RESEARCH CENTER
Saclay - Île-de-France

FIELD

Activity Report 2019

Section Partnerships and Cooperations

Edition: 2020-03-21

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COMETE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. LOST2DNN

Program: DATAIA Call for Research Projects

Project title: Leakage of Sensitive Training Data from Deep Neural Networks

Duration: October 2019 - September 2022

Coordinators: Catuscia Palamidessi, Inria Saclay, EPI Comète and Pablo Piantanida, Centrale Supèlec

Other PI's and partner institutions: Georg Pichler, TU Wien, Austria

Abstract: The overall project goal is to develop a fundamental understanding with experimental validation of the information-leakage of training data from deep learning systems. More specifically, we aim at:

- Developing a compelling case study based on state-of-the-art algorithms to perform model inversion attacks, showcasing the feasibility of uncovering specified sensitive information from a trained software (model) on real data.
- Quantifying information leakage. Based on the uncovered attacks, the amount of sensitive information present in trained software will be measured or quantified. The resulting measure of leakage will serve as a basis for the analysis of attacks and for the development of robust mitigation techniques.
- Mitigating information leakage. Strategies will be explored to avoid the uncovered attacks and minimize the potential information leakage of a trained model.

8.2. National Initiatives

8.2.1. 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

8.3. European Initiatives: FP7 & H2020 Projects

8.3.1. HYPATIA

Program: European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme.

Project acronym: HYPATIA

Project title: Privacy and Utility Allied

Duration: October 2019 – September 2024

Principal Investigator: Catuscia Palamidessi

Abstract: With the ever-increasing use of internet-connected devices, such as computers, smart grids, IoT appliances and GPS-enabled equipments, personal data are collected in larger and larger amounts, and then stored and manipulated for the most diverse purposes. Undeniably, the big-data technology provides enormous benefits to industry, individuals and society, ranging from improving business strategies and boosting quality of service to enhancing scientific progress. On the other hand, however, the collection and manipulation of personal data raises alarming privacy issues. Not only the experts, but also the population at large are becoming increasingly aware of the risks, due to the repeated cases of violations and leaks that keep hitting the headlines.

The objective of this project is to develop the theoretical foundations, methods and tools to protect the privacy of the individuals while letting their data to be collected and used for statistical purposes. We aim in particular at developing mechanisms that can be applied and controlled directly by the user thus avoiding the need of a trusted party, are robust with respect to combination of information from different sources, and provide an optimal trade-off between privacy and utility.

8.4. International Initiatives

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

8.4.1.1. 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 2019 - December 2021.

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.

8.4.2. Inria 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

8.4.3. Participation in Other International Programs

8.4.3.1. 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..

8.4.3.2. 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.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Yusuke Kawamoto, Researcher, AIST, Japan, AIST, March 2019 and Nov-Dec 2019

Takao Murakami, Researcher, AIST, Japan, AIST, March 2019

Sophia Knight, Assistant Professor, University of Minnesota, USA, May 2019

Carlos Olarte, Assistant Professor, Universidade Federal do Rio Grande do Norte, Brazil. Nov 2019

Camilo Rueda, Professor, Universidad Javeriana de Cali, Colombia. May-July 2019

Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil. Nov 2019

Sergio Ramirez, PhD student, Universidad Javeriana de Cali, Colombia. Oct-Dec 2019

Carlos Pinzon, Master student, Universidad Javeriana de Cali, Colombia. Nov 2019

8.5.2. Internships

Sayan Biswas, Master student, Univ. of Bath, UK. From Jun 2019 until Sep 2019

Noemie Fong, Master student, ENS Paris. Jan-Feb 2019

Federica Granese, Univ. Od Rome "La Sapienza", Italy. From Mar 2019 until Jun 2019

Boammani Lompo, ENS Rennes. From May 2019 until Jul 2019

DATASHAPE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Mini course on "Sheaf Theory and Topological Data Analysis" taught by Rodrigo Cordoniu (Nice University) at Inria Sophia Antipolis — 8 weeks, 2h per week, Feb 2019 to Apr 2019.

7.2. National Initiatives

7.2.1. ANR

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

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

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

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

- See also: https://members.loria.fr/Olivier.Devillers/aspag/

7.3. International Research Visitors

7.3.1. Visits of International Scientists

- Arijit Ghosh, Indian Statistical Institute, Kolkata, India (September 2019)
- Ramsay Dyer Berkeley Publishing (September 2019)
- Mathijs Wintraecken, IST Austria (September and October 2019)

7.3.1.1. Internships

- Alex Delalande, Centrale-Supelec, (May-October 2019).

7.3.1.2. Research Stays Abroad

- Martin Royer, Fujitsu Laboratories, Tokyo, 2 months.

DEDUCTEAM Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Valentin Blot obtained funding for hiring Étienne Miquey as a post-doctoral researcher from Île-de-France region's DIM-RFSI (Domaine d'Intérêt Majeur - Réseau Francilien en Sciences Informatiques).

8.2. 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.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Frédéric Blanqui cooperates with various researchers in Japan: Makato Hamana (Gunma University), Yoji Akama (Tohoku University) and Kentaro Kikuchi (Tohoku University).

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

Gilles Dowek has spent two weeks at the Institute of Software in Beijing where he has worked with Ying Jiang, Wu Peng, and Wenhui Zhang.

Gilles Dowek has spent two weeks at the University of Buenos Aires where he has worked with Alejandro Díaz-Caro.

Frédéric Blanqui has been invited for two weeks in Japan by Yoji Akama (Tohoku University) and Makato Hamana (Gunma University).

As a "Short Term Scientific Mission" financed by COST Action EUTypes, Guillaume Genestier spent five weeks in Chalmers University, Gothenburg, Sweden, to cooperate with Jesper Cockx and Andreas Abel on the translation between the proof assistant Agda and Dedukti.

GRACE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Participants: Daniel Augot, Matthieu Rambaud.

Daniel Augot and Matthieu Rambaud (Institut Mines-Telecom) received a Digicosme Grant, to fund a new PhD student, A. Saadeh, starting November 2019, on the topic of Secure Multiparty Computation.

8.2. National Initiatives

8.2.1. ANR MANTA

Participants: Daniel Augot, Alain Couvreur, Françoise Levy-Dit-Vehel, Philippe Lebacque, Matthieu Rambaud, Isabella Panaccione, Luca de Feo.

MANTA (accepted July 2015, starting March 2016, Ended September 2019): "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.

We have four annual national retreats, the last one in January 2019, and we organized a closing international workshop in August 2019, with more than 40 participants, half French, half international.

See http://anr-manta.inria.fr/.

8.2.2. ANR CIAO

Participants: Benjamin Smith, Luca de Feo, Antonin Leroux, Mathilde de La Morinerie.

ANR **CIAO** (Cryptography, Isogenies, and Abelian varieties Overwhelming) is a JCJC 2019 project, led by Damien Robert (Inria EP LFANT). This project, which started in October 2019, will examine applications of higher-dimensional abelian varieties in isogeny-based cryptography.

8.2.3. ANR CBCRYPT

Participant: Alain Couvreur.

ANR **CBCRYPT** (Code–based Cryptography) This is a project from (*Appel à projets générique, Défi 9, Liberté et sécurité de l'Europe, de ses citoyens et de ses résidents, Axe 4 ; Cybersécurité*). This project, starting in october 2017 led by Jean-Pierre Tillich (Inria, EP Cosmiq) focusses on the design and the security analysis of code–based primitives, in the context of the current NIST competition.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Participant: Benjamin Smith.

- SPARTA https://www.sparta.eu/ is a cybersecurity competence network, with the objective to collaboratively develop and implement top-tier research and innovation actions

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Alessandro Neri visited us from September 2019 to December 2019, as post-doctoral visitor, to work on rank-metric codes.
- Vincent Neiger (Mcf, Univ. Limoges) visited our team twice. One week in march and one meek in november, to work on the decoding of Reed–Solomon codes.

MEXICO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- MATTHIAS FUEGGER is co-leading the Digicosme working group *HicDiesMeus* on *Highly Constrained Discrete Agents for Modeling Natural Systems*.
- STEFAN HAAR is co-leading the Digicosme working group *TheoBioR* on *Computational methods for modelling and analysing biological networks*.

8.2. 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.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Susanna DONATELLI was invited professor of ENS Paris-Saclay during one month in January, working with Serge Haddad on the expressiveness and conciseness of temporal logic for Markov chains. This work was also coninued durin a visit of Serge Haddad at the university of Torino in March. Their joint work has led to a publication to appear in the international conference LATA 2020 at Milano.
- Sven DZIADEK, Sep-Nov 2019 (PhD student, Univ. Leipzig)

8.3.1.1. Research Stays Abroad

- JURAJ KOLCˇÁK visited the SDM group of Hasuo Ichiro at NII Tokyo from August 2018 to February 2019, working in particular on differential logics.

PARSIFAL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. DIM-RFSI

Gabriel Scherer obtained funding from the Région Île-de-France to hire a post-doc, Luc Pellissier, to work on canonical representation of programs (linking proof theory and category-theory approaches), in collaboration with Adrien Guatto in IRIF (Université Paris 7).

9.2. National Initiatives

9.2.1. 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.

9.2.2. Competitivity 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.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Claudio Sacerdoti Coen (Universita di Bologna, Italy) spent a month visiting Beniamino Accattoli thanks to funding for short-term international visits.

SPECFUN Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

- *De rerum natura*. This project, set up by the team, was accepted this year and will be funded until 2023. It gathers over 20 experts from four fields: computer algebra; the Galois theories of linear functional equations; number theory; combinatorics and probability. Our goal is to obtain classification algorithms for number theory and combinatorics, particularly so for deciding irrationality and transcendence.

7.1.2. Research in Pairs

Alin Bostan together with Marc Mezzaroba (CNRS, Sorbonne Université) and Tanguy Rivoal (CNRS, Université Grenoble-Alpes) have done a "research in pairs" on the Fast Computation of Values of D-Finite Functions, from December 2 to 6, 2019, at CIRM (Luminy, France). The aim of the joint project was to investigate the implications of arithmetic properties of linear differential equations on the computational complexity of their numerical solutions. They focussed on E- and G-functions, which are power series solutions of differential equations that additionally satisfy strong arithmetic conditions and play a major role in Diophantine approximation. The main goal for this research session was to understand several remarks, given without proof by Chudnovsky and Chudnovsky in the late 1980s, and stating that number-theoretic properties could lead to slightly better complexity bounds for E- and G-functions than in the general case.

7.2. International Research Visitors

7.2.1. Visits of International Scientists

7.2.1.1. Internships

- Pierre Lairez supervised during two months Abhijit Balachandra, M1-level student from the Indian Institute of Science (Bangalore). They studied some new aspects of the numerical computation of the topology of complex algebraic surfaces.

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. See 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. 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.

9.2.4. 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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Jorge Sousa Pinto, professor from Universidade do Minho (Braga, Portugal, https://haslab.uminho.pt/jsp/) visited the team for 1 month in May 2019. We interact with him on the topic of the formalization of VC generation algorithms [21]. He also proposed a formalization using the Why3 tool.

CELESTE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

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).

COMMANDS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. IPL

8.1.1.1. 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 [27], [15] have been renewed in this framework.

8.1.1.2. 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 Postdoc of D. Lunz (started Nov. 2019).

DEFI Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. 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.i 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.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. 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.

7.3. International Initiatives

7.3.1. Inria International Labs

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

IIL CWI-Inria

Associate Team involved in the International Lab:

7.3.1.1. 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).

7.3.1.2. 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. Bellasoued on inverse scattering problems

Faculté des Sciences de Sfax. Collaboration with Pr. S. Chaabane on inverse problems for singular parameters

University of Sousse. Collaboration with Pr. M. Khenissi on transmission eigenvalues

Colorado School of Mines. Collaboration with F. Pourahmadian on differential LSM

ns of solution derivatives.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Fioralba Cakoni and David Colton, 1 week, March 2019

7.4.1.1. PostDocs, Internships

- PostDoc, Xiaoli Liu, Sampling methods for time dependent problems, H. Haddar
- Master thesis, Marwa Mansouri, Inside-outside duality with artificial backgrounds, L. Chesnel and H. Haddar.
- PostDoc, Imen Mekkaoui, In-vivo cardiac diffusion magnetic resonanace imaging: simulations and parameters estimation, Jing Rebecca Li and Jan Hesthaven.
- Master thesis, Try Nguyen Tran, French-Vietnam Master Program in Applied Mathematics, Jing Rebecca Li
- Master thesis, Nouha jenhani, ENIT, LAMSIN, H. Haddar
- Master thesis, Amal Labidi, ENIT, LAMSIN, H. Haddar

DISCO Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

Islam Boussaada is a deputy director of the IRS iCODE Institute, the institute for control and decision of the Idex Paris Saclay (http://icode-institute.fr).

- The project *Distributed Algorithms for Microbiological Systems* was funded by iCODE.
- The project *Symbolic/Numerical Methods and Implementations in Delayed-Control design* was funded by iCODE.
- The project *From modeling to control of microalgae growth in photo-bioreactor* was funded by iCODE.
- The project *Distributed Algorithms for Microbiological systems* was funded by iCODE.

6.2. National Initiatives

Islam Boussaada is a member of the administration council of the Association SAGIP (https://www.sagip.org), which structures and promotes the disciplines of automatic control and industrial engineering at the national level.

6.2.1. ANR

Giorgio Valmorbida is a member of the ANR HANDY - Hybrid And Networked Dynamical sYstems (http://projects.laas.fr/handy). Project Summary: Networked dynamical systems are ubiquitous in current and emerging technologies. From energy grids, fleets of connected autonomous vehicles to online social networks, the same scenario arises in each case: dynamical units interact locally to achieve a global behavior. When considering a networked system as a whole, very often continuous-time dynamics are affected by instantaneous changes, called jumps, leading to so-called hybrid dynamical systems. The jumps may originate from (i) the intrinsic dynamics of the nodes, like in multimedia delivery with fixed rate encoding, (ii) intrinsic limitations of the control actions, possibly constrained to a finite set of possible selections, like in power converters within energy grids, (iii) the creation/loss of links or the addition/removal of nodes like in renewable energy systems and social networks. Hybrid phenomena thus play an essential role in these control applications, and call upon the development of novel adapted tools for stability and performance analysis and control design. In this context, the aim of HANDY project is to provide methodological control-oriented tools for realistic networked models, which account for hybrid phenomena.

6.3. European Initiatives

6.3.1. 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 AURORA**

Project acronym: -

Project title: Control and Observation of Nonlinear Systems

Duration: 01/2019-12/2019

Coordinator: Giorgio VALMORBIDA

Other partners: NTNU, Norvège

Abstract: Control theory and controller design for linear dynamical systems is well developed. The same cannot be said for nonlinear systems and searching for a general set of design tools applicable to any nonlinear system may be futile. Restricting the class of system dynamics with the aim of developing a more complete set of controller design tools for such a restricted model class therefore appears to be a reasonable approach. One such restricted class of system dynamics is the class of polynomial dynamical systems, for which stability analysis and controller design tools based on Convex Optimization has recently flourished, using so-called Sum of Squares (SOS) programming. Three topics were studied: - Time discretization techniques. SOS programming for discrete time system is less developed than for continuous time systems. This research task will then study discretization techniques leading to polynomial or rational models. In particular we will develop methods to compare the continuous time system and the discretized one by, for instance, comparing estimates of the region of attraction of stable equilibria. - Observer design. In many applications, not all states are measured, and therefore they have to be inferred using a state observer. Note that the so-called Certainty Equivalence Principle does not in general hold for nonlinear systems. This research task will therefore address observer design using SOS programming, and study the effects of interactions between controller design and observer design on the stability of the overall system. - Benchmark application. CentraleSupelec has a cart and pendulum experimental setup. The complexity of SOS-based controller design for this system is near the limit of what can be accommodated by current optimization packages and computational resources. This research task will test the limits of available numerical solution tools and provide a convincing demonstration of the capabilities of SOS-based controller design.

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.

6.4. International Initiatives

6.4.1. Inria International Partners

6.4.1.1. Informal International Partners

- Louisiana State University, Baton Rouge, USA
- Rutgers University, USA
- CINVESTAV, IPN, Mexico-City, Mexico
- Southern Illinois University, USA
- The University of Texas at Austin, Dept. of Aerospace Engineering & Engineering Mechanics, USA
- City University of Hong Kong, China
- Czech technical university in Prague, Czech Republic
- Budapest University of Technology and Economics, Hungary
- Katholieke Universiteit Leuven, Belgium
- Blikent University, Turkey
- Northeastern University, China
- Northeastern University, Boston, USA
- Universidad de Chile, Chile
- School of Mathematics, University of Leeds, U.K.
- UNICAMP, Brazil
- Kyoto University, Japan
- University Badji Mokhtar-Annaba, Algeria
- University Mouloud-Mammeri Tizi Ouzou, Algeria
- Universitat Politècnica de Catalunya, Spain
- University of Melbourne, Australia

6.4.2. Participation in Other International Programs

The team is member of the GDRI (International Research Group funded by CNRS) SpaDisco (following the GDRI Delsys) since 2017.

6.5. International Research Visitors

6.5.1. Visits of International Scientists

Jie Chen, CityU Hong Kong, 16-20 Dec 2019.

André Fioravanti, UNICAMP, Brazil, 1-7 Dec 2019.

Dan Ma, Northeastern University, 16-20 Dec 2019.

Hitay Özbay, Bilkent University, 4-8 Dec 2019.

Matheus Souza, UNICAMP, Brazil, 1-7 Dec 2019.

Joao Manoel Gomes da Silva Jr, UFRGS, Brazil, 15 Jul -15 Ago 2019.

Ross Drummond, University of Oxford, U.K., 1-7 Dec 2019.

Yutaka Yamamoto, Kyoto University, Japan, 30 oct - 8 Dec 2019.

6.5.1.1. Internships

Master internship: Lotfi Baour, Qualitative behaviour of two models of bacteria communication, Université de Cergy-Pontoise. Supervisors: Catherine Bonnet, Walid Djema, Matthias Fuegger and Thomas Nowak.

Master internship: Khaoula El Farhani, Modeling, estimation and control of microalgae growth for energy production and synthesis of molecules of high added values, CentraleSupelec, 05-09/2019. Supervisors: Sette Diop and Islam Boussaada.

Master internship: Jawher Kahouli, estimation and modelling of microalgae growth in photobioreactor, IPSA/Sup'Biotech,02-08/2019. Supervisors: Islam Boussaada, Ali El Ati and Jean-Yves Trosset.

Master internship: Robin Lacombe, qualification and start-up of Synoxis nano 2l photobioreactor, IPSA/Sup'Biotech,02-08/2019. Supervisors: Islam Boussaada, Ali El Ati and Jean-Yves Trosset.

Master internship: Lucas Leclerc, Modelling of bacteria communication through EDO/EDP, CentraleSupélec. Supervisor: Catherine Bonnet, Matthias Fuegger and Thomas Nowak.

Master internship: Javier Eduardo Pereyra Zamundio, New backstepping design using satificial delays for systems with pointwise delays, CINVESTAV, Instituto Politecnico Nacional. Supervisors: Sabine Mondié, Frédéric Mazenc.

6.5.2. Visits to International Teams

Islam Boussaada visited Budapest University of Technology and Economics during 1-7 Dec 2019.

Giorgio Valmorbida visited the University of Oxford 15-17 Jul 2019.

Giorgio Valmorbida visited the UFRGS, CEFET-Divinopolis, and the UNICAMP, Brazil 26 Jul - 6 Ago 2019.

GAMMA Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

6.1.1.1. 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.

POEMS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- ANR project NonlocalDD *(Non-local domain decomposition methods in electromagnetics)*
  Partners: Inria Alpines, Inria POEMS, Inria Magique 3D
  Start: 10/2015. End: 09/2020. 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, CentraleSupelec, BRGM, GDS
  Start: 11/2018. End: 10/2021. Administrator: ENSTA
  Participant of POEMS: S. Chaillat
  Coordinator: K. Meza Fajardo (BRGM)

8.1.2. DGA

- Contracts between DGA and POEMS:
  - Contract on *boundary element methods and high-frequency problems*
    Participants: E. Lunéville, M. Lenoir, N. Kielbasiewicz.
    Start: 10/2018. End: 09/2021. Administrator: ENSTA
    In partnership with F. Alouges and M. Aussal (CMAP, Ecole Polytechnique).
- DGA provides partial funding for several PhD students:
  - C. Bénéteau 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)

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

Juan Pablo Borthagaray (Universidad de la República, Uruguay)

Shravan Veerapaneni (Univ. of Michigan at Ann Arbor, USA)

Bojan Guzina (University of Minnesota, USA)

Jean-François Molinari (EPFL, Lausanne, Switzerland)

Fioralba Cakoni (University of Rutgers, USA)

Wilkins Aquino (Duke University, USA)

Bojan Guzina (University of Minnesota, USA)

Jorge Albella (University of Santiago de Compostela, Spain)

Carlos Perez Arancibia (Pontificia Universidad Católica, Chile)

Camille Carvalho (UC Merced, Merced, USA)

Simon Chandler Wilde (University of Reading, UK)

Mahadevan Ganesh (Colorado School of Mines, USA)
Christophe Geuzaine (Université de Liège, Belgium)
Marcus Grote (Universitaet Basel, Switzerland)
Moez Khenissi (Univesité de Sousse, Tunisia)
Sergei Nazarov (Saint-Petersburg University, Russia)
Karl-Mikael Perfekt (University of Reading, UK)
Jerónimo Rodríguez (University of Santiago de Compostela, Spain)
Ruben Rosales (MIT, USA)
Adrien Semin (TU Darmstadt, Germany)
Knut Sølna (University of California, Irvine, USA)
Catalin C. Turc (NJIT, NJ, USA)
Jun Zou (Chinese University of Hong Kong, HK)

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Mahadevan Ganesh (Colorado School of Mines, USA) — March 2019
- Carlos Jerez-Hanckes (Universidad Adolfo Ibanez, Chile) — Septembre 2019
- Shravan Veerapaneni (Univ. of Michigan at Ann Arbor, USA) — November 2019

RANDOPT Project-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 Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- Youhei Akimoto, Tsukuba University, Japan
- Tobias Glasmachers, Ruhr University, Bochum, Germany
- Tea Tušar, Jozef Stefan Institute, Ljubljana, Slovenia

9.4. International Research Visitors

9.4.1. Visits to International Teams

9.4.1.1. Research Stays Abroad

Anne Auger and Dimo Brockhoff visited Tea Tušar (Jozef Stefan Institute, Slovenia) for two weeks in April 2019

TAU Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **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
- **HUSH** 2020-2023 (348kEuros), *The HUman Supply cHain behind smart technologies*.
  Coordinator: Antonio A. Casilli (Telecom Paris)
  Participant: Paola Tubaro

9.1.2. Others

- **Nutriperso** 2017-2020, 122 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
- **IRS CDS** 2017-2020, 75 kEuros. Personalized recommendations toward healthier eating practices
  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** 2015-2019 (258 kEuros) Machine Learning on a mass-memory architecture.
  Coordinator: Bruno Farcy (Bull SAS)
  Participants: Marc Schoenauer, Guillaume Charpiat, Cécile Germain-Renaud
- **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 Recommandation 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)
- **ScGlass** 2016-2020 (10 M$), "Cracking the Glass problem" international collaboration on cracking the glass problem, funded by the Simons Fundation (NY, NYC, USA).
  Coordinator: 13 PIs around the world (see https://scglass.uchicago.edu/)
  Participants: (alumni, actively collaborating with members) François Landes

9.2. European Initiatives

9.2.1. Collaborations with Major European Organizations

CERN: collaboration with two major CERN experiments (ATLAS and CMS) on the role of machine learning at all stages of the scientific discovery process. C. Germain supervises a CERN-funded PhD.

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

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.

TROPICAL Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- 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. Labex Hadamard

- Projet du Labex Hadamard, intitulé "ALgebraic Methods in gAmes and optimization ALMA", conjoint avec le PGMO, coordonné par E. Tisgaridas (Inria Paris) et X. Allamigeon, faisant intervenir M. Akian et S. Gaubert.

9.1.3. IRS iCODE (Institut pour le Contrôle et la Décision de l'Idex Paris-Saclay)

- White project "New perspectives in the numerical solution of Hamilton-Jacobi-Bellman partial differential equations", coordinated by M. Akian, including S. Gaubert and members of the EPC Commands (Inria Saclay and École polytechnique), UMA (ENSTA), and LMO (Paris-Sud).

9.1.4. Centre des Hautes Études du Ministère de l'Intérieur

- Project "Optimisation de la performance de centres de traitement d'appels d'urgence en cas d'événements planifiés ou imprévus", coordinated by X. Allamigeon, involving M. Boyet, B. Colin and S. Gaubert.

9.2. International Initiatives

9.2.1. Participation in Other International Programs

- Bilateral projects FACCTS, between the University of Chicago (Statistics) – Lek-Heng Lim– and Ecole polytechnique – Stéphane Gaubert– "Tropical geometry of deep learning".
- Math AmSud Project ARGO, "Algebraic Real Geometry and Optimization", accepted, with CMM (Chile), Univ. Buenos Aires (Argentina), Univ. Fed. Rio and Univ. Fed. Ceara (Brasil), Univ Savoie and CMAP, Ecole polytechnique (France).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Oliver Lorscheid, IMPA, Rio (on sabattical at MPI, Bonn), one week in June and 3 days in October, joint invitation with CMLS, Ecole polytechnique.
- Louis Rowen, Bar Ilan University, 3 days in March.
- Sergei Sergeev, Birmingham, 1 week in April.
- Grigorio Malajovich, Univ. Federal, Rio, 1 week in August.
- Armando Gutiérrez, Aalto University, 2 days in February.

9.3.1.1. Internships

- Sarah Vannucci, PhD student, University of Salerno, has been invited for 3 months in the team.

9.3.2. Visits to International Teams

- S. Gaubert
  - Univ. Birmingham, Math and Stats Dep, Jan. 2019 (visiting S. Sergeev)
  - Univ. Bar Ilan, Math Dep, June 2019 (visiting L. Rowen)
  - Univ. Baltimore, Math Dep, Oct. 2019 (visiting A. Sagnier)
- B. Tran
  - U. de Hong Kong, March-April 2019 (2 months, visiting Zheng Qu)
- C. Walsh
  - Univ. Kent, School of Mathematics, Statistics and Actuarial Science, 1 week in November (visiting B. Lemmens and M. Roelands).

LIFEWARE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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. Boulier (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);

9.1.2. Inria Project Lab

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

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- H2020 FET-OPEN COSY-BIO (2017-2020), on "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 Khammash (ETHZ), Grégory Batt, Guy-Bart Stan (Imperial College), and Lucia Marucci (Bristol U).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

The following researchers have been invited for short visits:

- Jean-Louis Lassez, retired IBM Yorktown, USA
- Lucia Nasti, Univ. Pisa, Italy
- Claudia Lopez Zazueta, NTNU, Norway

9.3.1.1. Internships

- Orianne Bargain (TU Dresden Germany)
- Elisabeth Degrand (KTH, Stockholm Sweden)

M3DISIM Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

ANR JCJC LungManyScale, M. Genet, P. Moireau, D. Chapelle (383 k€) – The lungs' architecture and function are well characterized; however, many fundamental questions remain (e.g., there is no quantitative link between tissue- and organ-level material responses), which represent real health challenges (e.g., Idiopathic Pulmonary Fibrosis is a poorly understood disease, for which a mechanical vicious cycle has been hypothesized, but not demonstrated). The general objective of this project is twofold: (i) scientifically, to better understand pulmonary mechanics, from the alveola to the organ in health and disease; (ii) clinically, to improve diagnosis and prognosis of patients through personalized computational modeling. More precisely, This project aims at developing a many-scale model of the pulmonary biomechanics, linked by computational nonlinear homogenization. The model will integrate the experimental and clinical data produced by partners, through an estimation pipeline that will represent augmented diagnosis and prognosis tools for the clinicians.

ANR ODISSE, P. Moireau, S. Imperiale (154 k€) – Motivated by some recent developments from two different fields of research, that is, observer design for finite-dimensional systems and inverse problems analysis for some PDE systems, the ODISSE project aims at developing rigorous methodological tools for the design of estimating algorithms for infinite-dimensional systems arising from hyperbolic PDE systems.

ANR SIMR, P. Moireau, D. Chapelle (97 k€) SIMR is a multi-disciplinary project seeking a better understanding of the biophysical mechanisms involved in mitral valve (MV) regurgitation diseases, to improve decision-making in patients by helping to determine the optimal timing for surgery. This project aims at facing this major issue with the following main two objectives: (1) Evaluate the biophysical consequences of MV repair and (2) Design numerical tools, for cardiac hemodynamics, fluid-structure interaction and myocardium biomechanics to provide an in silico counterpart of the in vivo data obtained by tension measurement and imaging.

8.1.2. 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), J.M. Allain (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.

8.2. European Initiatives

8.2.1. 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.

8.3. International Initiatives

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

8.3.1.1. 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.

8.4. International Research Visitors

8.4.1. 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 January until March 2019 and from December 2019, joint work on model learning and data assimilation coupling.

OPIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- DATAIA UltraBioLearn (2019-2022). The project aims to research machine learning approaches for medical applications, in particular by leveraging semi-supervised learning using generative, graph-based and certifiable networks, in the context of predicting patient response to cancer treatments. Responsible: H. Talbot, F. Malliaros (N. Lassau, Institut Gustave Roussy).

9.2. National Initiatives

9.2.1. ANR

- Program: ANR PRC

  Project acronym: CoMeDIC

  Project title: Convergent Metrics for DIscrete 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: 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.

9.2.2. Others

- Program: CNRS-CEFIPRA

  Project acronym: NextGenBP

  Project title: Looking Beyond Backpropagation in Deep Learning

  Duration : 2017-2019

  Coordinator: E. Chouzenoux
- Program: PHC - Campus France

  Projet acronym: POLONIUM

Project title: When Poisson and Gauss meet in imaging
Duration: 2018-2020
Coordinator: J.C. Pesquet

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

- Program: H2020 ITN Marie Sklodowska-Curie
  Projet acronym: SUNDIAL
  Project Title: SUrvey Network for Deep Imaging Analysis and Learning
  Duration: 2017-2021
  Coordinator: Reynier Peletier (U. Groningen, NL), local: Hugues Talbot

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- Sup'Com Tunis - Prof. Amel Benazza-Benhayia. Collaboration Topic: Multispectral imaging and image compression.
- North Carolina State University - Prof. Patrick Louis Combettes. Collaboration Topic: Fixed point theory.
- Heriot-Watt University, UK - Prof. Audrey Repetti and Prof. Yves Wiaux. Collaboration Topic: Large-scale image restoration.
- University of Edinburgh, UK - Prof. Victor Elvira. Collaboration Topic: Bayesian signal processing.
- Indraprastha Information Institute Technology, Delhi, India - Prof. Angshul Majumdar. Collaboration Topic: Dictionary learning.
- Universidad Técnica Federico Santa María, Valparaíso, Chile - Prof. Luis M. Briceño-Arias. Collaboration Topic: Stochastic optimization.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Angshul Majumdar, IIIT Delhi, India, June 2019 and December 2019
- Prof. Apostolos N. Papadopoulos, Aristotle University of Thessaloniki, June 2019 to July 2019
- Prof. Patrick L. Combettes, North Carolina State University, US, 18-22 February 2019
- W. Tang (PhD student), North Carolina State University, US, 2-29 May 2019
- S. Sharma (PhD student), IIIT Delhi, India, June 2019 to August 2019

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- M. Vakalopoulou, visiting researcher for 1 month (June-July 2019): Stony Brook University, research team of D. Samaras.
- T. Estienne, 4 months internship (May-August 2019): Center for Biomedical Image Computing and Analytics (CBICA) of University of Pennsylvania.
- E. Battistella, 4 months internship (August-December 2019): Computational Robotics, AI & Biomedicine Lab of RICE University.
- M. Sahasrabudhe, 2 months intership (November-December 2019): Boston Children's Hospital & Harvard Medical School.

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], Nicolas Chartier, Loubna El Gueddari, Zaccharie Ramzi, Chaithya Giliyar Radhkrishna.

This project is funded by CEA DRF-Impulsion.

the DRF-impulsion CEA program which has been transformed into a CEA PTC program for 2 years (2018-2020), in collaboration with Pierre Kestener, La Maison de la Simulation (CEA/CNRS).

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, Jérome 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. CDS2

Participants: Alexandre Gramfort [Correspondant], Gaël Varoquaux, Maria Telenczuk, Jiaping Liu.

CDS2 is an "Strategic research initiative" of the Paris Saclay University Idex https://www.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 2 engineers: Maria Telenczuk and Jiaping (Lucy) Liu.

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, an 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, http://www.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. MultiFracs 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.

9.2.1.5. DARLING: Distributed adaptation and learning over graph signals

Participant: Philippe Ciuciu [Correspondant].

The project will be starting in 2020 with a post-doc to be hired probably in 2021.

The DARLING project will aim to propose new adaptive learning methods, distributed and collaborative on large dynamic graphs in order to extract structured information of the data flows generated and/or transiting at the nodes of these graphs. In order to obtain performance guarantees, these methods will be systematically accompanied by an in-depth study of random matrix theory. This powerful tool , never exploited so far in this context although perfectly suited for inference on random graphs, will thereby provide even avenues for improvement. Finally, in addition to their evaluation on public data sets, the methods will be compared with each other using two advanced imaging techniques in which two of the partners are involved: radio astronomy with the giant SKA instrument (Obs. Côte d'Azur) and magnetoencephalographic brain imaging (Inria Parietal at NeuroSpin, CEA Saclay). These involve the processing of time series on graphs while operating at extreme observation scales.

9.2.1.6. meegBIDS.fr: Standardization, sharing and analysis of MEEG data simplified by BIDS

Participant: Alexandre Gramfort [Correspondant].

The project accepted by ANR in 2019 will be starting in 2020 with an engineer to be hired in 2020. This project is in collaboration with the MEG groups at CEA NeuroSpin and the Brain and Spine Institute (ICM) in Paris.

The neuroimaging community recently started an international effort to standardize the sharing of data recorded with magnetoencephalography (MEG) and with electroencephalography (EEG). This format, known as the Brain Imaging Data Structure (BIDS), now needs a wider adoption, notably in the French neuroimaging community, along with the development of dedicated software tools that operate seamlessly on BIDS formatted datasets. The meegBIDS.fr project has three aims: 1) accelerate the research cycles by allowing analysis software tools to work with BIDS formated data, 2) simplify data sharing with high quality standards thanks to automated validation tools, 3) train French neuroscientists to leverage existing public BIDS MEG/EEG datasets and to share their own data with little efforts.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. VirtualBrainCloud

Title:

Programm: H2020 FET Open

Duration: 01/01/2019 - 31/12/2022

Coordinator: Petra Ritter

Inria contact: Bertrand Thirion

Summary:

The central goal of this project is the development of a cloud-based platform for biomedical research and clinical decision-making that helps to improve early patient-specific diagnosis and treatment of NDD and has substantial potential for significant positive socioeconomic impact.

The platform integrates several aims that revolve around early diagnosis, prognosis, and personalized treatment of neurodegenerative diseases (NDD) like Alzheimer's disease (AD) and Parkinson's disease (PD). It is becoming increasingly clear that meeting this objective requires a multifactorial approach that takes into account individual genetic, metabolic and environmental aspects, and that integrates them with the understanding of the biophysical processes underlying NDD.

More information can be found here https://virtualbraincloud-2020.eu/tvb-cloud-main.html.

9.3.1.2. 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.

9.3.1.3. 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).

9.3.1.4. 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@SiliconValley
Associate Team involved in the International Lab:

9.4.1.1. 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.

Inria@SiliconValley
Associate Team involved in the International Lab:

9.4.1.2. LargeSmallBrainNets

Title: Characterizing Large and Small-scale Brain Networks in Typical Populations Using Novel Computational Methods for dMRI and fMRI-based Connectivity and Microstructure

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Stanford Cognitive and Systems Neuroscience Laboratory - Vinod Menon

Start year: 2019

See also: http://pages.saclay.inria.fr/demian.wassermann/largesmallbrainnets/

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. Lately, interest has shifted towards developing a deeper understanding of the brain's macroscopic and microscopic architectures and their 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, i.e. cortical regions, and their structural inter-connectivity, collectively the brain's macrostructure or "connectome", are, however, poorly understood. Quantifying in vivo how these nodes' microstructure, specifically cellular composition or cytoarchitecture, influences the cognitive tasks in which these are involved is fundamental problem in understanding the connectome. Furthermore, the coupling between within and across-subject contributions to the connectome and cognitive differences hampers the identification and understanding of the link between brain structure and function, and human cognition.

Critically, there is a dearth of computational methods for reliably identifying functional nodes of the brain, their micro and macrostructure in vivo, and separating the population and subject-specific effects. 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 relate the brain's macrostructure with its function. Specifically, we will focus on being able to separate population and subject-specific contributions within these models using state-of-the-art human brain imaging techniques and open-source data from the Human Connectome Project (HCP) and the Adolescent Brain Cognitive Development study (ABCD). To this end, we will first develop and validate novel computational tools for (1) formulating and fitting large scale random effect models on graphs derived from functional and structural connectivity and (2) implement techniques enabling us to impose different regularization schemes based on sparsity and multicollinearity of the model parameters.

The second major goal of this project is characterizing the cytoarchitecture of the nodes, i.e. cortical regions, at the microscopic level and their relationship with the brain's hemodynamical function and cognition. For this, we will (1) identify cortical areas with specific cytoarchitecture in the human cortex and use them to develop diffusion MRI-based models, (2) validate these models with numerical simulations of the dMRI signal and animal models, and (3) establish the relationship between cytoarchitecture and hemodynamical function measured from fMRI and cognition. For this we will leverage multi-shell high-angular diffusion MRI from public databases such as HCP and ABCD.

Finally, we will use to use our newly developed computational tools to characterize normal structural and functional brain networks in neurotypical adults. Due to the complementarity of the cognitive

science and imaging techniques expertise 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 and its relation to cognition.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Aapo Havärinen has been with parietal since April 2019 for a one-year visit, funded by the Dataia convergence institute.
- Luigi Gresele (MPI Tübingen) has been visiting the team in November-December 2019.
- Cedric Xu (UPenn) visited the team for three months in June-August 2019.
- James Cole (UCL) visited the team in December 2019.
- Yu Zhang (BIC, Montreal) visited the team during one week in September 2019
- Bemsibom Toh (HWU, Edinburgh) visited the team during two months in September-November 2019

9.5.2. Visits to International Teams

9.5.2.1. Sabbatical programme

Gael Varoquaux is spending one year in Montreal (September 2019-September 2020), hosted at MILA and Montreal Neuroimaging Institute at McGill Unviversity.

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 Valparaiso (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://sasmotidep.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 2019.

Cristian Meza, Universidad de Valparaiso, Chile, September 2019.

TRIBE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Digicosme - Thesis - ECOMICENE

Participants: Cedric Adjih, Hirah Malik, Michel Kieffer [L2S, CNRS–CentraleSupelec–Univ Paris-Sud, Univ Paris-Saclay], Claudio Weidmann [ETIS / ENSEA - Université de Cergy-Pontoise, CNRS (UMR 8051)].

Partners: Centrale-Supelec L2S, ETIS-ENSEA

Subject : Efficient COding of Meta-information in Information-CEntric NEtworks.

8.1.2. Digicosme - Post doc - ICN-based-Vehicles

Participants: Cedric Adjih, Ines Khoufi [Telecom SudParis], Anis Laouiti [Telecom SudParis].

Partners: SAMOVAR, Telecom Sud-Paris (IPP)

Subject: In this work, the project is to design and propose a new architecture model that combines several new emerging research fields which are FANETs (Flying Ad-hoc NETworks). We will modelled a FANET problem of information gathering and distribution, reviewed related literature in [5]. We are now focusing on some mobility patterns for the FANETs in order to optimize the movement of the flying vehicles while they are enhancing the radio coverage for the VANETs and trying to improve data exchange experience between different damaged locations, using genetic algorithms. (link)

8.1.3. Digicosme - Engineer - LoRaWAN simulator

Participants: Cedric Adjih, Kinda Khawam [UVSQ], Samer Lahoud [ESIB], Steven Martin [LRI, Université Paris-Saclay].

Subject: LoRa-MAB: A Flexible Simulator for Decentralized Learning Resource Allocation in IoT Networks

The simulator is available at https://github.com/tuyenta/IoT-MAB

8.2. National Initiatives

8.2.1. Equipex FIT:

Participants: Cedric Adjih, Alexandre Abadie [Inria, SED], Emmanuel Baccelli.

Partners: Sorbonne Université, Inria (Lille, Sophia-Antipolis, Grenoble), INSA, 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.

8.2.2. ANR

8.2.2.1. MITIK

Participants: Aline Carneiro Viana, Catuscia Palamidessi.

Funding instrument/scientific committee: PRC/CE25

Project acronym: MITIK

Project title: Mobility and contact traces from non-intrusive passive measurements

Duration: 2020–2023

Coordinator: Aline Carneiro Viana

Other partners: COMETE/Inria, Universite de la Rochelle, Sorbonne Universite.

Abstract: The MITIK project is a 42-month ANR project that will start in February 2020. Mitik's primary objective is the design of an entirely new methodology to help the community obtain real wireless contact traces that are non-intrusive, representative, and independent of third parties. The secondary outcome of the project is be the public release of (1) the measurement tool designed for the easy contact gathering task; (2) contact traces which are clean, processed, and privacy-preserving, i.e., protecting both the anonymity and the location privacy of the users; and (3) their spatiotemporal statistical analysis. We expect that Miti's outcomes will support non-biased research on the modeling as well as on the leveraging of wireless contact patterns.

8.2.2.2. GORILLA

Participants: Cedric Adjih, Aline Carneiro Viana, Nadjib Achir.

Funding instrument/scientific committee: Under submission to the PRC/CE25 (Phase I)

Project acronym: GORILLA

Project title: GeO-distributed pRivacy-preserving InteLLigent orchestrAtion of data-hungry Services

Duration: 2021–2024

Coordinator: Cedric Adjih

Other partners: IRIT – Toulouse INP, LS2N – IMT Atlantiquen L2TI – University Paris 13.

Abstract: The GORILLA project has been submitted to the ANR - PCR program (PHASE I). Users of mobile applications keep calling for better user privacy while getting better user experience, and this fact has become a competitive challenge for application developers. As of today, privacy is often promoted through personal storage and is sometimes opposed to cloud solutions which are nevertheless well-established. GORILLAS proposes to revisit this dilemma with the recent emergence of edge computing. The idea is to leverage edge computing as a middle ground that will act as a trusted third party that ensures privacy and confidentiality requirements. GORILLAS will design a framework that captures the user's privacy requirements, the services requirements as well as current and future users, networks, edge, and cloud operational contexts to perform privacy-persistent and QoE-aware data placement in addition to a tailored QoE-aware service computing orchestration over edge and cloud resources

8.3. European Initiatives

8.3.1. H2020 SPARTA project

Participants: Emmanuel Baccelli, Francois-Xavier Molina.

Program: H2020 SU-ICT-03-2018: Establishing and operating a pilot for a Cybersecurity Competence Network to develop and implement a common Cybersecurity Research & Innovation Roadmap

Project acronym: SPARTA

Project title: Strategic Programs for Advanced Research and Technology in Europe

Duration: 2019-2022

Participant from TRiBE: Emmanuel Baccelli, Francois-Xavier Molina

Other partners include CEA, TU Muenchen, IMT among many others

Abstract: The Sparta project is a 3-year H2020 project started in February 2019, which will put in motion a competence network on cybersecurity, with a view to shape a future EU-wide cybersecurity agency. In more details: TRiBE participates on topics around low-power IoT security, whereby RIOT is used as the base platform on top of which advances will be experimented with and made available in practice.

8.4. International Initiatives

8.4.1. Inria Project Lab RIOT-fp

Project lead: Emmanuel Baccelli

Full name: Reconcile IoT & Future-Proof Security

Partners: teams EVA, PROSECCO (Inria Paris), teams GRACE, TRiBE (Inria Saclay), team TEA, CELTIQUE (Inria Rennes), Freie Universitaet Berlin

Project Start: April 2019

Project Length: 4 years

Website: https://future-proof-iot.github.io/

Summary:

Today's Internet of Things (IoT) does not provide an acceptable tradeoff of functionality vs. risk for end-users. To improve this tradeoff, we must simultaneously

(i) enrich IoT functionality and (ii) improve IoT cyber-security with respect to diverse attack vectors. Concerning the former, RIOT is emerging as one of the major open-source software platforms for low-end IoT devices. Concerning the latter, research challenges must be addressed in various domains including secure network protocol stacks, cryptography, software execution guarantees, embedded system design. RIOT-fp is a research project on IoT cyber-security. Taking a global and

practical approach, RIOT-fp gathers partners planning a scientific agenda aiming to enhance RIOT with an array of security mechanisms. The main scientific challenges tackled by RIOT-fp are: (1) developing high-speed, high-security, low-memory IoT crypto primitives, (2) providing guarantees for software execution on low-end IoT devices, and (3) enabling secure IoT software updates and supply-chain, over the network.

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

8.4.2.1. 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 – Ending year: 2019

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-utisateurs. En construisant des modèles d'allocation les 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.

Nest steps: A new proposal extending the EMBRACE project was submitted in Nov. 2019. Besides, partners keep going their collaborations with two students currently visiting the team (Lucas Santos from UFMG and Felipe Fonseca from UFG) and with two researchers from UFG starting their sabbatical year from February 2020.

8.4.3. Inria International Partners

8.4.3.1. 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.

8.4.3.2. Informal International Partners

1. Although the project has finished, the team keep going their collaboration with UFMG and UFG institutions, previous partners of EMBRACE project, on human behavior leveraging in 5G networks.
2. Collaboration with Mark Crovella from Boston University, where Licia Amichi will spend 5 months in an internship from March 2020. She will work on our current collaboration on the modelling and analysis of novelty-seeking preferences in human mobility.
3. Collaboration with Javier Bustos from NIC Lab/University of Chile, involving the PhD co-advising of Diego Madriaga, who is doing a joint PhD between Univ. of Chile and IPP and is working on short-term time series analysis and prediction for anticipatory Nnetworking.
4. Collaboration with Ana Aguiar from University of Porto, involving the PhD co-advising of Emanuel Lima, who is working on data offloading via mobile crowdsensing.
5. Collaboaration with Marco Fiore from IMDEA on adaptive sampling of human mobility. This collaboration involves the participation of Diego Madriaga.
6. Informal collaborations with ENSI Tunis and ENIso.

8.4.4. Participation in Other International Programs

8.4.4.1. 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.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Prof. Kleber Vieira Cardoso and Sand Luz Correa forom UFG, Brazil, will do their sabbatical year at the TRiBE team, under Brazilian funding and in the context of the EMBRACe project. They will work with Aline C. Viana and Felipe Fonseca on trajectory reconstruction of tourists and their 5G resource optimization.

8.5.2. Internships

Felipe Fonseca is doing an internship of 3 months in our team (Nov 201-Jan 2020). He work with Aline C. Viana, Kleber V. Cardoso and Sand L. Correa on trajectory reconstruction of tourists.
Lucas Santos is doing an internship of 3 months in our team (Nov 201-Jan 2020) 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.
Douglas Teixira did an internship of 10 months our team (May 2019-Jan 2020) in the context of EMBRACE associated team. He is in cotutelle between IPP and UFMG and is co-advised by Aline C. Viana and Jussara Almeida on the limits of a context-aware predictability of human mobility.
Amina Ben Hassine did an intership of 6 months (2019) in collaboration with Ichrak Amdouni (ENSISo) and Anis Laouiti (Telecom SudParis) on the subject of "Unmanned Aerial Vehicles Path Planning Using Machine Learning" using reinforcement learning.

8.5.3. Visits to International Teams

8.5.3.1. Research Stays Abroad

Aside of working for Inria, **Emmanuel Baccelli** is also Professor at Freie Universitaet (FU) Berlin, within the context of a chair resulting of a partnership between Inria, FU Berlin and Einstein Center for Digital Future (ECDF: umbrella organization for Berlin's technical universities). The topic of this chair is *Open and Secure IoT Ecosystem*. In this context, Emmanuel Baccelli stays at FU Berlin. See online: https://www.digital-future.berlin/en/about-us/professors/prof-dr-emmanuel-baccelli/

AVIZ Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

- PCR ANR project EMBER "Situated Visualizations for Personal Analytics". Duration: 48 months. Total funding: 712 k€. Partners: Inria Saclay, Inria Bordeaux, Sorbonne Université. Coordinator: Pierre Dragicevic. See website: http://ember.inria.fr/.
- 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.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: ANR PRCI

Project acronym: MicroVis

Project title: Micro visualizations for pervasive and mobile data exploration

Duration: 11/2019 - 08/2022

Coordinator: Petra Isenberg

Other partners: University of Stuttgart

Abstract: The goal of this joint Franco-German project is to study very small data visualizations, micro visualizations, in display contexts that can only dedicate minimal rendering space for data representations. We will study human perception of and interaction with micro visualizations given small as well as complex data. The increasing demand for data visualizations on small mobile devices such as fitness tracking armbands, smart watches, or mobile phones drives our research. Given this usage context, we focus on situations in which visualizations are used "on the go," while walking, riding a vehicle, or running. It is still unclear to which extent our knowledge of desktop-sized visualizations transfers to contexts that involve minimal display space, diverse viewing angles, and moving displays.

Program: 2016 FWF–ANR Call for French-Austrian Joint Projects

Project acronym: ILLUSTRARE

Project title: Integrative Visual Abstraction of Molecular Data

Duration: 48 months

Coordinator: Tobias Isenberg and Ivan Viola

Other partners: TU Wien, Austria

Abstract: The essential building block of visualization is the phenomenon of visual abstraction. While visual abstraction is intuitively understood, there is no scientific theory associated with it that would be useful in the visualization synthesis process. Our central aim of this project is thus to gain better understanding of the visual abstraction characteristics. We lay down a hypothetical initial basis of theoretical foundations of visual abstractions in the proposal. We hypothesize that visual abstraction is a multidimensional phenomenon that can be spanned by axes of abstraction. Besides abstractions associated with a static structure we take a closer look at abstractions related to dynamics, procedures, and emergence of the structure. We also study abstraction characteristics related to multi-scale phenomena defined both in space and in time. This hypothetical basis is either supported or rejected by means of exemplary evidence from the specific application domain of

structural biology. Structural biology data is very complex, it includes the aspect of emergence and it is defined over multiple scales. Furthermore, abstraction has led to key discoveries in biology, such as the organization of the DNA. We study the multiscale visual abstraction characteristics on the visualization of long nucleic strands and the abstractions that convey emerging phenomena on visualization of molecular machinery use cases. From these two fields we work toward a theory of visual abstraction in a bottom-up manner, investigating the validity of the theory in other application domains as well.

Program: CHIST-ERA

Project acronym: IVAN

Project title: Interactive and Visual Analysis of Networks

Duration: May 2018 - April 2021

Coordinator: Dr. Torsten Möller, Uni Wien, Austria

Other partners: EPFL, Switzerland, Inria France, Uni Wien, Austria

Abstract: 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 principal 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.

9.2.2. Collaborations with Major European Organizations

The Bauhaus-Universität Weimar (Germany)

Steve Haroz collaborates with Florian Echtler to analyze research transparency in human-computer interaction.

Hasso Plattner Institute (Germany)

Pierre Dragicevic and Tobias Isenberg collaborate with Amir Semmo on stylization filters for facilitating the examination of disturbing visual content.

University of Zurich (Switzerland)

Pierre Dragicevic and Steve Haroz collaborate with Chat Wacharamanotham on transparent statistical reporting and efficient statistical communication.

KU Leuven (Belgium)

Pierre Dragicevic collaborates with Andrew Vande Moere on a survey on data physicalization.

Linköping University (Sweden)

Tobias Isenberg, Xiyao Wang, and Mickael Sereno collaborate with Lonni Besançon on interaction with 3D visualization.

University of Granada (Spain)

Tobias Isenberg collaborates with Domingo Martin and German Arroyo on digital stippling.

University of Roma (Italy), TU Darmstadt (Germany)

Jean-Daniel Fekete Fekete collaborates with Giuseppe Santucci, Carsten Binnig and colleagues on the design of database benchmarks to better support visualization;

University of Bari (Italy)

Jean-Daniel Fekete collaborates with Paolo Buono on hypergraph visualization;

University of Konstanz (Germany)

Petra Isenberg collaborated with Johannes Fuchs and Anastasia Bezerianos on visualization for teaching clustering algorithms.

9.3. International Initiatives

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

9.3.1.1. 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 successfull 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 to 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).

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Microsoft Research: Petra Isenberg, Tobias Isenberg, and Tanja Blascheck regularly collaborate with Bongshin Lee on topics related to non-desktop visualizations such as mobile visualization, ubiquitous visualization, or touch interaction for visualization.
University of Maryland: Catherine Plaisant regularly collaborates with various team members on projects related to temporal exploratory visualization.

9.3.3. Participation in Other International Programs

9.3.3.1. Inria International Chairs

IIC PLAISANT Catherine

Title: Visual Analytics for Exploratory Data Analysis

International Partner (Institution - Laboratory - Researcher):

University of Maryland (United States) - HCIL - Catherine Plaisant

Duration: 2018 - 2022

Start year: 2018

Visual Analytics for Exploratory Data Analysis: The project leverages Dr. Plaisants 30 years of experience in the design and evaluation of novel user interface and the longstanding synergies between my research activities and those of the AVIZ lab. It also builds on early collaborative activities having taken place between Maryland and Inria during a 2017 summer visit. The joint work particularly focuses on: event analysis, network analysis, and novel evaluation methods for visual analytics.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Catherine Plaisant (June–July): Invited professor from the University of Maryland, USA. Invited through a DigiCosme grant, Catherine Plaisant has spent two months with Aviz. We have launched two research projects, one on hypergraph visualization and one on tracing users to understand their use of visualization. Catherine Plaisant has interacted with all of the Aviz students and post-doctoral fellows, as well as with the permanent researchers.
- Paolo Buono, from the University of Bari, Italy (August–September): Paolo Buono has spent two months with Aviz working on the visualization of dynamic networks. He has collaborated with Paoa Valdivia, Catherine Plaisant, and Jean-Daniel Fekete for that project. He has also interacted with all the members of Aviz.
- 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.
- Wesley Willett and Lora Oehlberg (June): as part of the associated team SEVEN both professors came for a three-day workshop to Aviz during which we discussed designs for the noise project sensors and the associated data displays. We also worked in more depth on a survey article we plan to publish.

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.
- ContentCheck (2015-2018) is an ANR project led by I. Manolescu, 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.
- CQFD (2019-2022) is an ANR project coordinated by F. Ulliana (U. Montpellier), in collaboration with U. Rennes 1 (F. Goasdoué), Inria Lille (P. Bourhis), Institut Mines Télécom (A. Amarilli), Inria Paris (M. Thomazo) and CNRS (M. Bienvenu). Its research aims at investigating efficient data management methods for ontology-based access to heterogeneous databases (polystores).

8.1.2. Others

- 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 heterogenous 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 represen- tation, 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.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

- We collaborate with Alin Deutsch and Rana Al-Otaibi from the University of California in San Diego, on the topic of efficient data management in polystore sytems.
- We collaborate with Helena Galhardas from the University of Lisbon on the topic of efficiently interconnecting heterogeneous data sources for journalistic applications.
- We collaborate with Anna Liu from U. Massachussets at Amherst; she co-advises PhD thesis of several students in the group (E. Huang and L. Di Palma).

8.3.3. Participation in 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/connectionlens/

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

We have hosted from January to July 2019 the sabbatical visit of Juliana Freire, a professor at the New York University and the president of the prestigious ACM SIGMOD scientific association.

EX-SITU Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. 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.

8.1.2. Projet numérique du Learning Center de l'Université

Type: Equipment and subcontracting

Funding: Learning Center Paris-Saclay

Duration: 2019

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 Ph.D. students 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. The project was presented at the Ph.D. graduation ceremony of Université Paris-Saclay in June, 2019, and at the Fête de la Science in October, 2019, and will be permanently exhibited in the future Learning Center of Université Paris-Saclay.

8.1.3. Living Archive

Type: Equipment and human resources

Funding: STIC department grant

Duration: 2019-2020

Coordinator: Sarah Fdili Alaoui

Partners: Learning Center

Inria contact: Sarah Fdili Alaoui

Abstract: The project's ambition is to design interactive systems that allow practioners to easily document their dance using their own methods and personal artifacts emphasizing a first-person perspective and minimizing imposed choices from academic researchers.

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, CentraleSupelec, 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.

8.3.1.3. Humane AI (801)

Title: Toward AI Systems That Augment and Empower Humans by Understanding Us, our Society and the World Around Us

Program: FET Flagships

Duration: March 2019 - February 2020

Coordinator: DFKI (Germany)

Partners:

Aalto Korkeakoulusaatio SR (Finland)

Agencia Estatal Consejo Superior De Investigaciones Cientificas (Spain)

Albert-ludwigs-universitaet Freiburg (Germany)

Athina-erevnitiko Kentro Kainotomias Stis Technologies Tis Pliroforias, Ton Epikoinonion Kai Tis Gnosis (Greece)

Consiglio Nazionale Delle Ricerche (Italy)

Deutsches Forschungszentrum Fur Kunstliche Intelligenz GMBH (Germany)

Eidgenoessische Technische Hochschule Zürich (Switzerland)

Fondazione Bruno Kessler (Italy)

German Entrepreneurship GMBH (Germany)

INESC TEC - Instituto De Engenharia De Sistemas E Computadores, Tecnologia E Ciencia (Portugal)
ING Groep NV (Netherlands)
Institut Jozef Stefan (Slovenia)
Institut Polytechnique De Grenoble (France)
Knowledge 4 All Foundation LBG (United Kingdom)
Kobenhavns Universitet (Denmark)
Kozep-europai Egyetem (Hungary)
Ludwig-maximilians-universitaet Muenchen (Germany)
Max-planck-gesellschaft Zur Forderung Der Wissenschaften EV (Germany)
Technische Universitaet Kaiserslautern (Germany)
Technische Universitaet Wien (Austria)
Technische Universitat Berlin (Germany)
Technische Universiteit Delft (Netherlands)
Thales SIX GTS FRANCE SAS (France)
The University Of Sussex (United Kingdom)
Universidad Pompeu Fabra (Spain)
Universita Di Pisa (Italy)
Universiteit Leiden (Netherlands)
University College Cork - National University Of Ireland, Cork (Ireland)
Uniwersytet Warszawski (Poland)
Volkswagen AG (Germany)

Inria contact: Wendy Mackay

The presence and capabilities of artificial intelligence (AI) have grown significantly and will continue to do so. The Humane AI Flagship will develop the scientific foundations and technological breakthroughs needed to shape the ongoing AI revolution. The goal is to deploy AI systems that enhance human capabilities and empower individuals and societies, and ultimately extend human intelligence (rather than replace it). With 35 partners from 17 countries, Humane AI is undertaking a preparatory action to draft an ambitious research agenda to provide competitive advantages to European industry and substantial benefits to society. Partners are united by the vision of a new generation of ethical, value-oriented, and human-centric European approach to AI.

8.4. International Initiatives

8.4.1. Participation in Other International Programs

8.4.1.1. Inria International Chairs

IIC MCGRENERE Joanna

Title: Personalization through Co-Adaptive Human-Computer Interaction

International Partner (Institution - Laboratory - Researcher):

University of British Columbia (Canada) - Dept of Computer Science - Joanna McGrenere

Duration: 2017 - 2021

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 and Michel Beaudouin-Lafon.

Susanne Bødker, Professor at Aarhus University, Denmark, visited for a week to work with Wendy Mackay and Michel Beaudouin-Lafon.

8.5.1.1. Internships

Injung Lee, Ph.D. student from KAIST, South Korea, visited for five months to work with Michel Beaudouin-Lafon.

ILDA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. 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, Vanessa Peña-Araya, Nicole Barbosa Sultanum.

9.2. European Initiatives

9.2.1. 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.

9.3. International Initiatives

9.3.1. 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.

9.3.2. 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), Sebastian Fehlandt (Inria Chile), José Galaz (Inria Chile), Sebastian Pereira (Inria Chile), Grazia Prato (Inria Chile).

9.3.2.1. Informal International Partners

We have had multiple collaboration projects with Microsoft Research in Redmond, USA. Hugo Romat visited the EPIC team for three months, and this collaboration led to the following publications at CHI 2018 [75], CHI 2019 [22] and UIST 2019 [9]. Anastasia Bezerianos also continues working with that team on topics related to smartwatch interaction and visualization that appeared in TVCG 2019 (InfoVis 2018) [11].

Our long-term collaboration with University of Konstanz, Germany continues. After publications at TVCG/InfoVis in 2014 and 2018 [46], [47], Anastasia Bezerianos has co-authored a paper at Eurographics 2019 with these colleagues [18].

Finally, our ongoing collaboration with Northwestern University, USA continues. Anastasia Bezerianos and past PhD student Evanthia Dimara (PhD defended in 2017) have worked on publications in TVCG 2019 [12] [42].

PETRUS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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.

8.1.2. GDP-ERE, DATA-IA project (Sept. 2018 - Jan. 2022)

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. These 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 computers 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

8.1.3. Postdoc DIM RFSI, Ile-de-France Region (2019 - 2020)

Partners: Inria (PETRUS).
This project is a continuation of Julien Loudet's Phd thesis. Julien finalized a CIFRE thesis defended in October 2019. This thesis is the result of a solid collaboration (another CIFRE thesis was defended in 2018) between the PETRUS team and the startup Cozy Cloud, which is also working on the personal cloud issue. The project finances 8 months of postdoc for Julien. The objective is to enforce the collaboration with Cozy Cloud by allowing the postdoc (i) to submit an extended journal paper on his last results (DISPERS protocol), (ii) to realize a detailed specification of the distributed protocols developed during his PhD for their implementation in the Cozy Cloud platform and (iii) to collaborate with a future PhD candidate of a new thesis in collaboration with Cozy Cloud exploring decentralized automatic learning techniques in the personal cloud context.