



RESEARCH CENTER
Saclay - Île-de-France

FIELD

Activity Report 2016

Section Partnerships and Cooperations

Edition: 2017-08-25

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COMETE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Projects funded by Digiteo-DigiCosme*

9.1.1.1. *OPTIMEC*

Project title: Optimal Mechanisms for Privacy Protection

Duration: September 2016 - August 2019

Coordinator: Catuscia Palamidessi, Inria Saclay, EPI Comète

Other PI's: Serge Haddadm ENS Cachan.

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

9.1.1.2. *D-SPACES*

Project title: D-spaces : Distributed Spaces in Concurrent Epistemic Systems

Duration: Nov 2013 - Oct 2016

Coordinator: Frank Valencia, CNRS-LIX and Inria Saclay, EPI Comète

Other PI's: Stefan Haar ENS Cachan.

Abstract: In this project we developed an innovative and expressive computational model for these systems that coherently combines techniques for the analysis of concurrent systems such as process calculi with epistemic and spatial formalisms.

9.2. National Initiatives

9.2.1. *Large-scale initiatives*

Project acronym: CAPPRIS

Project title: Collaborative Action on the Protection of Privacy Rights in the Information Society

Duration: September 2013 - December 2016

URL: <https://cappri.inria.fr/>

Coordinator: Daniel Le Metayer, Inria Grenoble

Other partner institutions: The project involves four Inria research centers (Saclay, Saphia-Antipolis, Rennes and Grenoble), CNRS-LAAS, Eurecom and the university of Namur. Besides computer scientists, the consortium also includes experts in sociology and in law, thus covering the complementary areas of expertise required to reach the objectives.

Abstract: The goal of this project is to study the challenges related to privacy in the modern information society, trying to consider not only the technical, but also the social and legal ones, and to develop methods to enhance the privacy protection.

9.3. International Initiatives

9.3.1. *Inria-MSR joint lab*

9.3.1.1. *Privacy-Friendly Services and Apps*

Title: Privacy-Friendly Services and Applications

Inria principal investigator: Catuscia Palamidessi

International Partners:

Cedric Fournet, Microsoft Research Lab, Cambridge, UK

Andy Gordon, Microsoft Research Lab, Cambridge, UK

Duration: 2014 - 2016

URL: <http://www.msr-inria.fr/projects/privacy-friendly-services-and-apps/>

Abstract: This is a project sponsored by Microsoft Research Lab, on methods to preserve privacy in web services and location-based services.

9.3.2. Inria Associate Teams

9.3.2.1. 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: 2016

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.

9.3.3. Inria International Partners

9.3.3.1. Informal International Partners

Geoffrey Smith, Florida International University (United States)

Carroll Morgan, NICTA (Australia)

Annabelle McIver, Macquarie University (Australia)

Moreno Falaschi, Professor, University of Siena, Italy

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

Camilo Rueda, Professor, Universidad Javeriana Cali, Colombia

9.3.4. Participation in Other International Programs

9.3.4.1. 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 aim at investigating quantitative notions and tools for proving program correctness and protecting privacy. In particular, we will 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.

9.3.4.2. *PACE*

Program: ANR Blanc International

Project title: Beyond plain Processes: Analysis techniques, Coinduction and Expressiveness

Duration: January 2013 - December 2016

URL: <http://perso.ens-lyon.fr/daniel.hirschhoff/pace/>

Coordinator: Daniel Hirschhoff, Ecole Normale Supérieure de Lyon

Other PI's and partner institutions: Catuscia Palamidessi, Inria Saclay, Frank Valencia, CNRS-LIX and Inria Saclay (France). Davide Sangiorgi, University of Bologna (Italy). Yuxi Fu, Shanghai Jiao Tong University (China).

Abstract: This project objective is to enrich and adapt these methods, techniques, and tools to much broader forms of interactive models, well beyond the realm of "traditional" processes.

9.3.4.3. *LOCALI*

Program: ANR Blanc International

Project title: Logical Approach to Novel Computational Paradigms

Duration: January 2012 - December 2016

URL: <http://www.agence-nationale-recherche.fr/?Project=ANR-11-IS02-0002>

Coordinator: Gilles Dowek, Inria Rocquencourt

Other PI's and partner institutions: Catuscia Palamidessi, Inria Saclay. Thomas Erhard, Paris VII. Ying Jiang, Chinese Academy of Science in Beijing (China).

Abstract: This project aims at exploring the interplays between logic and sequential/distributed computation in formalisms like the lambda calculus and the π calculus. Going back to the fundamentals of the definitions of these calculi, the project plans to design new programming languages and proof systems via a logical approach.

9.3.4.4. *MUSICAL*

Program: CNPq Science Without Borders.

Project title: Music and Spatial Interaction with Constraints, Algebra and Logic: Foundations and Applications.

Duration: Oct 2014 - Oct 2016

URL: <http://cic.puj.edu.co/~caolarte/musical/Musical/Welcome.html>

Coordinator: Elaine Pimentel, Universidade Federal do Rio Grande do Norte (Brazil),

Other PI's and partner institutions: Camilo Rueda, PUJ Cali (Colombia). Carlos Olarte, Universidade Federal do Rio Grande do Norte (Brazil). Frank Valencia, CNRS-LIX and Inria Saclay (France). Gerard Assayag, IRCAM (France).

Abstract: This multi-disciplinary project aims to develop and integrate tools from logic and concurrency theory for the design and analysis of reactive systems and to their application to musical processes and multimedia systems.

9.3.4.5. *CLASSIC*

Program: Colciencias - Conv. 712.

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 PUJ Cali (Colombia).

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

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..

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Mario Ferreira Alvim Junior, Assistant Professor, Federal University of Minas Gerais, Brazil, Dec 2016

Annabelle McIver, Associate Professor, Macquarie University, Australia, Dec 2016

Carroll Morgan, Professor, University of New South Wales and NICTA, Australia, Dec 2016

Geoffrey Smith, Professor, Florida International University, USA, Dec 2016

Camilo Rueda, Professor, PUJ Cali, Colombia, May 2016 and Nov 2016.

Camilo Rocha, Professor, PUJ Cali, Colombia, Oct 2016.

9.4.2. Visits to International Teams

Catuscia Palamidessi visited the Computer Security team of Roberto Focardi at the University of Venice, Italy, from 4 April to 30 April, 2016.

DATASHAPE Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR TOPDATA

Participants: Jean-Daniel Boissonnat, Frédéric Chazal, David Cohen-Steiner, Mariette Yvinec, Steve Oudot, Marc Glisse.

- Acronym : TopData.
- Type : ANR blanc.
- Title : Topological Data Analysis: Statistical Methods and Inference.
- Coordinator : Frédéric Chazal (DATASHAPE).
- Duration : 4 years starting October 2013.
- Others Partners: Département de Mathématiques (Université Paris Sud), Institut de Mathématiques (Université de Bourgogne), LPMA (Université Paris Diderot), LSTA (Université Pierre et Marie Curie).
- Abstract: TopData aims at designing new mathematical frameworks, models and algorithmic tools to infer and analyze the topological and geometric structure of data in different statistical settings. Its goal is to set up the mathematical and algorithmic foundations of Statistical Topological and Geometric Data Analysis and to provide robust and efficient tools to explore, infer and exploit the underlying geometric structure of various data.

Our conviction, at the root of this project, is that there is a real need to combine statistical and topological/geometric approaches in a common framework, in order to face the challenges raised by the inference and the study of topological and geometric properties of the wide variety of larger and larger available data. We are also convinced that these challenges need to be addressed both from the mathematical side and the algorithmic and application sides. Our project brings together in a unique way experts in Statistics, Geometric Inference and Computational Topology and Geometry. Our common objective is to design new theoretical frameworks and algorithmic tools and thus to contribute to the emergence of a new field at the crossroads of these domains. Beyond the purely scientific aspects we hope this project will help to give birth to an active interdisciplinary community. With these goals in mind we intend to promote, disseminate and make our tools available and useful for a broad audience, including people from other fields.

- See also: <http://geometrica.saclay.inria.fr/collaborations/TopData/Home.html>

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. ERC GUDHI

Title: Algorithmic Foundations of Geometry Understanding in Higher Dimensions.

Program: FP7.

Type: ERC.

Duration: February 2014 - January 2019.

Coordinator: Inria.

PI: Jean-Daniel Boissonnat.

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

9.3. International Initiatives

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

9.3.1.1. CATS

Title: Computations And Topological Statistics

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Department of Statistics - Larry Wasserman

Start year: 2015

See also: <http://geometrica.saclay.inria.fr/collaborations/CATS/CATS.html>

Topological Data Analysis (TDA) is an emergent field attracting interest from various communities, that has recently known academic and industrial successes. Its aim is to identify and infer geometric and topological features of data to develop new methods and tools for data exploration and data analysis. TDA results mostly rely on deterministic assumptions which are not satisfactory from a statistical viewpoint and which lead to a heuristic use of TDA tools in practice. Bringing together the strong expertise of two groups in Statistics (L. Wasserman's group at CMU) and Computational Topology and Geometry (Inria Geometrica), the main objective of CATS is to set-up the mathematical foundations of Statistical TDA to design new TDA methods and to develop efficient and easy-to-use software tools for TDA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Ramsay Dyer (April and November 2016)

Arijit Ghosh, Indian Statistical Institute, Kolkata (April and November 2016)

Jose Carlos Gomez Larranaga, CIMAT, Guanajuato, Mexico (September 2016)

Kim Jisu, CMU, Pittsburgh, USA (May and December 2016).

Antony Bak, Palantir company, USA (October 2016)

9.4.1.1. Internships

Uday Kusupati, Indian Institute of Technology, Bombay (May-July 2016)

Sandip Banerjee (bourse Charpak), Indian Statistical Institute, Kolkata (March-August 2016)

Sameer Desai, Indian Statistical Institute, Kolkata (October-December 2016)

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Steve Oudot and Jérémy Cochoy spent 3 months (Sept.-Nov.) at the Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University. They were invited there for the semester program entitled *Topology in Motion* (see <https://icerm.brown.edu/programs/sp-f16/>).

DEDUCTEAM Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Locali

We are coordinators of the ANR-NFSC contract Locali with the Chinese Academy of Sciences.

7.1.2. ANR BWare

We are members of the ANR BWare, which started on September 2012 (David Delahaye is the national leader of this project). The aim of this project is to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method. The methodology used in this project consists in building a generic platform of verification relying on different theorem provers, such as first-order provers and SMT solvers. We are in particular involved in the introduction of Deduction modulo in the first-order theorem provers of the project, i.e. Zenon and iProver, as well as in the backend for these provers with the use of Dedukti.

7.1.3. ANR Tarmac

We are members of the ANR Tarmac on models of computation, coordinated by Pierre Valarcher.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: **CA COST Action CA15123**

Project acronym: **EUTYPES**

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

Duration: 21/03/16 - 20/03/20

Coordinator: Herman Geuvers

7.3. International Initiatives

7.3.1. Participation in Other International Programs

Login

Title: Logic and Information

International Partner (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (Argentina) - Ricardo Oscar Rodrigues

Duration: 2015 - 2016

This project aims to propose an improvement on a long-term already existing collaboration between Inria, the brazilians and the argentin named team. We already have a CAPES-COFECUB cooperation (n. 690/10, namely “Teorias lógicas contemporâneas e a filosofia da linguagem: questões epistemológicas e semânticas”) that led to many students interchange and technical visits of Professors, including the organisation of some workshops (the last one was the 2nd Workshop on Logic and Semantics, at UERJ, Ilha Grande-RJ, Brazil. Prof. Gilles Dowek is also a Co-Advisor with Prof. Edward Hermann Haeusler of a brazilian Ph.D. Candidate in this project (and a former one also in this project, these two candidates finalised recently a sandwich doctorate - similar to stage doctorale - at Inria). Prof. Gilles Dowek also collaborates with other members of this team and is supervising a post-doc project of another member. Since 2011 members of the team presents.

FoQCoSS

Title: Foundations of Quantum Computation: Syntax and Semantics

International Partners (Institution - Laboratory - Researcher):

Universidad Nacional de Quilmes (Argentina) - Alejandro Diaz-Caro

CNRS (France) - Simon Perdrix

Duration: 2016 - 2017

The design of quantum programming languages involves the study of many characteristics of languages which can be seen as special cases of classical systems: parallelism, probabilistic systems, non-deterministic systems, type isomorphisms, etc. This project proposes to study some of these characteristics, which are involved in quantum programming languages, but also have a more immediate utility in the study of nowadays systems. In addition, from a more foundational point of view, we are interested in the implications of computer science principles for quantum physics. For example, the consequences of the Church-Turing thesis for Bell-like experiments: if some of the parties in a Bell-like experiment use a computer to decide which measurements to make, then the computational resources of an eavesdropper have to be limited in order to have a proper observation of non-locality. The final aim is to open a new direction in the search for a framework unifying computer science and quantum physics.

7.4. International Research Visitors

7.4.1. Internships

- Clément Chouteau, from May 2016 to July 2016
- David Pham (Univ. Évry) from June 2016 to July 2016

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

F. Gilbert spent one month in the formal methods team at NASA Langley Research Center, to work with Cesar Munoz on the use of automated theorem provers to verify PVS proofs.

GRACE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. PEPS Aije-bitcoin

Within the group PAIP (Pour une Approche Interdisciplinaire de la Privacy), D. Augot presented the cryptographic and peer-to-peer principles at the heart of the Bitcoin protocol (electronic signature, hash functions, and so on). Most of the information is publicly available: the history of all transactions, evolution of the source code, developers' mailing lists, and the Bitcoin exchange rate. It was recognized by the economists in our group that such an amount of data is very rare for an economic phenomenon, and it was decided to start research on the history of Bitcoin, to study the interplay between the development of protocol and the development of the economical phenomenon.

The project **Aije-Bitcoin** (analyse informatique, juridique et économique de Bitcoin) was accepted as interdisciplinary research for a PEPS (Projet exploratoire Premier Soutien) cofunded by the CNRS and Université de Paris-Saclay. This one-year preliminary program will enable the group to master the understanding of Bitcoin from various angles, allowing more advanced research in the following years.

One M2 intern, E. Palazzollo, was intern in Sceaux, with aim to qualify the nature of bitcoin, as an asset, currency, etc.

This project ended in March 2016

9.1.2. IDEALCODES

Idealcodes is a two-year Digiteo research project, started in October 2014. The partners involved are the École Polytechnique (X) and the Université de Versailles–Saint-Quentin-en-Yvelines (Luca de Feo, UVSQ). After hiring J. Nielsen the first year, we have hired V. Ducet for the second year, both working at the boundary between coding theory, cryptography, and computer algebra

Idealcodes spans the three research areas of algebraic coding theory, cryptography, and computer algebra, by investigating the problem of lattice reduction (and root-finding). In algebraic coding theory this is found in Guruswami and Sudan's list decoding of algebraic geometry codes and Reed–Solomon codes. In cryptography, it is found in Coppersmith's method for finding small roots of integer equations. These topics were unified and generalised by H. Cohn and N. Heninger [25], by considering algebraic geometry codes and number field codes under the deep analogy between polynomials and integers. Sophisticated results in coding theory could be then carried over to cryptanalysis, and vice-versa. The generalized view raises problems of computing efficiently, which is one of the main research topics of Idealcodes.

The last year of the one-year project aims to find matrices with good diffusion properties over small finite fields. The principle is to find non-maximal matrices, but with better coefficients and implementation properties. The relevant cryptographic properties to be studied correspond to the weight distribution of the associated code. Since we use Algebraic-Geometry codes, much more powerful techniques can be used for computing these weight distribution, using and improving Duursma's ideas [28].

9.1.3. IRT System-X

D. Augot is co-advising a PhD candidate, H.-M. Bissierier, on “les relations contractuelles de droit privé à l'épreuve de la technologie des blockchains”, i.e. on (French) law and so-called “smart contracts”. D. Augot will mainly help H.-M. Bissierier to clarify the essential computer science topics and issues relevant to the most important blockchains (bitcoin, ethereum). Then H.-M. Bissierier will be advised by C. Zolynksi for remaining two years, fixing research directions.

9.2. National Initiatives

9.2.1. ANR

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

9.2.2. DGA

Cybersecurity. Inria and DGA contracted for three PhD topics at the national level, one of them involving Grace. Grace started a new PhD, and hired P. Karpman. The topic of this PhD is complementary to the above DIFMAT-3: while DIFMAT-3 provides fundamental methods for dealing with AG codes, in application for diffusion layers in block ciphers, the topic here is to make concrete propositions of block ciphers using these matrices. P. Karpman is coadvised by T. Peyrin (Nanyang Technological University, Singapore), by P.-A. Fouque (Université de Rennes), and D. Augot.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. PQCRYPTO

Title: Post-quantum cryptography for long-term security

Programm: H2020

Duration: March 2015 - March 2018

Coordinator: TECHNISCHE UNIVERSITEIT EINDHOVEN

Partners:

Academia Sinica (Taiwan)

Bundesdruckerei (Germany)

Danmarks Tekniske Universitet (Denmark)

Katholieke Universiteit Leuven (Belgium)

Nxp Semiconductors Belgium Nv (Belgium)

Ruhr-Universitaet Bochum (Germany)

Stichting Katholieke Universiteit (Netherlands)

Coding Theory and Cryptology group, Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Darmstadt (Germany)

University of Haifa (Israel)

Inria contact: Nicolas Sendrier

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

It might seem that having three systems offers enough variation, but these systems are all broken as soon as large quantum computers are built. The EU and governments around the world are investing heavily in building quantum computers; society needs to be prepared for the consequences, including cryptanalytic attacks accelerated by these computers. Long-term confidential documents

such as patient health-care records and state secrets have to guarantee security for many years, but information encrypted today using RSA or elliptic curves and stored until quantum computers are available will then be as easy to decipher.

PQCRYPTO will allow users to switch to post-quantum cryptography: cryptographic systems that are not merely secure for today but that will also remain secure long-term against attacks by quantum computers. PQCRYPTO will design a portfolio of high-security post-quantum public-key systems, and will improve the speed of these systems, with reference implementations.

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

MEXICO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

We will be participating in the ANR Project ALGORECELL that starts in 2017.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Serge Haddad is participating in the ERC EQUALLS, 'Enhancing the Quality of Interacting Systems', directed by Patricia Bouyer.

8.3. International Initiatives

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

8.3.1.1. LifeForm

Title: Life Sciences need formal Methods !

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2016

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

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

8.3.2. Participation in Other International Programs

UMI with CMI, India, starting in 2017; currently LIA INFORMEL, see below.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Visits by Victor Khomenko and Maciej Koutny within the LifeForm associated team

8.4.2. Internships

- **Juraj Kolcák** from Masaryk University, Brno, Czech Republic, on *Efficient Analysis of Boolean Networks under Parameter Uncertainty*, Spring/summer of 2016 (Master's thesis research); director: Stefan Haar
- **Clara Scherbaum** from Aachen University, Germany, on *Computing Cut Sets for Petri Nets*, Spring 2016, LSV (ENS Cachan),
- **Hugues Mandon**: Algorithms for cellular reprogramming.

8.4.3. Visits to International Teams

8.4.3.1. Research Stays Abroad

Paul Gastin is visiting IIT Bombay and Chennai Mathematical Institute, India, from October 10, 2016 to March 10, 2017.

PARSIFAL Project-Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. Proofcert

Title: ProofCert: Broad Spectrum Proof Certificates

Programm: FP7

Type: ERC

Duration: January 2012 - December 2016

Coordinator: Inria

Inria contact: Dale Miller

There is little hope that the world will know secure software if we cannot make greater strides in the practice of formal methods: hardware and software devices with errors are routinely turned against their users. The ProofCert proposal aims at building a foundation that will allow a broad spectrum of formal methods—ranging from automatic model checkers to interactive theorem provers—to work together to establish formal properties of computer systems. This project starts with a wonderful gift to us from decades of work by logicians and proof theorist: their efforts on logic and proof has given us a universally accepted means of communicating proofs between people and computer systems. Logic can be used to state desirable security and correctness properties of software and hardware systems and proofs are uncontroversial evidence that statements are, in fact, true. The current state-of-the-art of formal methods used in academics and industry shows, however, that the notion of logic and proof is severely fractured: there is little or no communication between any two such systems. Thus any efforts on computer system correctness is needlessly repeated many time in the many different systems: sometimes this work is even redone when a given prover is upgraded. In ProofCert, we will build on the bedrock of decades of research into logic and proof theory the notion of proof certificates. Such certificates will allow for a complete reshaping of the way that formal methods are employed. Given the infrastructure and tools envisioned in this proposal, the world of formal methods will become as dynamic and responsive as the world of computer viruses and hackers has become.

8.1.2. Collaborations in European Programs, Except FP7 & H2020

8.1.2.1. FISP: ANR blanc International

Participants: Kaustuv Chaudhuri, François Lamarche, Sonia Marin, Dale Miller, Lutz Straßburger.

Title: The Fine Structure of Formal Proof Systems and their Computational Interpretations

Duration: 01/01/2016 – 31/12/2018

Partners:

University Paris VII, PPS (PI: Michel Parigot)

Inria Saclay–IdF, EPI Parsifal (PI: Lutz Straßburger)

University of Innsbruck, Computational Logic Group (PI: Georg Moser)

Vienna University of Technology, Theory and Logic Group (PI: Matthias Baaz)

Total funding by the ANR: 316 805 EUR

The FISP project is part of a long-term, ambitious project whose objective is to apply the powerful and promising techniques from structural proof theory to central problems in computer science for which they have not been used before, especially the understanding of the computational content of proofs, the extraction of programs from proofs and the logical control of refined computational operations. So far, the work done in the area of computational interpretations of logical systems is mainly based on the seminal work of Gentzen, who in the mid-thirties introduced the sequent calculus and natural deduction, along with the cut-elimination procedure. But that approach shows its limits when it comes to computational interpretations of classical logic or the modelling of parallel computing. The aim of our project, based on the complementary skills of the teams, is to overcome these limits. For instance, deep inference provides new properties, namely full symmetry and atomicity, which were not available until recently and opened new possibilities at the computing level, in the era of parallel and distributed computing.

8.1.2.2. *COCA HOLA: ANR JCJC Project*

Participant: Beniamino Accattoli.

Title: COst model for Complexity Analyses of Higher-Order programming Languages.

Collaborators: Ugo Dal Lago (University of Bologna & Inria), Delia Kesner (Paris Diderot University), Damiano Mazza (CNRS & Paris 13 University), Claudio Sacerdoti Coen (University of Bologna).

Duration: 01/10/2016 – 31/09/2019

Total funding by the ANR: 155 280 EUR

The COCA HOLA project aims at developing complexity analyses of higher-order computations, i.e. that approach to computation where the inputs and outputs of a program are not simply numbers, strings, or compound data-types, but programs themselves. The focus is not on analysing fixed programs, but whole programming languages. The aim is the identification of adequate units of measurement for time and space, i.e. what are called reasonable cost models. The problem is non-trivial because the evaluation of higher-order languages is defined abstractly, via high-level operations, leaving the implementation unspecified. Concretely, the project will analyse different implementation schemes, measuring precisely their computational complexity with respect to the number of high-level operations, and eventually develop more efficient new ones. The goal is to obtain a complexity-aware theory of implementations of higher-order languages with both theoretical and practical downfalls.

The project stems from recent advances on the theory of time cost models for the lambda-calculus, the computational model behind the higher-order approach, obtained by the principal investigator and his collaborators (who are included in the project).

COCA HOLA will span over three years and is organised around three work packages, essentially:

1. extending the current results to encompass realistic languages;
2. explore the gap between positive and negative results in the literature;
3. use ideas from linear logic to explore space cost models, about which almost nothing is known.

8.2. International Initiatives

8.2.1. *Participation in Other International Programs*

8.2.1.1. *PHC Amadeus: Analytic Calculi for Modal Logics*

Participants: Kaustuv Chaudhuri, Sonia Marin, Giselle Reis, Lutz Straßburger.

Title: Analytic Calculi for Modal Logics

Duration: 01/01/2016 – 31/12/2017

Austrian Partner: TU Wien, Institute for Computer Science (Department III)

Modal logics are obtained from propositional logics by adding modalities \Box and \Diamond , meaning necessity and possibility. Originally studied by philosophers in order to reason about knowledge and belief, modal logics have nowadays many applications in computer science. Well known examples are epistemic logics, which allow to formally reason about the knowledge of independently acting and interacting agents, temporal logics, which allow to reason about temporal properties of processes, and authentication logics, which are used to formally reason about authentication protocols.

The purpose of this project is to develop a proof theory for variants of modal logic that have applications in modern computer science but that have been neglected by traditional proof theory so far.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Professor Chuck Liang (from Hofstra University, NY, USA) visited the team from 5 June to 25 June 2016 in order to continue his collaborations with team members on basic questions of proof theory. In particular, he worked with Miller on identifying possible means to allow classical and intuitionistic logic to be mixed in a common proof system. Miller is exploring how the resulting ideas might be able to reorganize the notion of kernel logic used within the ProofCert project.

8.3.1.1. Internships

Ameni Chtourou was an intern funded by ProofCert during May, June, and July 2016. She was advised by Accattoli and worked with using the Abella theorem prover to formalize connections various connections between λ -term evaluation and abstract machine models.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

Stéphane Graham-Lengrand spent 8 months, from January 2016 to August 2016, at SRI International, Computer Science Lab. This visit developed a collaboration with N. Shankar, MP Bonacina, D. Jovanovic, and Martin Schaeff on new algorithms and new architectures for automated and interactive theorem proving, as well as on new programme verification techniques.

SPECFUN Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

FastRelax (ANR-14-CE25-0018).

Goal: Develop computer-aided proofs of numerical values, with certified and reasonably tight error bounds, without sacrificing efficiency.

Leader: B. Salvy (Inria, ÉNS Lyon). Participants: Assia Mahboubi, Th. Sibut-Pinote.

Website: <http://fastrelax.gforge.inria.fr/>.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

- Program: COST
- Project acronym: EUTYPES (CA15123)
- Project title: The European research network on types for programming and verification
- Duration: October 2015 - October 2019
- Coordinator: Herman Geuvers (Radboud University, Nijmegen, the Netherlands)
- Other partners: Czech Republic, Estonia, Macedonia, Germany, Greece, the Netherlands, Norway, Poland, Serbia, Slovenia, United Kingdom.
- 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. Europe has a strong type theory community, ranging from foundational research to applications in programming languages, verification and theorem proving, which is in urgent need of better networking. A COST Action that crosses the borders will support the collaboration between groups and complementary expertise, and mobilise a critical mass of existing type theory research.

8.3. International Research Visitors

8.3.1. Research Stays Abroad

- Thomas Sibut-Pinote has spent two months at Microsoft Research Cambridge, visiting Georges Gonthier and working on mathematical libraries for the Lean proof assistant. He also participated in a hackathon internal to Microsoft Research with the goal to apply formal methods to the verification of the smart contracts involved in the Ethereum framework for cryptocurrency.

TOCCATA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *ELFIC*

Participants: Sylvie Boldo [contact], Claude Marché, Guillaume Melquiond.

ELFIC is a working group of the Digicosme Labex. S. Boldo is the principal investigator. It began in 2014 for one year and was extended for one year. <https://digicosme.lri.fr/GT+ELFIC>

The ELFIC project focuses on proving the correctness of the FELiScE (Finite Elements for Life Sciences and Engineering) C++ library which implements the finite element method for approximating solutions to partial differential equations. Finite elements are at the core of numerous simulation programs used in industry. The formal verification of this library will greatly increase confidence in all the programs that rely on it. Verification methods developed in this project will be a breakthrough for the finite element method, but more generally for the reliability of critical software relying on intricate numerical algorithms.

Partners: Inria team Pomdapi; Ecole Polytechnique, LIX; CEA LIST; Université Paris 13, LIPN; UTC, LMAC (Compiègne).

9.1.2. *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)

9.2. 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 48 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 48 months, starting on October 1st, 2015. <https://vocal.lri.fr/>

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

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

9.2.3. ANR Ajacs

Participant: Arthur Charguéraud [contact].

The AJACS research project is funded by the programme “Société de l’information et de la communication” of the ANR, for a period of 42 months, starting on October 1st, 2014. <http://ajacs.inria.fr/>

The goal of the AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts implemented in JavaScript, the most widely used language for the Web. The proposal is to prove correct analyses for JavaScript programs, in particular information flow analyses that guarantee no secret information is leaked to malicious parties. The definition of sub-languages of JavaScript, with certified compilation techniques targeting them, will allow deriving more precise analyses. Another aspect of the proposal is the design and certification of security and privacy enforcement mechanisms for web applications, including the APIs used to program real-world applications. On the Toccata side, the focus will be on the formalization of secure subsets of JavaScript, and on the mechanization of proofs of translations from high-level languages into JavaScript.

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

9.2.4. ANR FastRelax

Participants: Sylvie Boldo [contact], Guillaume Melquiond.

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

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

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

9.2.5. ANR Soprano

Participants: Sylvain Conchon [contact], Guillaume Melquiond.

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

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

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

9.2.6. ANR CAFEIN

Participant: Sylvain Conchon [contact].

The CAFEIN research project is funded by the programme “Ingénierie Numérique & Sécurité” of the ANR, for a period of 3 years, starting on February 1st, 2013. <https://cavale.enseeiht.fr/CAFEIN/>.

This project addresses the formal verification of functional properties at specification level, for safety critical reactive systems. In particular, we focus on command and control systems interacting with a physical environment, specified using the synchronous language Lustre.

A first goal of the project is to improve the level of automation of formal verification, by adapting and combining existing verification techniques such as SMT-based temporal induction, and abstract interpretation for invariant discovery. A second goal is to study how knowledge of the mathematical theory of hybrid command and control systems can help the analysis at the controller’s specification level. Third, the project addresses the issue of implementing real valued specifications in Lustre using floating-point arithmetic.

Partners: ONERA, CEA List, ENSTA, teams Maxplus (Inria Saclay - Île-de-France), team Parkas (Inria Paris - Rocquencourt), Perpignan University, Prover Technology, Rockwell Collins.

9.2.7. ANR BWare

Participants: Sylvain Conchon [contact], Jean-Christophe Filliâtre, Andrei Paskevich, Claude Marché.

The BWare research project is funded by the programme “Ingénierie Numérique & Sécurité” of the ANR, a period of 4 years, starting on September 1st, 2012. <http://bware.lri.fr>.

BWare is an industrial research project that aims to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method and requiring high guarantee of confidence. The methodology used in this project consists of building a generic platform of verification relying on different theorem provers, such as first-order provers and SMT solvers. The variety of these theorem provers aims at allowing a wide panel of proof obligations to be automatically verified by the platform. The major part of the verification tools used in BWare have already been involved in some experiments, which have consisted in verifying proof obligations or proof rules coming from industrial applications [109]. This therefore should be a driving factor to reduce the risks of the project, which can then focus on the design of several extensions of the verification tools to deal with a larger amount of proof obligations.

The partners are: Cedric laboratory at CNAM (CPR Team, project leader); teams Gallium and Deducteam (Inria Paris - Rocquencourt) ; Mitsubishi Electric R&D Centre Europe, ClearSy (the company which develops and maintains *Atelier B*), and the start-up OCamlPro.

9.2.8. ANR Verasco

Participants: Guillaume Melquiond [contact], Sylvie Boldo, Arthur Charguéraud, Claude Marché.

The Verasco research project is funded by the programme “Ingénierie Numérique & Sécurité” of the ANR, for a period of 4 years and a half, starting on January 1st, 2012. Project website: <http://verasco.imag.fr>.

The main goal of the project is to investigate the formal verification of static analyzers and of compilers, two families of tools that play a crucial role in the development and validation of critical embedded software. More precisely, the project aims at developing a generic static analyzer based on abstract interpretation for the C language, along with a number of advanced abstract domains and domain combination operators, and prove the soundness of this analyzer using the *Coq* proof assistant. Likewise, the project keeps working on the CompCert C formally-verified compiler, the first realistic C compiler that has been mechanically proved to be free of miscompilation, and carry it to the point where it could be used in the critical software industry.

Partners: teams Gallium and Abstraction (Inria Paris - Rocquencourt), Airbus avionics and simulation (Toulouse), IRISA (Rennes), Verimag (Grenoble).

9.2.9. *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.

9.2.10. *ANR PARDI*

Participant: Sylvain Conchon [contact].

Verification of parameterized distributed systems, 2016-2021.

Partners: Université Paris VI - Université Paris XI - Inria NANCY

9.3. European Initiatives

9.3.1. *FP7 & H2020 Projects*

Project acronym: ERC Deepsea

Project title: Parallel dynamic computations

Duration: Jun. 2013 - Jun. 2018

Coordinator: Umut A. Acar

Other partners: Carnegie Mellon University

Abstract:

The objective of this project is to develop abstractions, algorithms and languages for parallelism and dynamic parallelism with applications to problems on large data sets. Umut A. Acar (affiliated to Carnegie Mellon University and Inria Paris - Rocquencourt) is the principal investigator of this ERC-funded project. The other main researchers involved are Mike Rainey (Inria, Gallium team), who is full-time on the project, and Arthur Charguéraud (Inria, Toccata team), who works 40% of his time to the project. Project website: <http://deepsea.inria.fr/>.

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.

9.3.3. Collaborations with Major European Organizations

Imperial College London (UK)

Certification of JavaScript, AJACS project

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Ran Chen is a PhD student from Institute of Software (Chinese Academy of Sciences, Beijing, China) visiting the team for 10 months under the supervision of C. Marché and J.-J. Lévy (PiR2 team, Inria Paris). She is working on the formal verification of graphs algorithms, and also in the context of the CoLiS project on verification of some aspects of the Unix file system and shell scripts. [34]
- Cláudio Belo Lourenço is a PhD student from Universidade do Minho, Portugal. He studies deductive verification of imperative programs and the behaviour of different kinds of verification condition generators [101]. The goal of his visit is to use Why3 as a platform for prototyping and experimental evaluation of these generators.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- F. Faissolle has spent two months visiting B. Spitters at Aarhus University (Denmark) They proposed an extension of ALEA library to continuous datatypes.[32].
- M. Roux has spent three months with D. Jovanovic and B. Dutertre at SRI (California, USA). They worked on extending Sally, the new model checker of SRI based on SAL, to add the verification of parameterized cache coherence protocols. The software can be found on <https://github.com/SRI-CSL/sally>.
- S. Conchon has been invited a month at SRI by D. Jovanovic. During this visit, he has collaborated with CSL researchers to compare the design and implementation choices between the model checkers Sally and Cubicle.

COMMANDS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Gaspard Monge Program for Optimization and Operational Research (Fondation Jacques Hadamard)
 - Title : Optimal control of partial differential equations using parameterizing manifolds, model reduction, and dynamic programming,
 - Funding : 9,000 Euro (for 2015-16), 10,000 Euro (for 2016-17)
 - PI : Axel Kröner
 - Period : 2015 – 2017
 - Further members : Frédéric Bonnans (Inria Saclay and CMAP, École Polytechnique), Mickaël Chekroun (UCLA, Los Angeles), Martin Gubisch (University of Konstanz), Karl Kunisch (University of Graz), Hasnaa Zidani (ENSTA ParisTech).

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

- Michael D. Chekroun, U.C.L.A, collaboration on the approximation and reduction of optimal control problems in infinite dimension.
- Alejandro Jofré, CMM, U. Chile, Santiago de Chile. Cosupervision of B. Heymann's PhD thesis.
- Pablo Lotito, U. Tandil, Argentina, supervision of Justina Gianatti's PhD.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- M. Chekroun (University of California, Los Angeles), 12.-14.12.2016.
- Johannes Pfeiffer (Technische Universität München), 12.-14.12.2016.

9.3.1.1. Internships

- Luis Alberto Croquevielle Rendic: Classification of probability measures based on Optimal Transportation theory. January-March 2016. U. Catolica, Santiago, Chile.
- Justina Gianatti, Discretization of stochastic control problems, U. Rosario (Argentina), May-July 2016.

DEFI Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR Metamath: Modelization and numerical simulation of wave propagation in metamaterials, program MN, September 2011- November 2016. This is a joint ANR with POEMS, Inria Saclay Ile de France project team (Coordinator, S. Fliss), DMIA, Département de Mathématiques de l'ISAE and IMATH, Laboratoire de Mathématiques de l'Université de Toulon. <https://www.rocq.inria.fr/poems/metamath>
- ANR CIACM "Computational Imaging of the Aging Cerebral Microvasculature", funded by ANR Program "US-French Collaboration". French Partners (Coordinating partner CEA Neurospin): CEA Neurospin (Coordinator Luisa Ciobanu), Inria Saclay (Coordinator Jing-Rebecca Li). US Partner: Univ of Illinois, bioengineering department (Coordinator Brad Sutton). Duration: Sept 2013-Sept 2016.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Declared Inria International Partners

QUASI

Title: Qualitative Approaches to Scattering and Imaging

International Partner (Institution - Laboratory - Researcher):

University of Rutgers (United States) - Fioralba Cakoni

Duration: 2013 - 2017

Start year: 2013

We concentrate on the use of qualitative methods in acoustic and electromagnetic inverse scattering theory with applications to nondestructive evaluation of materials and medical imaging. In particular, we would like to address theoretical and numerical reconstruction techniques to solve the inverse scattering problems using either time harmonic or time dependent measurements of the scattered field. The main goal of research in this field is to not only detect but also identify geometric and physical properties of unknown objects in real time.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Fioralba Cakoni (4 months)
- David Colton (1 week)
- Semra Ahmetola (11 months)
- Armin Lechleiter (1 week)
- Bojan Guzina (1 week)
- Helle Majander (12 months)

9.3.1.1. Internships

- Irene De Teresa-Trueba (University of Delaware) 3 months
- Jacob Rezac (University of Delaware) 3 months
- Marwa Kchaou (ENIT) 3 months
- BumsuKim (Ecole Polytechnique), from Jul 2016 until Nov 2016
- KevisshNapal (Inria), from May 2016 until Oct 2016
- Hoang An Tran (Ecole Polytechnique), from Apr 2016 until Jun 2016

DISCO Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- DIGITEO Project (DIM LSC) ALMA3

Project title: Mathematical Analysis of Acute Myeloid Leukemia (AML) and its treatments

September 2014 - August 2017

Coordinator: Catherine Bonnet

Other partners: Inria Paris-Rocquencourt, France, L2S, France, UPMC, St Antoine Hospital Paris

Abstract: this project follows the regional projects ALMA (2010-2014) and ALMA2 (2011-2013). Starting from the work of J. L. Avila Alonso's PhD thesis in ALMA the aim of this project is to provide a refined coupled model of healthy and cancer cell dynamics in AML whose (stability) analysis will enable evaluation of polychemiotherapies delivered in the case of AML which have a high level of Flt-3 duplication (Flt-3-ITD).

7.2. National Initiatives

7.2.1. Industrial-Academic Institute

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

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

Program: ITN

Project acronym: TEMPO

Project title: Training in Embedded Predictive Control and Optimization

Duration: January 2014 - January 2018

Coordinator: Tor Arne Johanson; with Sorin Olaru (as French PI)

Other partners: U. Frieberg, Oxford, Imperial College; NTNU Trondheim; STUBA Bratislava; EPFL Lausanne; KU Leuven, Renault, ABB, Ampyx Power

Abstract: TEMPO is an international PhD program for highly motivated young scientists, where state-of-the-art research is combined with a comprehensive training program. The network is funded by the European Community's Seventh Framework program. The European Commission wants to make research careers more attractive to young people and therefore offers early-stage researchers (ESRs) a PhD program the opportunity to improve their research skills, join established research teams and enhance their career prospects via the Marie Curie Initial Training Networks (ITN) in the area of Embedded Predictive Control and Optimization.

Program: IEF

Project acronym: FUTURISM

Project title: Multiple sensor FaUlt ToleRant control for management of Interconnected nonlinear Systems

Duration: May 2014 - April 2016

Coordinator: Sorin Olaru

Abstract: The primary research objective of this project is the design and analysis of novel methods for diagnosing multiple sensor faults and compensating their effects on multi-sensory schemes used for controlling interconnected, nonlinear systems. The second main objective of this project is the application of these methods to complex systems.

7.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: PHC STEFANIK 2016 (Slovakia)

Project acronym: AIMPC

Project title: Advanced techniques for practical implementation of model predictive control strategies

Duration: January 2016 - December 2017

Coordinator: Cristina Stoica (France), Martin Gulan (Slovakia)

Abstract: The proposed project is dedicated to the model predictive control with a particular emphasis on its practical implementations. The main objective is to explore new techniques allowing for an efficient deployment of control algorithms on embedded, preferably low-cost microcontrollerbased computing platforms. The inherent hardware memory/speed issues that become particularly challenging for fast real-time applications are to be addressed by appropriate acceleration and complexity reduction techniques targeting either the implicit or the explicit control laws while preserving the optimality of associated solutions. The run-time performance of the proposed control policies will be experimentally verified and monitored in chosen existing applications.

Program: PHC BOSPHORE 2016 (Turkey)

Project title: Robust Control of Time Delayed Linear Parameter Varying Systems via Switched Controllers.

Duration: January 2016 - December 2017

Coordinator: Frédéric Mazenc (France), Hitay Özbay (Turkey).

Abstract: The main goal of this project is to develop computational algorithms for robust controller design for different classes of time delay systems appearing in various engineering applications such as chemical processes, transportation systems and communications networks. The participants will consider control problems of significant practical implications in this area: (i) developing new computational techniques for simple (low order) reliable and scalable decentralized controllers for control of (and control over) networks; and (ii) reducing conservatism in recently developed dwell-time based stability results for the analysis of switched time delay systems. Moreover, design of scalable low order controllers for reducing the effect of time delays is an important problem investigated in this project. One of the objectives of this collaboration is to generalize the design techniques already developed by the French and Turkish teams to larger classes of time delay systems, in particular multi-input-multi-output (MIMO) systems with time varying delays.

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 favour scientific advancement in above mentioned areas by coordinating activities of academic research groups towards an efficient deployment of fractal theory to industry applications.

7.4. International Initiatives

Catherine Bonnet is the co-supervisor together with André Fioravanti of a PhD student of Unicamp (Brazil).

Guillaume Sandou is the co-supervisor of a PhD student in the Ecole nationale d'ingénieur de Tunis, on the optimal tuning of MPC controllers using stochastic optimization methods.

7.4.1. Inria International Labs

7.4.1.1. Informal International Partners

- College of Mathematics and Information Science, Shaanxi Normal University, China
- School of Control Science and Engineering, Dalian University of Technology, Dalian, China
- Louisiana State University, Baton Rouge, USA
- School of Electrical Engineering at the Tel-Aviv University, Israel
- The University of Texas at Austin, Dept. of Aerospace Engineering & Engineering Mechanics, USA
- Bilkent University, Turkey
- Universidad de Chile, Chile
- School of Mathematics, University of Leeds, U.K.
- University Federale Rio de Janeiro, Brazil
- UNICAMP, Brazil
- Kyoto University, Japan

7.4.2. Participation in Other International Programs

7.4.2.1. International Initiatives

STADE

Title: Stability and Dichotomies in Differential Equations (Ordinary & Delay).

International Partners (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Mathematics Department - Gonzalo Robledo

Universidad de la Republica Uruguay (Uruguay) - Faculty of Engineering - Pablo Monzon

Duration: 2016 - 2017

Start year: 2016

See also: <http://www.stade.cl/pages/list.html>

The ship-flags of this project are the concepts of dichotomy and stability in an ODE & DDE framework. We intend to study some theoretical and applied problems involving these concepts and its relations. In particular, converse stability results (expressed in the existence of density functions), feedback stabilization, stability in delay differential equations and some applications to bioprocesses.

7.5. International Research Visitors

Gonzalo Robledo, Universidad de Chile, Chile, 14/11 – 28/11.

Hitay Ozbay, Bilkent University, 26/10 – 02/11.

Saed Ahmed, Bilkent University, 04/12 – 16/12.

7.5.1. Visits of International Scientists

Stefanella Boatto, Federale University Rio de Janeiro, Brazil, 2 October-23 December

André Fioravanti, UNICAMP, Sao Paulo, Brazil, 24 November-31 December

Emilia Fridman, Tel-Aviv University, Israel, 23-30 September

Yutaka Yamamoto, Kyoto University, Japan, 6 September-19 November

7.5.2. Visits to International Teams

7.5.2.1. Research Stays Abroad

Matsumae International Foundation (MIF) fellowship - 3 months research visit of Sorin Olaru (June-September 2016) to Kyushu Institute of Technology (Hosted by Prof. Hiroshi Ito).

Mitacs Globalink Research Award – 3 months research visit of Dina Irofti (July – October 2016) to University of Lethbridge, Alberta, Canada (hosted by Marc R. Roussel).

GAMMA3 Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

F. Alauzet, N. Barral, V. Menier and A. Loseille are part of the MAIDESC ANR (2013-2015) on mesh adaptation for moving interfaces in CFD.

T. Grosgees, D. Barchiesi, A. Cherouat, H. Borouchaki, L. Giraud-Moreau and A. Chaari sont membres de l'ANR NONOMOPRH (2011-2016) sur le développement et la mise au point d'une instrumentation optique pour déterminer la distribution en tailles et le coefficient de forme de nanofils (NF) ou de nanotubes (NT) en suspension dans un écoulement.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

- UMRIDA <https://sites.google.com/a/numeca.be/umrida/>

6.3. International Initiatives

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

6.3.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2014

See also: https://www.rocq.inria.fr/gamma/gamma/Membres/CIPD/Frederic.Alauzet/AssociateTeam_AM2NS/AT_am2ns.html

Numerical simulation is now mature and has become an integral part of design in science and engineering applications. Meshing, i.e., discretizing the computational domain, is at the core of the computational pipeline and a key element to significant improvements. The AM2NS Associate Team focus on developing the next generation of automated meshing methods to improve their robustness and the mesh quality to solve the ever increasing complexity of numerical simulations. Four major meshing issues are targeted: (i) more robustness for mesh generation methods in recovering a given data set, (ii) higher quality for anisotropic adapted meshes via constraint alignment, (iii) higher quality for boundary layer meshes near geometry singularities, and (iv) more robustness in handling complex displacement for moving mesh methods. The impact of this collaborative research will be to provide more reliable solution output predictions in an automated manner by using these new meshing methods.

GECO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project *Stabilité des systèmes à excitation persistante*, Program MathIng, Labex LMH, 2013-2016. This project is about different stability properties for systems whose damping is intermittently activated. The coordinator is Mario Sigalotti. The other members are Yacine Chitour and Guilherme Mazanti.
- iCODE is the Institute for Control and Decision of the Idex Paris Saclay. It was launched in March 2014 for two years until June 2016. We have been involved in three actions funded by iCODE:
 - one action on control of quantum systems, in collaboration with Nicoals Boulant of Neurospin. The action was coordinated by Ugo Boscain;
 - one action on control of wave propagation on networks. The action was coordinated by Mario Sigalotti;
 - one action on switched system. The action was coordinated by Marianne Akian (and handled by MAXPLUS).

Starting from November 2016, iCODE has been renewed for three years as a IRS (*Institut de Recherche Strategique*) by the Idex Paris Saclay. The funded actions have still not been identified.

- Starting from the end of 2015, we obtained a grant by PGMO (Gaspard Monge Program for Optimisation and operational research) on Geometric Optimal Control. The grant duration is one year, has been renewed in 2016 and is still renewable for a third year. The grant is coordinated by Mario Sigalotti (up to August, it was co-coordinated by Luca Rizzi as well).

8.2. National Initiatives

8.2.1. ANR

The ANR SRGI starts at the end of 2015, for a duration of four years. GECO is one of one of the partners of the ANR. The national coordinator is Emmanuel Trélat (UPMC) and the local one Ugo Boscain.

SRGI deals with sub-Riemannian geometry, hypoelliptic diffusion and geometric control.

8.2.2. Other initiatives

Ugo Boscain and Mario Sigalotti are members of the project DISQUO of the program Inphyniti of the CNRS (duration: one year renewable). Coordinator: Thomas Chambrion (Nancy).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Program: ERC Starting Grant

Project acronym: GeCoMethods

Project title: Geometric Control Methods for the Heat and Schroedinger Equations

Duration: Initially accepted from 1/5/2010 to 1/5/2015, the project has been extended for one additional year, up to 1/5/2016.

Coordinator: Ugo Boscain

Abstract: The aim of this project is to study certain PDEs for which geometric control techniques open new horizons. More precisely we plan to exploit the relation between the sub-Riemannian distance and the properties of the kernel of the corresponding hypoelliptic heat equation and to study controllability properties of the Schroedinger equation.

All subjects studied in this project are applications-driven: the problem of controllability of the Schroedinger equation has direct applications in Laser spectroscopy and in Nuclear Magnetic Resonance; the problem of nonisotropic diffusion has applications in cognitive neuroscience (in particular for models of human vision).

Participants. Main collaborator: Mario Sigalotti. Other members of the team: Andrei Agrachev, Riccardo Adami, Thomas Chambrion, Grégoire Charlot, Yacine Chitour, Jean-Paul Gauthier, Frédéric Jean.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

SISSA (Scuola Internazionale Superiore di Studi Avanzati), Trieste, Italy.

Sector of Functional Analysis and Applications, Geometric Control group. Coordinator: Andrei A. Agrachev.

We collaborate with the Geometric Control group at SISSA mainly on subjects related with sub-Riemannian geometry. Thanks partly to our collaboration, SISSA has established an official research partnership with École Polytechnique.

8.4.2. Participation in Other International Programs

- Laboratoire Euro Maghrébin de Mathématiques et de leurs Interactions (LEM2I)
<http://lem2i.math.cnrs.fr/>
- GDRE Control of Partial Differential Equations (CONEDP)
<http://www.ceremade.dauphine.fr/~glass/GDRE/>

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Andrei Agrachev (SISSA, Italy) is visiting the GECO team for one year, starting in September 2016.

POEMS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The post-doc of Maryna Kachanovska is funded by the Fondation Mathématique Jacques Hadamard (FMJH).

9.2. National Initiatives

9.2.1. ANR

- ANR project *METAMATH: modélisation mathématique et numérique pour la propagation des ondes en présence de métamatériaux*. Partners: EPI DEFIL (Inria Saclay), IMATH-Université de Toulon, LJLL-Paris 6 University.
Start : 12/01/2011, End : 11/30/2016. Administrator : Inria. Coordinator : Sonia Fliss.
- ANR project *CHROME: Chauffage , réflectométrie et Ondes pour les plasmas magnétiques*
Partners: LJLL-Paris 6 University, Université de Lorraine
Start : 10/01/2012, End : 19/09/2016 Administrator : Inria Coordinator for POEMS: Eliane Bécache
- ANR project *RAFFINE: Robustesse, Automatisation et Fiabilité des Formulations INTégrales en propagation d'ondes : Estimateurs a posteriori et adaptivité*
Partners: EADS, IMACS, ONERA, Thales
Start : January 2013. End : June 2017. Administrator : Inria. Coordinator: Marc Bonnet.
- ANR project *Non-Local Domain Decomposition Methods in Electromagnetism*.
Partners: Inria Alpines, Inria POEMS, Inria Magique 3D.
Start : 2015, End : 2019. Administrator : Inria. Coordinator: Xavier Claeys.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. BATWOMAN

Type: FP7 Marie Curie

Objectif: Basic Acoustics Training - & Workprogram On Methodologies for Acoustics - Network

Duration: September 2013 - August 2017

Coordinator: Martin Wifling, VIRTUAL VEHICLE (AT)

Inria contact: P. Joly

Abstract: The BATWOMAN ITN aims at structuring research training in basic and advanced acoustics and setting up a work program on methodologies for acoustics for skills development in a highly diverse research field offering multiple career options.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Wilkins Aquino (Duke University)

Eric Chung (Chinese University of Hong Kong)

Bojan Guzina (University of Minnesota)

Sergei Nazarov (Saint-Petersburg University)

Jeronimo Rodriguez (University of Santiago de Compostela)

Adrien Semin (Technische Universität Berlin)

Julian Ott (Karlsruhe Institut für Technologie)

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Stefan Sauter, University of Zürich, Switzerland (2 months)

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Gilles Celeux and Christine Keribin have a collaboration with the Pharmacoepidemiology and Infectious Diseases (PhEMI, INSERM) groups.

Christine Keribin is treasurer of the Société Française de Statistique (SFdS).

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

8.2. National Initiatives

8.2.1. ANR

SELECT is part of the ANR funded MixStatSeq.

8.3. International Initiatives

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

Julie Josse was chair of user!2016, Stanford, CA, USA, July 2016. <http://user2016.org/>

Julie Josse is member of the R foundation.

TAO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **PGMO NUMBBER** 2016-2018 (60 kEuros)
Coordinator: FMJH(Fondation mathématiques Jacques Hadamard - Paris Saclay) & Anne Auger
Participants: Anne Auger, Nikolaus Hansen

9.2. National Initiatives

- **ROMModel Reduction and Multiphysics Optimization** 2014-2016 (50 Keuros)
Coordinator: IRT System X
Participants: Marc Schoenauer, Michèle Sebag, François Gonard (PhD)
- **MAJOREA Collaborative Filtering Approach to Matching Job Openings and Job Seekers**, 2013-2016 (105 kEuros)
Thomas Schmitt's PhD (funded by ISN).
Participants: Philippe Caillou, Michèle Sebag, Thomas Schmitt (PhD)
- **AutoMLAn empirical approach to Machine Learning** 2014-2017 (104 kEuros)
Sourava Mishra's PhD
Participants: Michèle Sebag, Balazs Kégl, Sourava Mishra
- **ReMODELRewarded Multimodal Online Deep Learning** 2015-2016 (31,5 kEuros)
This project lies at the junction of reinforcement learning, deep learning, computational neuroscience and developmental robotic fields. It is closely related to the transversal DIGITEO robotic theme, Roboteo.
Participants: Michèle Sebag, Mathieu Lefort, Alexander Gepperth
- **AMIQAP** 2015-2016 (12 months of Postdoctoral fellow). Project funded by ISN
Participants: Philippe Caillou, Olivier Goudet, Isabelle Guyon, Michèle Sebag, Paola Tubaro, Diviyan Kalavanathan (2016 intern, 2017 PhD)
- **NUMBBO** 2012-2017 (290kEuros for TAO). Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers, ANR project, Coordinator Anne Auger, Inria. Other partners: Dolphin, Inria Lille, Ecole des Mines de Saint-Etienne, TU Dortmund
Participants: Anne Auger, Nikolaus Hansen, Marc Schoenauer, Ouassim Ait ElHara
- **ACTEUR** 2014-2018 (236kEuros). Cognitive agent development for urban simulations, ANR project, Coordinator P. Taillandier (IDEES, Univ Rouen).
Participant: Philippe Caillou

9.2.1. Other

- **POST** 2014-2017 (1,220 MEuros, including 500 kEuros for a 'private' cluster). Platform for the optimization and simulation of trans-continental grids
ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie)
Coordinator: ARTELYS
Participants: Olivier Teytaud, Marie-Liesse Cauwet, Jérémie Decock, Sandra Cecilia Astete Morales, David L. Saint-Pierre, J. Decock
- **E-LUCID** 2014-2017 (194 kEuros)
Coordinator: Thales Communications & Security S.A.S
Participants: Marc Schoenauer, Cyril Furtlehner

- **PIA ADAMME 2015-2018** (258 kEuros)
Coordinator: Bull SAS
Participants: Marc Schoenauer, Yann Ollivier, Gaetan Marceau Caron, Guillaume Charpiat, Cécile Germain-Renaud, Michèle Sebag
- **CNES contract 2015-2017** (70 kEuros)
Coordinator: Manuel Grizonnet (CNES) & Yuliya Tarabalka (Inria Sophia-Antipolis, Titane team)
Participant: Guillaume Charpiat
- **ESA Tender 2016-2017** (52 kEuros)
Coordinator: Oana Togt (TNO) & Marc Schoenauer
Participant: Marc Schoenauer

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

EHRI-II 2015-2019 (7 969 kEuros). European Holocaust Research Infrastructure, H2020, Coordinator NIOD, Amsterdam. Digital Humanities.

Participants: Gregory Grefenstette

See.4C 2016-2017 (2 700 kEuros). SpatiotEmporal ForEcasting: Coopetition to meet Current Cross-modal Challenges

Participants: Isabelle Guyon

9.3.2. Collaborations with Major European Organizations

MLSpaceWeather 2015-2019. Coupling physics-based simulations with Artificial Intelligence.

Coordinator: CWI

Participants: Michèle Sebag, Aurélien Decelle, Cyril Furtlehner.

ESA tender 2015-2016, through collaboration with TNO (see Section 9.2.1).

9.4. International Initiatives

9.4.1. CIADM

Title: Computational intelligence and Decision making

International Partner (Institution - Laboratory - Researcher):

NUTN (Taiwan) - Multimedia Informatics Lab - Chang-Shing Lee

Start year: 2015

See also: <http://www.lri.fr/~teytaud/indema.html>

The associate team works on computation intelligence for decision making, with different application fields for the various partners: - power systems (Tao) - eLearning (Oase) - games (Ailab)

9.4.2. S3-BBO

Title: Threefold Scalability in Any-objective Black-Box Optimization

International Partner (Institution - Laboratory - Researcher):

Shinshu (Japan) - Tanaka-Hernan-Akimoto Laboratory - Hernan Aguirre

Start year: 2015

See also: <http://francejapan.gforge.inria.fr/doku.php?id=associateteam>

This associate team brings together researchers from the TAO and Dolphin Inria teams with researchers from Shinshu university in Japan. Additionally, researchers from the University of Calais are external collaborators to the team. The common interest is on black-box single and multi-objective optimization with complementary expertises ranging from theoretical and fundamental aspects over algorithm design to solving industrial applications. The work that we want to pursue in the context of the associate team is focused on black-box optimization of problems with a large number of decision variables and one or several functions to evaluate solutions, employing distributed and parallel computing resources. The objective is to theoretically derive, analyze, design, and develop scalable black-box stochastic algorithms including evolutionary algorithms for large-scale optimization considering three different axes of scalability: (i) decision space, (ii) objective space, and (iii) availability of distributed and parallel computing resources.

We foresee that the associate team will make easier the collaboration already existing through a proposal funded by Japan and open-up a long term fruitful collaboration between Inria and Shinshu university. The collaboration will be through exchanging researchers and Ph.D. students and co-organization of workshops.

9.4.3. Informal International Partners

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

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

9.4.4. Participation in Other International Programs

9.4.4.1. Indo-French Center of Applied Mathematics

Contextual multi-armed bandits with hidden structure

Title: Contextual multi-armed bandits with hidden structure

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - ECE - Aditya Gopalan

Duration: 12 months - April 2017

Start year: April 2016

Recent advances in Multi-Armed Bandit (MAB) theory have yielded key insights into, and driven the design of applications in, sequential decision making in stochastic dynamical systems. Notable among these are recommender systems, which have benefited greatly from the study of contextual MABs incorporating user-specific information (the context) into the decision problem from a rigorous theoretical standpoint. In the proposed initiative, the key features of (a) sequential interaction between a learner and the users, and (b) a relatively small number of interactions per user with the system, motivate the goal of efficiently exploiting the underlying collective structure of users. The state-of-the-art lacks a wellgrounded strategy with provably near-optimal guarantees for general, low-rank user structure. Combining expertise in the foundations of MAB theory together with recent advances in spectral methods and low-rank matrix completion, we target the first provably near-optimal sequential low-rank MAB

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- **Edgar Galvan Lopez** University College Dublin, April 2015 - December 2016, funded by the ELEVATE Fellowship, the Irish Research Council's Career Development Fellowship co-funded by Marie Curie Actions.

9.5.1.1. Internships

- **Borja Seijo** Universidade da Coruña, Galicia, Spain, October-November 2016, self-funded. Worked on missing data under the supervision of Isabelle Guyon.
- **Tomas Lungenstrass**, June 2016 - June 2017, self-funded. Worked on magnetic storm prediction under A. Decelle's, C. Furtlehner's and M. Sebag's supervision.

TROPICAL Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Participation of Cormac Walsh to the ANR white project FINSLER (Géométrie de Finsler et applications), 2012-2016.
- Projet ANR CAFEIN (Combinaison d'approches formelles pour l'étude d'invariants numériques), responsable P.L. Garoche. Partenaires : ONERA, CEA LIST, ENSTA Paristech, Inria Saclay (Maxplus, Toccata, Parkas), Université de Perpignan, Prover, Rockwell Collins France.
- Projet ANR MALTHY (Méthodes ALgébriques pour la vérification de modèles Temporisés et HYbrides), responsable T. Dang. Partenaires : Verimag, CEA LIST, Inria Rennes, Inria Saclay, VISEO/Object Direct.
- Projet ANR DEMOCRITE ("DEmonstrateur d'un MOteur de Couverture des Risques sur un TERRitoire), responsable Emmanuel Lapébie (CEA). Partenaires : CEA-GRAMAT, BSPP, Inria Saclay (Maxplus), Institut PPRIME - UPR3346 (CNRS, Univ. Poitiers, ISAE-ENSMA), IPSIS, SYSTEL, ARMINES-E.M. Alès-ISR, CERDACC (Univ. de Haute-Alsace).

9.1.2. Programme Gaspard Monge pour l'Optimisation

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

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

- White project "Stabilité et stabilisation des systèmes commutés" (Oct 2014-June 2016), including M. Akian, X. Allamigeon, S. Gaubert, and members of EPI Geco, L2S, LIX, LSV (ENS Cachan), UVSQ.

9.2. International Research Visitors

9.2.1. Visits of International Scientists

- Ricardo Katz (Conicet and Cifasis, Argentina), May-June 2016
- Rajendra Bhatia (Indian Statistical Institute, New Delhi), 2 weeks in June 2016.
- Vladimir Gurvich (Rutgers), 2 weeks in Dec 2016.

9.2.2. Visits to International Teams

9.2.2.1. Research Stays Abroad

- S. Gaubert, invitation of one week to HKU, Hong-Kong, collaboration with Zheng Qu.

AMIB Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. FRM

Yann Ponty is the Bioinformatics PI for a *Fondation de la Recherche Médicale*-funded project.

Fondation pour la Recherche Medicale – *Analyse Bio-informatique pour la recherche en Biologie* program

- Approche comparatives haut-débit pour la modelisation de l'architecture 3D des ARN à partir de données experimentales
- 2015–2018
- Yann Ponty, A. Denise, M. Regnier, A. Saaidi (PhD funded by FRM)
- B. Sargueil (Paris V – Experimental partner), J. Waldispuhl (Univ. McGill)

6.2. European Initiatives

6.2.1. Collaborations in European Programs, Except FP7 & H2020

Yann Ponty is the French PI for the French/Austrian RNALANDS project, jointly funded by the French ANR and the Austrian FWF, in partnership with the Theoretical Biochemistry Institute (University of Vienna, Austria), LRI (Univ. Paris-Sud) and EPI BONSAI (Inria Lille-Nord Europe).

French/Austrian International Program

RNALANDS (ANR-14-CE34-0011)

Fast and efficient sampling of structures in RNA folding landscapes

01/10/2014–30/09/2018

Coordinated by AMIB (Inria Saclay) and TBI Vienna (University of Vienna)

EPI BONSAI/INRIA Lille - Nord Europe, Vienna University (Austria), LRI, Université Paris-Sud (France)

The main goal of the RNALands project is to provide efficient tools for studying the kinetics of RiboNucleic Acids, based on efficient sampling strategies.

Partenariat Henri Curien (CampusFrance, programme Staël)

Random constrained permutations: Algorithms and Analysis

01/01/2015–31/12/2016

Coordinated by CMAP (Ecole Polytechnique) and Maths Dept (Univ. Zürich, Switzerland)

LIX (Ecole Polytechnique), LIPN (Univ Paris XIII), LIGM (Univ Marne-la-Vallée)

The goals of this collaborative network is to initiate or push several collaborations related to the structure of random constrained permutations. AMIB bring their strength in random generation and discrete algorithms, and benefit from the considerable expertise accumulated at University of Zürich on permutation patterns.

6.3. International Initiatives

6.3.1. Inria International Labs

6.3.1.1. Declared Inria International Partners

Title: AMAVI - Combinatorics and Algorithms for the Genomic sequences

International Partner (Institution - Laboratory - Researcher):

Vavilov Institute of General Genetics (Russia (Russian Federation)) - Department of Computational Biology - Vsevolod Makeev

Duration: 2013 - 2017

Start year: 2013

VIGG and AMIB teams has a more than 12 years long collaboration on sequence analysis. The two groups aim at identifying DNA motifs for a functional annotation, with a special focus on conserved regulatory regions. In the current 3-years project CARNAGE, our collaboration, that includes Inria-team MAGNOME, is oriented towards new trends that arise from Next Generation Sequencing data. Combinatorial issues in genome assembly are addressed. RNA structure and interactions are also studied.

The toolkit is pattern matching algorithms and analytic combinatorics, leading to common software.

6.3.1.2. Regular International Partners

AMIB enjoys regular interactions with the following institutions:

- Simon Fraser University (Vancouver, Canada). The Mathematics department at SFU has ongoing projects on RNA design, comparative genomics and RNA structure comparison with our team. M. Mishna (SFU) will also visit Inria Saclay in January 2017 to push an ongoing collaboration on 2D walks;
- McGill University (Montréal, Canada). Following our productive collaboration with J. Waldispühl (Computer Science Dept, McGill), and the recent defense of V. Reinharz's PhD, whose thesis was co-supervised by AMIB members, we plan to increase our interactions on SHAPE data analysis by applying for an Inria associate team;
- King's college (London, UK). Our collaboration with L. Mouchard (AMIB associate) and S. Pissis on string processing and data structures is at the core of Alice Héliou's PhD. To finalize the implementation of her algorithms and apply them on real data, Alice has spent a two month period during the summer of 2016 at the EBI.

6.3.2. Participation in Other International Programs

France-Stanford exchange program

Duration: 2014 - 2016

Start year: 2014

See also: http://francestanford.stanford.edu/collaborative_projects

Amélie Héliou is co-supervised by H. Van Den Bedem in Stanford. Her two-months visit to Stanford during the Fall of 2016 was funded by France-Stanford.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

6.4.1.1. Internships

Frédéric Lavner

Date: 01/07/2016- 31/08/2016

Institution: ENSEA (France)

Supervisor: Mireille Régnier

Maria Waldl

Date: 01/08/2016 - 31/09/2016

Institution: TBI, University of Vienna (Austria)

Supervisor: Yann Ponty

6.4.2. Visits to International Teams

- Yann Ponty has visited M. Mishna and C. Chauve at the Simon Fraser University for two weeks in July 2016;
- Juraj Michalik has visited A. Tanzer and I. Hofacker at the university of Vienna (Austria) for one week in November 2016;
- Mireille Régnier has visited MIPT (Moscow) and Novossibirsk University to enhance student exchanges between these universities and Ecole polytechnique.

6.4.2.1. Research Stays Abroad

- Alice Héliou has visited the EBI (UK) for two months during the Fall of 2016;
- Amélie Héliou has visited Stanford University (USA) for two months during the Summer of 2016;

GALEN Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- Program: ANR Blanc International
 Project acronym: ADAMANTIUS
 Project title: Automatic Detection And characterization of residual Masses in pAtients with lymphomas through fusioN of whole-body diffusion-weighted mri on 3T and 18F-flUorodeoxyglucoSe pet/ct
 Duration: 9/2012-8/2015
 Coordinator: CHU Henri Mondor - FR
- Program: ANR JCJC
 Project acronym: HICORE
 Project title: HIERarchical COMpositional REpresentations for Computer Vision
 Duration: 10/2010-9/2014
 Coordinator: ECP - FR
- Program: ANR JCJC
 Project acronym: LearnCost
 Project title: Learning Model Constraints for Structured Prediction
 Duration: 2014-2018
 Coordinator: Inria Saclay - FR
- Program: ITMOs Cancer & Technologies pour la santé d'Aviesan / INCa
 Project acronym: CURATOR
 Project title: Slice-to-Image Deformable Registration towards Image-based Surgery Navigation & Guidance
 Duration: 12/2013-11/2015
 Coordinator: ECP - FR

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. I-SUPPORT

Title: ICT-Supported Bath Robots

Programm: FP7

Duration: March 2015 - March 2018

Coordinator: Robotnik Automation S.L.L.

Partners:

Bethanien Krankenhaus - Geriatisches Zentrum - Gemeinnutzige GMBH (Germany)

Fondazione Santa Lucia (Italy)

Institute of Communication and Computer Systems (Greece)

Karlsruher Institut für Technologie (Germany)

Theofanis Alexandridis Kai Sia Ee (OMEGATECH) (Greece)

Robotnik Automation Sll (Spain)

Scuola Superiore di Studi Universitari E di Perfezionamento Sant'Anna (Italy)

Frankfurt University of Applied Sciences (Germany)

Inria contact: Iasonas Kokkinos

The I-SUPPORT project envisions the development and integration of an innovative, modular, ICT-supported service robotics system that supports and enhances older adults' motion and force abilities and assists them in successfully, safely and independently completing the entire sequence of bathing tasks, such as properly washing their back, their upper parts, their lower limbs, their buttocks and groin, and to effectively use the towel for drying purposes. Advanced modules of cognition, sensing, context awareness and actuation will be developed and seamlessly integrated into the service robotics system to enable the robotic bathing system to adapt to the frail elderly population' capabilities and the frail elderly to interact in a master-slave mode, thus, performing bathing activities in an intuitive and safe way. Adaptation and integration of state-of-the-art, cost-effective, soft-robotic manipulators will provide the hardware constituents, which, together with advanced human-robot force/compliance control that will be developed within the proposed project, will form the basis for a safe physical human-robot interaction that complies with the most up-to-date safety standards. Human behavioural, sociological, safety, ethical and acceptability aspects, as well as financial factors related to the proposed service robotic infrastructure will be thoroughly investigated and evaluated so that the I-SUPPORT end result is a close-to-market prototype, applicable to realistic living settings.

8.2.1.2. *MOBOT*

Title: Intelligent Active MObility Aid RoBOT integrating Multimodal Communication

Programm: FP7

Duration: February 2013 - January 2016

Coordinator: Technische Universität München

Partners:

Bartlomiej Marcin Stanczyk (Poland)

Athena Research and Innovation Center in Information Communication & Knowledge Technologies (Greece)

Bethanien Krankenhaus - Geriatisches Zentrum - Gemeinnutzige (Germany)

Diaplasia Rehabilitation Center (Greece)

Ecole Centrale des Arts et Manufactures (France)

Technische Universitaet Muenchen (Germany)

Ruprecht-Karls-Universitaet Heidelberg (Germany)

Inria contact: Iasonas Kokkinos

Mobility disabilities are prevalent in our ageing society and impede activities important for the independent living of elderly people and their quality of life. The MOBOT project aims at supporting mobility and thus enforcing fitness and vitality by developing intelligent active mobility assistance robots for indoor environments that provide user-centred, context-adaptive and natural support. Our driving concept envisions cognitive robotic assistants that act (a) proactively by realizing an autonomous and context-specific monitoring of human activities and by subsequently reasoning on meaningful user behavioural patterns, as well as (b) adaptively and interactively, by analysing multi-sensory and physiological signals related to gait and postural stability, and by performing adaptive compliance control for optimal physical support and active fall prevention. Towards these targets, a multimodal action recognition system will be developed to monitor, analyse and predict user actions with a high level of accuracy and detail. The main thrust of our approach will be the

enhancement of computer vision techniques with modalities such as range sensor images, haptic information as well as command-level speech and gesture recognition. Data-driven multimodal human behaviour analysis will be conducted and behavioural patterns will be extracted. Findings will be imported into a multimodal human-robot communication system, involving both verbal and nonverbal communication and will be conceptually and systemically synthesised into mobility assistance models taking into consideration safety critical requirements. All these modules will be incorporated in a behaviour-based and context-aware robot control framework. Direct involvement of end-user groups will ensure that actual user needs are addressed. Finally, user trials will be conducted to evaluate and benchmark the overall system and to demonstrate the vital role of MOBOT technologies for Europe's service robotics.

8.2.1.3. RECONFIG

Type: FP7

Defi: Cognitive Systems and Robotics

Instrument: Specific Targeted Research Project

Objectif: Cognitive Systems and Robotics

Duration: February 2013 - January 2016

Coordinator: Dimos Dimarogonas

Partner: KTH (SE)

Inria contact: Iasonas Kokkinos

The RECONFIG project aims at exploiting recent developments in vision, robotics, and control to tackle coordination in heterogeneous multi-robot systems. Such systems hold promise for achieving robustness by leveraging upon the complementary capabilities of different agents and efficiency by allowing sub-tasks to be completed by the most suitable agent. A key challenge is that agent composition in current multi-robot systems needs to be constant and pre-defined. Moreover, the coordination of heterogeneous multi-agent systems has not been considered in manipulative scenarios. We propose a reconfigurable and adaptive decentralized coordination framework for heterogeneous multiple & multi-DOF robot systems. Agent coordination is held via two types of information exchange: (i) at an implicit level, e.g., when robots are in contact with each other and can sense the contact, and (ii) at an explicit level, using symbols grounded to each embodiment, e.g, when one robot notifies one other about the existence of an object of interest in its vicinity.

8.2.1.4. Strategie

Title: Statistically Efficient Structured Prediction for Computer Vision and Medical Imaging

Programm: FP7

Duration: January 2014 - December 2017

Coordinator: Inria

Inria contact: Matthew Blaschko

'Inference in medical imaging is an important step for disease diagnosis, tissue segmentation, alignment with an anatomical atlas, and a wide range of other applications. However, imperfections in imaging sensors, physical limitations of imaging technologies, and variation in the human population mean that statistical methods are essential for high performance. Statistical learning makes use of human provided ground truth to enable computers to automatically make predictions on future examples without human intervention. At the heart of statistical learning methods is risk minimization - the minimization of the expected loss on a previously unseen image. Textbook methods in statistical learning are not generally designed to minimize the expected loss for loss functions appropriate to medical imaging, which may be asymmetric and non-modular. Furthermore, these methods often do not have the capacity to model interdependencies in the prediction space, such as those arising from spatial priors, and constraints arising from the volumetric layout of human anatomy. We aim to develop new statistical learning methods that have these capabilities,

to develop efficient learning algorithms, to apply them to a key task in medical imaging (tumor segmentation), and to prove their convergence to optimal predictors. To achieve this, we will leverage the structured prediction framework, which has shown impressive empirical results on a wide range of learning tasks. While theoretical results giving learning rates are available for some algorithms, necessary and sufficient conditions for consistency are not known for structured prediction. We will consequently address this issue, which is of key importance for algorithms that will be applied to life critical applications, e.g. segmentation of brain tumors that will subsequently be targeted by radiation therapy or removed by surgery. Project components will address both theoretical and practical issues.'

8.2.2. Collaborations with Major European Organizations

8.2.2.1. CT dose and IQ optimization

Title: Development of a system helping in optimizing and tailoring computed tomography protocols

Program: Collaboration et encadrement de these CIFRE

Partners: GE Medical Systems, Université Paris-Est Créteil Val de Marne

Duration: December 2014 - November 2017

The purpose of the PhD is to create a method of CT dose and IQ optimization taking into account clinical indication, patient's characteristics and previous exams. The method will consist (i) in linking a clinical indication to IQ defined by quantitative physical metrics and (ii) in quantifying the patient's morphology from the analysis of local scans.

8.2.2.2. Imaging biomarkers in ILD

Title: Développement d' outils de Quantification en Imagerie dans les maladies respiratoires chroniques fibrosantes et obstructives

Program: Fondation de Coopération Scientifique

Partners: GE Medical Systems SCS

Duration: April 2016 - March 2019

We aim to test two different approaches for the development of new imaging biomarkers in interstitial lung disease (scleroderma): assessment of the regional lung elasticity through deformable registration and tissue characterization by textural analysis. We will also study structural changes in obstructive lung disease (cystic fibrosis) in order to develop new imaging biomarkers based on elastic registration, histogram and textural analysis.

8.2.2.3. SuBSAmPLE

Title: Identification and prediction of salient brain states through probabilistic structure learning towards fusion of imaging and genomic data

Partners: Fondation de Coopération Scientifique Digiteo

Duration: January 2012 - December 2016 (extended by 1 year)

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- UCL – Collaboration with Professor Arthur Gretton. Topic: non-parametric hypothesis testing
- University of Toronto – Collaboration with Professors Raquel Urtasun and Richard Zemel. Topic: Representation of Scene Graphs for Image Retrieval and Visual Question Answering
- MILA, Université de Montréal - Collaboration with Kyle Kastner from the lab of Professor Yoshua Bengio. Topic: Efficient Inference of Graph Structures using Deep Learning

- Sup'Com Tunis – Collaborative research with Amel Benazza-Benhayia. Collaboration Topic: Multispectral imaging
- University of Patras, Greece – Collaborative research with V. Megalooikonomou. Collaboration Topic: Biosignal analysis.
- University of Oxford – Collaborative research with Andrea Vedaldi. Collaboration Topic: Deep Learning for Texture Recognition.
- Google Research – Collaborative research with George Papandreou. Collaboration Topic: Deep Learning for Semantic Segmentation.
- Universitat Polytechnical de Catalonia – Collaborative research with Francesc Moreno. Collaboration Topic: Deep Learning for Image Descriptors.
- Ecole Polytechnique Federale de Lausanne (EPFL) – Collaborative research with Eduard Trulls. Collaboration Topic: Deep Learning for Image Descriptors.
- University of California at Los Angeles – Collaborative research with Alan Yuille. Collaboration Topic: Deep Learning for Semantic Segmentation.
- University of Massachusetts at Amherst – Collaborative research with Subhansu Maji. Collaboration Topic: Deep Learning for Texture Recognition.
- Ryerson University – Collaborative research with Kostas Derpanis. Collaboration Topic: Deep Learning for Learning Segmentation.
- University of Pennsylvania - Collaborative research with Aristeidis Sotiras. Collaboration Topic: Higher Order Graphs in biomedical image analysis.

LIFEWARE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

- ANR-MOST BIOPSY (2016-2020) on “Biochemical Programming System”, coordinated by F. Molina (CNRS, Sys2diag, Montpellier) and J.H. Jiang (National Taiwan University), with F. Fages.
- ANR MEMIP (2016-2020) on “Mixed-Effects Models of Intracellular Processes”, coordinated by G. Batt, with P. Hersen, (CNRS/Paris7), E. Cinquemani (Inria EPI IBIS) and M. Lavielle (Inria/CNRS/Polytechnique, EPI XPOP).
- ANR COGEX (2016-2019) on “Computer Aided Control of Gene Expression” coordinated by P. Hersen (MSC lab, CNRS/Paris7), with G. Batt and G. Truan (LISBP, CNRS/INSA).
- ANR Blanc HYCLOCK (2014-2018) on “Hybrid modeling of time for Circadian Clock Biology and Chronopharmacology”, coordinated by F. Delaunay (CNRS, Nice), with F. Lévi (INSERM Paris-Sud), G. Bernot (CNRS I3S, Nice), O. Roux (Ecole Centrale Nantes), F. Fages and S. Soliman.
- ANR Blanc **STOCH-MC** (2014-2018) on “Stochastic Models: Scalable Model Checking”, coordinated by Blaise Genest (Inria Rennes), with Grégory Batt, Wieslaw Zielonka (LIAFA), and Hugo Gimbert (LaBRI).
- ANR Investissement Avenir **ICEBERG** project (2011-2016) “From population models to model populations”, coordinated by Grégory Batt, with Pascal Hersen (MSC lab, Paris Diderot Univ./CNRS), Reiner Veitia (Institut Jacques Monod, Paris Diderot Univ./CNRS), Olivier Gandrillon (BM2A lab, Lyon Univ./CNRS), Cédric Lhoussaine (LIFL/CNRS), and Jean Krivine (PPS lab, Paris Diderot Univ./CNRS).

8.1.2. GENCI Contract

- GENCI (2009-2016) attribution of 300000 computation hours per year on the Jade cluster of 10000 cores of GENCI at CINES, Montpellier. Used for our hardest parameter search problems in BIOCHAM-parallel.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

In the context of the PhD thesis of Virgile Andréani, we initiated a collaboration with the lab of Lingchong You in the Biomedical Engineering department of Duke University (NC, USA).

8.2.2. Participation in Other International Programs

- French-German PROCOPE (2015-2017) grant on “Réduction de modèle et analyse de grands réseaux biochimiques par des méthodes stoechiométriques et tropicales”, coord. Prof. Andreas Weber, University of Bonn, Germany, and Prof. Ovidiu Radulescu, Univ. Montpellier, France.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Our group received for a sabbatical stay of six months

- Prof. David Rosenblueth, University of Mexico, Mexico.

We also received for short visits:

- Prof. Mark Chaplain, University of St-Andrews, UK,
- Prof. Attila Attila Csikász-Nagy, King's College London,
- Dr. Jakob Ruess, IST Austria,
- Dr. Amaury Pouly, Univ. Oxford, UK,
- Dr. Christoph Zechner, ETH Zurich,
- Prof. Natalio Krasnogor, Newcastle University, UK,

8.3.1.1. Research Stays Abroad

Virgile Andréani visited Lingchong You's lab (Duke U.) for two weeks in March 2016.

M3DISIM Project-Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. VP2HF

Title: Computer model derived indices for optimal patient-specific treatment selection and planning in Heart Failure

Programm: FP7

Duration: October 2013 - March 2017

Coordinator: King's College London (UK)

See also: <http://vp2hf.eu/>

Inria contact: Dominique Chapelle

Abstract: Heart failure (HF) is one of the major health issues in Europe affecting 6 million patients and growing substantially because of the ageing population and improving survival following myocardial infarction. The poor short to medium term prognosis of these patients means that treatments such as cardiac re-synchronisation therapy and mitral valve repair can have substantial impact. However, these therapies are ineffective in up to 50% of the treated patients and involve significant morbidity and substantial cost. The primary aim of VP2HF is to bring together image and data processing tools with statistical and integrated biophysical models mainly developed in previous VPH projects, into a single clinical workflow to improve therapy selection and treatment optimisation in HF.

PARIETAL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CoSmic project

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

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

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 (Inria-CEA 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-telescope the goal will consist of extracting high temporal resolution information in order to study fast transient events.

8.1.2. BrainAMP project

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Andre Monteiro Manoel.

This is a collaborative project with Lenka Zdeborová, Theoretical Physics Institute (CEA) funded by the CEA program drf-impulsion.

In many scientific fields, the data acquisition devices have benefited of hardware improvement to increase the resolution of the observed phenomena, leading to ever larger datasets. While the dimensionality has increased, the number of samples available is often limited, due to physical or financial limits. This is a problem when these data are processed with estimators that have a large sample complexity, such as multivariate statistical models. In that case it is very useful to rely on structured priors, so that the results reflect the state of knowledge on the phenomena of interest. The study of the human brain activity through high-field MRI belongs among these problems, with up to 10^6 features, yet a set of observations limited by cost and participant comfort.

We are missing fast estimators for multivariate models with structured priors, that furthermore provide statistical control on the solution. Approximate message passing methods are designed to work optimally with low-sample-complexity, they accommodate rather generic class of priors and come with an estimation of statistical significance. They are therefore well suited for our purposes.

We want to join forces to design a new generation of inverse problem solvers that can take into account the complex structure of brain images and provide guarantees in the low-sample-complexity regime. To this end, we will first adapt AMP to the brain mapping setting, using first standard sparsity priors (e.g. Gauss-Bernoulli) on the model. We will then consider more complex structured priors that control the variation of the learned image patterns in space. Crucial gains are expected from the use of the EM algorithm for parameter setting, that comes naturally with AMP. We will also examine the estimators provided by AMP for statistical significance. BrainAMP will design a reference inference toolbox released as a generic open source library. We expect a 3- to 10-fold improvement in CPU time, that will benefit to large-scale brain mapping investigations.

8.1.3. iConnectom project

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Elvis Dohmatob.

This is a Digiteo project (2014-2017).

Mapping brain functional connectivity from functional Magnetic Resonance Imaging (MRI) data has become a very active field of research. However, analysis tools are limited and many important tasks, such as the empirical definition of brain networks, remain difficult due to the lack of a good framework for the statistical modeling of these networks. We propose to develop population models of anatomical and functional connectivity data to improve the alignment of subjects brain structures of interest while inferring an average template of these structures. Based on this essential contribution, we will design new statistical inference procedures to compare the functional connections between conditions or populations and improve the sensitivity of connectivity analysis performed on noisy data. Finally, we will test and validate the methods on multiple datasets and distribute them to the brain imaging community.

8.1.4. *MetaCog project*

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

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 activations. 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.

8.1.5. *CDS2*

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Guillaume Lemaitre.

CDS2 is an "Strategic research initiative" of the Paris Saclay University Idex <http://datascience-paris-saclay.fr>. Although it groups together many partners of the Paris Saclay ecosystem, Parietal has been deeply involved in the project. It currently funds a post-doc for Guillaume Lemaitre.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. *MultiFrac project*

Participants: Philippe Ciuciu [Correspondant], Daria La Rocca.

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.

8.2.1.2. *BrainPedia project*

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux.

BrainPedia is an ANR JCJC (2011-2015) which addresses the following question: Neuroimaging produces huge amounts of complex data that are used to better understand the relations between brain structure and function. While the acquisition and analysis of this data is getting standardized in some aspects, the neuroimaging community is still largely missing appropriate tools to store and organize the knowledge related to the data. Taking advantage of common coordinate systems to represent the results of group studies, coordinate-based meta-analysis approaches associated with repositories of neuroimaging publications provide a crude solution to this problem, that does not yield reliable outputs and loses most of the data-related information. In this project, we propose to tackle the problem in a statistically rigorous framework, thus providing usable information to drive neuroscientific knowledge and questions.

8.2.1.3. *Niconnect project*

Participants: Bertrand Thirion, Gaël Varoquaux [Correspondant], Alexandre Abraham, Kamalaker Reddy Dadi, Darya Chyzyk, Mehdi Rahim.

- **Context:** The NiConnect project (2012-2016) arises from an increasing need of medical imaging tools to diagnose efficiently brain pathologies, such as neuro-degenerative and psychiatric diseases or lesions related to stroke. Brain imaging provides a non-invasive and widespread probe of various features of brain organization, that are then used to make an accurate diagnosis, assess brain rehabilitation, or make a prognostic on the chance of recovery of a patient. Among different measures extracted from brain imaging, functional connectivity is particularly attractive, as it readily probes the integrity of brain networks, considered as providing the most complete view on brain functional organization.

- **Challenges:** To turn methods research into popular tool widely usable by non specialists, the NiConnect project puts specific emphasis on producing high-quality open-source software. NiConnect addresses the many data analysis tasks that extract relevant information from resting-state fMRI datasets. Specifically, the scientific difficulties are *i)* conducting proper validation of the models and tools, and *ii)* providing statistically controlled information to neuroscientists or medical doctors. More importantly, these procedures should be robust enough to perform analysis on limited quality data, as acquiring data on diseased populations is challenging and artifacts can hardly be controlled in clinical settings.
- **Outcome of the project:** In the scope of computer science and statistics, NiConnect pushes forward algorithms and statistical models for brain functional connectivity. In particular, we are investigating structured and multi-task graphical models to learn high-dimensional multi-subject brain connectivity models, as well as spatially-informed sparse decompositions for segmenting structures from brain imaging. With regards to neuroimaging methods development, NiConnect provides systematic comparisons and evaluations of connectivity biomarkers and a software library embedding best-performing state-of-the-art approaches. Finally, with regards to medical applications, the NiConnect project also plays a support role in on going medical studies and clinical trials on neurodegenerative diseases.
- **Consortium**
 - Parietal Inria research team: applied mathematics and computer science to model the brain from MRI
 - LIF INSERM research team: medical image data analysis and modeling for clinical applications
 - CATI center: medical image processing center for large scale brain imaging studies
 - Henri-Mondor hospital neurosurgery and neuroradiology: clinical teams conducting research on treatments for neurodegenerative diseases, in particular Huntington and Parkinson diseases
 - Logilab: consulting in scientific computing

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. HBP

Title: The Human Brain Project

Programm: FP7

Duration: October 2013 - September 2016

Coordinator: EPFL

Partners: 100 across Europe

Inria contact: Olivier Faugeras

Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases. This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics,

Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity. A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: Marie Curie

Project acronym: Neuroimaging Power

Project title: Effect size and power for neuroimaging.

Duration: mois année début - mois année fin

Coordinator: Inria

Other partners: Univ. Stanford, USA

Abstract: There is an increasing concern about statistical power in neuroscience research. Critically, an underpowered study has poor predictive power. Findings from a low-power study are unlikely to be reproducible, and thus a power analysis is a critical component of any paper. This project aims to promote and facilitate the use of power analyses. A key component of a power analysis is the specification of an effect size. However, in neuroimaging, there is no standardised way to communicate effect sizes, which makes the choice of an appropriate effect size a formidable task. The best way today to perform a power analysis is by collecting a pilot data set, a very expensive practice. To eliminate the need for pilot data, we will develop a standardised measure of effect size taking into account the spatial variance and the uncertainty of the measurements. Communicating effect sizes in new publications will facilitate the use of power analyses. To further alleviate the need for pilot data, we will provide a library of effect sizes for different tasks and contrasts, using open data projects in neuroimaging. We will integrate our effect size estimator in open repositories NeuroVault and OpenfMRI. Consequently, these effect sizes can then serve as a proxy for a pilot study, and as such, a huge cost in the design of an experiment is eliminated. A new experiment will not be identical to the open data and as such the hypothesised parameters might not be fully accurate. To address this issue, we present a flexible framework to analyse data mid-way without harming the control of the type I error rate. Such a procedure will allow re-evaluating halfway an experiment whether it is useful to continue a study, and how many more subjects are needed for statistically sound inferences. To make our methods maximally available, we will write a software suite including all these methods in different programming platforms and we will provide a GUI to further increase the use of power analyses.

8.4. International Initiatives

8.4.1. MetaMRI

Title: Machine learning for meta-analysis of functional neuroimaging data

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Psychology - Russ Poldrack

Start year: 2015

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

Neuroimaging produces huge amounts of complex data that are used to better understand the relations between brain structure and function. Observing that the neuroimaging community is still largely missing appropriate tools to store and organize the knowledge related to the data, Parietal team and Poldrack's lab, have decided to join forces to set up a framework for functional brain image meta-analysis, i.e. a framework in which several datasets can be jointly analyzed in order to accumulate information on the functional specialization of brain regions. MetaMRI will build upon Poldrack's lab expertise in handling, sharing and analyzing multi-protocol data and Parietal's recent developments of machine learning libraries to develop a new generation of meta-analytic tools.

XPOP Team

9. Partnerships and Cooperations

9.1. European Initiatives

9.1.1. FP7 & H2020 Projects

The Drug Disease Model Resources (DDMoRe) consortium will build and maintain a universally applicable, open source, model-based framework, intended as the gold standard for future collaborative drug and disease modeling and simulation.

The DDMoRe project is supported by the Innovative Medicines Initiative (IMI), a large-scale public-private partnership between the European Union and the pharmaceutical industry association EFPIA.

Marc Lavielle was leader of WP6: "New tools for Model Based Drug Development".

DDMoRe website: <http://www.ddmore.eu>

Duration: 2010 - 2016

Project members: Uppsala Universitet, Sweden; University of Navarra, Spain; Universiteit Leiden, Netherlands; Université Paris Diderot, France; Università degli Studi di Pavia, Italy; UCB Pharma, Belgium; Simcyp, UK; Pfizer, UK; Optimata, Israel; Novo Nordisk, Denmark; Novartis, Switzerland; Merck Serono, Switzerland; Takeda, Switzerland; Mango Business Solutions, UK; Lixoft, France; Interface Europe, Belgium; Institut de Recherches Internationales Servier, France; Inria, France; GlaxoSmithKline Research and Development, UK; Freie Universität Berlin, Germany; F. Hoffmann - La Roche, Switzerland; EMBL - European Bioinformatics Institute, UK; Eli Lilly, UK; Cyprotex Discovery, UK; Consiglio Nazionale delle Ricerche, Italy; AstraZeneca, Sweden.

9.2. International Initiatives

9.2.1. Informal International Partners

Marc Lavielle is Adjunct Professor at the Faculty of Pharmacy of Florida University.

Marc Lavielle is Adjunct Professor at the Faculty of Pharmacy of Buffalo University.

Julie Josse collaborates with Susan Holmes, Stanford University.

Eric Moulines regularly collaborates with Sean P. Meyn, University of Florida.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Ricardo Rios, Universidad Central de Venezuela, Caracas: September 2016.

INFINE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. LiveGrid

Participants: Cedric Adjih, Emmanuel Baccelli.

Infine is one of the teams from Inria participating to LiveGrid: LiveGrid is a consortium of the main actors of industry, research organisations, local authorities and competitive cluster from the Paris-Saclay campus. The goal of LiveGrid is make the Paris-Saclay campus one of the leader regions of smart grids. Infine expertise is in infrastructure: testbeds, communication protocols, embedded open source OS.

8.2. National Initiatives

8.2.1. Equipex FIT

Participants: Cedric Adjih, Emmanuel Baccelli, Alexandre Abadie, Philippe Lubrano, Ichrak Amdouni, Alaeddine Weslati, Vincent Ladeveze.

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

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

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

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

The Infine team is actively collaborating with UPEC on wireless sensor network testbeds (and protocols): in 2015 and 2016, the testbed from UPEC with 45 Arduino nodes has been [integrated with the FIT IoT-LAB testbed](#).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. AGILE (H2020 project)

Participants: Emmanuel Baccelli, Cedric Adjih.

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

Project acronym: AGILE

Project title: Adoptive Gateways for dIverse muLtipLe Environments

Duration: 2015-2017

Coordinator: Emmanuel Baccelli

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

Abstract:

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

8.3.1.2. *ARMOUR (H2020 project)*

Participants: Cedric Adjih, Emmanuel Baccelli, Oliver Hahm.

Program: H2020 ICT-12-2015 Topic: Integrating experiments and facilities in FIRE+

Project acronym: ARMOUR

Project title: Large-Scale Experiments of IoT Security Trust

Duration: 2016-2018

Coordinator: Serge Fdida (UPMC)

Other partners: UPMC (France), Synelixis (Greece), SMA (France), UI (Portugal), JRC (Belgium), EGM (France), OdinS (Spain).

Abstract:

The ARMOUR project is a 2-year H2020 project started in February 2016. The ARMOUR project is aimed at providing duly tested, benchmarked and certified Security & Trust technological solutions for large-scale IoT using upgraded FIRE large scale IoT/Cloud testbeds properly-equipped for Security & Trust experimentations. To this, ARMOUR will: (1) Enhance two outstanding FIRE testbeds (> 2700 nodes; 500 users) with the ARMOUR experimentation toolbox for enabling large-scale IoT Security & Trust experiments; (2) Deliver six properly experimented, suitably validated and duly benchmarked methods and technologies for enabling Security & Trust in the large-scale IoT; and (3) Define a framework to support the design of Secure & Trusted IoT applications as well as establishing a certification scheme for setting confidence on Security & Trust IoT solutions.

8.3.2. *Collaborations in European Programs, Except FP7 & H2020*

8.3.2.1. *EU CHIST-ERA MACACO*

Participants: Aline Carneiro Viana, Emmanuel Baccelli, Eduardo Mucelli.

Program: EU CHIST-ERA, topic Context- and Content-Adaptive Communication Networks

Project acronym: MACACO

Project title: Mobile context-Adaptive CAching for COntent-centric networking

Duration: 2013-2016

Coordinator: Aline Carneiro Viana

Other partners: INPT-ENSEEIH at University of Toulouse, University of Birmingham (UK), SUPSI (Switzerland), CNR (Italy) and Federal University of Minas Gerais (Brazil)

Abstract:

MACACO (Mobile context-Adaptive Caching for Content-centric networking) is a 3-year CHIST-ERA European Project addressing the topic Context- and Content-Adaptive Communication Networks. It is funded by ANR in France, SNSF in Switzerland, and ESPRC in UK. It focus on data offloading mechanisms that take advantage of context and content information. Our intuition is that if it is possible to extract and forecast the behaviour of mobile network users in the three dimensional space of time, location and interest (i.e. what, when and where users are pulling data from the network), it is possible to derive efficient data offloading protocols. Such protocols would pre-fetch the identified data and cache it at the network edge at an earlier time, preferably when the mobile network is less charged, or offers better quality of service. This project has officially started in November 2013.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

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

8.4.1.2. Informal International Partners

- On-going collaboration with Hamburg University of Applied Science around RIOT.
- Informal collaborations with UIUC and UMass.
- Informal collaborations with ENSI Tunis and Sesame Tunis.

8.4.2. Participation in Other International Programs

8.4.2.1. PHC PESSOA 2015

Participant: Aline Carneiro Viana.

PHC PESSOA 2015 with University of Coimbra (2015-2016).

Program: -FCT - Programa PESSOA

Project title: Routine-based Enhanced Connectivity under User Mobility

Duration: 2015-2016

Coordinator: Aline Carneiro Viana and João Paulo da Silva Machado Garcia Vilela (University of Coimbra)

Abstract: The main goal of this project is to improve WiFi connectivity of users under mobility. The steady growth of smart-phones usage has put cellular networks under great strain, justifying the need for WiFi offloading as a solution that transfers part of the demand on cellular networks to WiFi hotspots that are in many cases already available. However, this must be performed in a way that provides benefits to the cellular operator while ensuring users a similar level of connectivity that they would achieve with cellular networks, even under user mobility (e.g. walking, taking a bus/train, etc). In this work we aim at (1) developing prediction mechanisms for selection of best hotspots by users under mobility, and (2) develop lightweight security schemes to reduce the burden of the association/authentication process of WiFi networks, therefore making WiFi offloading an effective and secure alternative to the growing demand on cellular networks.

8.5. International Research Visitors

8.5.1. Visits to International Teams

8.5.1.1. Research Stays Abroad

Emmanuel Baccelli was Visiting Professor at Freie Universitaet (FU) Berlin in 2016, within the context of the formal collaboration IOTPUSH with this university on research topics about the Internet of Things, RIOT and Information-Centric Networking.

AVIZ Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR FITOC: From Individual To Collaborative Visual Analytics

Participants: Petra Isenberg [correspondant], Jean-Daniel Fekete, Pierre Dragicevic, Pascal Goffin, Wesley Willett.

The goal of this project is to help bringing collaboration to existing individual visual data analysis work. It is situated in the domain of information visualization, a subdomain of computer science, but views and tries to support data analysis as a social process. The work is motivated by the fact that a large amount of data analysis work is conducted by individuals in isolated tool, such as Excel, R, SPSS, Tableau, and others. Synthesis and sharing of the results then happens in another set of tools such as notes, email, or office documents. The research is situated in the domain of visualization which has a long tradition of building tools and techniques for individual data analysis. Currently there are technological innovations under way to help people analyze data together, but there is still a disconnect between the two modes of data analysis (collaborative and individual). In this project, we want to find ways in which information can best be used and shared visually while transitioning between individual and collaborative data analysis activities.

The project ended in July, 2016.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CENDARI

Title: Collaborative European Digital/Archival Infrastructure

Programm: FP7

Duration: February 2012 - January 2016

Coordinator: Trinity College - Dublin

Partners:

Consortium of European Research Libraries (United Kingdom)

Koninklijke Bibliotheek (Netherlands)

Fondazione Ezio Franceschini Onlus (Italy)

Freie Universitaet Berlin (Germany)

King's College London (United Kingdom)

"matematički Institutnu, Beograd" (Serbia)

Narodni Knihovna Ceske Republiky (Czech Republic)

Societa Internazionale Per Lo Studio Del Medioevo Latino-S.I.S.M.E.L.Associazione (Italy)

The Provost, Fellows, Foundation Scholars & The Other Members of Board of The College of The Holy & Undivided Trinity of Queen Elizabeth Near Dublin (Ireland)

Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (Germany)

The University of Birmingham (United Kingdom)

Universitaet Stuttgart (Germany)

Universita Degli Studi di Cassino E Del Lazio Meridionale (Italy)

Inria contact: L. Romary

'The Collaborative European Digital Archive Infrastructure (CENDARI) will provide and facilitate access to existing archives and resources in Europe for the study of medieval and modern European history through the development of an 'enquiry environment'. This environment will increase access to records of historic importance across the European Research Area, creating a powerful new platform for accessing and investigating historical data in a transnational fashion overcoming the national and institutional data silos that now exist. It will leverage the power of the European infrastructure for Digital Humanities (DARIAH) bringing these technical experts together with leading historians and existing research infrastructures (archives, libraries and individual digital projects) within a programme of technical research informed by cutting edge reflection on the impact of the digital age on scholarly practice. The enquiry environment that is at the heart of this proposal will create new ways to discover meaning, a methodology not just of scale but of kind. It will create tools and workspaces that allow researchers to engage with large data sets via federated multilingual searches across heterogeneous resources while defining workflows enabling the creation of personalized research environments, shared research and teaching spaces, and annotation trails, amongst other features. This will be facilitated by multilingual authority lists of named entities (people, places, events) that will harness user involvement to add intelligence to the system. Moreover, it will develop new visual paradigms for the exploration of patterns generated by the system, from knowledge transfer and dissemination, to language usage and shifts, to the advancement and diffusion of ideas.'

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- Univ. of Konstanz, Jean-Daniel Fekete collaborates with Michael Behrischon network exploration based on matrices [4], [3].
- NYU, Jean-Daniel Fekete collaborates with Enrico Bertini and his students on multidimensional visualization and exploration [23]/
- Microsoft Research Redmond, Jean-Daniel Fekete collaborates with Nathalie Henry-Riche on the visualization of dynamic networks (see 6.3).
- Stanford University. Mathieu Le Goc, Jean-Daniel Fekete and Pierre Dragicevic collaborate with Sean Follmer on Swarm User Interfaces and the design of the Zooids (section 7.1).
- Univ of Calgary. Pierre Dragicevic collaborates with Wesley Willett on situated data visualization.
- Univ of Washington, Univ Chicago and Univ Zurich. Pierre Dragicevic collaborates with Matthew Kay, Steve Haroz and Chat Wacharamanatham on transparent statistical reporting.
- Microsoft Research, Redmond, University of Waterloo, University of Calgary. Petra Isenberg and Tobias Isenberg collaborate with Bongshin Lee, Mark Hancock, Diane Watson, and Sheelagh Carpendale on touch vs. mouse interaction
- Microsoft Research, Redmond. Petra Isenberg collaborates with Bongshin Lee on mobile visualization research.
- Univ. of Vienna, Austria: Petra Isenberg and Tobias Isenberg collaborate with Torsten Möller and Michael Sedlmair on visualization practices and evaluation of visualization.
- Univ. of Maryland, Baltimore County, USA: Petra Isenberg and Tobias Isenberg collaborate with Jian Chen on visualization practices and evaluation of visualization.
- Georgia Tech, USA: Petra Isenberg and Tobias Isenberg collaborate with John Stasko on visualization practices.
- Univ. Groningen, the Netherlands: Petra Isenberg and Tobias Isenberg collaborate with Lingyun Yu and Konstantinos Efstathiou on context-aware 3D selection.

- Univ. of Granada, Spain: Tobias Isenberg collaborates with Domingo Martín on non-photorealistic rendering.
- Techn. Univ. of Vienna, Austria: Tobias Isenberg collaborates with Ivan Viola on illustrative visualization.
- Univ. of Bergen, Norway: Tobias Isenberg collaborates with Stefan Bruckner on interactive visualization.
- Univ. of Ulm, Germany: Tobias Isenberg collaborates with Timo Ropinski on interactive visualization.
- Worms Univ. of Appl. Sciences, Germany: Tobias Isenberg collaborates with Alexander Wiebel on interactive visualization.
- Univ. Koblenz-Landau, Germany: Tobias Isenberg collaborates with Kai Lawonn on illustrative visualization.
- Univ. Magdeburg, Germany: Tobias Isenberg collaborates with Bernhard Preim on illustrative visualization.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Sriram Karthik Badam, PhD, Univ. of Maryland, from Jun 2016 until Sep 2016
- Yanhong Wu, PhD, Hong-Kong Univ. of Science and Technology, from May to Sep. 2016

CEDAR 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, to start at the end of 2016.
- CBOD (“Cloud-Based Organizational Design”) is a 4-year ANR started in 2014, coordinated by prof. Ahmed Bounfour from UPS. Its goal is to study and model the ways in which cloud computing impacts the behavior and operation of companies and organizations, with a particular focus on the cloud-based management of data, a crucial asset in many companies.
- ContentCheck (2015-2018) is an ANR project in collaboration with U. Rennes 1 (F. Goasdoué), INSA Lyon (P. Lamarre), the LIMSI lab from U. Paris Sud, and the Le Monde newspaper, in particular their fact-checking team Les Décodeurs. Its aim is to investigate content management models and tools for journalistic fact-checking.
- Datalyse is funded for 3.5 years as part of the *Investissement d’Avenir - Cloud & Big Data* national program. The project is led by the Grenoble company Eolas, a subsidiary of Business & Decision. It is a collaboration with LIG Grenoble, U. Lille 1, U. Montpellier, and Inria Rhône-Alpes aiming at building scalable and expressive tools for Big Data analytics. The project has ended in November 2016.

8.1.2. LabEx, IdEx

- Structured, Social and Semantic Search (S4) is a 3-year project started in October 2013, financed by the *LabEx (Laboratoire d’Excellence)* DIGICOSME. The project aims at developing a data model for rich structured content enriched with semantic annotations and authored in a distributed setting, as well as efficient algorithms for top-k search on such content. The project has ended in September 2016.
- CloudSelect is a three-years project started in October 2015. It is financed by the *Institut de la Société Numérique (ISN)* of the IDEX Paris-Saclay; it funds the PhD scholarship of S. Cebiric. The project is a collaboration with A. Bounfour from the economics department of Université Paris Sud. The project aims at exploring technical and business-oriented aspects of data mobility across cloud services, and from the cloud to outside the cloud. Research contributing to this project is carried in collaboration with U. California in San Diego (UCSD) (see Section 3.1).

8.1.3. Others

- ODIN is a four-year project started in 2014, funded by the Direction Générale de l’Armement, between the SemSoft company, IRISA Rennes and Cedar. The project aims to develop a complete framework for analytics on Web data, in particular taking into account uncertainty, based on Semantic Web technologies such as RDF.
- Google Award I. Manolescu has received a Google Award in collaboration with X. Tannier from LIMSI/CNRS and Université de Paris-Sud. The award is given within a call specifically dedicated to computing tools for computational journalism. The project given the award focuses on “Event Thread Extraction for Viewpoint Analysis”; the project has finished at the end of 2016.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

The permanent members of the team participate to build a proposal called GDMA (Graph Data Management and Analytics, for an European Joint Doctorate within the Initial Training Network (ITN) chapter of Europe's H2020 program, with the University of Aalborg (Denmark), Université Libre de Bruxelles, Universitat Politècnica de Catalunya, and University of Ioannina (Greece). If successful the project would involve six PhD thesis co-supervised in Cedar and starting in 2018, three students mostly residing with us, and three abroad working with our partners from Aalborg and Brussels.

I. Manolescu has submitted a Marie-Curie proposal titled IDEAA (An interactive toolbox to help citizens understand and build a viewpoint on specific issues by monitoring, analysing, and interlinking public data from EU institutions) to host a junior researcher (Mirjana Mazuran from Politecnico di Milano) for two years.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

We continue collaborating with U. California in San Diego (UCSD) following the OAKSAD associated team (2013-2015), in particular in the Estocada project (Section 7.1).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Several international guests gave seminars in our group:

- L. Ach and M. Rezk (Rakuten)
- D. Calvanese (University of Bolzano)
- R. Cheng (Hong Kong University)
- M. Franklin (University of Berkeley)
- R. Kontchakov, S. Kikot, M. Zakharyashev (Birbeck University College)
- Y. Papakonstantinou (University of California in San Diego)
- V. Vianu (University of California in San Diego)

8.4.1.1. Internships

- R. Alotaibi visited the team for two months working on scalable heterogeneous stores with D. Bursztyn and I. Manolescu.
- D. Lanti visited the team for five months, working on efficient semantic query answering with D. Bursztyn.

DAHU Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Acronym: PRODAQ

Title: Proof systems for Data Queries

Coordinator: Sylvain Schmitz

Duration: January 2015 – September 2019

Abstract: The project aims at developing proof systems for data logics. It is at the interface between several research communities in database theory, infinite-state system verification and proof theory. The main thrust behind the project is the investigation of proof-theoretic tools for data logic, using in particular insights from substructural logics, and using counter systems as a means to obtain algorithms and complexity results.

8.2. International Research Visitors

8.2.1. Visits of International Scientists

Victor Vianu, June 15 to September 15, UC San diego

EX-SITU Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *MultiVis – Novel Interaction Models for Multi-surface Visualization*

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2014-2017

Coordinator: James Eagan (Institut Mines Telecom)

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

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to design, evaluate, and implement novel interaction models that help users appropriate multiple computational surfaces in the sense-making process. Our initial approach is to operationalize and extend the instrumental interaction model to specifically accommodate the specific needs of the sense-making process for information visualization. This project funds Marc-Emmanuel Perrin, a joint PhD student between the VIA group at Institut Mines-Telecom and ExSitu.

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

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2015-2018

Coordinator: Olivier Rioul (Institut Mines Telecom)

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

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to conduct fundamental studies of aimed movements based on information theory. The project studies the interaction phenomena involved in pointing, in order to discover novel, more effective pointing techniques. This project funds Wanyu Liu, a joint Ph.D. student between the COMELEC and VIA groups at Institut Mines Telecom and ExSitu.

9.1.3. *SensoMotorCVE – Sensor-motor Interface for Collaborative Virtual Environments with Heterogeneous Devices: Application to Industrial Design*

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2014-2017

Coordinator: Patrick Bourdot (LIMSI-CNRS)

Partners: Univ. Paris-Sud, Inria, CNRS

Inria contact: Cédric Fleury

Abstract: In the context of collaborative virtual environments, the goal of this project is to develop a sensorimotor interface model for CAD data manipulation that supports heterogeneous interactive systems such as wall-sized displays or immersive virtual reality rooms. This project funds Yujiro Okuya, a joint Ph.D. student between the VENISE group at LIMSI and ExSitu.

9.1.4. *La Grande Vitrine des Choses*

Type: Art-science grant

Funding: IDEX Paris-Saclay

Duration: 2015-2016

Coordinators: Michel Beaudouin-Lafon & Wendy Mackay

Partners: Univ. Paris-Sud, Inria, CNRS, Theater group $n + 1$

Abstract: Art-science project funded by "La Diagonale Paris-Saclay" to create, in collaboration with the theater group "n+1", an interactive store front in the form of an advent calendar, where users must discover which gestures to perform in order make an animated character open the next window. This installation raises the question of who is controlling whom: Participants think that their gestures directly control the character, but the system actually uses shaping techniques from experimental psychology that encourage users to make successive approximations to the correct gesture. The installation was demonstrated at the Fête de la Science in October, 2016, and was shown during the month of December, 2016 in the Evry shopping mall, next to the Agora Theater. It will also be shown in the Curiositas festival in Gif-sur-Yvette in May, 2017.

9.2. National Initiatives

9.2.1. *Investissements d'Avenir*

9.2.1.1. *Digiscope - Collaborative Interaction with Complex Data and Computation*

Type: EQUIPEX (Equipement d'Excellence)

Duration: 2011-2020

Coordinator: Michel Beaudouin-Lafon

Partners: FCS Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, Ecole Centrale Paris, Université Versailles - Saint-Quentin, ENS Cachan, 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. At the end of 2016, all ten rooms are operational, and the telepresence network is being deployed.

9.2.2. *Institut Universitaire de France*

9.2.2.1. *The Instrumental Paradigm*

Type: IUF senior fellowship

Duration: 2011-2016

Principal investigator: Michel Beaudouin-Lafon

Abstract: Tools or instruments are a natural way to interact with the real world, and can serve as a powerful metaphor to interact with on-line information. An instrument reifies interaction: it turns an interaction into a meaningful object for users, designers and developers. We envision a future where large, monolithic and closed applications are replaced by a rich ecology of instruments and information containers that can interoperate, giving users the power to shape their own environments. Our work on multisurface interaction [2] and Webstrates [5] illustrate this approach.

9.3. European Initiatives

9.3.1. European Research Council (ERC)

9.3.1.1. Creating Human-Computer Partnerships

Program: ERC Advanced Grant

Project acronym: CREATIV

Project title: Creating Human-Computer Partnerships

Duration: mois année début - mois année fin

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.

9.3.1.2. 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.

9.4. International Initiatives

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

9.4.1.1. DECibel

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

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2016

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

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Joanna McGrenere, Professor at University of British Columbia, Vancouver, Canada, visited ExSitu for her entire sabbatical, from September, 2015 to July, 2016.
- Jim Hollan, Professor at University of California at San Diego (UCSD), visited from April to June, 2016.

ILDA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

ScaleGest. Surface Gestures for Advanced Graphical Interfaces: Which Gesture for What. (2014-2017) Funded by Digiteo. In collaboration with Telecom ParisTech: **109Keuros**. Participants: Caroline Appert (PI), Rafael Morales Gonzalez, Emmanuel Pietriga.

The project aims at designing gesture-based interaction for expert users who navigate and manipulate large datasets. In the context of advanced graphical applications, the number of gestures should be large-enough to cover the set of controls (*i.e.*, commands and parameter settings) but remain simple-enough to avoid exceeding human abilities. Making gesture-based interaction scale with graphical applications' growing complexity can be achieved only by understanding the foundational aspects of this input modality. This project is about characterizing and structuring both the space of application controls and the space of surface gestures in order to establish guidelines for appropriate control-gesture mappings. It is also about the definition of a sound and systematic evaluation methodology that will serve as a reference benchmark for evaluating these mappings. The resulting control-gesture mappings are demonstrated in the specific application domains of cartography and astronomy.

9.2. National Initiatives

9.2.1. ANR

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

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

9.2.2. Collaborations with other French Research Organizations

CorTextViz. (2015-2016) Funded by INRA (Institut National de la Recherche Agronomique). In collaboration with project-team Aviz at Inria Saclay (Jean-Daniel Fekete) and INRA (Jean-Philippe Cointet, Guy Riba). Interactive visualization of medium-scale multi-level networks, supporting data storytelling on wall displays. Participants: André Spritzer, Emmanuel Pietriga (PI), Anastasia Bezerianos.

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

- European Southern Observatory (ESO)
- ALMA Operations Monitoring and Control - design and implementation of state-of-the-art interactive visualization components for the operations monitoring and control software that runs the ALMA radio-observatory in Chile.
- 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 [24], to be built in the Canary Islands (Spain) and in the Atacama desert (Chile).

9.4. International Initiatives

9.4.1. Inria International Labs

Inria Chile / CIRIC. 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 [15]. He is now scientific advisor to Inria Chile's visualization lab.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- University of Konstanz: Daniel Keim and Johannes Fuchs on mapping out the design space for visualization glyphs [14]. Participants: Anastasia Bezerianos.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Shumin Zhai, Google, June 2016
- Iftach Sadeh, DESY/CTA Observatory, April 2016

9.5.1.1. Internships

- María Grazia Prato, Inria Chile, April 2016

SMIS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR PerSoCloud (Jan. 2017 - Jan. 2020)

Partners: Orange Labs (coordinator), Inria-SMIS, Cozy Cloud, Univ. of Versailles.
SMIS funding: 170k€.

The objective of PerSoCloud is to design, implement and validate a fullfledged 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. ANR KISS (Dec. 2011 - Feb. 2016)

Partners: Inria-SMIS (coordinator), Inria-SECRET, LIRIS, Univ. of Versailles, CryptoExperts, Gemalto, Yvelines district.
SMIS funding: 230k€.

The idea promoted in KISS is to embed, in trusted devices, software components capable of acquiring, storing and managing securely various forms of personal data (e.g., salary forms, invoices, banking statements, geolocation data, depending on the applications). These software components form a Personal Data Server which can remain under the holder's control. The scientific challenges include: embedded data management issues tackling regular, streaming and spatio-temporal data (e.g., geolocation data), data provenance-based privacy models, crypto-protected distributed protocols to implement private communications and secure global computations.

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

Partners: Cozy Cloud (coordinator), Qwant, Inria-SMIS, FING.
SMIS funding: 149k€.

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

8.1.4. CAPPRIS Project-Lab (Dec. 2011 - Dec. 2016)

Inria Partners: PRIVATICS (coordinator), SMIS, PLANETE, CIDRE, COMETE.
External partners: Univ. of Namur, Eurecom, LAAS.
Funding: not associated to individual project-teams.

An Inria Project Lab (IPL) is a long-term multi-disciplinary project launched by Inria to sustain large scale risky research actions in line with its own strategic plan. CAPPRIS stands for "Collaborative Action on the Protection of Privacy Rights in the Information Society". The key issues that are addressed are: (1) the identification of existing and future threats to privacy, (2) the definition of formally grounded measures to assess and quantify privacy, (3) the definition of the fundamental principles underlying privacy by design and methods to apply them in concrete situations and (4) The integration of the social and legal dimensions. To assess the relevance and significance of the research results, they are confronted to three classes of case studies CAPPRIS partners are involved in: namely Online Social Networks, Location Based Services and Electronic Health Record Systems.

8.1.5. *CityLab@Inria, Inria Project Lab (May 2014 -).*

Inria Partners: CLIME, DICE, FUN, MIMOVE, MYRIADS, SMIS, URBANET, WILLOW.

External partners: UC Berkeley.

Funding: not associated to individual project teams.

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

8.1.6. *VALDO (Valorisation et monétisation des données personnelles à l'ère du Big Data), Digital Society Institute (DSI) (May 2015 - Sept. 2016).*

Partners: DANTE and SMIS (co-organizers), CERDI, RITM.

SMIS funding: 50K€.

The objective of this project is to study with a multidisciplinary approach (i.e., computer science, law and economics) the impact of putting a certain (e.g., monetary) value on personal data, over the behavior of individuals (that are the rightful owners of the data) and market companies (that make usage of the personal data) in terms of data protection practices and data usage.