



RESEARCH CENTER
Saclay - Île-de-France

FIELD

Activity Report 2018

Section Partnerships and Cooperations

Edition: 2019-03-07

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COMETE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. OPTIMEC

Project title: Optimal Mechanisms for Privacy Protection

Funded by: DigiCosme

Duration: September 2016 - July 2018

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

Other PI's: Serge Haddad, ENS Cachan.

Abstract: In this project we investigate classes of utility and privacy measures, and we devise methods to obtain optimal mechanisms with respect to the trade-off between utility and privacy. In order to represent the probabilistic knowledge of the adversary and of the user, and the fact that mechanisms themselves can be randomized, we consider a probabilistic setting. We focus, in particular, on measures that are expressible as linear functions of the probabilities.

7.1.2. SUPREME

Project title: Statistical-Utility Preserving Methods for Privacy Protection

Funded by: Département STIC

Duration: 2018 - 2019

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

Other PI's: Serge Haddad, ENS Cachan.

Abstract: In this project we study the theoretical foundations, methods and tools to protect the privacy of the individuals under certain constraints. In particular we focus on mechanisms that: (1) are robust with respect to combination of information from different sources, (2) can be applied directly by the user, thus avoiding the need of a trusted party, and (3) provide an optimal trade-off between privacy and utility.

7.2. National Initiatives

7.2.1. REPAS

Program: ANR Blanc

Project title: Reliable and Privacy-Aware Software Systems via Bisimulation Metrics

Duration: October 2016 - September 2021

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

Other PI's and partner institutions: Ugo del Lago, Inria Sophia Antipolis (EPI Focus) and University of Bologna (Italy). Vincent Danos, ENS Paris. Filippo Bonchi, ENS Lyon.

Abstract: In this project we investigate quantitative notions and tools for proving program correctness and protecting privacy. In particular, we focus on bisimulation metrics, which are the natural extension of bisimulation on quantitative systems. As a key application, we will develop a mechanism to protect the privacy of users when their location traces are collected.

7.2.2. MAGIC

Program: PEPS I3A

Project title: Machine Games for Information Protection

Duration: February 2018 - December 2018

Coordinator: Konstantinos Chatzikokolakis, CNRS (EPI Comète) and Ecole Polytechnique

Other PI's and partner institutions: Giovanni Cherubin, EPFL, Switzerland. Serge Haddad, ENS Cachan.

Abstract: In this project, we study a Machine Learning approach to develop methods for the Protection of Private Information. The idea is based on the Generative Adversarial Network (GAN) paradigm: the defender and the attacker are modeled as two adversaries in a game, where the payoff is the attacker's acquisition of the user's private data by exploiting the system vulnerabilities, side information, and probabilistic inference.

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. LOGIS

Title: Logical and Formal Methods for Information Security

Inria principal investigator: Konstantinos Chatzikokolakis

International Partners:

Mitsuhiro Okada, Keio University (Japan)

Yusuke Kawamoto, AIST (Japan)

Tachio Terauchi, JAIST (Japan)

Masami Hagiya, University of Tokyo (Japan)

Start year: January 2016 - December 2018

URL: <http://www.lix.polytechnique.fr/~kostas/projects/logis/>

Abstract: The project aims at integrating the logical / formal approaches to verify security protocols with (A) complexity theory and (B) information theory. The first direction aims at establishing the foundations of logical verification for security in the computational sense, with the ultimate goal of automatically finding attacks that probabilistic polynomial-time adversaries can carry out on protocols. The second direction aims at developing frameworks and techniques for evaluating and reducing information leakage caused by adaptive attackers.

7.3.2. Participation in International Programs

7.3.2.1. CLASSIC

Program: Colciencias - Conv. 712.

Project acronym: CLASSIC.

Project title: Concurrency, Logic and Algebra for Social and Spatial Interactive Computation.

Duration: Oct 2016 - Oct 2019.

URL: <http://goo.gl/Gv6Lij>

Coordinator: Camilo Rueda, Universidad Javeriana de Cali, Colombia.

Other PI's and partner institutions: Carlos Olarte, Universidade Federal do Rio Grande do Norte, Brazil and Frank Valencia, CNRS-LIX and Inria Saclay.

Abstract: This project will advance the state of the art of domains such as mathematical logic, order theory and concurrency for reasoning about spatial and epistemic behaviour in multi-agent systems..

7.3.2.2. EPIC

Program: STIC-Amsud.

Project acronym: EPIC.

Project title: EPistemic Interactive Concurrency/

Duration: Oct 2016 - Oct 2018.

URL: <https://sites.google.com/site/sticamsudepic/>

Coordinator: Frank Valencia, CNRS-LIX and Inria Saclay.

Other PI's and partner institutions: Carlos Olarte, Universidade Federal do Rio Grande do Norte, Brazil and Camilo Rueda, Universidad Javeriana de Cali, Colombia.

Abstract: The aim of the project is to coherently combine and advance the state of the art of domains such as concurrency theory, information theory and rewriting systems for reasoning about social networks.

7.3.2.3. *FACTS*

Program: ECOS NORD.

Project acronym: FACTS.

Project title: Foundational Approach to Cognition in Today's Society.

Duration: Jan 1 2019 - Dec 31, 2021.

URL: <https://goo.gl/zVhg32>

Coordinator: Frank Valencia, Ecole Polytechnique.

Other PI's and partner institutions: Jean-Gabriel Ganascia LIP6, Sorbonne University and Camilo Rueda, Universidad Javeriana de Cali, Colombia.

Abstract: This projects aims at studying the phenomenon of "Group Polarization"; the tendency for a group to learn or acquire beliefs or to make decisions that are more extreme than the initial inclinations of its members.

7.3.3. *Inria International Partners*

7.3.3.1. *PriDat*

Project title: Privacy-Friendly Data Analytics

Funded by: Siebel Energy Institute

Duration: September 2018 - August 2019

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

Other PI's: Giovanni Cherubin, EPFL, Switzerland. Moreno Falaschi, University of Siena, Italy. Mario Ferreira, Federal University of Minas Gerais, Brazil.

Abstract: The objective of this project is to develop methodologies for protecting the privacy of individuals while letting their data be collected and used for analytical purposes.

7.3.3.2. *Informal International Partners*

Geoffrey Smith, Florida International University, USA

Carroll Morgan, NICTA , Australia

Annabelle McIver, Maquarie University, Australia

Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil

Camilo Rueda, Professor, Universidad Javeriana de Cali, Colombia

Carlos Olarte, Universidade Federal do Rio Grande do Norte, Brazil

Camilo Rocha, Associate Professor, Universidad Javeriana de Cali, Colombia

7.4. **International Research Visitors**

7.4.1. *Visits of International Scientists*

Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil. Dec 2018

Borja de Balle Pigem. Sr. Machine Learning Scientist. Amazon, UK. Dec 2018

Takao Murakami, Assistant Professor, National Institute of Advanced Industrial Science and Technology (AIST), Japan. Dec 2018

Yusuke Kawamoto, Assistant Professor, National Institute of Advanced Industrial Science and Technology (AIST), Japan. March 2018 and Nov-Dec 2018

Carlos Olarte, Assistant Professor, Universidade Federal do Rio Grande do Norte, Brazil. Oct-Dec 2018

Daniele Gorla, Professor, University of Rome "La Sapienza". Aug - Sep 2018.

Giovanna Broccia, PhD student, University of Pisa, Italy, June 2018

Camilo Rueda, Professor, Universidad Javeriana de Cali, Colombia. May 2018 and Nov 2018

Prakash Panangaden, University of McGill, Montreal, Canada. Feb 2018

7.4.2. Internships

Haoteng Yin. Academy for Advanced Interdisciplinary Studies, Peking University. From June 2018 until Sept 2018.

Kacem Kefki. University of Paris Saclay. From June 2018 until July 2018.

Arthur Américo. Universidade Federal de Minas Gerais. From April 2018 until June 2018.

Noémie Fong. ENS Paris. From April 2018 until Sept 2019.

Pedro Bahamondes. Ecole Polytechnique. From Sept 2017 until March 2018.

Joaquin Felici. Univ. of Cordoba. From Sept 2017 until Jan 2018.

Jason Lopez, Universidad Javeriana de Cali, Colombia. From May until Agost 2018.

DATASHAPE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR ASPAG

Participant: Marc Glisse.

- Acronym : ASPAG.
- Type : ANR blanc.
- Title : Analysis and Probabilistic Simulations of Geometric Algorithms.
- Coordinator : Olivier Devillers (équipe Inria Gamble).
- Duration : 4 years from January 2018 to December 2021.
- Others Partners: Inria Gamble, LPSM, LABRI, Université de Rouen, IECL, Université du Littoral Côte d'Opale, Telecom ParisTech, Université Paris X (Modal'X), LAMA, Université de Poitiers, Université de Bourgogne.
- Abstract:

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 Aspaga project brings together experts of these communities to address the problem of geometric data. We will more specifically work on the following three interdependent directions.

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

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

(3) Understanding geometric algorithms: the analysis of algorithm is an essential step in assessing the strengths and weaknesses of algorithmic principles, and is crucial to guide the choices made when designing a complex data processing pipeline. Any analysis must strike a balance between realism and tractability; the current analyses of many geometric algorithms are notoriously unrealistic. Aside from the purely scientific objectives, one of the main goals of Aspaga 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.

- See also: <https://members.loria.fr/Olivier.Devillers/aspaga/>

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. GUDHI

Title: Algorithmic Foundations of Geometry Understanding in Higher Dimensions

Programm: FP7

Type: ERC

Duration: February 2014 - January 2019

Coordinator: Inria

Inria contact: Jean-Daniel Boissonnat.

The central goal of this proposal is to settle the algorithmic foundations of geometry understanding in dimensions higher than 3. We coin the term geometry understanding to encompass a collection of tasks including the computer representation and the approximation of geometric structures, and the inference of geometric or topological properties of sampled shapes. The need to understand geometric structures is ubiquitous in science and has become an essential part of scientific computing and data analysis. Geometry understanding is by no means limited to three dimensions. Many applications in physics, biology, and engineering require a keen understanding of the geometry of a variety of higher dimensional spaces to capture concise information from the underlying often highly nonlinear structure of data. Our approach is complementary to manifold learning techniques and aims at developing an effective theory for geometric and topological data analysis. To reach these objectives, the guiding principle will be to foster a symbiotic relationship between theory and practice, and to address fundamental research issues along three parallel advancing fronts. We will simultaneously develop mathematical approaches providing theoretical guarantees, effective algorithms that are amenable to theoretical analysis and rigorous experimental validation, and perennial software development. We will undertake the development of a high-quality open source software platform to implement the most important geometric data structures and algorithms at the heart of geometry understanding in higher dimensions. The platform will be a unique vehicle towards researchers from other fields and will serve as a basis for groundbreaking advances in scientific computing and data analysis.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Wolfgang Polonik, UC Davis, California. Sept. and Oct. 2018. Statistical aspects of persistent homology.
- Arijit Ghosh, Indian Statistical Institute, Kolkata, India (December 2018)
- Ramsay Dyer, Berkeley Publishing (December 2018)

9.3.1.1. Internships

- Shreya Arya, BITS Pilani University, India, August-July 2018.

DEDUCTEAM Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

The ANR PROGRAMme is an ANR for junior researcher Liesbeth Demol (CNRS, UMR 8163 STL, University Lille 3) to which G. Dowek participates. The subject is: “What is a program? Historical and Philosophical perspectives”. This project aims at developing the first coherent analysis and pluralistic understanding of “program” and its implications to theory and practice.

8.2. International Initiatives

Brazil: STIC Amsud.

Argentina: Ecos

China: Inria-NSFC

8.3. Informal International Partners

Our main international partners are Alejandro Díaz-Caro (Buenos Aires), Bruno Lopes (Niteroi), Ying Jiang (Beijing), Florian Rabe (Bremen), Brigitte Pientka (McGill), César Muñoz (NASA), and Stéphane Graham-Lengrand (SRI).

8.4. International Research Visitors

Alejandro Díaz-Caro (Buenos Aires) has visited Deducteam for two weeks.

Ying Jiang (Beijing) has visited Deducteam for three weeks.

Aristomenis-Dionysios Papadopoulos (Imperial College, London) has visited Deducteam. He worked with Frédéric Blanqui on the development of a rewrite tactic in DEDUKTI [27].

8.4.1. Visits to International Teams

Gilles Dowek has spent two weeks at the University of Buenos Aires.

Gilles Dowek has spent two weeks at the Institute of Aerospace (USA).

GRACE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Participants: Daniel Augot, Matthieu Rambaud.

A “research initiative” “BART” (Blockchain advanced research and technologies) has been launched with three partners: Inria, Institut Mines-Télécom, and System-X. This is funded by *Institut de recherche System-X*, located in Paris-Saclay area, whose objective is to connect industry and academia. A new PhD has been started, with L. Benmouffok, hired in October 2018, whose topic is the use of secure multiparty computation in blockchains.

8.2. National Initiatives

8.2.1. ANR

Participants: Daniel Augot, Alain Couvreur, Matthieu Rambaud.

MANTA (accepted July 2015, starting March 2016): “Curves, surfaces, codes and cryptography”. This project deals with applications of coding theory error correcting codes to in cryptography, multi-party computation, and complexity theory, using advanced topics in algebraic geometry and number theory. The kickoff was a one week-retreat in Dordogne (20 participants), and we had another four day meeting in Saclay in November 17. See <http://anr-manta.inria.fr/>.

8.3. European Initiatives

8.3.1. SPARTA

- Program: H2020
- Project acronym: SPARTA
- Project title: SPARTA
- Duration: three years
- Coordinator: CEA
- Other partners: IMT, Inria, ANSSI
- Abstract: Propose, test, validate and exploit the possible organizational, technological and operational setup of a cybersecurity competence network; Produce a roadmap that include targets to be achieved by the end of the project, as well as priorities to be addressed in the future by the Cybersecurity Competence Network; Serve to align research, education and certification; Build on and align existing roadmap efforts.

Participant: Benjamin Smith.

8.3.2. PQCRYPTO

Title: Post-quantum cryptography for long-term security

Programm: H2020

Duration: March 2015 - March 2018

Coordinator: TECHNISCHE UNIVERSITEIT EINDHOVEN

Partners:

Academia Sinica (Taiwan)

Bundesdruckerei (Germany)
Danmarks Tekniske Universitet (Denmark)
Katholieke Universiteit Leuven (Belgium)
Nxp Semiconductors Belgium Nv (Belgium)
Ruhr-Universitaet Bochum (Germany)
Stichting Katholieke Universiteit (Netherlands)
Coding Theory and Cryptology group, Technische Universiteit Eindhoven (Netherlands)
Technische Universitaet Darmstadt (Germany)
University of Haifa (Israel)

Inria contact: Nicolas Sendrier

Online security depends on a very few underlying cryptographic algorithms. Essentially all applications today are based on RSA or on the discrete-logarithm problem in finite fields or on elliptic curves. Cryptographers optimize parameter choices and implementation details for these systems and build protocols on top of these systems; cryptanalysts fine-tune attacks and establish exact security levels for these systems.

These systems are all broken as soon as large quantum computers are built. Long-term confidential documents such as patient health-care records and state secrets have to guarantee security for many years, but information encrypted today using RSA or elliptic curves and stored until quantum computers are available will then be as easy to decipher.

PQCRYPTO will allow users to switch to post-quantum cryptography: PQCRYPTO will design a portfolio of high-security post-quantum public-key systems, and will improve the speed of these systems, with reference implementations.

Our team is engaged in WP3.3 “advanced applications for the cloud”. We envision to focus essentially on secure multiparty computation, essentially the information theoretically secure constructions, who are naturally secure against a quantum computer invoked on classical queries. We will study whether these protocols still resist quantum queries. This work sub package started March 2015, ended in March 2018.

Participants: Daniel Augot, Matthieu Rambaud.

MEXICO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Serge Haddad and Yann Duploux have been participating in the *Simulation pour la sécurité du véhicule autonome* (SVA) project at SystemX, in cooperation with Renault, on the application of formal methods to the development of embedded systems for autonomous vehicles.
- Matthias Függer co-leads the Digicosme working group HicDiesMeus on "Highly Constrained Discrete Agents for Modeling Natural Systems" (parsys.lri.fr/HicDiesMeus).
- Matthias Függer participates in the Farman project Dicimus in collaboration with Thomas Nowak (LRI). The project is on modeling of bacterial interactions using techniques from distributed computing theory and VLSI design.

9.2. National Initiatives

- Thomas Chatain, Stefan Haar, Serge Haddad and Stefan Schwoon are participating in the ANR Project [ALGORECELL](#).
- Matthias Függer participates in the ANR project FREDDA on verification and synthesis of distributed algorithms.
- Laurent Fribourg participates in Digicosme Emergence Project "CODECSY" in collaboration with Antoine Girard (CentraleSupélec).

9.3. European Initiatives

Serge Haddad is a member of the European project ERC EQualIS "Enhancing the Quality of Interacting Systems" headed by Patricia Bouyer.

9.4. International Initiatives

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

9.4.1.1. LifeForm

Title: Life Sciences need formal Methods !

International Partner (Institution - Laboratory - Researcher):

Newcastle University (United Kingdom) - School of Computing Science - Victor Khomenko

Start year: 2016

See also: <http://projects.lsv.ens-cachan.fr/LifeForm/>

This project extends an existing cooperation between the MEXICO team and Newcastle University on partial-order based formal methods for concurrent systems. We enlarge the partnership to bioinformatics and synthetic biology. The proposal addresses challenges concerning formal specification, verification, monitoring and control of synthetic biological systems, with use cases conducted in the Center for Synthetic Biology and the Bioeconomy (CSBB) in Newcastle. A main challenge is to create a solid modelling framework based on Petri-net type models that allow for causality analysis and rapid state space exploration for verification, monitoring and control purposes; a potential extension to be investigated concerns the study of attractors and cell reprogramming in Systems Biology.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Josep Carmona (UPC Barcelona) visited us in April and July 2018. He collaborated with Thomas Chatain on process mining.

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Research Stays Abroad

- Juraj Kolcák has started, in August 2018, a 6-month research visit in the MMM group / NII Tokyo (Japan), funded by the ERATO project, to work with the PI, Prof. Ichiro Hasuo. Stefan Haar has visited that group from Oct 29 to Friday Nov 2, preceded by a visit to Prof. Tatsuya Akutsu's group at Kyoto University (Uji campus) on Oct 26.

PARSIFAL Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

COCA HOLA: Cost Models for Complexity Analyses of Higher-Order Languages, coordinated by B. Accattoli, 2016–2019.

FISP: The Fine Structure of Formal Proof Systems and their Computational Interpretations, coordinated by Lutz Straßburger in collaboration with Université Paris 7, Universität Innsbruck and TU Wien, 2016–2019.

8.1.2. Competitvity Clusters

UPScale: Universality of Proofs in SaCLay, a Working Group of LabEx DigiCosme, organized by Chantal Keller (LRI) with regular participation from Parsifal members and a post-doc co-supervision.

8.2. International Research Visitors

8.2.1. Internships

Simon Colin did an M1 internship supervised by G. Scherer, conducting a static analysis to check the safety, in OCaml, of unboxing annotations on type declarations.

Alban Reynaud did an L3 internship supervised by G. Scherer, conducting a static analysis to check the safety, in OCaml, of recursive value declarations.

8.2.2. Visits to International Teams

8.2.2.1. Research Stays Abroad

S. Graham-Lengrand was an International Fellow at SRI International, for 25 months over a period of three years between 2015 and 2018.

SPECFUN Project-Team

8. Partnerships and Cooperations

8.1. International Research Visitors

8.1.1. Internships

- Jiadong Han did a Master internship from March to August. Under the supervision of Pierre Lairez, he studied the computation of adaptive grid to improve the computation of the homology of semialgebraic sets.

TOCCATA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *ELEFFAN*

Participant: Sylvie Boldo [contact].

ELEFFAN is a Digicosme project funding the PhD of F. Faissole. S. Boldo is the principal investigator. It began in 2016 for three years. <https://project.inria.fr/eleffan/>

The ELEFFAN project aims at formally proving rounding error bounds of numerical schemes.

Partners: ENSTA Paristech (A. Chapoutot)

9.1.2. *MILC*

Participant: Sylvie Boldo [contact].

MILC is a DIM-RFSI project. It is a one-year project (2018–2019) that aims at formalizing measure theory and Lebesgue integral in the Coq proof assistant. <https://lipn.univ-paris13.fr/MILC/>

Partners: Université Paris 13 (M. Mayero, PI), Inria Paris, Inria Saclay

9.2. National Initiatives

9.2.1. *ANR CoLiS*

Participants: Claude Marché [contact], Andrei Paskevich.

The CoLiS research project is funded by the programme “Société de l’information et de la communication” of the ANR, for a period of 60 months, starting on October 1st, 2015. <http://colis.irif.univ-paris-diderot.fr/>

The project aims at developing formal analysis and verification techniques and tools for scripts. These scripts are written in the POSIX or bash shell language. Our objective is to produce, at the end of the project, formal methods and tools allowing to analyze, test, and validate scripts. For this, the project will develop techniques and tools based on deductive verification and tree transducers stemming from the domain of XML documents.

Partners: Université Paris-Diderot, IRIF laboratory (formerly PPS & LIAFA), coordinator; Inria Lille, team LINKS

9.2.2. *ANR Vocal*

Participants: Jean-Christophe Filliâtre [contact], Andrei Paskevich.

The Vocal research project is funded by the programme “Société de l’information et de la communication” of the ANR, for a period of 60 months, starting on October 1st, 2015. <https://vocal.lri.fr/>

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

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

9.2.3. ANR FastRelax

Participants: Sylvie Boldo [contact], Guillaume Melquiond.

This is a research project funded by the programme “Ingénierie Numérique & Sécurité” of the ANR. It is funded for a period of 48 months and it has started on October 1st, 2014. <http://fastrelax.gforge.inria.fr/>

Our aim is to develop computer-aided proofs of numerical values, with certified and reasonably tight error bounds, without sacrificing efficiency. Applications to zero-finding, numerical quadrature or global optimization can all benefit from using our results as building blocks. We expect our work to initiate a “fast and reliable” trend in the symbolic-numeric community. This will be achieved by developing interactions between our fields, designing and implementing prototype libraries and applying our results to concrete problems originating in optimal control theory.

Partners: team ARIC (Inria Grenoble Rhône-Alpes), team MARELLE (Inria Sophia Antipolis - Méditerranée), team SPECFUN (Inria Saclay - Île-de-France), Université Paris 6, and LAAS (Toulouse).

9.2.4. ANR Soprano

Participants: Sylvain Conchon [contact], Guillaume Melquiond.

The Soprano research project is funded by the programme “Sciences et technologies logicielles” of the ANR, for a period of 42 months, starting on October 1st, 2014. <http://soprano-project.fr/>

The SOPRANO project aims at preparing the next generation of verification-oriented solvers by gathering experts from academia and industry. We will design a new framework for the cooperation of solvers, focused on model generation and borrowing principles from SMT (current standard) and CP (well-known in optimization). Our main scientific and technical objectives are the following. The first objective is to design a new collaboration framework for solvers, centered around synthesis rather than satisfiability and allowing cooperation beyond that of Nelson-Oppen while still providing minimal interfaces with theoretical guarantees. The second objective is to design new decision procedures for industry-relevant and hard-to-solve theories. The third objective is to implement these results in a new open-source platform. The fourth objective is to ensure industrial-adequacy of the techniques and tools developed through periodical evaluations from the industrial partners.

Partners: team DIVERSE (Inria Rennes - Bretagne Atlantique), Adacore, CEA List, Université Paris-Sud, and OCamlPro.

9.2.5. FUI LCHIP

Participant: Sylvain Conchon [contact].

LCHIP (Low Cost High Integrity Platform) is aimed at easing the development of safety critical applications (up to SIL4) by providing: (i) a complete IDE able to automatically generate and prove bounded complexity software (ii) a low cost, safe execution platform. The full support of DSLs and third party code generators will enable a seamless deployment into existing development cycles. LCHIP gathers scientific results obtained during the last 20 years in formal methods, proof, refinement, code generation, etc. as well as a unique return of experience on safety critical systems design. <http://www.clearsy.com/en/2016/10/4260/>

Partners: 2 technology providers (ClearSy, OCamlPro), in charge of building the architecture of the platform; 3 labs (IFSTTAR, LIP6, LRI), to improve LCHIP IDE features; 2 large companies (SNCF, RATP), representing public ordering parties, to check compliance with standard and industrial railway use-case.

The project lead by ClearSy has started in April 2016 and lasts 3 years. It is funded by BpiFrance as well as French regions.

9.2.6. ANR PARDI

Participant: Sylvain Conchon [contact].

Verification of PARAmeterized DIStributed systems. A parameterized system specification is a specification for a whole class of systems, parameterized by the number of entities and the properties of the interaction, such as the communication model (synchronous/asynchronous, order of delivery of message, application ordering) or the fault model (crash failure, message loss). To assist and automate verification without parameter instantiation, PARDI uses two complementary approaches. First, a fully automatic model checker modulo theories is considered. Then, to go beyond the intrinsic limits of parameterized model checking, the project advocates a collaborative approach between proof assistant and model checker. <http://pardi.enseeiht.fr/>

The proof lead by Toulouse INP/IRIT started in 2016 and lasts for 4 years. Partners: Université Pierre et Marie Curie (LIP6), Université Paris-Sud (LRI), Inria Nancy (team VERIDIS)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. EMC2

Participant: Sylvie Boldo [contact].

A new ERC Synergy Grant 2018 project, called Extreme-scale Mathematically-based Computational Chemistry (EMC2) has just been accepted. The PIs are É. Cancès, L. Grigori, Y. Maday and J.-P. Piquemal. S. Boldo is part of the work package 3: validation and certification of molecular simulation results. <https://www.sorbonne-universite.fr/newsroom/actualites/erc-synergy-grant-2018>

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: COST (European Cooperation in Science and Technology).

Project acronym: EUTypes <https://eutypes.cs.ru.nl/>

Project title: The European research network on types for programming and verification

Duration: 2015-2019

Coordinator: Herman Geuvers, Radboud University Nijmegen, The Netherlands

Other partners: 36 members countries, see http://www.cost.eu/COST_Actions/ca/CA15123?parties

Abstract: Types are pervasive in programming and information technology. A type defines a formal interface between software components, allowing the automatic verification of their connections, and greatly enhancing the robustness and reliability of computations and communications. In rich dependent type theories, the full functional specification of a program can be expressed as a type. Type systems have rapidly evolved over the past years, becoming more sophisticated, capturing new aspects of the behaviour of programs and the dynamics of their execution.

This COST Action will give a strong impetus to research on type theory and its many applications in computer science, by promoting (1) the synergy between theoretical computer scientists, logicians and mathematicians to develop new foundations for type theory, for example as based on the recent development of "homotopy type theory", (2) the joint development of type theoretic tools as proof assistants and integrated programming environments, (3) the study of dependent types for programming and its deployment in software development, (4) the study of dependent types for verification and its deployment in software analysis and verification. The action will also tie together these different areas and promote cross-fertilisation.

COMMANDS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. IPL

9.1.1.1. Algae in Silico

Inria Project Lab ALGAE IN SILICO (2014-2018) was dedicated to provide an integrated platform for numerical simulation of microalgae “from genes to industrial process“. Commands joined the project in 2017 to tackle the optimization aspects. Our previous collaborations with teams Modemic and Biocore on bioreactors [31], [19] have been renewed in this framework, see [11]

9.1.1.2. Cosy

Inria Project Lab COSY (started in 2017) aims at exploiting the potential of state-of-art biological modelling, control techniques, synthetic biology and experimental equipment to achieve a paradigm shift in control of microbial communities. More precisely, we plan to determine and implement control strategies to make heterogeneous communities diversify and interact in the most profitable manner. Study of yeast cells has started in collaboration with team Lifeware (G. Batt) in the framework of the PhD of V. Andreani, and is pursued in the PhD of E. Weill (started 2018).

9.2. International Research Visitors

9.2.1. Visits of International Scientists

Several visits by L. Pfeiffer, U. Graz, and A. Kröner, U. Humboldt.

DEFI Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. EVE

- Title : Virtual prototyping of EVE engines
- Type : Co-funded from Region Aquitaine and Inria
- Duration : 36 months
- Starting : October 2018
- Coordinator : P.M. Congedo
- Abstract : The main objective of this thesis is the construction of a numerical platform, for permitting an efficient virtual prototyping of the EVE expander. This will provide EXOES with a numerical tool, that is much more predictive with respect to the tools currently available and used in EXOES, by respecting an optimal trade-off in terms of complexity/cost needed during an industrial design process. Two research axes will be mainly developed. First, the objective is to perform some high-predictive numerical simulation for reducing the amount of experiments, thanks to a specific development of RANS tools (Reynolds Averaged Navier-Stokes equations) for the fluids of interest for EXOES. These tools would rely on complex thermodynamic models and a turbulence model that should be modified. The second axis is focused on the integration of the solvers of different fidelity in a multi-fidelity platform for performing optimization under uncertainties. The idea is to evaluate the system performances by using massively the low-fidelity models, and by correcting these estimations via only few calculations with the high-fidelity code.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. UTOPIAE

Program: H2020 MSCA-ITN

Project acronym: UTOPIAE

Project title: Handling the unknown at the edge of tomorrow

Duration: January 2017- December 2020

Coordinator: M. Vasile (Strathclyde University)

Other partners: see <http://utopiae.eu/> for additional details

UTOPIAE is a European research and training network looking at cutting edge methods bridging optimisation and uncertainty quantification applied to aerospace systems. The network will run from 2017 to 2021, and is funded by the European Commission through the Marie Skłodowska-Curie Actions of H2020. The network is made up of 15 partners across 6 European countries, including the UK, and one international partner in the USA, collecting mathematicians, engineers and computer scientists from academia, industry, public and private sectors.

Mission statement : To train, by research and by example, 15 Early Stage Researchers in the field of uncertainty quantification and optimisation to become leading independent researchers and entrepreneurs that will increase the innovation capacity of the EU. To equip the researchers with the skills they will need for successful careers in academia and industry. To develop fundamental mathematical methods and algorithms to bridge the gap between Uncertainty Quantification and Optimisation and between Probability Theory and Imprecise Probability Theory for Uncertainty Quantification to efficiently solve high-dimensional, expensive and complex engineering problems.

9.3. International Initiatives

9.3.1. Inria International Labs

P.M. Congedo is the Inria Coordinator of the CWI-Inria Inria International Lab.

III CWI-Inria

Associate Team involved in the International Lab:

9.3.1.1. COMMUNES

Title: Computational Methods for Uncertainties in Fluids and Energy Systems

International Partner (Institution - Laboratory - Researcher):

CWI (Netherlands) - Scientific Computing Group - Daan Crommelin

Start year: 2017

See also: <https://project.inria.fr/inriacwi/projects/communes/>

This project aims to develop numerical methods capable to take into account efficiently unsteady experimental data, synthetic data coming from numerical simulation and the global amount of uncertainty associated to measurements, and physical-model parameters. We aim to propose novel algorithms combining data-inferred stochastic modeling, uncertainty propagation through computer codes and data assimilation techniques. The applications of interest are both related to the exploitation of renewable energy sources: wind farms and solar Organic Rankine Cycles (ORCs).

9.3.1.2. Informal International Partners

University of Zurich : R. Abgrall. Collaboration on high order adaptive methods for CFD and uncertainty quantification.

Politecnico di Milano, Aerospace Department (Italy) : Pr. A. Guardone. Collaboration on ALE for complex flows (compressible flows with complex equations of state).

von Karman Institute for Fluid Dynamics (Belgium). With Pr. T. Magin we work on Uncertainty Quantification problems for the identification of inflow condition of hypersonic nozzle flows.

Rutgers University. Collaboration with Pr. F. Cakoni on transmission eigenvalues.

University of Delaware. Collaboration with Pr. D. Colton on inverse scattering theory

Ecole Nationale des Ingénieurs de Tunis. Collaboration with Pr. M. Moakher on Diffusion MRI

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Fioralba Cakoni, one month, July 15-August 14, 2018

DISCO Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Industrial-Academic Institute

Guillaume Sandou is the head of the RISEGrid Institute. The Institute is dedicated to the study, modelling and simulation of smart electric distribution grids and their interactions with the whole electric power system. It is located in CentraleSupélec and gathers about 20 people (academic and industrial researchers, PhD students, post-doctoral researchers). The Institute has been renewed in 2018 for 5 new years.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: **COST Action**

Project acronym: FRACTAL

Project title: Fractional-order systems; analysis, synthesis and their importance for future design

Duration: November 2016 - October 2020

Coordinator: Jaroslav Koton Czech Republic

Abstract: Fractional-order systems have lately been attracting significant attention and gaining more acceptance as generalization to classical integer-order systems. Mathematical basics of fractional-order calculus were laid nearly 300 years ago and since that it has gained deeply rooted mathematical concepts. Today, it is known that many real dynamic systems cannot be described by a system of simple differential equation or of integer-order system. In practice we can encounter such systems in electronics, signal processing, thermodynamics, biology, medicine, control theory, etc. The Action will favor scientific advancement in above mentioned areas by coordinating activities of academic research groups towards an efficient deployment of fractal theory to industry applications.

Program: **PHC BALATON**

Project acronym: SadHuB

Project title: Analysis of stabilizability of delayed dynamical system as function of the systems parameters and the time delays with applications to human balancing

Duration: 01/2018-12/2019

Coordinator: Islam Boussaada

Other partners: Budapest University of Technology and Economics, Hungary

Abstract: Motivated by a class of Time-delay systems occurring in modeling of many mechanical engineering applications, this project aims to associate researchers from control theory, applied mathematics and mechanical engineering to build together a general methodology for the analysis and control of mechanical/bio-mechanical structures. In particular, the human balance is often considered as a control system which operates in the presence of delays, primarily due to the time it takes to acquire the information needed for decision-making, to create control decisions, and to execute these decisions. A particular interest will be devoted to the delayed human balance, where a depthful study of the delay effect on the stability is expected.

Program: **PHC BRANCUSI**

Project acronym: Proco

Project title: systems with propagation: new approaches in control design for oscillations quenching

Duration: 01/2017-12/2018

Coordinator: Islam Boussaada

Other partners: Craiova University, Romania

Abstract: Propagation systems are met and analyzed in various fields, in natural sciences (Physics, Chemistry, Biology etc.) as well as in engineering sciences (energy, mechanics, electricity, optics etc.). According to projects research objectives, the general object of analysis is represented by the controlled systems with distributed parameters which are usually met in technology dynamical systems with parameter space variation along a single space variable. The standard physical phenomena that are modeled are: diffusion, transport and propagation, thus leading to partial differential equations of parabolic (diffusion), hyperbolic (propagation) and advection first order (transportation), respectively. According to the project main subject, the main application of the studies aimed at the automatically controlled processes in the field of energy in a domain where propagation phenomena are dominant. The scientific novelty of the studies arises from the consideration of the systems described by conservation laws in the following fields: oil drilling and extraction, co-generation (combined heat-electricity generation), energy production in hydroelectric plants.

Program: **PHC CARLOS J FINLEY (Cuba)**

Project title: Modélisation et commande pour les processus de cryoconservation.

Duration: June 2017 - December 2018

Coordinator: Sorin Olaru (France), Marcos Martinez Montero (Turkey).

Abstract: The aim of this project is to initiate a collaboration on subjects related to the mathematical modelling of the dynamics involved in the cryopreservations process. In particular, the viability analysis of the vegetal material subject to cryogeny is one of the main objectives. The approach will rely on the evaluation electric leakage properties.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

- Louisiana State University, Baton Rouge, USA
- School of Electrical Engineering at the Tel-Aviv University, Israel
- The University of Texas at Austin, Dept. of Aerospace Engineering & Engineering Mechanics, USA
- Blikent University, Turkey
- Universidad de Chile, Chile
- School of Mathematics, University of Leeds, U.K.
- University Federale Rio de Janeiro, Brazil
- UNICAMP, Brazil
- Kyoto University, Japan

7.3.2. Participation in Other International Programs

Giorgio Valmorbida is leading the CNRS funded IRN - SPaDisCo (International Research Network - Systèmes à Paramètres Distribués et Contraintes) composed by more than 50 researchers from Belgium, Czech Republic, France, Italy, Sweden, Turkey and the United Kingdom.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Stefanella Boatto, Federale University Rio de Janeiro, Brazil, 1 January- 2 March.

Pedro Luis Dias Peres, UNICAMP, Brazil, December 2018.

Valter Leite Junior, CEFET-MG, Brazil, May 2018.

Antonis Papachristodoulou, University of Oxford, UK, September 2018.

Yutaka Yamamoto, Kyoto University, Japan, 6 Sept - 6 Nov.

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

Islam Boussaada spent one month during July 2018 as a Research Associate at the Department of Electronic Engineering at City University of Hong Kong. He started a research collaboration with Professor Jie Chen Team.

GAMMA3 Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ANR IMPACTS 2018-2021

Ideal Mesh generation for modern solvers and computing ArchitectureS.

- Coordinateur : Adrien Loseille
- The rapid improvement of computer hardware and physical simulation capabilities has revolutionized science and engineering, placing computational simulation on an equal footing with theoretical analysis and physical experimentation. This rapidly increasing reliance on the predictive capabilities has created the need for rigorous control of numerical errors which strongly impact these predictions. A rigorous control of the numerical error can be only achieved through mesh adaptivity. In this context, the role of mesh adaptation is prominent, as the quality of the mesh, its refinement, and its alignment with the physics are major contributions to these numerical errors. The IMPACTS project aims at pushing the envelope in mesh adaptation in the context of large size, very high fidelity simulations by proposing a new adaptive mesh generation framework. This framework will be based on new theoretical developments on Riemannian metric-field and on innovative algorithmic developments coupling a unique cavity-operator with an advancing-point techniques in order to produce high quality hybrid, curved and adapted meshes.

7.2. International Initiatives

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

7.2.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

Mississippi State University (United States) - Center for Advanced Vehicular Systems -
Computational Fluid Dynamics Dept. (CAVS-CFD) - Marcum David

Start year: 2017

See also: http://pages.saclay.inria.fr/frederic.alauzet/AssociateTeam_AM2NS/AT_am2ns.html

The purpose of the AM2NS Associate Team is to mutualize the knowledge of all teams in order to develop the next generation of meshing methods and their parallelization to address the new challenges in numerical simulations for industrial problems. The Associate Team is composed of four partners: Inria, Mississippi State University, The Boeing Company and Massachusetts Institute of Technology.

7.2.1.2. MODIS

Title: High-order discrete geometric modeling

International Partner (Institution - Laboratory - Researcher):

Polytechnique Montréal (Canada) - Computer Science - François Guibault

Start year: 2017

See also: <http://pages.saclay.inria.fr/patrick.laug/MODIS/MODIS.html>

In the area of geometric modeling, major challenges are linked to the efficient visualization of CAD surfaces and to the generation of meshes adapted to numerical simulation. In this context, the conception of a discrete geometric model provides a simple and universal representation model, without the need for CAD. A first study has been carried out for the conception of a model of order 1 (one) defined by a 'triangulation' composed of quadrilaterals and triangles. The advantage of this model of order 1 lies in its geometric simplicity. However, in the case of complex surfaces, it may require a very large number of elements, and besides it is not sufficiently rich to give certain essential characteristics like geometric curvatures. The main goal of this project is to extend this discrete model of order 1 to higher orders.

RANDOPT Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- PGMO/FMJH project “AESOP: Algorithms for Expensive Simulation-Based Optimization”, 7kEUR, 2017–2019

9.2. National Initiatives

9.2.1. ANR

- ANR project “Big Multiobjective Optimization (BigMO)”, Dimo Brockhoff participates in this project through the Inria team BONUS in Lille (2017–2020)

9.3. International Research Visitors

9.3.1. Visitors to RandOpt

- Filip Matzner, October 15–19 and December 10–14, 2018

9.3.2. Internships

- Eugenie Marescaux, March–July 2018
- Xudong Zhang, March–August 2018

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Sylvain Arlot and Pascal Massart co-organize a working group at ENS (Ulm) on statistical learning.

8.2. National Initiatives

8.2.1. ANR

SELECT is part of the ANR-funded MixStatSeq.

Sylvain Arlot and Matthieu Lerasle are part of the ANR grant FAST-BIG (Efficient Statistical Testing for high-dimensional Models: application to Brain Imaging and Genetics), which is lead by Bertrand Thirion (Inria Saclay, Parietal).

8.3. International Initiatives

Gilles Celeux is one of the co-organizers of the international working group on model-based clustering. This year this workshop took place in Ann Arbor (USA).

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

Kevin Bleakley stayed at the Pasteur Institute, Cambodia, while working on several collaborations in dengue fever and encephalitis, from February–March 2018.

Jean-Michel Poggi: Universidad de la República (Montevideo, Uruguay), Facultad de Ingeniería, Instituto de Matemática y Estadística “Prof. Ing. Rafael Laguardia”, 17-28 February 2018.

TAU Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **ACTEUR** 2014-2018 (236kEuros). Cognitive agent development for urban simulations,
Coordinator: P. Taillandier (IDEES, Univ Rouen)
Participant: Philippe Caillou
- **EPITOME** 2017-2020 (225kEuros), *Efficient rePresentation TO structure large-scale satellite iMagEs* (Section 7.5.2).
Coordinator: Yuliya Tarabalka (Titane team, Inria Sophia-Antipolis)
Participant: Guillaume Charpiat

9.1.2. Others

- **E-LUCID** 2014-2018 (194 kEuros), anomaly detection in network packets.
Coordinator: Thales Communications & Security S.A.S
Participants: Marc Schoenauer, Cyril Furtlehner, Luis Marti (until 12/2017)
- **Nutriperso** 2017-2020, 87 kEuros. Personalized recommendations toward healthier eating practices (Section 7.3.2).
U. Paris-Saclay IRS (*Initiative de Recherche Stratégique*)
Partners: INRA (coordinator), INSERM, Agro Paristech, Mines Telecom
Participants: Philippe Caillou, Flora Jay, Michèle Sebag, Paola Tubaro
- **PIA Adamme** 2015-2018 (258 kEuros) Machine Learning on a mass-memory architecture.
Coordinator: Bruno Farcy (Bull SAS)
Participants: Marc Schoenauer, Guillaume Charpiat, Cécile Germain-Renaud, Yasmina Bouzbiba, Etienne Brame
- **NEXT** 2017-2021 (675 kEuros). Simulation, calibration, and optimization of regional or urban power grids (Section 4.2).
ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie)
Coordinator: ARTELYS
Participants Isabelle Guyon, Marc Schoenauer, Michèle Sebag, Victor Berger (PhD), Herilalaina Rakotoarison (PhD), Berna Bakir Batu (Post-doc)
- **DATAIA Vadore** 2018-2020 (105 kEuros) Valorizations of Data to improve matching in the labor market, with CREST (ENSAE) and Pôle Emploi (Section 7.3.1).
Coordinator: Michèle Sebag
Participants: Philippe Caillou, Isabelle Guyon
- **PIA JobAgile** 2018-2021 (379 kEuros) *Evidence-based Recommendation pour l'Emploi et la Formation* (Section 7.3.1).
Coordinator: Michèle Sebag and Stéphanie Delestre (Qapa)
Participants: Philippe Caillou, Isabelle Guyon
- **HADACA** 2018-2019 (50 kEuros), within EIT Health, for the organization of challenges toward personalized medicine (Section 7.6).
Coordinator: Magali Richard (Inria Grenoble)
Participants: Isabelle Guyon

- **IPL HPC-BigData** 2018-2022 (100 kEuros) High Performance Computing and Big Data (Section 7.5.5)
Coordinator: Bruno Raffin (Inria Grenoble)
Participants: Guillaume Charpiat, Loris Felardos (PhD)

9.2. European Initiatives

9.2.1. Collaborations with Major European Organizations

MLSpaceWeather 2015-2019. Coupling physics-based simulations with Artificial Intelligence (Section 7.5.3).

Coordinator: CWI

Participants: Aurélien Decelle, Cyril Furtlehner, Michèle Sebag

9.3. International Initiatives

9.3.1. Inria International Labs

IIL CWI-Inria

Associate Team involved in the International Lab:

9.3.1.1. MDG-TAO

Title: Data-driven simulations for Space Weather predictions

International Partner (Institution - Laboratory - Researcher):

CWI (Netherlands) - Multiscale Dynamics Group - Enrico Camporeale

Start year: 2017

See also: <http://pages.saclay.inria.fr/cyril.furtlehner/html/mdg-tao.html> and Section 7.5.3 .

We propose an innovative approach to Space Weather modeling: the synergetic use of state-of-the-art simulations with Machine Learning and Data Assimilation techniques, in order to adjust for errors due to non-modeled physical processes, and parameter uncertainties. We envision a truly multidisciplinary collaboration between experts in Computational Science and Data assimilation techniques on one side (CWI), and experts in Machine Learning and Data Mining on the other (Inria). Our research objective is to realistically tackle long-term Space Weather forecasting, which would represent a giant leap in the field. This proposal is extremely timely, since the huge amount of (freely available) space missions data has not yet been systematically exploited in the current computational methods for Space Weather. Thus, we believe that this work will result in cutting-edge results and will open further research topics in space Weather and Computational Plasma Physics.

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

Isabelle Guyon partner of Google Zurich *Preparation of a competition AutoDL: Automatic Deep Learning*. See Section 7.6 .

9.3.2.2. Informal International Partners

Marc Schoenauer partner of the ARC-DP (Australian Research Council Discovery Project) *Bio-inspired computing methods for dynamically changing environments*. Coordinator: University of Adelaide (Frank Neumann), 5 years from Nov. 2015, 400 k\$-AUS. Visit to Adelaide: 2 weeks in Feb. 2017, 2 weeks planned in 2019.

Isabelle Guyon Partner of UC Berkeley *Fingerprint verification with deep siamese neural networks using ultrasonic sensor data*. Co-advisor of a master student (Baiyu Chen). Partners: Alyosha Efros, Bernhard Boser.

Guillaume Charpiat partner of Boulder University *Hurricane trajectory prediction*. Co-advisor of a master student (Mo Yang). Partners: Sophie Giffard-Roisin, Claire Monteleoni. See Section 7.5.6 .

TROPICAL Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Projet ANR MALTHY (Méthodes ALgébriques pour la vérification de modèles Temporisés et HYbrides), responsable T. Dang. Partenaires : Verimag, CEA LIST, Inria Rennes, Inria Saclay, VISEO/Object Direct.
- Projet ANR DEMOCRITE ("DEmonstrateur d'un MOteur de Couverture des Risques sur un TERRitoire), responsable Emmanuel Lapébie (CEA). Partenaires : CEA-GRAMAT, BSPP, Inria Saclay (Maxplus), Institut PPRIME - UPR3346 (CNRS, Univ. Poitiers, ISAE-ENSMA), IPSIS, SYSTEL, ARMINES-E.M. Alès-ISR, CERDACC (Univ. de Haute-Alsace).
- Projet ANR JCJC CAPPS ("Combinatorial Analysis of Polytopes and Polyhedral Subdivisions"), responsable Arnau Padrol (IMJ-PRG, Sorbonne Université). Partenaires : IMJ-PRG (Sorbonne Université), Inria Saclay (Tropical), LIGM (Université Paris-Est Marne-la-Vallée), LIF (Université Aix-Marseille), CERMICS (École Nationale des Ponts et Chaussées), LIX (École Polytechnique).

9.1.2. Programme Gaspard Monge pour l'Optimisation

- Projet intitulé "Méthodes tropicales pour l'optimisation", responsable X. Allamigeon, faisant intervenir M. Akian, V. Boeuf, S. Gaubert, A. Hochart, R. Katz, et M. Skomra.

9.2. European Initiatives

9.2.1. Collaborations with Major European Organizations

- Partner: Michael Joswig, TU-Berlin.
- Topic : Tropical geometry.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- Collaboration with Ricardo D. Katz, CIFASIS-CONICET, Rosario (Argentina). Research invitation at CMAP during 2 months.
- Collaboration with Shmuel Friedland, University of Illinois at Chicago (invitation or Stéphane Gaubert at Chicago of one week in May 2018).
- Collaboration with Alejandro Jofre, CMM, University of Chile, Santiago: invitation of Paulin Jacquot of two months (May-June) 2018.
- Collaboration with Zheng Qu, Math. Department, Hongk Kong University.

9.3.2. Participation in Other International Programs

- Collaboration with Gleb Koshevoy, Poncelet Laboratory, Moscow (research invitation of Gleb Koshevoy at CMAP during one week).
- Collaboration with Aris Daniilidis, from CMM, University of Chile, Santiago.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Aris Daniilidis, from CMM, University of Chile, Santiago, Sept-Dec 2018. Invited to École polytechnique within the Gaspard Monge Visiting Professor Program (GMVP) of École polytechnique, with the support of Fondation de l'École polytechnique.
- Roberto Bobadilla Solari, invited PhD student, University of Chile, Santiago, from Sep 2018 until Nov 2018, funded by Inria, associated to the visit of Aris Daniilidis.
- Gonzalo Flores Garcia, invited PhD student, University of Chile, Santiago, from Sep 2018 until Dec 2018, associated to the visit of Aris Daniilidis.
- Sebastian Tapia Garcia, invited PhD student, University of Chile, Santiago, funded by GMVP, associated to the visit of Aris Daniilidis.
- Francisco Javier Antonio Venegas Martinez, invited PhD student, University of Chile, Santiago, from Sep 2018 until Nov 2018, funded by Inria, associated to the visit of Aris Daniilidis.
- Rajendra Bhatia (Ashoka University, India), June 2018.
- Gleb Koshevoy (Russian Academy of Sciences), Nov 2018.

9.4.1.1. Internships

- Raphael Pellegrin (Imperial College, London), research summer internship, on tropical positivstellensätze.
- Marin Boyet (École Nationale Supérieure des Mines de Paris), research internship, colorful interior of convex bodies and solvability of tropical polynomial systems.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Marianne Akian, Institut Mittag Leffler, Jan 15-March 3, 2018.
- Stéphane Gaubert, Institut Mittag Leffler, Jan 15-March 3, 2018.
- Stéphane Gaubert, joint invitation by the Statistics Department of University of Chicago (Lek Heng Lim) and the Maths and Computer Science Department of University of Illinois at Chicago (Shmuel Friedland), May 20-26, 2018.

GALEN-POST Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

Program: ANR PRC

Project acronym: CoMeDIC

Project title: Convergent Metrics for DIcrete Calculus

Duration: 2016-2021

Coordinator: J.-O. Lachaud (Univ. Rhones Alpes Savoie Mont-Blanc), Local: H. Talbot

Program: ANR PRCE

Project acronym: R-Vessel-X

Project title: Extraction et interprétation robustes des réseaux vasculaires dans les images biomédicales hépatiques

Duration: 2018-2022

Coordinator: A. Vacavant (Univ. Clermont Auvergne), local: H. Talbot

Program: ANR JCJC

Project acronym: LearnCost

Project title: Learning Model Constraints for Structured Prediction

Duration: 2014-2018

Coordinator: M. Blaschko

Program: ANR JCJC

Project acronym: MajIC

Project title: Majorization-Minimization Algorithms for Image Computing

Duration: 2017-2021

Coordinator: E. Chouzenoux

Program: ANR JCJC

Project acronym: AVENUE

Project title: A Visual memory network for scene understanding

Duration: 2018-2022

Coordinator: Dr. Karteek Alahari (Inria Grenoble - Rhône-Alpes). Local: F. Malliaros.

9.1.2. Others

Program: CNRS MASTODONS

Project acronym: TABASCO

Project title: Traitement du bruit non Gaussien en spectroscopie

Duration: 2016-2018

Coordinator: E. Chouzenoux

Program: CNRS-CEFIPRA

Project acronym: NextGenBP

Project title: Looking Beyond Backpropagation in Deep Learning

Duration : 2017-2019

Coordinator: E. Chouzenoux

Program: CNRS MI
 Projet acronym: SUPREMA
 Project title: Super-résolution en microscopie biphotonique
 Duration: 2018
 Coordinator: E. Chouzenoux
 Program: PHC - Campus France
 Projet acronym: POLONIUM
 Project title: When Poisson and Gauss meet in imaging
 Duration: 2018-2020
 Coordinator: E. Chouzenoux

9.2. European Initiatives

9.2.1. H2020 Projects

Program: H2020 ITN Marie Skłodowska-Curie
 Project acronym: SUNDIAL
 Project title: SURvey Network for Deep Imaging Analysis and Learning
 Duration: 2017-2021
 Coordinator: R. Peletier (Univ. Groningen, NL), local: H. Talbot

9.3. International Initiatives

9.3.1. Informal International Partners

Sup'Com Tunis - Pr. Amel Benazza-Benhayia. Collaboration Topic: Multispectral imaging.
 University of Patras, Greece - Dr. V. Megalooikonomou. Collaboration Topic: Biosignal analysis.
 University of Pennsylvania - Prof. Aristeidis Sotiras. Collaboration Topic: Higher Order Graphs in biomedical image analysis.
 University of Montréal, MILA - Dr. Eugene Belilovsky, Pr. Simon Lacoste-Julien. Collaboration Topic : Deep learning, scattering transform.
 Berkeley University - Dr. Michael Eickenberg and Dr. Damien Scieur. Collaboration Topic : Deep learning.
 KU Leuven - Pr. Matthew Blashcko. Collaboration Topic : Scattering transform.
 University of Amsterdam - Dr. Jörn Jacobsen. Collaboration Topic : Deep learning.
 Aristotle University of Thessaloniki, Greece - Prof. Apostolos N. Papadopoulos. Collaboration Topic: Graph mining and learning.
 Indraprastha Information Institute Technology, Delhi, India - Dr. Angshul Majumdar. Collaboration Topic: Dictionary learning.
 Universidad Técnica Federico Santa María, Valparaíso, Chile - Dr. Luis M. Briceño-Arias. Collaboration Topic: Stochastic optimization.
 North Carolina State University - Prof. Patrick Louis Combettes. Collaboration Topic: Stochastic optimization.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Dr. Luis M. Briceño-Arias, Universidad Técnica Federico Santa María, Valparaíso, Chile, 1 Jun. - 1 Jul. 2018, 21 Nov. - 21 Dec. 2018
 Jyoti Maggu (PhD student), IIIT New Delhi, India, 05 Mar.-28 May 2018
 Vanika Singhal (PhD student), IIIT New Delhi, India, 05 Mar.-20 Apr. 2018
 Georgios Panagopoulos (PhD student), Ecole Polytechnique, 15 Jun. - 31 Jul. 2018

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

M.C. Corbineau, Department of Physics, Informatics and Mathematics, Università degli studi di Modena e Reggio Emilia, Modena, Italy, 20 Sep. - 20 Oct. 2018.

LIFEWARE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

- ANR-FWF CyberCircuits (2018-2022): “Cybergenetic circuits to test composability of gene networks”, co-coordinated by C. Guet (IST Austria, Klosterneuburg, Austria) and J. Ruess (Inria EPI Lifeware);
- ANR-DFG **SYMBIONT** (2018-2021) on “Symbolic Methods for Biological Systems”, coordinated by T. Sturm (CNRS, LORIA, Nancy, France) and A. Weber (Univ. Bonn, Germany) with F. Fages and F. Boulter (U. Lille), O. Radulescu (U. Montpellier), A. Schuppert (RWTH Aachen), S. Walcher (RWTH Aachen), W. Seiler (U. Kassel);
- ANR-MOST **BIOPSY** (2016-2020) on “Biochemical Programming System”, coordinated by F. Molina (CNRS, Sys2diag, Montpellier) and J.H. Jiang (National Taiwan University), with F. Fages;
- ANR **MEMIP** (2016-2020) on “Mixed-Effects Models of Intracellular Processes”, coordinated by G. Batt, with P. Hersen, (CNRS/Paris7), E. Cinquemani (Inria EPI IBIS) and M. Lavielle (Inria/CNRS/Polytechnique, EPI XPOP);
- ANR **COGEX** (2016-2019) on “Computer Aided Control of Gene Expression” coordinated by P. Hersen (MSC lab, CNRS/Paris7), with G. Batt and G. Truan (LISBP, CNRS/INSA);
- ANR Blanc **HYCLOCK** (2014-2018) on “Hybrid modeling of time for Circadian Clock Biology and Chronopharmacology”, coordinated by F. Delaunay (CNRS, Nice), with F. Lévi (INSERM Paris-Sud), G. Bernot (CNRS I3S, Nice), O. Roux (Ecole Centrale Nantes), F. Fages and S. Soliman;
- ANR Blanc **STOCH-MC** (2014-2018) on “Stochastic Models: Scalable Model Checking”, coordinated by Blaise Genest (Inria Rennes), with Grégory Batt, Wieslaw Zielonka (LIAFA), and Hugo Gimbert (LaBRI).

8.1.2. Inria Project Lab

- IPL **COSY** (2017-2021) “real-time control of synthetic microbial communities”, coordinated by Eugenio Cinquemani (Ibis, Inria), with Jean-Luc Gouzé (Biocore, Inria), Gregory Batt, Frédéric Bonnans (Commands, Inria), Efimov Denis (Non-A, Inria), and Hans Geiselman (BIOP, Université Grenoble-Alpes), Beatrice Laroche (Maiage, Inra Jouy-en-Josas).

8.2. European Initiatives

8.2.1. H2020 Projects

- H2020 FET-OPEN **COSY-BIO** (2017-2020), “Control Engineering of Biological Systems for Reliable Synthetic Biology Applications”, coordinated by Diego di Bernardo (Tigem), with Filippo Menolascina (Edinburgh U), Mario di Bernardo (Naples U), Pascal Hersen (Paris7 U), Mustafa Khamash (ETHZ), Gregory Batt, Guy-Bart Stan (Imperial College), and Lucia Marucci (Bristol U).

8.3. International Research Visitors

8.3.1. Visits of International Scientists

The following researchers have been invited for short visits

- Carlo Spaccasassi, Microsoft Research Cambridge, UK
- Debdas Paul, Univ. Stuttgart, Germany

8.3.1.1. Internships

Lucia Nasti, PhD candidate at the Università of Pisa, Italy, is visiting our group for 4 months.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

Jakob Ruess stayed at IST Austria twice a week in Feb and Nov 2018.

M3DISIM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Other funding

IPM-MS project (for Imagerie Polarimétrique de Mueller pour la réalisation d'un système original de caractérisation des propriétés mécaniques des Matériaux Structurés). 50k€ funded by the LABEX Lasips. This project, which involves the LPICM laboratory (Ecole Polytechnique, CNRS), the LMS (Ecole Polytechnique, CNRS, Mines ParisTech) and the Centre des Matériaux (Mines ParisTech), aims at developing an optical tool to study the link between the mechanical properties of a material and its hierarchical organization. Despite the development of new methods to observe the microstructure, one of the limitations is the number of observations that can be obtained on a given sample in a realistic experimental time. To overcome this difficulty, we are planning to use the Mueller polarimetry to obtain at a fast rate (a few frames per second, compared to a few frames per half-hour) relevant information on the local anisotropy of biological (heart, skin) and composite (short fibers composite) samples.

G. Bureau, software engineer in the team, was funded by an Inria Reo industrial contract with KephaliOS, a startup working on innovative artificial valves devices.

9.2. European Initiatives

9.2.1. Collaborations with Major European Organizations

Partner 1: Division of Biomedical Engineering & Imaging Sciences (BMEIS), St Thomas' Hospital, King's College London, UK

clinical-modeling topics mostly encompassing congenital heart diseases (BMEIS acts as "Other participant" in the Inria Associate team ToFMod, and R. Chabiniok additionally performs clinical MRI exams at St Thomas' hospital 0.5 days / week.

Partner 2: Department of Mathematics, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Czech Republic

model-constrained image registrations, trans-valvular flow in pathological valves.

Partner 3: Institute for Clinical and Experimental Medicine in Prague

Cardiovascular MRI

9.3. International Initiatives

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

9.3.1.1. ToFMod

Title: Cardiac Biomechanical Modeling of Chronic Right Ventricular Loading

International Partner (Institution - Laboratory - Researcher):

UT Southwestern Medical Center, Dallas, Texas (United States), Mohammad Tarique Hussain

Start year: 2018

See also: <https://m3disim.saclay.inria.fr/associated-team/>

This collaboration aims at addressing a crucial issue in cardiology of congenital heart diseases, namely, the optimal timing of pulmonary valve replacement (PVR) in patients with surgically repaired tetralogy of Fallot (ToF) prone to chronic pulmonary regurgitation or right ventricular outflow tract stenosis. Our strategy consists in exploiting the predictive power of biomechanical modeling to shed light in the decision process. We will start by a detailed proof-of-concept study, based on datasets that will be acquired in patients indicated for percutaneous PVR, prior to the procedure, and in the follow-up at 3- and 12-months post-PVR. These datasets will be first used to calibrate the Inria M3DISIM patient-specific heart model simulating a cardiac cycle (at each follow-up time point) to access the myocardial properties – namely, the active contractility and passive stiffness. The instantaneous tissue properties will be statistically analyzed and compared with the level of reverse remodeling – i.e. the positive outcome of PVR. Secondly, the data at each time point will be used to calibrate and further develop the models of long-term tissue remodeling created by the M3DISIM researchers. It is only by combining such invaluable longitudinal data with biomechanical modeling expertise that progress can be achieved in the above objective, indeed.

9.4. International Research Visitors

9.4.1. Invited researchers

- T. Hussain, A. Tandon (Senior researchers at UTSW Medical Center Dallas): joint work in the scope of the Inria Associate team ToFMOD
- F. Regazzoni (3rd year PhD student from MOX, Milan, Italy): From Sept 2018, joint work on model learning and data assimilation coupling.

9.4.2. Internships

- K. Solovska (Czech Technical University and IKEM Prague): 1-30 August 2018, collaborative work with M. Genet and R. Chabiniok in the scope of the Inria Associate team ToFMOD

PARIETAL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Inserm-Inria project

This project is funded by the joint Inserm and Inria program ‘médecine numérique’ and is conducted in collaborations with our clinical partners from the Lariboisière hospital, Inserm uni U942 BioCANVAS (Biomarkers in Cardio-Neuro-VAScular diseases). It supports the PhD thesis of David Sabbagh.

Participants:

- Denis Engemann [coordinator, co-advisor]
- Alexandre Gramfort [thesis director, co-advisor]
- Etienne Gayat [clinical collaborator, co-advisor]
- Fabrice Vallée [clinical collaborator]
- David Sabbagh [PhD Student]

Post-operative delirium (POD) is a potential complication of anesthesia during surgery. It is often associated with adverse outcomes and is aggravated by aging. In elderly patients, post-operative complications have been estimated to incur tens of million US dollars of costs each year in the United States by prolonging hospitalization and potentially affecting health prognosis. Recent studies suggest that POD can already be prevented by improving electrophysiological monitoring of anesthesia depth and individual dosage of anesthetic agents. Doing so probably minimizes the time patients spend in a coma-like state that manifests itself in isoelectric burst suppression, an electroencephalogram (EEG) pattern characterized by alternation between quiescence and high-amplitude bursts, and causally linked to POD. However, such an enterprise, currently, depends on the trained clinical electrophysiologist and guidance by commercially provided EEG indices of states of consciousness. One such metric is the bispectral index (BIS), which, like other related metrics, does not explicitly take into account baseline changes related to normative aging and may therefore be biased when used naively.

While electrophysiological signatures of aging (e.g. drop in Alpha and Gamma band power), states of consciousness (e.g. drop in Theta band long-range connectivity) and drug response (e.g. anteriorization of alpha band power in propofol anesthesia) have been separately investigated in the past years, their common denominators are not known. It is therefore difficult to detect individual risk, choose the optimal dosage, and automate anesthesia monitoring readily for any patient in any hospital.

The goal of this research project is to build statistical models that enable prediction of burst suppression and subsequent POD by exploiting diverse EEG-signatures of states of consciousness in the context of aging. We approach this challenge by recasting it as a problem of learning brain-age from the point of view of electrophysiology of consciousness.

9.1.2. CoSmic project

Participants: Philippe Ciuciu [Correspondant], Carole Lazarus, Loubna El Gueddari.

This project is funded by CEA DRF-Impulsion.

This is a collaborative project with Jean-Luc Stark, (CEA) funded by the DRF-impulsion CEA program.

Compressed Sensing is a recent theory in maths that allows the perfect recovery of signals or images from compressive acquisition scenarios. This approach has been popularized in MRI over the last decade as well as in astrophysics (noticeably in radio-astronomy). So far, both of these fields have developed skills in CS separately. The aim of the COSMIC project is to foster collaborations between CEA experts in MRI (Parietal team within NeuroSpin) and in astrophysics (CosmoStat lab within the Astrophysics Department). These interactions will allow us to share different expertise in order to improve image quality, either in MRI or in radio-astronomy (thanks to the interferometry principle). In this field, given the data delivered by radio-telescopes, the goal consists in extracting high temporal resolution information in order to study fast transient events.

9.1.3. *Metacog*

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Jérôme Dockès.

This project is funded by Digiteo.

This is a Digicosme project (2016-2019) and a collaboration with Fabian Suchanek (Telecom Paritech).

Understanding how cognition emerges from the billions of neurons that constitute the human brain is a major open problem in science that could bridge natural science –biology– to humanities –psychology. Psychology studies performed on humans with functional Magnetic Resonance Imaging (fMRI) can be used to probe the full repertoire of high-level cognitive functions. While analyzing the resulting image data for a given experiment is a relatively well-mastered process, the challenges in comparing data across multiple datasets poses serious limitation to the field. Indeed, such comparisons require to pool together brain images acquired under different settings and assess the effect of different *experimental conditions* that correspond to psychological effects studied by neuroscientists.

Such meta-analyses are now becoming possible thanks to the development of public data resources –OpenfMRI <http://openfmri.org> and NeuroVault <http://neurovault.org>. As many others, researchers of the Parietal team understand these data sources well and contribute to them. However, in such open-ended context, the description of experiments in terms of cognitive concepts is very difficult: there is no universal definition of cognitive terms that could be employed consistently by neuroscientists. Hence meta-analytic studies loose power and specificity. On the other hand, <http://brainspell.org> provide a set of curated annotation, albeit on much less data, that can serve as a seed or a ground truth to define a consensual ontology of cognitive concepts. Relating these terms to brain activity poses another challenge, of statistical nature, as brain patterns form high-dimensional data in perspective with the scarcity and the noise of the data.

The purpose of this project is to learn a semantic structure in cognitive terms from their occurrence in brain activation. This structure will simplify massive multi-label statistical-learning problems that arise in brain mapping by providing compact representations of cognitive concepts while capturing the imprecision on the definition these concepts.

9.1.4. *HiDimStat*

Participants: Bertrand Thirion [Correspondant], Jerome-Alexis Chevalier, Joseph Salmon.

This project is funded by Digiteo.

This is a Digicosme project (2017-2020) and a collaboration with Joseph Salmon (Telecom Paritech).

The HiDimStat project aims at handling uncertainty in the challenging context of high dimensional regression problem. Though sparse models have been popularized in the last twenty years in contexts where many features can explain a phenomenon, it remains a burning issue to attribute confidence to the predictive models that they produce. Such a question is hard both from the statistical modeling point of view, and from a computation perspective. Indeed, in practical settings, the amount of features at stake (possibly up to several millions in high resolution brain imaging) limit the application of current methods and require new algorithms to achieve computational efficiency. We plan to leverage recent developments in sparse convex solvers as well as more efficient reformulations of testing and confidence interval estimates to provide several communities with practical software handling uncertainty quantification. Specific validation experiments will be performed in the field of brain imaging.

9.1.5. *Template estimation for arbitrary alignments: application to brain imaging.*

Participants: Bertrand Thirion [Correspondant], Thomas Bazeille.

This project is funded by Digiteo.

In the recent years, the nature of scientific inference has shifted quite substantially from model-based to predictive approaches, thanks to the generalization of powerful machine learning techniques. While this has certainly improved scientific standards, this has also obscured the objects and concepts on which inference is drawn. For instance, it is now possible –based on some initial data– to predict individual brain activity topographies, yet the very notion of a standard brain template has become increasingly elusive. Given the importance of establishing models for the progress of knowledge, we revisit the problem of model inference on data with high variance. Specifically, in a context where almost arbitrary transformation can successfully warp observations to each other with high accuracy, what is the common definition of a population model underlying all these observations? What is the working definition of a template ? We plan to leverage recent developments on optimal transport and multivariate analysis to build working definition of templates; we will use them in a brain imaging context to build a novel generation of brain templates.

9.1.6. *AMPHI project*

Participants: Bertrand Thirion [Correspondant], Joseph Salmon, Antonio Andre Monteiro Manoel.

This is a Digicosme project (2017-2020) and a collaboration with Joseph Salmon (Telecom Paritech) and Lenka Zdeborova (CEA, IPhT).

In many scientific fields, the data acquisition devices have benefited of hardware improvement to increase the resolution of the observed phenomena, leading to ever larger datasets. While the dimensionality has increased, the number of samples available is often limited, due to physical or financial limits. This is a problem when these data are processed with estimators that have a large sample complexity, such as multivariate statistical models. In that case it is very useful to rely on structured priors, so that the results reflect the state of knowledge on the phenomena of interest. The study of the human brain activity through neuroimaging belongs among these problems, with up to 10^6 features, yet a set of observations limited by cost and participant comfort. We are missing fast estimators for multivariate models with structured priors, that furthermore provide statistical control on the solution. Approximate message passing (AMP) methods are designed to work optimally with low- sample-complexity, they accommodate rather generic class of priors and come with an estimation of statistical significance. They are therefore well suited for our purposes. We want to join forces to design a new generation of inverse problem solvers that can take into account the complex structure of brain images and provide guarantees in the low-sample-complexity regime. To this end, we will first adapt AMP to the brain mapping setting, using first standard sparsity priors (e.g. Gauss-Bernoulli) on the model. We will then consider more complex structured priors that control the variation of the learned image patterns in space. Crucial gains are expected from the use of the EM algorithm for parameter setting, that comes naturally with AMP. We will also examine the estimators provided by AMP for statistical significance. AMPHI will design a reference inference toolbox released as a generic open source library. We expect a 3- to 10-fold improvement in CPU time, that will benefit to large-scale brain mapping investigations.

9.1.7. *CDS2*

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Guillaume Lemaitre, Joris Van Den Bossche.

CDS2 is an "Strategic research initiative" of the Paris Saclay University Idex <http://datascience-paris-saclay.fr>. Although it groups together many partners of the Paris Saclay ecosystem, Parietal has been deeply involved in the project. It currently funds a post-doc for Guillaume Lemaitre and an engineer positions for Joris van den Bossche. Alexandre Boucaud was funded till December as engineer.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. *Neuroref: Mathematical Models of Anatomy / Neuroanatomy / Diffusion MRI*

Participants: Demian Wassermann [Correspondant], Antonia Machlouzarides Shalit, Valentin Iovene.

While mild traumatic brain injury (mTBI) has become the focus of many neuroimaging studies, the understanding of mTBI, particularly in patients who evince no radiological evidence of injury and yet experience clinical and cognitive symptoms, has remained a complex challenge. Sophisticated imaging tools are needed to delineate the kind of subtle brain injury that is extant in these patients, as existing tools are often ill-suited for the diagnosis of mTBI. For example, conventional magnetic resonance imaging (MRI) studies have focused on seeking a spatially consistent pattern of abnormal signal using statistical analyses that compare average differences between groups, i.e., separating mTBI from healthy controls. While these methods are successful in many diseases, they are not as useful in mTBI, where brain injuries are spatially heterogeneous.

The goal of this proposal is to develop a robust framework to perform subject-specific neuroimaging analyses of Diffusion MRI (dMRI), as this modality has shown excellent sensitivity to brain injuries and can locate subtle brain abnormalities that are not detected using routine clinical neuroradiological readings. New algorithms will be developed to create Individualized Brain Abnormality (IBA) maps that will have a number of clinical and research applications. In this proposal, this technology will be used to analyze a previously acquired dataset from the INTRuST Clinical Consortium, a multi-center effort to study subjects with Post-Traumatic Stress Disorder (PTSD) and mTBI. Neuroimaging abnormality measures will be linked to clinical and neuropsychological assessments. This technique will allow us to tease apart neuroimaging differences between PTSD and mTBI and to establish baseline relationships between neuroimaging markers, and clinical and cognitive measures.

9.2.1.2. DirtyData: Data integration and cleaning for statistical analysis

Participants: Gaël Varoquaux [Correspondant], Patricio Cerda Reyes, Pierre Glaser.

Machine learning has inspired new markets and applications by extracting new insights from complex and noisy data. However, to perform such analyses, the most costly step is often to prepare the data. It entails correcting errors and inconsistencies as well as transforming the data into a single matrix-shaped table that comprises all interesting descriptors for all observations to study. Indeed, the data often results from merging multiple sources of informations with different conventions. Different data tables may come without names on the columns, with missing data, or with input errors such as typos. As a result, the data cannot be automatically shaped into a matrix for statistical analysis.

This proposal aims to drastically reduce the cost of data preparation by integrating it directly into the statistical analysis. Our key insight is that machine learning itself deals well with noise and errors. Hence, we aim to develop the methodology to do statistical analysis directly on the original dirty data. For this, the operations currently done to clean data before the analysis must be adapted to a statistical framework that captures errors and inconsistencies. Our research agenda is inspired from the data-integration state of the art in database research combined with statistical modeling and regularization from machine learning.

Data integrating and cleaning is traditionally performed in databases by finding fuzzy matches or overlaps and applying transformation rules and joins. To incorporate it in the statistical analysis, and thus propagate uncertainties, we want to revisit those logical and set operations with statistical-learning tools. A challenge is to turn the entities present in the data into representations well-suited for statistical learning that are robust to potential errors but do not wash out uncertainty.

Prior art developed in databases is mostly based on first-order logic and sets. Our project strives to capture errors in the input of the entries. Hence we formulate operations in terms of similarities. We address typing entries, deduplication -finding different forms of the same entity- building joins across dirty tables, and correcting errors and missing data.

Our goal is that these steps should be generic enough to digest directly dirty data without user-defined rules. Indeed, they never try to build a fully clean view of the data, which is something very hard, but rather include in the statistical analysis errors and ambiguities in the data.

The methods developed will be empirically evaluated on a variety of dataset, including the French public-data repository, data.gouv.fr. The consortium comprises a company specialized in data integration, Data Publica, that guides business strategies by cross-analyzing public data with market-specific data.

9.2.1.3. *FastBig Project*

Participants: Bertrand Thirion [Correspondant], Jerome-Alexis Chevalier, Tuan Binh Nguyen.

In many scientific applications, increasingly-large datasets are being acquired to describe more accurately biological or physical phenomena. While the dimensionality of the resulting measures has increased, the number of samples available is often limited, due to physical or financial limits. This results in impressive amounts of complex data observed in small batches of samples.

A question that arises is then : what features in the data are really informative about some outcome of interest ? This amounts to inferring the relationships between these variables and the outcome, conditionally to all other variables. Providing statistical guarantees on these associations is needed in many fields of data science, where competing models require rigorous statistical assessment. Yet reaching such guarantees is very hard.

FAST-BIG aims at developing theoretical results and practical estimation procedures that render statistical inference feasible in such hard cases. We will develop the corresponding software and assess novel inference schemes on two applications : genomics and brain imaging.

9.2.1.4. *MultiFrac project*

Participant: Philippe Ciuciu [Correspondant].

The scale-free concept formalizes the intuition that, in many systems, the analysis of temporal dynamics cannot be grounded on specific and characteristic time scales. The scale-free paradigm has permitted the relevant analysis of numerous applications, very different in nature, ranging from natural phenomena (hydrodynamic turbulence, geophysics, body rhythms, brain activity,...) to human activities (Internet traffic, population, finance, art,...).

Yet, most successes of scale-free analysis were obtained in contexts where data are univariate, homogeneous along time (a single stationary time series), and well-characterized by simple-shape local singularities. For such situations, scale-free dynamics translate into global or local power laws, which significantly eases practical analyses. Numerous recent real-world applications (macroscopic spontaneous brain dynamics, the central application in this project, being one paradigm example), however, naturally entail large multivariate data (many signals), whose properties vary along time (non-stationarity) and across components (non-homogeneity), with potentially complex temporal dynamics, thus intricate local singular behaviors.

These three issues call into question the intuitive and founding identification of scale-free to power laws, and thus make uneasy multivariate scale-free and multifractal analyses, precluding the use of univariate methodologies. This explains why the concept of scale-free dynamics is barely used and with limited successes in such settings and highlights the overriding need for a systematic methodological study of multivariate scale-free and multifractal dynamics. The Core Theme of MULTIFRACS consists in laying the theoretical foundations of a practical robust statistical signal processing framework for multivariate non homogeneous scale-free and multifractal analyses, suited to varied types of rich singularities, as well as in performing accurate analyses of scale-free dynamics in spontaneous and task-related macroscopic brain activity, to assess their natures, functional roles and relevance, and their relations to behavioral performance in a timing estimation task using multimodal functional imaging techniques.

This overarching objective is organized into 4 Challenges:

1. Multivariate scale-free and multifractal analysis,
2. Second generation of local singularity indices,
3. Scale-free dynamics, non-stationarity and non-homogeneity,
4. Multivariate scale-free temporal dynamics analysis in macroscopic brain activity.

9.3. European Initiatives

9.3.1. *FP7 & H2020 Projects*

9.3.1.1. *NeuroLang*

Title: Accelerating Neuroscience Research by Unifying Knowledge Representation and Analysis Through a Domain Specific Language

Programm: ERC Starting researcher

Duration: 01/03/2018 - 28/02/2023

Coordinator: Demian Wassermann

Inria contact: Demian Wassermann

Summary:

Neuroscience is at an inflection point. The 150-year old cortical specialization paradigm, in which cortical brain areas have a distinct set of functions, is experiencing an unprecedented momentum with over 1000 articles being published every year. However, this paradigm is reaching its limits. Recent studies show that current approaches to atlas brain areas, like relative location, cellular population type, or connectivity, are not enough on their own to characterize a cortical area and its function unequivocally. This hinders the reproducibility and advancement of neuroscience.

Neuroscience is thus in dire need of a universal standard to specify neuroanatomy and function: a novel formal language allowing neuroscientists to simultaneously specify tissue characteristics, relative location, known function and connectional topology for the unequivocal identification of a given brain region.

The vision of NeuroLang is that a unified formal language for neuroanatomy will boost our understanding of the brain. By defining brain regions, networks, and cognitive tasks through a set of formal criteria, researchers will be able to synthesize and integrate data within and across diverse studies. NeuroLang will accelerate the development of neuroscience by providing a way to evaluate anatomical specificity, test current theories, and develop new hypotheses.

NeuroLang will lead to a new generation of computational tools for neuroscience research. In doing so, we will be shedding a novel light onto neurological research and possibly disease treatment and palliative care. Our project complements current developments in large multimodal studies across different databases. This project will bring the power of Domain Specific Languages to neuroscience research, driving the field towards a new paradigm articulating classical neuroanatomy with current statistical and machine learning-based approaches.

9.3.1.2. *SLAB* (698)

Title: Signal processing and Learning Applied to Brain data

Programm: ERC Starting researcher

Duration: 01/04/2017 - 31/08/2021

Coordinator: Alexandre Gramfort

Partner: LTCI , Telecom ParisTech (France)

Inria contact: Alexandre Gramfort

Summary:

Understanding how the brain works in healthy and pathological conditions is considered as one of the challenges for the 21st century. After the first electroencephalography (EEG) measurements in 1929, the 90's was the birth of modern functional brain imaging with the first functional MRI and full head magnetoencephalography (MEG) system. In the last twenty years, imaging has revolutionized clinical and cognitive neuroscience.

After pioneering works in physics and engineering, the field of neuroscience has to face two major challenges. The size of the datasets keeps growing. The answers to neuroscience questions are limited by the complexity of the signals observed: non-stationarity, high noise levels, heterogeneity of sensors, lack of accurate models. *SLAB* will provide the next generation of models and algorithms for mining electrophysiology signals which offer unique ways to image the brain at a millisecond time scale.

SLAB will develop dedicated machine learning and signal processing methods and favor the emergence of new challenges for these fields. SLAB focuses on five objectives: 1) source localization with M/EEG for brain imaging at high temporal resolution 2) representation learning to boost statistical power and reduce acquisition costs 3) fusion of heterogeneous sensors 4) modeling of non-stationary spectral interactions to identify functional coupling between neural ensembles 5) development of fast algorithms easy to use by non-experts.

SLAB aims to strengthen mathematical and computational foundations of brain data analysis. The methods developed will have applications across fields (computational biology, astronomy, econometrics). Yet, the primary impact of SLAB will be on neuroscience. The tools and high quality open software produced in SLAB will facilitate the analysis of electrophysiology data, offering new perspectives to understand how the brain works at a mesoscale, and for clinical applications (epilepsy, autism, tremor, sleep disorders).

9.3.1.3. Neuroimaging power (262)

Title: Neuroimaging power

Programm: Marie Curie Fellowship

Duration: 01/11/2016 - 31/10/2019

Coordinator: Inria

Partner: BOARD OF TRUSTEES OF THE LELAND STANFORD JUNIOR UNIVERSITY (United States)

Inria contact: Bertrand Thirion

Summary:

There is an increasing concern about statistical power in neuroscience research. Critically, an underpowered study has poor predictive power. Findings from a low-power study are unlikely to be reproducible, and thus a power analysis is a critical component of any paper. This project aims to promote and facilitate the use of power analyses.

A key component of a power analysis is the specification of an effect size. However, in neuroimaging, there is no standardised way to communicate effect sizes, which makes the choice of an appropriate effect size a formidable task. The best way today to perform a power analysis is by collecting a pilot data set, a very expensive practice. To eliminate the need for pilot data, we will develop a standardised measure of effect size taking into account the spatial variance and the uncertainty of the measurements. Communicating effect sizes in new publications will facilitate the use of power analyses.

To further alleviate the need for pilot data, we will provide a library of effect sizes for different tasks and contrasts, using open data projects in neuroimaging. We will integrate our effect size estimator in open repositories NeuroVault and OpenfMRI. Consequently, these effect sizes can then serve as a proxy for a pilot study, and as such, a huge cost in the design of an experiment is eliminated.

A new experiment will not be identical to the open data and as such the hypothesised parameters might not be fully accurate. To address this issue, we present a flexible framework to analyse data mid-way without harming the control of the type I error rate. Such a procedure will allow re-evaluating halfway an experiment whether it is useful to continue a study, and how many more subjects are needed for statistically sound inferences. To make our methods maximally available, we will write a software suite including all these methods in different programming platforms and we will provide a GUI to further increase the use of power analyses.

9.3.1.4. HBP SGA1

Title: Human Brain Project Specific Grant Agreement 1

Programm: FET Flagship

Duration: 01/04/2016 - 31/02/2020

Coordinator: Katrin Amunts

Partners: 150 european labs, please see <https://www.humanbrainproject.eu/en/open-ethical-engaged/contributors/partners>

Inria contact: Bertrand Thirion

Summary

Understanding the human brain is one of the greatest scientific challenges of our time. Such an understanding can provide profound insights into our humanity, leading to fundamentally new computing technologies, and transforming the diagnosis and treatment of brain disorders. Modern ICT brings this prospect within reach. The HBP Flagship Initiative (HBP) thus proposes a unique strategy that uses ICT to integrate neuroscience data from around the world, to develop a unified multi-level understanding of the brain and diseases, and ultimately to emulate its computational capabilities. The goal is to catalyze a global collaborative effort. During the HBP's first Specific Grant Agreement (SGA1), the HBP Core Project will outline the basis for building and operating a tightly integrated Research Infrastructure, providing HBP researchers and the scientific Community with unique resources and capabilities. Partnering Projects will enable independent research groups to expand the capabilities of the HBP Platforms, in order to use them to address otherwise intractable problems in neuroscience, computing and medicine in the future. In addition, collaborations with other national, European and international initiatives will create synergies, maximizing returns on research investment. SGA1 covers the detailed steps that will be taken to move the HBP closer to achieving its ambitious Flagship Objectives.

9.3.1.5. HBP SGA2

Title: Interactive Computing E-Infrastructure for the Human Brain Project

Programm: FET Flagship

Duration: 01/04/2018 - 31/03/2020

Coordinator: Katrin Amunts

Partners: see <https://www.humanbrainproject.eu/en/open-ethical-engaged/contributors/partners/>

Inria contact: Bertrand Thirion

Summary:

The HBP Flagship was launched by the European Commission's Future and Emerging Technologies (FET) scheme in October 2013, and is scheduled to run for ten years. The Flagships, represent a new partnering model for visionary, long-term European cooperative research in the European Research Area, demonstrating the potential for common research efforts. The HBP has the following main objectives:

- Create and operate a European scientific Research Infrastructure for brain research, cognitive neuroscience, and other brain-inspired sciences
- Gather, organise and disseminate data describing the brain and its diseases
- Simulate the brain
- Build multi-scale scaffold theory and models for the brain
- Develop brain-inspired computing, data analytics and robotics
- Ensure that the HBP's work is undertaken responsibly and that it benefits society.

More information on the HBP's Flagship Objectives is available in the Framework Partnership Agreement.

The timeline of the Project is split into multiple phases, each of which will be covered by a separate funding agreement. The current phase is Specific Grant Agreement Two (SGA2), which spans the two-year period from April 2018–April 2020. The HBP is funded via several sources. Total funding is planned to be in the region of EUR 1 billion; around one half of which will be provided by the

European Union, and the other by Member States and private funding sources. The European Union contributed EUR 54 million to the Project in the Ramp-Up Phase (October 2013 to March 2016), EUR 89 million for the second phase (SGA1), and EUR 88 million for the current phase (SGA2). The FET Flagships Staff Working Document provides further information on how Flagships are funded.

9.4. International Initiatives

9.4.1. Inria International Labs

Inria@Silicon Valley

Associate Team involved in the International Lab:

9.4.1.1. *LargeBrainNets*

Title: Characterizing Large-scale Brain Networks Using Novel Computational Methods for dMRI and fMRI-based Connectivity

International Partner (Institution - Laboratory - Researcher):

Stanford Cognitive & Systems Neuroscience Lab, Stanford Medical School, USA. Contact: Vinod Menon.

Start year: 2016

See also: <http://www-sop.inria.fr/members/Demian.Wassermann/large-brain-nets.html>

In the past two decades, brain imaging of neurotypical individuals and clinical populations has primarily focused on localization of function and structures in the brain, revealing activation in specific brain regions during performance of cognitive tasks through modalities such as functional MRI. In parallel, technologies to identify white matter structures have been developed using diffusion MRI. More recently, interest has shifted towards developing a deeper understanding of the brain's intrinsic architecture and its influence on cognitive and affective information processing. Using for this resting state fMRI and diffusion MRI to build the functional and structural networks of the human brain.

The human brain is a complex patchwork of interconnected regions, and graph-theoretical approaches have become increasingly useful for understanding how functionally connected systems engender, and constrain, cognitive functions. The functional nodes of the human brain and their structural inter-connectivity, collectively the "connectome", are, however, poorly understood. Critically, there is a dearth of computational methods for reliably identifying functional nodes of the brain and their structural inter-connectivity in vivo, despite an abundance of high-quality data from the Human Connectome Project (HCP). Devising and validating methods for investigating the human connectome has therefore taken added significance.

The first major goal of this project is to develop and validate appropriate sophisticated computational and mathematical tools for identifying functional nodes at the whole-brain level and measuring structural and functional connectivity between them, using state-of-the-art human brain imaging techniques and open-source HCP data. To this end, we will first develop and validate novel computational tools for (1) identifying stable functional nodes of the human brain using resting-state functional MRI and (2) measuring structural connectivity between functional nodes of the brain using multi-shell high-angular diffusion MRI. Due to the complementarity of the two imaging techniques fMRI and dMRI, our novel computational methods methods, the synergy between the two laboratories of this associate team will allow us to reveal in unprecedented detail the structural and functional connectivity of the human brain.

The second major goal of this project is to use our newly developed computational tools to characterize normal structural and functional brain networks in neurotypical adults.

Inria@Silicon Valley

Associate Team involved in the International Lab:

9.4.1.2. *Meta&Co*

Title: Meta-Analysis of Neuro-Cognitive Associations

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Psychology department. - Russel Poldrack

Start year: 2018

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

Cognitive science and psychiatry describe mental operations: cognition, emotion, perception and their dysfunction. Cognitive neuroimaging bridge these mental concepts to their implementation in the brain, neural firing and wiring, by relying on functional brain imaging. Yet aggregating results from experiments probing brain activity into a consistent description faces the roadblock that cognitive concepts and brain pathologies are ill-defined. Separation between them is often blurry. In addition, these concepts and subdivisions may not correspond to actual brain structures or systems. To tackle this challenge, we propose to adapt data-mining techniques used to learn relationships in computational linguistics. Natural language processing uses distributional semantics to build semantic relationships and ontologies. New models are needed to learn relationships from heterogeneous signals: functional magnetic resonance images (fMRI), on the one hand, combined with related psychology and neuroimaging annotations or publications, on the other hand. Such a joint effort will rely on large publicly-available fMRI databases shared by Podrack Lab, as well as literature mining.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

- June 2018: Prof. Lilianne Mujica-Parodi (Univ Stony-Brook, NY USA)
- April-June 2018: Dr Abderrahim Halimi (Edinburgh, UK)
- October 2018: Prof. Nikos Makris (Harvard Medical School)
- December 2018: Dr. Lang Chen (Stanford Medical University)

XPOP Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

Mixed-Effects Models of Intracellular Processes: Methods, Tools and Applications (MEMIP)

Coordinator: Gregory Batt (InBio Inria team)

Other partners: InBio and IBIS Inria teams, Laboratoire Matière et Systèmes Complexes (UMR 7057; CNRS and Paris Diderot Univ.)

9.1.2. Institut National du Cancer (INCa)

Targeting Rac-dependent actin polymerization in cutaneous melanoma - Institut National du Cancer

Coordinator: Alexis Gautreau (Ecole Polytechnique)

Other partners: Laboratoire de Biochimie (Polytechnique), Institut Curie, INSERM.

9.2. International Initiatives

9.2.1. International Initiatives

SaSMoTiDep

Title: Statistical and Stochastic modeling for time-dependent data

International Partners (Institution - Laboratory - Researcher):

Universidad de Valparaíso (Chile) - Centro de Investigación y Modelamiento de Fenómenos Aleatorios Valparaíso (CIMFAV) - Cristian Meza Becerra

Universidad Nacional de Colombia (Colombia) - Department of Statistics - Viswanathan Arunachalam

Duration: 01/01/2018 - 31/12/2019

Start year: 2018

See also: <https://sasmotiddep.uv.cl>

In many applications, multiple measurements are made on one or several experimental units over a period of time. Such data could be called time-dependent data. From a statistical point of view, if we consider only one experimental unit, we can use a time series analysis. In the other hand, if we consider experimental designs (or observational studies) for several experimental units (or subjects) where each subject is measured at several points in time, we can use the term longitudinal data. In this project, we propose to study several statistical and stochastic models for repeated measures using parametric and non-parametric approaches. In particular, we will study the inference in complex mixed effects models, we will propose novel segmentation models for multiple series, non-parametric methods in dependent models and stochastic models. We will apply these methods to real data from several fields as biometrics, reliability, population dynamics and finance.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Ricardo Rios, Universidad Central de Venezuela, Caracas: September 2018.

INFINE-POST Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Equipex FIT:

Participants: Cedric Adjih, Emmanuel Baccelli, Alexandre Abadie [SED - Inria], Ichrak Amdouni [Ecole Nationale d'Ingénieurs de Sousse & CRISTAL].

Partners: Inria (Lille, Sophia-Antipolis, Grenoble), INSA, UPMC, Institut Telecom Paris, Institut Télécom Evry, LSIIT Strasbourg.

FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It provides this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project gives french internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the future internet. FIT was one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant program, in 2011.

One component of the FIT platform is the sets of IoT-LAB testbeds (see [the IoT-LAB web site](#)). These were motivated by the observation that the world is moving towards an "Internet of Things", in which most communication over networks will be between objects rather than people.

The Infine team is more specifically managing the FIT IoT-LAB site formerly at Rocquencourt, which recently moved to Saclay (on-going re-deployment), and is participating in the deployment of an additional IoT-lab testbed in Berlin (at Freie Universitaet Berlin).

7.1.2. ANR

The team has submitted three PRC ANR projects: two projects for the CE25, i.e., on "Réseaux de communication multi-usages, infrastructures de hautes performances, sciences et technologies logicielles" and one for the CE35, i.e., on "Révolution numérique : rapports au savoir et à la culture".

7.2. European Initiatives

7.2.1. H2020 Projects

7.2.2. AGILE (H2020 project)

Participants: Emmanuel Baccelli, Cedric Adjih.

Program: H2020 ICT-30-2015 Topic: Internet of Things and Platforms for Connected Smart Objects

Project acronym: AGILE

Project title: Adoptive Gateways for dIverse muLtiiple Environments

Duration: 2015-2018

Coordinator: Emmanuel Baccelli

Other partners: Canonical (UK), Eclipse IoT Foundation (IE), Mobistar (BE), Libelium (ES), Startupbootcamp IoT (SP), CREATE-NET (IT), iMinds (BE), Atos (SP), Rulemotion (UK), Jolocom (DE), Passau University (DE), Sky-Watch (DN), BioAssist (GR), Graz Technical University (AT), Eurotech (IT), IoTango (US).

Abstract: The AGILE project is a 3-year H2020 project started in January 2016, which will deliver an integrated framework of open source tools and platforms that interoperate for enabling the delivery of adaptive, self-configurable and secure IoT elements (both software and hardware) that can be utilized in a variety of scenarios. Such tools target actors with heterogeneous skills, including entrepreneurs, researchers, and individuals, aiming to enable the realization of IoT applications respecting user privacy and data ownership.

7.3. International Initiatives

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

7.3.1.1. EMBRACE

Title: Leveraging Human Behavior and Uncertainty in 5G Networks to Build Robust Resource Allocation and Services Orchestration Models

International Partners (Institution - Laboratory - Researcher):

UTFPR (Brazil) - Departamento Acadêmico de Informática (DAINF) Curso de Pós-Graduação em Engenharia Elétrica e Informática Industrial (CPGEI) - Anelise Munaretto

UFG (Brazil) - Institute of Computational Mathematics and Scientific / Engineering Computing - Kleber Vieira Cardoso

UFMG (Brazil) - Dpt of Statistics - Antonio A. F. Loureiro

Start year: 2017

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

Abstract: EMBRACE propose une architecture novatrice pour gérer des ressources et des services opérationnels hétérogènes. EMBRACE se concentre sur les défis scientifiques liés des ensembles de données collectées dans le monde réel et décrivant le comportement du réseau des utilisateurs. En particulier, EMBRACE exploite la modélisation du comportement humain en termes de mobilité, de demande de contenu, d'intérêts communs et des interactions entre-utilisateurs. En construisant des modèles d'allocation des ressources tenant compte de l'utilisateur, EMBRACE a pour objectif de diminuer l'incertitude et mieux cerner les profils humains dans les réseaux 5G. La communication D2D sera également utilisée comme service opérationnel pour gérer la croissance du trafic mobile en libérant des ressources des réseaux cellulaires, sans augmenter les coûts. La nouveauté de l'architecture réside dans les algorithmes conçus qui exploiteront les caractérisations tirés de l'analyse du comportement des utilisateurs, l'hétérogénéité du réseau, et de l'incertitude. L'évaluation par simulation et l'émulation sera également l'un des thèmes clés. Enfin, les équipes concernées (Inria Infine, UFMG, UFG, UTFPR) ont un long historique de coopération sur ces thèmes.

7.3.2. Inria International Partners

7.3.2.1. Declared Inria International Partners

1. Renewed IOTPUSH collaboration with Freie Universitaet Berlin around the long-term stay of Emmanuel Baccelli in Berlin, on research topics about the Internet of Things, RIOT and Information-Centric Networking.

7.3.2.2. Informal International Partners

1. On-going collaboration with Freie Universitaet Berlin and Hamburg University of Applied Science around RIOT.
2. Informal collaborations with UIUC and UMass.
3. Informal collaborations with ENSI Tunis and Sesame Tunis.
4. On-going strong collaboration with Sapienza University of Rome, Italy.
5. On-going strong collaboration with CNR Torino, Italy.

6. On-going collaboration with University of Porto, Portugal.
7. On-going collaboration with ENSAE/CNRS, France.
8. On-going collaboration with University of Edinburgh, UK.
9. On-going collaboration with Boston University, US.

7.3.3. Participation in Other International Programs

7.3.3.1. Indo-French project

The Inria teams Infine and Eva are part of the "D2D Communication for LTE Advanced Cellular Network" , a project funded by the Indo-French Centre for the Promotion of Advanced Research (CEFIPRA). With industrial partners, and also with Indian partners, this project is focusing on the evolution of cellular networks towards 5G: this includes exploration of device-to-device (D2D) communication, and more generally IoT communication in a cellular context. Research directions include efficient access for IoT devices (massive numbers of devices with low volume communication); combination of random access protocols/error coding/physical layer ; efficient neighbor discovery,

7.3.3.2. STIC AmSud MOTIf 2017

Participant: Aline Carneiro Viana.

Program: STIC AmSud

Project title: Mobile phone sensing of human dynamics in techno-social environment

Duration: 2017-2019

Coordinators: Marton Karsai (ENS/Inria) and Jussara M. Almeida (UFMG) and Alejo Salles (Univ. of Buenos Aires)

Abstract: Information and Communication Technology (ICT) is becoming increasingly social, as demonstrated by the multitude of emerging technologies and technology platforms that facilitate social interactions, taking place as communication via telephone, text message, email, online social networks etc. At the same time, our social activities are increasingly embedded in the ICT environments that enable and enhance our ability to transact, share experiences, and maintain social relationships. One of the best ways to explore these developments is through the mining and analysis of data, which are collected through mobile phones and allow us to investigate how individuals act when embedded in a technology-enabled environment. The MOTIf project builds on the analysis and modeling of geo-localized temporally detailed but fully anonymised mobile phone call networks. These datasets allow us to address the two scientific objectives about spatiotemporal patterns of service usage of anonymised individuals to learn when, where, and what people are doing; and about the fine-grained sociodemographic structure of society and its effect on the the individual social behaviour. In other words our goal in general is to understand how individuals behave in a dynamic techno-social environment.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Prof. Antonio F. Loureiro is a Visiting Researcher at Infine for 3 months, under the *DigiCosme Visiting Professor* funding. He worked with Aline C. Viana and the internship Joao Batista Borges on the inference of motifs from daily human mobility. He is also the Brazilian coordinator of the EMBRACE Inria associate team. He will give a series of lectures on “*What can a mobility trace tell us?*”.

7.4.1.1. Internships

Joao Batista Borges visited us for 2 weeks on October 2018 and will return on January 2019. The visits enter in the context of EMBRACE associated team. He work with Aline C. Viana and Antonio Loureiro on the extraction of motifs of mobility patterns of individuals that, when merged together, describe their daily motion and can be used to enhance mobility prediction.

Diego Madariaga Roman did an internship of 3 months at our team (Sep-Nov 2018). He work with Aline C. Viana, Marco Fiore and Panagiota Katsikouli on adaptive sampling frequency of human mobility.

Lucas Santos did an internship of 5 months at our team (May-Nov 2018), in the context of EMBRACE associated team. He work with Aline C. Viana and Pedro Olmo on the investigation of causalities in habits of human visits.

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

Emmanuel Baccelli is Visiting Professor at Freie Universitaet (FU) Berlin, within the context of the formal collaboration IOTPUSH with this university on research topics about the Internet of Things, RIOT and Information-Centric Networking.

POEMS-POST Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR project NonlocalDD (*Non-local domain decomposition methods in electromagnetics*)
Partners: Inria Alpines, Inria POEMS, Inria Magique 3D
Start: 10/2015. End: 09/2019. Administrator: Inria
Participants of POEMS: S. Chaillat, P. Joly
Coordinator: X. Claeys (LJLL, EPI ALPINES)
- ANR project MODULATE (*Modeling lOng-perioD groUnd motions, and assessment of their effects on Large-scale infrAsTructurEs*)
Partners: ENSTA (UME), Inria POEMS, CentraleSupélec, BRGM, GDS
Start: 11/2018. End: 10/2021. Administrator: ENSTA
Participant of POEMS: S. Chaillat
Coordinator: K. Meza Fajardo (BRGM)

9.1.2. DGA

- Contracts between DGA and POEMS:
 - Contract on *inverse problems*
Participants: L. Bourgeois
Start: 10/2016. End: 09/2018. Administrator: ENSTA
 - Contract on *boundary element methods and high-frequency problems*
Participants: E. Lunéville, M. Lenoir, N. Kielbasiewicz.
Start: 10/2015. End: 2021. Administrator: ENSTA
In partnership with F. Alouges and M. Aussal (CMAP, Ecole Polytechnique).
 - Contract on *the preconditioning of fast BEM solvers*
Participants: S. Chaillat, F. Amlani
Start: 10/2017. End: 12/2018. Administrator: ENSTA
- DGA provides partial funding for several PhD students:
 - A. Bera on the *design of invisible obstacles for acoustic and electromagnetic waves* (Start: 10/2016)
 - C. Beneteau on the *asymptotic analysis of time harmonic Maxwell equations in presence of metamaterials* (Start: 10/2017)
 - D. Chicaud on *domain decomposition methods for time-harmonic electromagnetic wave problems with complex media* (Start: 10/2018)

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

Wilkins Aquino (Duke University, USA)

Juan Pablo Borthagaray (University of Maryland, College Park, USA)

Fioralba Cakoni (University of Rutgers, USA)

Mahadevan Ganesh (Colorado School of Mines, USA)

Camille Carvalho (UC Merced, Merced, USA)
Christophe Geuzaine (Université de Liège, Belgium)
Bojan Guzina (University of Minnesota, USA)
Marcus Grote (Universitaet Basel, Switzerland)
Jean-François Molinari (EPFL, Lausanne, Switzerland)
Sergei Nazarov (Saint-Petersburg University, Russia)
Jerónimo Rodríguez (University of Santiago de Compostela, Spain)
Adrien Semin (TU Darmstadt, Germany)
Ricardo Weder (Universidad Nacional Autonoma, Mexico)
Shravan Veerapaneni (Univ. of Michigan at Ann Arbor, USA)
Jun Zou (Chinese University of Hong Kong, HK)

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Mahadevan Ganesh (Colorado School of Mines) – July 2018
- Bojan Guzina (University of Minnesota, USA) – Summer 2018, 1 month
- Michael Weinstein (Columbia University, USA) – May-June 2018
- Fedor Bakharev (Saint Petersburg State University, Russia) – July 2018

AVIZ Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Tobias Isenberg received an equipment grant from STIC, Paris-Saclay, for approx. EUR 5K

7.2. National Initiatives

- Naviscope Inria Project Lab on Image-guided Navigation and Visualization of large data sets in live cell imaging and microSCOPY; collaboration with several Inria project teams and external collaborators; this grant supports a PhD position and funds travel and equipment.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. IVAN

Title: Interactive and Visual Analysis of Networks

Programm: CHIST-ERA

Duration: May 2018 - April 2021

Coordinator: Dr. Torsten Möller, Uni Wien, Austria

Partners:

EPFL, Switzerland

Inria France

Uni Wien, Austria

Inria contact: Jean-Daniel Fekete

The main goal of IVAN is to create a visual analysis system for the exploration of dynamic or time-dependent networks (from small to large scale). Our contributions will be in three principle areas:

1. novel algorithms for network clustering that are based on graph harmonic analysis and level-of-detail methods;
2. the development of novel similarity measures for networks and network clusters for the purpose of comparing multiple network clusterings and the grouping (clustering) of different network clusterings; and
3. a system for user-driven analysis of network clusterings supported by novel visual encodings and interaction techniques suitable for exploring dynamic networks and their clusterings in the presence of uncertainties due to noise and uncontrolled variations of network properties.

Our aim is to make these novel algorithms accessible to a broad range of users and researchers to enable reliable and informed decisions based on the network analysis.

7.3.2. Collaborations in European Programs, Except FP7 & H2020

- Illustrare project co-funded by ANR, France, and FWF, Austria, funding a PhD position and funds for travel and equipment. The project investigates integrative visual abstraction of molecular data and is a collaboration with TU Wien, Austria

7.4. International Initiatives

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

7.4.1.1. SEVEN

Title: Situated and Embedded Visualization for Data Analysis

International Partner (Institution - Laboratory - Researcher):

University of Calgary (Canada) - ILab - Wesley Willett

Start year: 2018

See also: <http://aviz.fr/seven>

The goal of this joint work between the Aviz team at Inria Saclay and the ILab at the University of Calgary is to develop and study situated data visualizations to address the limitations of traditional platforms of data analytics. In a situated data visualization, the data is directly visualized next to the physical space, object, or person it refers to. Situated data visualizations can surface information in the physical environment and allow viewers to interpret data in-context, monitor changes over time, make decisions, and act on the physical world in response to the insights gained. However, research on this topic remains scarce and limited in scope. We will build on our track record of successful collaborations to jointly develop situated visualization as a novel research direction. The objective for the first year is to design and implement situated visualizations to support health and aging. Our joint work is expected generate benefits at multiple levels, including to society and industry (by empowering individuals and professionals with technology), to the scientific community (by developing a new research direction), to the academic partners (by reinforcing existing research links and establishing them as leaders on the topic), and to students (by providing them with unique training opportunities with a diverse team of world-class researchers).

7.4.2. Inria International Partners

7.4.2.1. Informal International Partners

- University of Maryland (USA), University of Roma (Italy), TU Darmstadt (Germany): Jean-Daniel Fekete collaborates with Leilani Battle, Giuseppe Santucci, Carsten Binnig and colleagues on the design of database benchmarks to better support visualization;
- University of Seoul (Korea): Jean-Daniel Fekete collaborates with Jaemin Jo and Jinwook Seoh on progressive algorithms and visualization techniques;
- University of Bari (Italy): Jean-Daniel Fekete collaborates with Paolo Buono on hypergraph visualization;
- Stanford University. Pierre Dragicevic and Jean-Daniel Fekete collaborate with Sean Follmer on swarm user interfaces.
- Hasso Plattner Institute. Pierre Dragicevic and Tobias Isenberg collaborate with Amir Semmo on stylization filters for facilitating the examination of disturbing visual content.
- University of Minnesota, USA: Tobias Isenberg is collaborating with Daniel F. Keefe on topics of the interactive exploration of 3D data.
- University of Granada, Spain: Tobias Isenberg is collaborating with Domingo Martin and German Arroyo on digital stippling.
- The University of Sydney, Australia. Steve Haroz collaborate with Alex Holcombe on analyzing open practices in vision science.
- Massachusetts Institute of Technology (CSAIL). Steve Haroz collaborates with Aude Oliva on investigating the impact of titles on memory of visualized data.
- University of Washington, University of Zurich and University of Toronto. Pierre Dragicevic and Steve Haroz collaborate with Matthew Kay and Chat Wacharamanatham on transparent statistical reporting and efficient statistical communication. Pierre Dragicevic collaborates with Matthew Kay and Fanny Chevalier on supporting research transparency with interactive research papers.

- University of Calgary. Pierre Dragicevic, Tobias Isenberg, and Petra Isenberg collaborate with Wesley Willett, Sheelagh Carpendale, and Lora Oehlberg on situated data visualization.
- Microsoft Research Redmond and University of Maryland. Petra Isenberg collaborate with Bongshin Lee, Mathieu Brehmer, and Eun Kyoung Choe on Mobile Visualization
- Microsoft Research Redmond. Petra Isenberg and Tanja Blascheck collaborate with Bongshin Lee on Micro Visualizations for Smartwatches

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Claudio Silva (August 2018 – June 2019): Sabbatical from New York University (USA). Also, invited professor through a DigiCosme grant for 3 months. Claudio Silva is spending one year with Aviz. We launched a bi-weekly seminar on explainable machine-learning with visualization.
- Michael McGuffin (October – November): visit from ETS Montreal (Canada). Michael McGuffin has spent a month with Aviz working on augmented reality and visualization, collaborating with Pierre Dragicevic, Jean-Daniel Fekete, and students.

7.5.1.1. Internships

- Jung Nam from the University of Minnesota visited for 3 months in the summer of 2018. His work centered on the use of storytelling mechanisms to support and communicate results of the exploration 3D data. This collaboration is still ongoing.

CEDAR Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- AIDE (“A New Database Service for Interactive Exploration on Big Data”) is an ANR “Young Researcher” project led by Y. Diao, started at the end of 2016.
- CBOD (“Cloud-Based Organizational Design”) is a 4-year ANR started in 2014, coordinated by prof. Ahmed Bounfour from UPS. Its goal is to study and model the ways in which cloud computing impacts the behavior and operation of companies and organizations, with a particular focus on the cloud-based management of data, a crucial asset in many companies.
- ContentCheck (2015-2018) is an ANR project in collaboration with U. Rennes 1 (F. Goasdoué), INSA Lyon (P. Lamarre), the LIMSI lab from U. Paris Sud, and the Le Monde newspaper, in particular their fact-checking team Les Décodeurs. Its aim is to investigate content management models and tools for journalistic fact-checking.

8.1.2. LabEx, IdEx

- CloudSelect is a three-years project started in October 2015. It is financed by the *Institut de la Société Numérique* (ISN) of the IDEX Paris-Saclay; it funds the PhD scholarship of S. Cebiric. The project is a collaboration with A. Bounfour from the economics department of Université Paris Sud. The project aims at exploring technical and business-oriented aspects of data mobility across cloud services, and from the cloud to outside the cloud.

8.1.3. Others

- ODIN is a four-year project started (2014-2018) funded by the Direction Générale de l’Armement, between the SemSoft company, IRISA Rennes and Cedar. The project focused on developing a complete framework for analytics on Web data, in particular taking into account uncertainty, based on Semantic Web technologies such as RDF.
- The goal of the iCODA project is to develop the scientific and technological foundations for knowledge-mediated user-in-the-loop collaborative data analytics on heterogeneous information sources, and to demonstrate the effectiveness of the approach in realistic, high-visibility use-cases. The project stands at the crossroad of multiple research fields—content analysis, data management, knowledge representation, visualization—that span multiple Inria themes, and counts on a club of major press partners to define usage scenarios, provide data and demonstrate achievements. This is a project funded directly by Inria (“Inria Project Lab”), and is in collaboration with GraphIK, ILDA, LINKMEDIA (coordinator), as well as the press partners AFP, Le Monde (Les Décodeurs) and Ouest-France.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- **IDEAA: Issue-Driven European Arena Analytics** is a project funded by the European Commission Union’s Horizon 2020 research and innovation programme. The project started in July 2018 for a duration of two years. Its purpose is to allow citizens to easily explore the trove of publicly available data with the aim of building a viewpoint on specific issues. Its main strengths are: supply users with succinct and meaningful knowledge with respect to the issue they are interested in; allow users

to interact with the provided knowledge to refine their information need and advance understanding; suggest interesting or unexpected aspects in the data and support the comparison of knowledge discovered from different data sources. IDEAA is inspired by human-to-human dialogues, where questions are explorative, possibly imprecise, and answers may be a bit inaccurate but suggestive, conveying an idea that stimulates the interlocutor to further questions.

The project supports a two-years presence of Mirjana Mazuran as an experienced post-doc in our team.

8.3. International Initiatives

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

8.3.1.1. WebClaimExplain

Title: Mining for explanations to claims published on the Web

International Partner (Institution - Laboratory - Researcher):

AIST (Japan) - Julien Leblay

Start year: 2017

See also: <https://team.inria.fr/cedar/projects/webclaimexplain/>

The goal of this research is to create tools to find explanations for facts and verify claims made online. While this process cannot be fully automated, the main focus of our work will be explanation finding via trusted sources, based on the observation that one can only trust a statement if he/she can explain it through rules and proofs that can themselves be trusted. Our WebClaimExplain collaboration has been particularly fruitful this year in terms of publications [9], [7], [18], [16], [14].

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

We resumed our collaboration with Prof. Alin Deutsch from University of California in San Diego (UCSD), during his invited stay at U. Paris Sud. We have completed a work (started in 2015-2016) on efficient view-based query rewriting in polystores, and submitted it to a major international conference.

8.3.3. Participation in Other International Programs

8.3.3.1. AYAME

WebClaimExplain

Title: Mining for explanations to claims published on the Web

International Partner (Institution - Laboratory - Researcher):

AIST (Japan) - Leblay Julien

Duration: 2017 - 2019

Start year: 2017

See also: <https://team.inria.fr/cedar/projects/webclaimexplain/>

The goal of this research is to create tools to find explanations for facts and verify claims made online. While this process cannot be fully automated, the main focus of our work will be explanation finding via trusted sources, based on the observation that one can only trust a statement if he/she can explain it through rules and proofs that can themselves be trusted.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Sabbatical programme

Juliana Freire, a professor at NYU and the chair of the ACM SIGMOD chapter, has been a visitor on sabbatical in the team since September 2018.

8.4.1.2. Internships

Lars Kegel, a PhD student at the university of Dresden, has visited the team until August 2018. He has worked on characterizing and generating time series data for benchmarking time series management software.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Yanlei Diao spent three months at U. Massachussets at Amherst, USA.

EX-SITU Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *MoveIT – Modeling the Speed/Accuracy Trade-Off of Human Aimed Movement with the Tools of Information Theory*

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2015-2018

Coordinator: Olivier Rioul (Institut Mines Telecom)

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to conduct fundamental studies of aimed movements based on information theory. The project studies the interaction phenomena involved in pointing, in order to discover novel, more effective pointing techniques. This project funds Wanyu Liu, a joint Ph.D. student between the COMELEC and VIA groups at Institut Mines Telecom and ExSitu. Wanyu defended her thesis in November 2018 [35] and received an Honorable Mention award for her CHI 2018 paper [22].

8.1.2. *An Augmented-Reality System for Collaborative Physical Modeling and Design*

Type: Equipment

Funding: STIC Paris-Saclay

Duration: 2017-2018

Coordinator: Theophanis Tsandilas

Partners: Univ. Paris-Sud, Inria

Inria contact: Theophanis Tsandilas

Abstract: The goal of the project is to develop an augmented-reality system to support collaboration over 3D models and enhance digital-fabrication approaches. It is a collaboration with the AVIZ group and provides funding (8k) for equipment.

8.1.3. *Le Plateau des Recherches Infinies*

Type: Equipment and subcontracting

Funding: Learning Center Paris-Saclay

Duration: 2017-2018

Coordinator: Michel Beaudouin-Lafon

Partners: Univ. Paris-Sud

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project (30k) is to create an interactive installation presenting the portraits of a hundred researchers from Université Paris-Saclay. It is a collaboration with portrait photographer Didier Goupy. The installation is designed to be exhibited in various sites of Université Paris-Saclay until it is permanently installed in the Learning Center of Université Paris-Saclay. This project supported Swati Swati, an intern, for two months over the summer. The project was presented at the Fête de la Science in October, 2018, and will be permanently exhibited in the future Learning Center of Université Paris-Saclay.

8.1.4. Virtual Reality for Interacting with Building Information Model at Paris-Saclay

Type: Equipment and human resources

Funding: STIC Paris-Saclay

Duration: 2018-2019

Coordinator: Jean-Marc Vézien (LIMSI-CNRS)

Partners: CNRS, Univ. Paris-Sud

Inria contact: Cédric Fleury

Abstract: The goal of this project is to develop interactive tools for BIM application in virtual reality using a user-centered design approach. The project will use as a case study the interior design of the *Learning Center* building on Paris-Saclay campus.

8.2. National Initiatives

8.2.1. ANR

ELEMENT: Enabling Learnability in Human Movement Interaction

Type: Equipment and human resources

Funding: ANR

Duration: 2019-2022

Coordinator: Baptiste Caramiaux, Sarah Fdili Alaoui, Wendy Mackay

Partners: IRCAM, LIMSI

Inria contact: Baptiste Caramiaux

Abstract: The goal of this project is to foster innovation in multimodal interaction, from non-verbal communication to interaction with digital media/content in creative applications, specifically by addressing two critical issues: the design of learnable gestures and movements; and the development of interaction models that adapt to a variety of user's expertise and facilitate human sensorimotor learning.

8.2.2. Investissements d'Avenir

8.2.2.1. Digiscope - Collaborative Interaction with Complex Data and Computation

Type: EQUIPEX (Equipement d'Excellence)

Duration: 2011-2019

Coordinator: Michel Beaudouin-Lafon

Partners: Université Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, CentraleSupélec, Université Versailles - Saint-Quentin, ENS Paris-Saclay, Maison de la Simulation

Overall budget: 22.5 Meuros, including 6.7 Meuros public funding from ANR

Abstract: The goal of the project is to create ten high-end interactive rooms interconnected by high-speed networks and audio-video facilities to support remote collaboration across interactive visualization environments. The equipment will be open to outside users and targets four main application areas: scientific discovery, product lifetime management, decision support for crisis management, and education and training. Digiscope includes the existing WILD room, and funded the WILDER room. ExSitu contributes its expertise in the design and evaluation of advanced interaction techniques and the development of distributed software architectures for interactive systems. All ten rooms and the telepresence network are operational. The project was successfully evaluated by an international jury in June, 2017.

8.3. European Initiatives

8.3.1. European Research Council (ERC)

8.3.1.1. Creating Human-Computer Partnerships

Program: ERC Advanced Grant

Project acronym: CREATIV

Project title: Creating Human-Computer Partnerships

Duration: June 2013 - May 2019

Coordinator: Wendy Mackay

Abstract: CREATIV explores how the concept of co-adaptation can revolutionize the design and use of interactive software. Co-adaptation is the parallel phenomenon in which users both adapt their behavior to the system's constraints, learning its power and idiosyncrasies, and appropriate the system for their own needs, often using it in ways unintended by the system designer. A key insight in designing for co-adaptation is that we can encapsulate interactions and treat them as first class objects, called interaction instruments. This lets us focus on the specific characteristics of how human users express their intentions, both learning from and controlling the system. By making instruments co-adaptive, we can radically change how people use interactive systems, providing incrementally learnable paths that offer users greater expressive power and mastery of their technology. The initial goal of the CREATIV project is to fundamentally improve the learning and expressive capabilities of advanced users of creative software, offering significantly enhanced methods for expressing and exploring their ideas. The ultimate goal is to radically transform interactive systems for everyone by creating a powerful and flexible partnership between human users and interactive technology.

8.3.1.2. Unified Principles of Interaction

Program: ERC Advanced Grant

Project acronym: ONE

Project title: Unified Principles of Interaction

Duration: October 2016 - September 2020

Coordinator: Michel Beaudouin-Lafon

Abstract: The goal of ONE is to fundamentally re-think the basic principles and conceptual model of interactive systems to empower users by letting them appropriate their digital environment. The project addresses this challenge through three interleaved strands: empirical studies to better understand interaction in both the physical and digital worlds, theoretical work to create a conceptual model of interaction and interactive systems, and prototype development to test these principles and concepts in the lab and in the field. Drawing inspiration from physics, biology and psychology, the conceptual model combines *substrates* to manage digital information at various levels of abstraction and representation, *instruments* to manipulate substrates, and *environments* to organize substrates and instruments into digital workspaces.

8.3.2. Marie Skłodowska-Curie Actions

8.3.2.1. Enhancing Motion Interaction through Music Performance

Program: Marie Curie grant

Project acronym: MIM

Project title: Enhancing Motion Interaction

Duration: 2016 - 2018

Coordinator: Baptiste Caramiaux

Abstract: The goal of the project to enhance Human Motion–Computer Interaction by leveraging a multidisciplinary approach across experimental psychology, music technology and computational modelling. Firstly, the project examines skilled activities, in particular music performance, in order to understand fundamental cognitive and psychological aspects of control and expression in human motion. The project involves computational models of motor control and expressive variations built from music performance data collected during psychophysical studies. Secondly, the project broaches the implementation of these models in Digital Musical Instruments (DMI), thus creating a new type of digital instrument based on sensorimotor learning mechanisms. The resulting DMI is then assessed through a user study in which elements of exploration and engagement will be tested over several sessions. Therefore, the project contributes to two main uncharted research areas. Firstly it contributes to the fundamental understanding of sensorimotor learning processes by considering complex human motion, specifically motion in music performance. Secondly, it represents an original application of computational modelling by modelling expressive musical gestures and transferring these models to interactive systems.

8.4. International Initiatives

8.4.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

8.4.1.1. DECibel

Title: Discover, Express, Create – Interaction Technologies For Creative Collaboration

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical and Computer Engineering,
Center for Magnetic Resonance Research - Bjoern Hartmann

Start year: 2016

The DECibel associated team includes Inria's ExSitu and the CITRIS Connected Communities Initiative (CCI) at UC Berkeley. ExSitu explores extreme interaction, working with creative professionals and scientists who push the limits of technology to develop novel interactive technologies that offer new strategies for creative exploration. ExSitu's research activities include: developing underlying theory (co-adaptive instruments and substrates), conducting empirical studies (participatory design with creative professionals), and implementing interactive systems (creativity support tools). The CITRIS Connected Communities Initiative investigates collaborative discovery and design through new technologies that enhance education, creative work, and public engagement. It develops interactive tools, techniques and materials for the rapid design and prototyping of novel interactive products, expertise sharing among designers, and citizen science investigations. DECibel will combine the strengths of these two groups to to investigate novel tools and technologies that support Discovery, Expressivity, and Creativity.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Joanne McGrenere, Professor at the University of British Columbia, Canada and Inria Chair, visited for two months, to work with Wendy Mackay, Carla Griggio, Jessalyn Alvina, Yi Zhang and John MacCallum.

8.5.1.1. Internships

Janin Koch, Ph.D. student from Aalto University, Finland, visited for three months to work with Wendy Mackay.

ILDA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

MapMuxing - Multi-dimensional Map Multiplexing. (2014-2018) Funded by the French National Research Agency (ANR). In collaboration with IGN (Institut National de l'Information Géographique et Forestière): **208Keuros/499Keuros**. Participants: Emmanuel Pietriga (PI), Caroline Appert, Olivier Chapuis. <http://mapmuxing.ign.fr>

The project explores novel ways of combining different maps and data layers into a single cartographic representation, and investigates novel interaction techniques for navigating in it. The project aims at going beyond the traditional pan & zoom and overview+detail interface schemes, and at designing and evaluating novel cartographic visualizations that rely on high-quality generalization, *i.e.*, the simplification of geographic data to make it legible at a given map scale, and symbol specification.

8.1.2. Inria - Ministère de la Culture

Visual Exploration of Linked Data on BnF's data portal (2017-2018) Funded by the French Ministère de la Culture and Inria. **65Keuros**. Participants: Emmanuel Pietriga (PI), Caroline Appert, Hande Gözükan, Marie Destandau, Léo Colombaro.

The project explores novel ways of visually navigating the data exposed by the Bibliothèque Nationale de France as linked data on <http://data.bnf.fr>.

8.1.3. Inria Project Lab (IPL)

ILDA participates to Inria Project Lab iCODA : Data Journalism : knowledge-mediated Content and Data Interactive Analytics, that started in 2017. A key issue in data science is the design of algorithms that enable analysts to infer information and knowledge by exploring heterogeneous information sources, structured data, or unstructured content. With journalism data as a landmark use-case, iCODA aims to develop the scientific and technological foundation for collaborative, heterogeneous data analysis, guided by formalized, user-centric knowledge. The project relies on realistic scenarios in data-journalism to assess the contribution of the project to this area. iCODA is at the crossroads of several research areas (content analysis, data management, knowledge representation, visualization) and is part of a club of partners of the world of the press. Equipes-projets Inria : Graphik, Ilda, Linkmedia, Cedar. Press partners: Le Monde, OuestFrance, AFP. Participants: Anastasia Bezerianos (PI), Emmanuel Pietriga, Tong Xue, Nicole Barbosa Sultanum.

8.1.4. CNRS - PEPS

VizGest. (2018) Funded by CNRS. In collaboration with LIMSI. **17Keuros**. Participants: C. Appert (PI).

Interacting with multi-display environments often involves using mid-air gestures that do not require any proximity between users and displays. However, mid-air gestures are not *visible* to users. VizGest aims at giving some visibility to mid-air gestures by means of annotations put in the physical environment thanks to augmented reality glasses.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

Deutsches Elektronen-Synchrotron (DESY): Scientific collaboration on the design and implementation of user interfaces for array operations monitoring and control for the Cherenkov Telescope Array (CTA) project, to be built in the Canary Islands (Spain) and in the Atacama desert (Chile), 2 years, contract started May 2018

8.3. International Initiatives

8.3.1. Inria International Labs

Inria Chile. From 2012 to 2015, Emmanuel Pietriga was the scientific leader of the Massive Data team at Inria Chile, working on projects in collaboration with the ALMA radio-telescope and the Millenium Institute of Astrophysics. He is now scientific advisor to Inria Chile's visualization projects, and is actively involved in the collaboration between Inria Chile and the LSST on the design and development of user interfaces for operations monitoring and control (see below), and the project between ESO and Inria Chile about the design and implementation of user interfaces for ALMA's Integrated Alarm System.

8.3.2. Inria International Partners

Association of Universities for Research in Astronomy (AURA): contract, jointly with Inria Chile, on the design and implementation of user interfaces for telescope operations monitoring and control for the Large Synoptic Survey Telescope (LSST) project, under construction in the Atacama desert (Chile), started 2017. Participants: Emmanuel Pietriga (ILDA), José Galaz (Inria Chile), Sebastian Pereira (Inria Chile), Grazia Prato (Inria Chile).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Nicole Barbosa Sultanum, Univ. Toronto, Canada, Oct 2018-Jan 2019.
- José Galaz, María Grazia Prato, Sebastian Pereira, Inria Chile, Dec 2018.

PETRUS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR PerSoCloud (Jan 2017 - Dec 2020)

Partners: Orange Labs (coordinator), PETRUS (Inria-UVSQ), Cozy Cloud, U. of Versailles.

The objective of PerSoCloud is to design, implement and validate a full-fledged Privacy-by-Design Personal Cloud Sharing Platform. One of the major difficulties linked to the concept of personal cloud lies in organizing and enforcing the security of the data sharing while the data is no longer under the control of a central server. We identify three dimensions to this problem. Devices-sharing: assuming that the primary copy of user U1's personal data is hosted in a secure place, how to share and synchronize it with U1's multiple (mobile) devices without compromising security? Peers-sharing: how user U1 could exchange a subset of his-her data with an identified user U2 while providing to U1 tangible guarantees about the usage made by U2 of this data? Community-sharing: how user U1 could exchange a subset of his-her data with a large community of users and contribute to personal big data analytics while providing to U1 tangible guarantees about the preservation of his-her anonymity? In addition to tackling these three scientific and technical issues, a legal analysis will guarantee compliance of this platform with the security and privacy French and UE regulation, which firmly promotes the Privacy by Design principle, including the current reforms of personal data regulation.

9.1.2. PIA - PDP SECSi (May 2016 - Dec 2017)

Partners: Cozy Cloud (coordinator), Qwant, PETRUS (Inria-UVSQ), FING.

The objective of this PIA-PDP (Programme Investissement d'Avenir - Protection des Données Personnelles) SECSi project is to build a concrete Personal Cloud platform which can support a large scale deployment of Self Data services. Three major difficulties are identified and will be tackled in this project: (1) how to implement and enforce a fine control of the data flow when personal data are exploited by third party applications, (2) how to protect these same applications when processing is delegated to the personal cloud platform itself and (3) how to implement personalized search on the web without hurting user's privacy.

9.1.3. CityLab@Inria, Inria Project Lab (May 2014 - Oct 2018)

Inria Partners: ARLES-MIMOVE, CLIME, DICE, FUN, MYRIADS, OAK, PETRUS, URBANET, WILLOW.
External partners: UC Berkeley.

CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. PETRUS contributes to Privacy-by-Design architectures for trusted smart objects so as to ensure privacy to citizens, which is critical for ensuring that urbanscale sensing contributes to social sustainability and does not become a threat. The PhD Thesis of Dimitris Tsoulovas, co-directed by MIMOVE and PETRUS, is funded by CityLab. <http://citylab.inria.fr/>

9.1.4. GDP-ERE, DATA-IA project (Sept. 2018 - Aug. 2021)

Partners: DANTE (U. of Versailles), PETRUS (Inria-UVSQ).

The role of individuals and the control of their data is a central issue in the new European regulation (GDPR) enforced on 25th May 2018. Data portability is a new right provided under those regulations. It allows citizens to retrieve their personal data from the companies and governmental agencies that collected them, in an interoperable digital format. The goals are to enable the individual to get out of a captive ecosystem, and to favor the development of innovative personal data services beyond the existing monopolistic positions. The consequence of this new right is the design and deployment of technical platforms, commonly known as Personal Cloud. But personal cloud architectures are very diverse, ranging from cloud based solutions where millions of personal cloud are managed centrally, to self-hosting solutions. This diversity is not neutral both in terms of security and from the point of view of the chain of liabilities. The GDP-ERE project tends to study those issues in an interdisciplinary approach by the involvement of jurists and computer scientists. The two main objectives are (i) to analyze the effects of the personal cloud architectures on legal liabilities, enlightened by the analysis of the rules provided under the GDPR and (ii) to propose legal and technological evolutions to highlight the share of liability between each relevant party and create adapted tools to endorse those liabilities. <http://dataia.eu/actualites/linstitut-dataia-vous-presente-le-projet-gdp-ere-rgpd-et-cloud-personnel-de-lempowerment>

9.2. International Research Visitors

9.2.1. Visits to International Teams

9.2.1.1. Research Stays Abroad

Iulian Sandu Popa has visited the Computer Science department of NJIT (New Jersey Institute of Technology) for two months (March to April) during 2018. Iulian has a long history of collaboration with this department at NJIT, this being his second long stay since 2011. In particular, he collaborates at NJIT with Professor Vincent Oria on topics related to spatiotemporal data management and with Professor Cristian Borcea on topics such as privacy-preserving mobile computing for location-based applications [5] and secure and distributed crowd-sensing for smart city applications. For the latter topic, a joint journal paper has been recently submitted (see Section 7.4).