charlie C.L. Wang (The Chinese University of Hong Kong), Sara McMains (University of California Berkeley), Brian Wyvill (University of Victoria), Daniele Panozzo (NYU), and Marc Alexa (TU-Berlin).

We have an ongoing collaboration with Tim Kuipers (TU Delft/Ultimaker) on algorithms for process planning.

9.3.2. Visits of International Scientists

We have invited Tim Kuipers, a developer at Ultimaker in the Netherlands, and a PhD student at TU Delft, to join us on an ongoing project in which Samuel Hornus and Sylvain Lefebvre are involved together with the GAMBLE team of Inria Nancy. Tim visited us in Nancy for 3 weeks in September.

<p align="center">**MULTISPEECH Project-Team**</p>

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 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 is to develop innovative technologies for health, and tools and strategies for personalized medicine. MULTISPEECH will collect data for distant-microphone voice commands.

9.1.3. Com-Medic ALOE

Company: Com-Medic (France)

Duration: Mar 2019 – August 2020

Participants: Denis Jouvet, Vincent Colotte, Slim Ouni, Louis Delebecque

Abstract: ALOE is a method of reading relying on a specific representation of sounds. Our involvement in the project is to develop tools to translate automatically and align text sentences into phone sequences as required by the ALOE system, and to provide audio and video tutoring examples.

9.2. National Initiatives

9.2.1. ANR ArtSpeech

Project acronym: ArtSpeech

Project title: Synthèse articulatoire phonétique

Duration: October 2015 - August 2020

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 via the numerical simulation of the human speech production processes, i.e. the articulatory, aerodynamic and acoustic aspects. Articulatory data comes from MRI and EPGG acquisitions.

9.2.2. 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

Abstract: The objective is to develop theoretical and applied tools to embed audio denoising and separation tools in web-based audio archives. The applicative scenario is to deal with the notorious audio archive "*Archives du CNRS — Musée de l'Homme*", gathering recordings dating back to the early 1900s.

9.2.3. PIA2 ISITE LUE

Project acronym: ISITE LUE

Project title: Lorraine Université d'Excellence

Duration: 2016 - 2020

Coordinator: Univ. Lorraine

Participants: Ioannis Douros, Yves Laprie

Abstract: LUE (Lorraine Université d'Excellence) was designed as an "engine" for the development of excellence, by stimulating an original dialogue between knowledge fields. Within challenge number 6: "Knowledge engineering" this project funds the PhD thesis of Ioannis Douros on articulatory modeling.

9.2.4. OLKI LUE

Project acronym: OLKI LUE

Project title: Open Language and Knowledge for Citizens, Lorraine Université d'Excellence

Coordinator: Christophe Cerisara (LORIA)

Participants: Tulika Bose, Dominique Fohr, Irène Illina

Abstract: The initiative aims at developing new algorithms that improve the automatic understanding of natural language documents, and a federated language resource distribution platform to enable and facilitate the sharing of open resources. This project funds the PhD thesis of Tulika Bose on the detection and classification of hate speech.

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, Elodie Gauthier, Thomas Girod, Denis Jouvet, Odile Mella, Slim Ouni, Leon Rohrbacher

Abstract: METAL aims at improving the learning of languages (written and oral) through development of new tools and analysis of numeric traces associated with students' learning. 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 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, Irène 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 deep learning approaches to recast the problem of synchronizing devices at the signal level as a multi-view learning problem.

9.2.8. ANR DEEP-PRIVACY

Project acronym: DEEP-PRIVACY

Project title: Distributed, Personalized, Privacy-Preserving Learning for Speech Processing

Duration: January 2019 - December 2022

Coordinator: Denis Jouvet

Other partners: LIUM (Le Mans), MAGNET (Inria Lille), LIA (Avignon)

Participants: Pierre Champion, Denis Jouvet, Emmanuel Vincent

Abstract: The objective is to elaborate a speech transformation that hides the speaker identity for an easier sharing of speech data for training speech recognition models; and to investigate speaker adaptation and distributed training.

9.2.9. ANR ROBOVOX

Project acronym: ROBOVOX

Project title: Robust Vocal Identification for Mobile Security Robots

Duration: Mar 2019 – Mar 2023

Coordinator: Laboratoire d'informatique d'Avignon (LIA)

Other partners: Inria (Nancy), A.I. Mergence

Participants: Antoine Deleforge, Sandipana Dowerah, Denis Jouvet, Romain Serizel

Abstract: The aim is to improve speaker recognition robustness for a security robot in real environment. Several aspects will be particularly considered such as ambiant noise, reverberation and short speech utterances.

9.2.10. ANR LEAUDS

Project acronym: LEAUDS

Project title: Learning to understand audio scenes

Duration: Apr 2019 - Sep 2022

Coordinator: Université de Rouen Normandie

Other partners: Inria (Nancy), Netatmo (Paris)

Participants: Mauricio Michel Olvera Zambrano, Romain Serizel, Emmanuel Vincent, and Christophe Cerisara (CNRS - LORIA)

Abstract: LEAUDS aims to make a leap towards developing machines that understand audio input through breakthroughs in the detection of thousands of audio events from little annotated data, the robustness to "out-of-the lab" conditions, and language-based description of audio scenes. MULTISPEECH is responsible for research on robustness and for bringing expertise on natural language generation.

9.2.11. Inria Project Lab HyAIAI

Project acronym: HyAIAI

Project title: Hybrid Approaches for Interpretable AI

Duration: Sep 2019 - Aug 2023

Coordinator: Inria LACODAM (Rennes)

Other partners: Inria TAU (Saclay), SEQUEL, MAGNET (Lille), MULTISPEECH, ORPAILLEUR (Nancy)

Participants: Irène Illina, Emmanuel Vincent, Georgios Zervakis

Abstract: HyAIAI is about the design of novel, interpretable artificial intelligence methods based on hybrid approaches that combine state of the art numeric models with explainable symbolic models.

9.2.12. ANR BENEPHIDIRE

Project acronym: BENEPHIDIRE

Project title: Stuttering: Neurology, Phonetics, Computer Science for Diagnosis and Rehabilitation

Duration: March 2019 - December 2023

Coordinator: Praxiling (Toulouse)

Other partners: LORIA (Nancy), INM (Toulouse), LiLPa (Strasbourg).

Participants: Yves Laprie, Slim Ouni, Shakeel Ahmad Sheikh

Abstract: This project brings together neurologists, speech-language pathologists, phoneticians, and computer scientists specializing in speech processing to investigate stuttering as a speech impairment and to develop techniques for diagnosis and rehabilitation.

9.2.13. ANR HAIKUS

Project acronym: HAIKUS

Project title: Artificial Intelligence applied to augmented acoustic Scenes

Duration: Dec 2019 - May 2023

Coordinator: Ircam (Paris)

Other partners: Inria (Nancy), IJLRA (Paris)

Participants: Antoine Deleforge, Emmanuel Vincent

Abstract: HAIKUS aims to achieve seamless integration of computer-generated immersive audio content into augmented reality (AR) systems. One of the main challenges is the rendering of virtual auditory objects in the presence of source movements, listener movements and/or changing acoustic conditions.

9.2.14. ANR Flash Open Science HARPOCRATES

Project acronym: HARPOCRATES

Project title: Open data, tools and challenges for speaker anonymization

Duration: Oct 2019 - Mar 2021

Coordinator: Eurecom (Nice)

Other partners: Inria (Nancy), LIA (Avignon)

Participants: Denis Jouvet, Md Sahidullah, Emmanuel Vincent

Abstract: HARPOCRATES will form a working group that will collect and share the first open datasets and tools in the field of speech privacy, and launch the first open challenge on speech privacy, specifically on the topic of voice de-identification.

9.2.15. ATT Dynalips & ATT Dynalips-2

Project acronym: DYNALIPS

Project title: Automatic Lip synchronization with speech

Duration: Jul 2018 - Dec 2019

Coordinator: Slim Ouni

Participants: Valerian Girard, Slim Ouni

Abstract: This is a technology transfer project of our research solution that aims to synchronize precisely and automatically the movement of the mouth of a 3D character with speech. We address 3D animation and video game industries.

9.2.16. InriaHub Carnot Technologies Vocales

Project title: InriaHub Carnot Technologies Vocales

Duration: Jan 2019 - Dec 2020

Coordinator: Denis Jouvet

Participants: Mathieu Hu, Denis Jouvet, Dominique Fohr, Vincent Colotte, Emmanuel Vincent, Romain Serizel

Abstract: This project aims to adjust and finalize the speech synthesis and recognition modules developed for research purposes in the team, so that they can be used in interactive mode.

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, Saarland University, Tilde SIA

Participants: Irène Illina, Denis Jouvet, Imran Sheikh, Brij Mohan Lal Srivastava, Mehmet Ali Tugtekin Turan, 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.

9.3.1.2. AI4EU

Program: ICT-26-2018-2020

Project acronym: AI4EU

Project title: European Artificial Intelligence On-Demand Platform and Ecosystem

Duration: 2019–2021

Coordinator: THALES

Other partners: 80 partners from 22 countries

Participants: Seyed Ahmad Hosseini, Slim Ouni

Abstract: The aim of AI4EU is to develop a European Artificial Intelligence ecosystem, from knowledge and algorithms to tools and resources.

9.3.1.3. CPS4EU

Program: PSPC-ECSEL

Project acronym: CPS4EU

Project title: Cyber-physical systems for Europe

Duration: June 2019 – June 2022

Coordinator: CEA

Other partners: 42 partners from 6 countries

Participants: Antoine Deleforge, Romain Serizel

Abstract: CPS4EU aims to develop key enabling technologies, pre-integration and development expertise to support the industry and research players' interests and needs for emerging interdisciplinary cyber-physical systems (CPS) and securing a supply chain around CPS enabling technologies and products.

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 2019

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, Mohamed Amine Menacer

Abstract: The idea is to develop a multilingual system to help people understand broadcast news in a foreign language and compare them to corresponding news available in the user's mother tongue. MULTISPEECH contributions concern mainly the speech recognition in French, English and Arabic videos.

9.3.2.2. M-PHASIS

Program: ANR-DFG

Project acronym: M-PHASIS

Project title: Migration and Patterns of Hate Speech in Social Media - A Cross-cultural Perspective

Duration: March 2019 - Feb 2022

Coordinators: Angeliki Monnier (CREM) and Christian Schemer (Johannes Gutenberg university)

Partners: CREM (UL), LORIA (UL), JGUM (Johannes Gutenberg-Universität), SAAR (Saarland University)

Participants: Irène Illina, Dominique Fohr, Ashwin Geet D'sa

Abstract: Focusing on the social dimension of hate speech, M-PHASIS seeks to study the patterns of hate speech related to migrants, and to provide a better understanding of the prevalence and emergence of hate speech in user-generated content in France and Germany. MULTISPEECH contributions concern mainly the automatic detection of hate speech in social media.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- Alessio Brutti & Maurizio Omologo, Fondazione Bruno Kessler (Italy)
  speech enhancement and speaker recognition [60]

- Samuele Cornell & Stefano Squartini, Università Politecnica delle Marche (Italy)
  speech enhancement and speaker recognition [59], [60]

- Tomi Kinnunen, University of Eastern Finland (Finland)
  speaker recognition & spoofing countermeasures [35], [12], [51], [54], [46].

- Justin Salamon, Adobe Research (USA)
  Sound event detection [48], [61]

- Junichi Yamagishi, National Institute of Informatics (Japan)
  speaker recognition & spoofing countermeasures [51], [46].

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Research Stays Abroad

- 2019 Sixth Frederick Jelinek Memorial Summer Workshop (Jun.–Aug. 2019, M. Pariente, S. Sivasankaran)

<div align="center">**ORPAILLEUR Project-Team**</div>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR ELKER (2017–2020)
Participants: Nacira Abbas, Miguel Couceiro, Amedeo Napoli.

The objectives of the ELKER ANR Research Project (https://project.inria.fr/elker/) are to study, formalize, and implement the search for link keys in RDF data [2]. Link keys generalize database keys in two independent directions, as firstly they deal with RDF data and secondly they apply across two relation datasets. In this project, we study the discovery of link keys and reasoning with link keys, being based on the FCA formalism. The ELKER project relies on the competencies of the Orpailleur Team in FCA and pattern structure algorithms, and also in 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 Grenoble Rhône Alpes, and LIASD at Université Paris 8.

9.1.1.2. ANR PractiKPharma (2016–2020)
Participants: Miguel Couceiro, Adrien Coulet, Pierre Monnin, Amedeo Napoli, 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. While most of the available knowledge in pharmacogenomics –state of the art knowledge– lies in the biomedical literature, with various levels of validation, an originality of PractiKPharma is to use Electronic Health Records (EHRs) to constitute cohorts of patients where to discover knowledge units. Indeed, these cohorts are mined for discovering potential pharmacogenomics patterns to be then validated w.r.t. literature knowledge for becoming actionable knowledge units. More precisely, firstly we have to discover 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 –the literature is in English whereas EHRs are in French– and on knowledge level, as EHRs represent observations at the patient level whereas the 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.

9.1.1.3. ANR AstroDeep (2019–2022)
Participants: Miguel Couceiro, Amedeo Napoli, Claire Theobald.

Astronomical surveys planned for the coming years will produce data that present analysis challenges not only because of their scale (hundreds of petabytes), but also by the complexity of the measurement challenges on very deep images (for instance subpercent-level measurement of colors or shapes on blended objects). New machine learning techniques appear very promising: once trained, they are very efficient and excel at extracting features from complex images. In the AstroDeep project, we aim at developing such machine learning techniques that can be applied directly on complex images without going through the traditional steps of astronomical image processing, that lose information at each stage. The developed techniques will help to leverage the observation capabilities of future surveys (LSST, Euclid, and WFIRST), and will allow a joint analysis of data.

The AstroDeep ANR Project involves three labs, namely APC Paris ("Astroparticules et Cosmologie Paris"), the Orpailleur Team at Inria Nancy Grand Est/LORIA, and "Département d'Astrophysique CEA Saclay".

9.1.2. Inria Project Labs, Exploratory Research Actions, and Technological Development Actions

Participants: Guilherme Alves Da Silva, Alexandre Bazin, Miguel Couceiro, Nyoman Juniarta, Tatiana Makhalova, Amedeo Napoli, Laureline Nevin, Abdelkader Ouali, Claire Theobald, Georgios Zervakis.

HyAiAI (IPL 2019-2022)   Recent progress in Machine Learning (ML) and especially in Deep Learning has made ML present and prominent in a wide range of applications. However, current and efficient ML approaches rely on complex numerical models. Then, the decisions which are proposed may be accurate but cannot be easily explained to the layman, especially in some cases where complex and human-oriented decisions should be made, e.g. to get a loan or not, to obtain a chosen enrollment at university. The objectives of the HyAIAI IPL are to study the problem of making ML methods interpretable. For that, we will design hybrid ML approaches that combine state of the art numerical models (e.g. neural networks) with explainable symbolic models (e.g. pattern mining). More precisely, one goal is to integrate high level domain constraints into ML models, to provide model designers information on ill-performing parts of the model, and to give the layman/practitioner understandable explanations on the results of the ML model.

The HyAIAI IPL project involves seven Inria Teams, namely Lacodam in Rennes (project leader), Magnet and SequeL in Lille, Multispeech and Orpailleur in Nancy, and TAU in Saclay.

Ordem (ADT 2019-2020)   One of the outputs of the former Hybride ANR project was the Orphamine system which aims at information retrieval and diagnosis aid in the domain of "rare diseases". The Orphamine system is based on domain knowledge, and in particular on medical ontologies such as ORDO ("Orphanet Rare Diseases Ontology") and HPO ("Human Phenotype Ontology"). In this way, the objective of the "Ordem" ADT is to update Orphamine, in making the system more accessible and more open. This requires many developments for developing the connections with domain knowledge, graph mining methods for retrieving relevant units in knowledge graphs, actual visualization tools, pattern mining, statistical decision tools for decision making (in particular log-linear models), and as well text mining tools for analyzing expert queries and medical literature about rare diseases. Such developments are and will be carried out until the end of next year, for making the system robust and publicly accessible through a web interface.

HyGraMi (PRE Inria 2018-2020)   Finally, the so called "projet de recherche exploratoire" (PRE) HyGraMi for "Hybrid Graph Mining for the Design of New Antibacterials" is about the fight against resistance of bacteria to antibiotics. The objective of HyGraMi is to design a hybrid data mining system for discovering new antibacterial agents. This system should rely on a combination of numeric and symbolic classifiers, that will be guided by expert domain knowledge. The analysis and classification of the chemical structures is based on an interaction between symbolic methods e.g. graph mining techniques, and numerical supervised classifiers based on exact and approximate matching. This year we work on a method based on tree decomposition for performing feature selection and improving data lining of such complex molecular structures [49].

9.2. European Initiatives

9.2.1. The H2020 CrossCult Project (2016-2019)

Participants: Miguel Couceiro, Nyoman Juniarta, Amedeo Napoli.

The H2020 CrossCult [0] project 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, (i) to lower cultural EU barriers and create unique cross-border perspectives, by connecting existing digital historical resources and by creating new ones through public participation, (ii) to create long-lasting experiences of social learning and entertainment that will provide a better understanding and re-interpretation of European history. To achieve

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[0]http://www.crosscult.eu/

this, CrossCult aims at connecting and combining existing digital cultural assets, at increasing integration, interaction, and reflection about European past and present history. CrossCult was implemented w.r.t. four real-world pilots including cities, museums, and cultural sites. The role of the Orpailleur Team, in conjunction with the LORIA Kiwi Team, was to work on data mining –actually sequence mining– and recommendation, with a focus on the mining visitor trajectories in a museum or a touristic site, and on the definition of a visitor profile in connection with domain knowledge.

The CrossCult project involved many teams, namely Luxembourg Institute for Science and Technology and Centre Virtuel de la Connaissance sur l'Europe (Luxembourg, leaders 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), and the Kiwi Team from LORIA together with the Orpailleur team.

9.3. International Initiatives

9.3.1. Inria International Labs

Inria@SiliconValley
Associate Team involved in the International Lab:

9.3.1.1. Snowball

> Title: Discovering knowledge on drug response variability by mining electronic health records
>
> International Partner (Institution - Laboratory - Researcher):
>
> > University of 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). This is motivated by the fact that many factors, genetic as well as environmental, contribute to 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, Adrien Coulet finished in September 2019 a two-years sabbatical stay in the lab of Nigam Shah at Stanford University initiated in September 2017 (and partly granted by an "Inria délégation").

9.3.2. Informal International Partners: Research Collaboration with HSE Moscow

Participants: Alexandre Bazin, Nacira Abbas, Guilherme Alves Da Silva, Miguel Couceiro, Nyoman Juniarta, Tatiana Makhalova, Amedeo Napoli, Justine Reynaud.

An ongoing 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 ongoing thesis of Tatiana Makhalova), and the the organization of scientific events, as the workshop FCA4AI with seven editions between 2012 and 2019 (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 seventh edition of the FCA4AI workshop in August 2019 at the IJCAI Conference which was held in Macao China.

<p style="text-align: center; color: red; font-weight: bold;">SEMAGRAMME Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

CPER LCHN

Langues, Connaissances et Humanités Numériques (Languages, Knowledge and Digital Humanities)

Duration: 2015 - 2020 Coordinator: Bruno Guillaume

Other partners: Université de Lorraine, Région Grand-Est, France

Participants: Maxime Amblard, Karën Fort, Bruno Guillaume

Abstract: This initiative is an interdisciplinary project which involves several laboratories in the Université de Lorraine. It aims to strengthen the University de Lorraine University in the areas of management and access to digital content. A huge part of the project concerns researches on language. The initiative combines national and regional funding which mainly supports equipment purchase. It proposes to set up scientific experimentation platforms to strengthen cooperation between Lorraine's partners thus enabling Lorraine to acquire significant visibility through national platforms for the dissemination of resources. Most of the online tools built in the team (https://zombiludik.org, http://match.grew.fr for instance) are available through virtual machines funded by the CPER.

8.2. National Initiatives

ODiM

Outils informatisés d'aide au Diagnostic des Maladies mentales

2019 - 2022

Coordinator: Maxime Amblard

Participants: Maxime Amblard, Vincent-Thomas Barrouillet, Samuel Buchel, Amandine Lecomte, Chuyuan Li, Michel Musiol

Abstract:

ODiM is an interdisciplinary project, at the interface of psychiatry-psychopathology, linguistics, formal semantics and digital sciences. It aims to replace the paradigm of Language and Thought Disorders (LTD) as used in the Mental Health sector with a semantic-formal and cognitive model of Discourse Disorders (DD). These disorders are translated into pathognomonic signs, making them complementary diagnostic tools as well as screening for vulnerable people before the psychosis's trigger. The project has three main components.

The work is based on real data from interviews with patients with schizophrenia. A data collection phase in partner hospitals and with a control group, consisting of interviews and neuro-cognitive tests, is therefore necessary.

The data collection will allow the development of the theoretical model, both in psycholinguistic and semantic formalization for the identification of diagnostic signs. The success of such a project requires the extension of the analysis methodology in order to increase the model's ability to identify sequences with symptomatic discontinuities.

If the general objective of the project is to propose a methodological framework for defining and understanding diagnostic clues associated with psychosis, we also wish to equip these approaches by developing software to automatically identify these clues, both in terms of discourse and language behaviour.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, Except FP7 & H2020

EnetCollect

European Network for Combining Language Learning with Crowdsourcing Techniques

2015- 2025

Coordinator: Lionel Nicolas and Verena Lyding (Chair & Grant Holder)

Participants: Karën Fort, Bruno Guillaume

Abstract:

Karën Fort and Bruno Guillaume participate in the EnetCollect [0] COST action. EnetCollect aims at performing the groundwork to set into motion a Research and Innovation trend combining the well-established domain of Language Learning with recent and successful crowdsourcing approaches.

- Karën Fort co-organized with Rodrigo Agerri (Univ. of the Basque Country) the first Hackathon (named Crowdfest) in January in Brussels,
- Karën Fort and Bruno Guillaume participated in the 3rd Annual Action meeting in Lisbon in March,
- Karën Fort participated to a Workgroup meeting in Malta in November.

Karën Fort pariticipates in the COST action NexusLinguarum [0]. The main aim of this action is to promote synergies across Europe between linguists, computer scientists, terminologists, and other stakeholders in industry and society, in order to investigate and extend the area of linguistic data science.

8.4. International Initiatives

8.4.1. Participation in other International Programs

Common work and a common workshop was held in Gothenburg with the Centre for Linguistic Theory and Studies in Probability (CLASP, University of Gothenburg, Sweden), especially with Robin Cooper, Ellen Breitholtz and Chris Howes on the topic of dialogical reasoning in patients with schizophrenia and formal approaches to (in)coherence and dynamics in dialogue. The visit was supported by the French Institute in Sweden (*Programme Galan*).

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[0] https://enetcollect.eurac.edu/
[0] https://www.cost.eu/actions/CA18209