RESEARCH CENTER

FIELD
Applied Mathematics, Computation and Simulation

Activity Report 2017

Section Partnerships and Cooperations

Edition: 2018-02-19

STOCHASTIC APPROACHES

ACUMES Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Collaboration with Venturi group

In the context of UCA partnerships, a collaboration with Venturi group has been initiated by R. Duvigneau and A. Habbal, concerning the aerodynamic optimization of a Formula-E vehicle and the multi-disciplinary modeling of an electric polar vehicle. This collaboration funded two internships (N. Abettan and A. Guincestre).

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. TramOpt

Title: A Traffic Management Optimization platform for enhanced road network efficiency

Programm: H2020

Duration: Mai 2017 - Octobre 2018

Coordinator: Inria

Inria contact: Paola Goatin

Building on the advances of the ERC TRAM3 project, the TRAMOPT PoC project aims are twofold:

- developing a robust prototype to allow real-life testing and deployment of a novel traffic control Decision Support System (DSS) based on a software platform for road traffic management including variable speed limits, ramp-metering and re-routing policies. This DSS is intended for public and private traffic managers to increase freeway network performances (e.g. congestion and pollution reduction);
- assessing the exploitation perspectives through a dedicated market study evaluating the added value of TRAMOPT over existing solutions and identifying the best business approach to foster uptake and commercialization of our technology.

7.3. International Initiatives

7.3.1. Inria International Labs

Inria@SiliconValley
Associate Team involved in the International Lab:

7.3.1.1. ORESTE

Title: Optimal REroute Strategies for Traffic managEment

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science (EECS) (EECS) - Alexandre M. Bayen

Start year: 2015

See also: http://www-sop.inria.fr/members/Paola.Goatin/ORESTE/index.html

This project focuses on traffic flow modeling and optimal management on road networks. Based on the results obtained during the first three years, we aim at further develop a unified macroscopic approach for traffic monitoring, prediction and control. In particular, we aim at investigating user equilibrium inference and Lagrangian controls actuations using macroscopic models consisting of conservation laws or Hamilton-Jacobi equations.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

- University of Brescia, Information Engineering (R.M. Colombo: http://rinaldo.unibs.it/)
- University of Mannheim, Scientific Computing Research Group (SCICOM) (S. Göttlich: http://lpwima.math.uni-mannheim.de/de/team/prof-dr-simone-goettlich/)
- University of Rutgers - Camden, Department of Mathematical Science (B. Piccoli: https://piccoli.camden.rutgers.edu/)

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- A. Borzi (August 2017, Univ. Wurzburg) : Existence of Nash equilibria for deterministic and stochastic differential games.
- S. Roy (September 2017, Univ. Wurzburg) : Fokker-Planck constrained Nash games and Infinite Dimensional Hamilton-Jacobi equations.
- T. Liard (September 2017, Rutgers University - Camden): well-posedness of traffic control problems by autonomous vehicles.
- A. Keimer (October 2017, UC Berkeley): modeling and well-posedness study for Dynamic Traffic Assignement.

7.4.1.1. Internships

- G. Piacentini (March-July 2017, University of Pavia): traffic control by autonomous vehicles..

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

- N. Laurent-Brouty visited UC Berkeley for 1 month in May 2017

CAGIRE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Predicting head losses in aeronautical fuel injectors

This is a 3-year programme, started mid-2015 and funded by Conseil Régional d'Aquitaine (2014 Call) and two small-size companies, AD Industrie (Gurmençon, France) and GDTECH (Bordes, France). The objective is to investigate the possibility of using advanced RANS or hybrid RANS-LES approaches to better predict the pressure losses in aeronautical fuel nozzles. [PB,RM]

9.1.2. SEIGLE

SEIGLE means "Simulation Expérimentation pour l'Interaction de Gouttes Liquides avec un Ecoulement fortement compressible". It is a 3-year program which has started since October 2017 and was funded by Régional Nouvelle-Aquitaine, ISAE-ENSMA, CESTA and Inria. The interest of understanding aerodynamic mechanisms and liquid drops atomization is explained by the field of applications where they play a key role, specially in the new propulsion technologies through detonation in the aerospace as well as in the securities field. The SEIGLE project was articulated around a triptych experimentation, modeling and simulation. An experimental database will be constituted. It will rely on a newly installed facility (Pprime), similar to a supersonic gust wind tunnel/ hypersonic from a gaseous detonation tube at high pressure. This will allow to test modeling approaches (Pprime / CEA) and numerical simulation (Inria / CEA) with high order schemes for multiphasic compressible flows, suitable for processing shock waves in two-phase media [VP, JJ].

9.2. National Initiatives

9.2.1. GIS Success

We are members of the CNRS GIS Success (Groupement d'Intérêt Scientifique) organised around two of the major CFD codes employed by the Safran group, namely AVBP and Yales 2. No scientific activity has been devoted around those codes during 2017 but Yales2 has been installed and tested on one of our workstation to prepare some planned scientific activity to come in 2018 in the field of low Mach flows and low Reynolds flows simulations [PB].

9.2.2. ANR MONACO_2025 [RM]

The ambition of the MONACO_2025 project, coordinated by Rémi Manceau, is to join the efforts made in *two different industrial sectors* in order to tackle the industrial simulation of transient, turbulent flows affected by buoyancy effects. It brings together two academic partners, the project-team Cagire hosted by the university of Pau, and the institute Pprime of the CNRS/ENSMA/university of Poitiers (PPRIME), and R&D departments of two industrial partners, the PSA group and the EDF group, who are major players of the automobile and energy production sectors, respectively.

- The main **scientific objective** of the project is to make a breakthrough in *the unresolved issue* of the modelling of turbulence/buoyancy interactions in transient situations, within the continuous hybrid RANS/LES paradigm, which consists in preserving a computational cost compatible with industrial needs by relying on statistical approaches where a fine-grained description of the turbulent dynamics is not necessary. The transient cavity flow experiments acquired during MONACO_2025 will provide the partners and the scientific community with *an unrivalled source of knowledge* of the physical mechanisms that must be accounted for in turbulence models.

- The main **industrial objective** is *to make available computational methodologies* to address dimensioning, reliability and security issues in buoyancy-affected transient flows. It is to be emphasized that such problems are *not tackled using CFD at present in the industry*. At the end of MONACO_2025, a panel of methodologies, ranging from simple URANS to sophisticated hybrid model based on improved RANS models, will be evaluated in transient situations, against the dedicated cavity flow experiments and a real car underhood configuration. This final benchmark exercise will form *a decision-making tool* for the industrial partners, and will thus pave the way towards high-performance design of low-emission vehicles and highly secure power plants. In particular, the project is in line with the *Full Digital 2025 ambition*, e.g., the declared ambition of the PSA group to migrate, within the next decade, to a design cycle of new vehicles nearly entirely based on CAE (computer aided engineering), without recourse to expensive full-scale experiments.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. SOPRANO

Participants: Rémi Manceau, Pascal Bruel, [Post doc starting in 2018].

Topic: MG-1.2-2015 - Enhancing resource efficiency of aviation

Project acronym: SOPRANO

Project title: Soot Processes and Radiation in Aeronautical inNOvative combustors

Duration: 01/09/2016 - 31/08/2020

Coordinator: SAFRAN

Other partners:

- France: CNRS, CERFACS, INSA Rouen, SAFRAN SA, Snecma SAS, Turbomeca SA.
- Germany: DLR, GE-DE Gmbh, KIT, MTU, RRD,
- Italy: GE AVIO SRL, University of Florence
- United Kingdom: Rolls Royce PLC, Imperial College of Science, Technology and Medecine, Loughborough University.

Abstract: For decades, most of the aviation research activities have been focused on the reduction of noise and NOx and CO2 emissions. However, emissions from aircraft gas turbine engines of non-volatile PM, consisting primarily of soot particles, are of international concern today. Despite the lack of knowledge toward soot formation processes and characterization in terms of mass and size, engine manufacturers have now to deal with both gas and particles emissions. Furthermore, heat transfer understanding, that is also influenced by soot radiation, is an important matter for the improvement of the combustor's durability, as the key point when dealing with low-emissions combustor architectures is to adjust the air flow split between the injection system and the combustor's walls. The SOPRANO initiative consequently aims at providing new elements of knowledge, analysis and improved design tools, opening the way to: • Alternative designs of combustion systems for future aircrafts that will enter into service after 2025 capable of simultaneously reducing gaseous pollutants and particles, • Improved liner lifetime assessment methods. Therefore, the SOPRANO project will deliver more accurate experimental and numerical methodologies for predicting the soot emissions in academic or semi-technical combustion systems. This will contribute to enhance the comprehension of soot particles formation and their impact on heat transfer through radiation. In parallel, the durability of cooling liner materials, related to the walls air flow rate, will be addressed by heat transfer measurements and predictions. Finally, the expected contribution of SOPRANO is to apply these developments in order to determine the main promising concepts, in the framework of current low-NOx technologies, able to control the emitted soot particles in terms of mass and size over a large range of operating conditions without compromising combustor's liner durability and performance toward NOx emissions.

In the SOPRANO project, our objective is to complement the experimental (ONERA) and LES (CERFACS) work by RANS computations of the flow around a multiperforated plate, in order to build a database making possible a parametric study of mass, momentum and heat transfer through the plate and the development of multi-parameter-dependent equivalent boundary conditions. Our activity is due to start in September 2018.

9.4. International Initiatives

9.4.1. Informal International Partners

- Collaboration with Alireza Mazaheri, from NASA Langley Research Center on the first order formulation of the compressible Navier-Stokes system (2-month leave of V. Perrier at National Institute of Aerospace, Hampton, VA).
- Collaboration with E. Dick (University of Ghent, Belgium) and Y. Moguen (UPPA) on the determination of the best splitting of variables for handling low Mach flows with a pressure-energy based coupling. [PB]
- Collaboration with A. Beketaeva and A. Naïmanova (Institute of Mathematics, Almaty, Kazakhstan) related to the simulations of a supersonic jet in crossflow configuration. Contacts were also made with Axel Vincent from Onera Palaiseau in order to have access to recent experimental data on supersonic combustion.The low-Mach preconditioning of an in-house ENO based compressible flow solver was also adressed. [PB] (10-day stay in Almaty).
- Collaboration with P. Correia (University of Evora, Portugal) related to the development of enhanced boundary conditions for the simulations of Mach zero flows with the artificial compressibility method. [PB] (5-day stay in Evora).
- Collaboration with S. Lardeau (Siemens Industry Software Computational Dynamics, Nuremberg, Germany) on the EB-RSM model and hybrid RANS/LES model for industrial applications. [RM]

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Sergio Elaskar (Conicet and University National of Cordoba, Argentina) visited LMAP-Cagire for a 1-week stay from August 28 to September 1, 2017.
- Prof. Ezequiel Del Rio (Polytechnic University of Madrid) visited LMAP-Cagire for a 4-day stay from August 21 to August 31, 2017. The objective of these two simultaneous visits was to determine the possibility of generating data on the Maveric test facility to validate the intermittency model (mapping) jointly developed by S. Elaskar and E. Del Rio.

CARDAMOM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR MAIDESC

Title: Maillages adaptatifs pour les interfaces instationnaires avec deformations, etirements, courbures.

Type: ANR

Duration: 48 months

Starting date : 1st Oct 2013

Coordinator: Dervieux Alain (Inria Sophia)

Abstract: Mesh adaptive numerical methods allow computations which are otherwise impossible due to the computational resources required. We address in the proposed research several well identified main obstacles in order to maintain a high-order convergence for unsteady Computational Mechanics involving moving interfaces separating and coupling continuous media. A priori and a posteriori error analysis of Partial Differential Equations on static and moving meshes will be developed from interpolation error, goal-oriented error, and norm-oriented error. From the minimization of the chosen error, an optimal unsteady metric is defined. The optimal metric is then converted into a sequence of anisotropic unstructured adapted meshes by means of mesh regeneration, deformation, high stretching, and curvature. A particular effort will be devoted to build an accurate representation of physical phenomena involving curved boundaries and interfaces. In association with curved boundaries, a part of studies will address third-order accurate mesh adaption. Mesh optimality produces a nonlinear system coupling the physical fields (velocities, etc.) and the geometrical ones (unsteady metric, including mesh motion). Parallel solution algorithms for the implicit coupling of these different fields will be developed. Addressing efficiently these issues is a compulsory condition for the simulation of a number of challenging physical phenomena related to industrial unsolved or insufficiently solved problems. Non-trivial benchmark tests will be shared by consortium partners and by external attendees to workshops organized by the consortium. The various advances will be used by SME partners and proposed in software market.

9.1.2. PIA TANDEM

Title: Tsunamis in the Atlantic and the English ChaNnel: Definition of the Effects through numerical Modeling (TANDEM)

Type: PIA - RSNR (Investissement d'Avenir, "Recherches en matière de Sûreté Nucléaire et Radioprotection")

Duration: 48 months

Starting date : 1st Jan 2014

Coordinator: H. Hebert (CEA)

Abstract: TANDEM is a project dedicated to the appraisal of coastal effects due to tsunami waves on the French coastlines, with a special focus on the Atlantic and Channel coastlines, where French civil nuclear facilities have been operated since about 30 years. As identified in the call RSNR, this project aims at drawing conclusions from the 2011 catastrophic tsunami, in the sense that it will allow, together with a Japanese research partner, to design, adapt and check numerical methods of tsunami hazard assessment, against the outstanding observation database of the 2011 tsunami. Then these validated methods will be applied to define, as accurately as possible, the tsunami hazard for the French Atlantic and Channel coastlines, in order to provide guidance for risk assessment on the nuclear facilities.

9.1.3. FUI ICARUS

Title: Intensive Calculation for AeRo and automotive engines Unsteady Simulations.

Type: FUI

Duration: January 2017 - December 2019

Coordinator: Turbomeca, Safran group

9.1.4. APP Bordeaux 1

Title : Reactive fluid flows with interface : macroscopic models and application to self-healing materials

Type : Project Bordeaux 1

Duration : 36 months

Starting : September 2014

Coordinator : M. Colin

Abstract : Because of their high strength and low weight, ceramic-matrix composite materials (CMCs) are the focus of active research, for aerospace and energy applications involving high temperatures. Though based on brittle ceramic components, these composites are not brittle due to the use of a fiber/matrix interphase that manages to preserve the fibers from cracks appearing in the matrix. The lifetime-determining part of the material is the fibers, which are sensitive to oxidation; when the composite is in use, it contains cracks that provide a path for oxidation. The obtained lifetimes can be of the order of hundreds of thousands of hours. These time spans make most experimental investigations impractical. In this direction, the aim of this project is to furnish predictions based on computer models that have to take into account: 1. the multidimensional topology of the composite made up of a woven ceramic fabric; 2. the complex chemistry taking place in the material cracks; 3. the flow of the healing oxide in the material cracks.

9.1.5. APP University of Bordeaux

Title : Modélisation d'un système de dégivrage thermique

Type : Project University of Bordeaux

Duration : 36 months

Starting : October 2016

Coordinator : H. Beaugendre and M. Colin

Abstract : From the beginning of aeronautics, icing has been classified as a serious issue : ice accretion on airplanes is due to the presence of supercooled droplets inside clouds and can lead to major risks such as aircrash for example. As a consequence, each airplane has its own protection system : the most important one is an anti-icing system which runs permanently. In order to reduce gas consumption, de-icing systems are developed by manufacturers. One alternative to real experiment consists in developing robust and reliable numerical models : this is the aim of this project. These new models have to take into account multi-physics and multi-scale environnement : phase change, thermal transfer, aerodynamics flows, etc. We aim to use thin films equations coupled to level-set methods in order to describe the phase change of water. The overall objective is to provide a simulation plateform, able to provide a complete design of these systems.

9.1.6. CRA - Region Aquitaine

Title : Virtual prototyping of EVE engines

Type : Co-funded from Region Aquitaine and Inria

Duration : 36 months

Starting : January 2017

Coordinator : P.M. Congedo

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

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: Ocean ERANET

Project acronym: **MIDWEST**

Project title: Multi-fidelity decision making tools for wave energy systems

Duration: October 2015- October 2018

Coordinator: M. Ricchiuto

Other partners: Chalmers University (Sweden), IST Lisbon (Portugal), DTU Compute (Denmark)

MIDWEST is a project starting in 2016 (kick-off in December 2015) and funded by the EU-OceaneraNET program by the French ADEME, by the Swedish SWEA, and by the Portuguese FCT, aiming at proposing new tools for the wave energy industry. Wave energy converters (WECs) design currently relies on low-fidelity linear hydrodynamic models. While these models disregard fundamental nonlinear and viscous effects – which might lead provide sub-optimal designs – high-fidelity fully nonlinear Navier-Stokes models are prohibitively computational expensive for optimization. The MIDWEST project will provide an efficient asymptotic nonlinear finite element model of intermediate fidelity, investigate the required fidelity level to resolve a given engineering output, construct a multi-fidelity optimization platform using surrogate models blending different fidelity models. Combining know how in wave energy technology, finite element modelling, high performance computing, and robust optimization, the MIDWEST project will provide a new efficient decision making framework for the design of the next generation WECs which will benefit all industrial actors of the European wave energy sector.

Program: H2020 MSCA-ITN

Project acronym: **UTOPIAE**

Project title: Handling the unknown at the edge of tomorrow

Duration: January 2017- December 2020

Coordinator: M. Vasile (Strathclyde University)

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

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

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

9.3. International Initiatives

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

9.3.1.1. COMMUNES

Title: Computational Methods for Uncertainties in Fluids and Energy Systems

International Partner (Institution - Laboratory - Researcher):

CWI (Netherlands) - Scientific Computing Group - Daan Crommelin

Start year: 2017

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

9.3.1.2. HAMster

Title: High order Adaptive moving MeSh finiTE elements in immeRsed computational mechanics

International Partner (Institution - Laboratory - Researcher):

Duke (United States) - Civil & Environmental Engineering and Mechanical Engineering & Material Science - Guglielmo Scovazzi

Start year: 2017

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

This project focuses on adaptive unstructured mesh finite element-type methods for fluid flows with moving fronts. These fronts may be interfaces between different fluids, or fluid/solid, and modelling or physical Â fronts (e.g. shock waves) present in the flow. The two teams involved in the project have developed over the years complementary strategies, Â one focusing more on an Eulerian description aiming at capturing fronts on adaptive unstructured grids, Â the other Â working more on Lagrangian approaches aiming at following exactly some of these features. Unfortunately, classical Lagrangian methods are at a disadvantage in the presence of complex deformation patterns, especially for fronts undergoing large deformations, since the onset of vorticity quickly leads to mesh rotation and eventually tangling. On the other end, capturing approaches, as well as Immersed Boundary/Embedded (IB/EB) methods, while providing Â enormous flexibility when considering complex cases, Â require a careful use of mesh adaptivity to guarantee an accurate capturing of interface physics. The objective of this team is to study advanced hybrid methods combining high order, adaptive, monotone capturing techniques developed in an Eulerian or ALE setting, with fitting techniques and fully Lagrangian approaches.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

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

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

von Karman Institute for Fluid Dynamics (Belgium). With Pr. T. Magin we work on Uncertainty Quantification problems for the identification of inflow condition of hypersonic nozzle flows. With Pr. H. Deconinck we work on the design of high order methods, including goal oriented mesh adaptation strategies

NASA Langley: Dr. Alireza Mazaheri. Collaboration on high order schemes for PDEs with second and third order derivatives, with particular emphasis on high order approximations of solution derivatives.

Technical University of Crete, School of Production Engineering & Management : Pr. A.I. Delis. Collaboration on high order schemes for depth averaged free surface flow models, including robust code to code validation

Chalmers University (C. Eskilsson) and Technical University of Denmark (A.-P. Engsig-Karup) : our collaboration with Chalmers and with DTU compute in Denmark aims at developing high order non hydrostatic finite element Boussinesq type models for the simulation floating wave energy conversion devices such as floating point absorbers ;

University of Delaware: F. Veron. Collaboration on the modelling of rain effects on wave propagation.

CNRS-LIMSI: O. Le Maitre. Collaboration on Uncertainty Quantification methods.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- From 14/07/17 to 23/07/17 and from 18/12/2017 to 13/01/2018 Guglielmo SCOVAZZI, professor at Duke University, US has visited Mario Ricchiuto to work on...
- From 25/07/2017 to 28/07/2017, Anne EGGELS (PhD / CWI) has visited P.M. Congedo and F. Sanson for working around clustering in UQ methods.
- From 02/2017 to 07/2017, Luca Cirrottola (PhD/ Politecnico di Milano) has visited Cecile Dobrzynski to work on..
- From 2/10/17 to 20/10/2017, Loic GIRALDI , post doc at Ecole Centrale de Nantes has visited P.M. Congedo for working on UQ methods.
- From 13/11/17 to 17/11/2017 Ting SONG (PhD / Duke University) has visited Mario Ricchiuto to work on..
- From 15/12/17to 07/01/18 Leo NOUVEAU,post doc at Duke University, has visited Héloise Beaugendre and Mario Ricchiuto to work on..
- From 19/03/17 to 25/03/17, Hossein GORJI, post-doc at the RWTH Aachen University (Germany), has visited Luc Mieussens to work on the modelling of collisions in gases by Fokker-Planck models
- From 06/09/17 to 13/09/17, Kazuo AOKI, professor at the National Cheng Kung University (Taiwan), has visited Luc Mieussens to work on kinetic modelling of rarefied gases.

9.4.1.1. Internships

- From June 2017 to Sep 2017 Alexandre Bourriaud (Inria, M. Sc. Student)
- From Apr 2017 to Aug 2017 Khawla Msheik (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Loic Hale (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Lola Bouet (Inria, M. Sc. Student)
- From Apr 2017 to Sep 2017 Remi Chassagne (Inria, M. Sc. Student)
- From Mar 2017 to Aug 2017 Saad Abouelfateh (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Stephane Capitaine–Vaillant (Inria, M. Sc. Student)
- From Mar 2017 to Aug 2017 Yamina Hamidi (Inria, M. Sc. Student)

DEFI Project-Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Participation in Other International Programs

8.1.1.1. International Initiatives

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.

8.2. International Research Visitors

8.2.1. Visits of International Scientists

- Fioralba Cakoni (2 weeks)
- David Colton (1 week)
- Armin Lechleiter (1 week)
- Rainer Kress (1 week)

8.2.1.1. Internships

- Marwa Kchaou (ENIT) 6 months
- FatmeMustapha (EDF) 6 months
- DucVu (Inria) 3 months

ECUADOR Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. MAIDESC

Ecuador is coordinator of the ANR project MAIDESC, with Inria team Gamma3, University of Montpellier II, CEMEF-Ecole des Mines, Inria-Bordeaux, Lemma and Transvalor. MAIDESC concentrates on mesh adaptation and in particular meshes for interfaces, third-order accuracy, meshes for boundary layers, and curved meshes. Project MAIDESC terminated in november 2017.

8.2. International Initiatives

8.2.1. Inria International Labs

Ecuador participates in the Joint Laboratory for Exascale Computing (JLESC) together with colleagues at Argonne National Laboratory. Laurent Hascoët visited Argonne National Laboratory, december 11-18.

GAMMA3 Project-Team

6. Partnerships and Cooperations

6.1. European Initiatives

6.1.1. FP7 & H2020 Projects

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

6.2. International Initiatives

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

6.2.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2017

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

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

6.2.1.2. MODIS

Title: High-order discrete geometric modeling

International Partner (Institution - Laboratory - Researcher):

Polytechnique Montréal (Canada) - Computer Science - François Guibault

Start year: 2017

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

IPSO Project-Team

5. Partnerships and Cooperations

5.1. Regional Initiatives

- A. Crestetto is member of the project "Pari Scientifique Régional Exprodil".
- M. Lemou is member of the project "Défis" of the University of Rennes 1, leader Nicolas Seguin.

5.2. National Initiatives

5.2.1. ANR MOONRISE: 2015-2019

Participants: Francois Castella, Philippe Chartier, Nicolas Crouseilles, Mohammed Lemou, Florian Mehats.

The project *Moonrise* submitted by Florian Méhats has been funded by the ANR for 4 years, for the period 2015-2019. This project aims at exploring modeling, mathematical and numerical issues originating from the presence of high-oscillations in nonlinear PDEs from the physics of nanotechnologies (quantum transport) and from the physics of plasmas (magnetized transport in tokamaks). The partners of the project are the IRMAR (Rennes), the IMT (Toulouse) and the CEA Cadarache. In the IPSO team, François Castella, Philippe Chartier, Nicolas Crouseilles and Mohammed Lemou are members of the project Moonrise.

Postdocs

- Loïc Le Treust has been hired as a Postdoc, under the supervision of Philippe Chartier and Florian Méhats. His contract started in september 2015 and ended in august 2016. Loïc Le Treust is now assistant professor at the university of Marseille.
- Xiaofei Zhao has been hired as a Postdoc from september 2015 to september 2016 under the supervision of Florian Méhats.

5.2.2. ANR MFG: 2016-2020

Participant: Arnaud Debussche.

Mean Field Games (MFG) theory is a new and challenging mathematical topic which analyzes the dynamics of a very large number of interacting rational agents. Introduced ten years ago, the MFG models have been used in many areas such as, e.g., economics (heterogeneous agent models, growth modeling,...), finance (formation of volatility, models of bank runs,...), social sciences (crowd models, models of segregation) and engineering (data networks, energy systems...). Their importance comes from the fact that they are the simplest (“stochastic control"-type) models taking into account interactions between rational agents (thus getting beyond optimization), yet without entering into the issues of strategic interactions. MFG theory lies at the intersection of mean field theories (it studies systems with a very large number of agents), game theory, optimal control and stochastic analysis (the agents optimize a payoff in a possibly noisy setting), calculus of variations (MFG equilibria may arise as minima of suitable functionals) and partial differential equations (PDE): In the simplest cases, the value of each agent is found by solving a backward Hamilton-Jacobi equation whereas the distribution of the agents’ states evolves according to a forward Fokker-Planck equation. The “Master" equation (stated in the space of probability measures) subsumes the individual and collective behaviors. Finally, modeling, numerical analysis and scientific computing are crucial for the applications. French mathematicians play a world-leading role in the research on MFG: The terminology itself comes from a series of pioneering works by J.-M. Lasry and P.-L. Lions who introduced most of the key ideas for the mathematical analysis of MFG; the last conference on MFG was held last June in Paris and organized by Y. Achdou, P. Cardaliaguet and J.-M. Lasry. As testifies the proposal, the number of researchers working on MFG in France (and also abroad) is extremely fast-growing, not only because the theoretical aspects are exciting and challenging, but also because MFG models find more and more applications. The aim of the project is to better coordinate the French mathematical research on MFG and to achieve significant progress in the theory and its applications.

The partners of the project are the CEREMADE laboratory (Paris Dauphine), the IRMAR laboratory (Rennes I), the university of Nice and of Tours.

5.2.3. ANR ACHYLLES: 2014-2018

Participant: Anais Crestetto.

The ACHYLLES project focuses on Long-Time Asymptotic-Preserving (LTAP) numerical schemes for hyperbolic systems of conservation laws supplemented by potentially stiff source terms. It ambitions to perform a breakthrough in the understanding and efficiency of LTAP scheme.

The partners are IMB (Bordeaux), LMV (Versailles) and LMJL (Nantes).

5.2.4. IPL FRATRES

IPSO is associated to IPL FRATRES which started in june 2015. The aim of this project is to organize Inria teams activities which develop mathematical and numerical tools in magnetically confined nuclear fusion. The ambition is to prepare the next generation of numerical modeling methodologies able to use in an optimal way the processing capabilities of modern massively parallel architectures. This objective requires close collaboration between a) applied mathematicians and physicists that develop and study mathematical models of PDE; b) numerical analysts developing approximation schemes; c) specialists of algorithmics proposing solvers and libraries using the many levels of parallelism offered by the modern architecture and d) computer scientists. The project road map ambitions to contribute in close connection with National and European initiatives devoted to nuclear Fusion to the improvement and design of numerical simulation technologies applied to plasma physics and in particular to the ITER project for magnetic confinement fusion.

Postdoc

- Xiaofei Zhao has been hired as a Postdoc, under the supervision of Nicolas Crouseilles and Sever Hirstoaga (Inria-Nancy). His contract started in october 2016 and ended in september 2017.

5.3. European Initiatives

5.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: EUROFusion Enabling Research

Project acronym: WPENR

Project title: Verification and development of new algorithms for gyrokinetic codes

Duration: january 2015 - december 2017.

Coordinator: E. Sonnendrücker (Max-Planck IPP, Germany)

Other partners: IPP, EPFL, CEA-Cadarache, university of Strasbourg, Toulouse, Marseille, Paris 6.

Abstract: Gyrokinetic codes play a major role in understanding the development and saturation of micro-turbulence in a magnetic fusion plasma and its influence on energy confinement time. The first aim of this proposal is to assess the reliability of gyrokinetic codes by extensive verification and benchmarking. All the major european gyrokinetic codes are involved in the proposal and this will enable them to define comparison elements, which ultimately will also facilitate the cross-validation of new physics. On the other hand we will develop new algorithms for extending the physics capabilities or the computational efficiency of different gyrokinetic codes. Finally we will also perform a prospective investigation of models and numerical methods that could help in the future to address physics where kinetic effects might play an important role but that cannot be handled with today's gyrokinetic codes, like L-H (low to high confinement) transition, edge physics or MHD time scales simulations.

5.4. International Initiatives

5.4.1. Informal International Partners

Members of the IPSO team have several international collaborations

- the group of S. Jin (university of Wisconsin, US).
- the group of W. Bao (university of Singapore).
- G. Vimart (university of Geneva, Swizerland).
- the group of A. Ostermann (university of Innsbrück).
- the SNS of Pisa (G. Da Prato).
- several US universities: Maryland (S. Cerrai), Chicago (C. Sparber), Colorado (O. Pinaud), $\cdots$
- $\cdots$

5.4.2. Participation in Other International Programs

- A. Crestetto is involved in the project PHC PROCOPE "Hétérogénéités Fortes dans les Modèles d'Ecoulement Fluide".

5.5. International Research Visitors

5.5.1. Visits to International Teams

- P. Chartier was invited by Fernando Casas, University of Castellon, Spain, July 6-9 2017.
- A. Crestetto was invited by Christian Klingenberg, Institute of Mathematics, Würzburg University, July 10-14 2017.
- M. Lemou was invited by Shi Jin, Jiao Tong university Shanghai, China, July 5-15 2017.
- M. Lemou was invited by Hao Wu, Tsinghua university Beijing, China, July 15-20 2017.

MATHERIALS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

The project-team is involved in several ANR projects:

- S. Boyaval is the PI of the ANR JCJC project SEDIFLO (2016-2020) to investigate new numerical models of solid transport in rivers.
- G. Stoltz is the PI of the ANR project COSMOS (2014-2018) which focuses on the development of efficient numerical techniques to simulate high-dimensional systems in molecular dynamics and computational statistics. It includes research teams from Institut Mines-Telecom, Inria Rennes and IBPC Paris.
- E. Cancès is a member of the ANR project BECASIM (2013-2017), PI: I. Danaila (Université de Rouen). This project is concerned with the numerical simulation of Bose-Einstein condensates.
- F. Legoll is a member of the ANR project CINE-PARA (2015-2019), PI: Y. Maday, UPMC. This project is concerned with parallel-in-time algorithms.

Members of the project-team are participating in the following GdR:

- CORREL (correlated methods in electronic structure computations),
- EGRIN (gravity flows),
- MANU (MAthematics for NUclear applications)
- MASCOT-NUM (stochastic methods for the analysis of numerical codes),
- MEPHY (multiphase flows)
- DYNQUA (time evolution of quantum systems, with applications to transport problems, nonequilibrium systems, etc.),
- REST (theoretical spectroscopy),
- CHOCOLAS (experimental and numerical study of shock waves).

The project-team is involved in two Labex, namely the Labex Bezout (started in 2011) and the Labex MMCD (started in 2012).

9.2. European Initiatives

The ERC consolidator Grant MSMATH (ERC Grant Agreement number 614492, PI T. Lelièvre) is running (it started in June 2014).

9.3. International Initiatives

The *Germaine de Staël* grant awarded to S. Boyaval (from CampusFrance Hubert-Curien program) has been used in 2017 to pursue the collaboration with A. Caboussat (Lausanne) about 3D numerical simulations of free-surface flows.

T. Lelièvre, G. Stoltz and F. Legoll participate in the Laboratoire International Associé (LIA) CNRS / University of Illinois at Urbana-Champaign on complex biological systems and their simulation by high performance computers. This LIA involves French research teams from Université de Nancy, Université de Lyon and Université Aix-Marseille. The LIA is renewed for 4 years, starting January 1st, 2018.

MEMPHIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Leading team of the regional project "Investigation and Modeling of Suspensions with the LOMA and LOF labs in Bordeaux

9.2. National Initiatives

We belong to the GDR AMORE on ROMs.

9.2.1. Starting grants

NEMO (A Numerical Enabler for MultiPhysics Simulations on Octrees) is an action to improve and merge all the main MEMPHIS numerical codes. To achieve this goal we have a 12 months financial support (Inria BSO FRM) for a young engineer. This work will be done with strong interaction the the local Inria BSO SED as well as Philippe Depouilly from the IMB "SED".
SMecH is a start-up project in software edition, carried on by Florian Bernard, research engineer in the MEMPHIS team. The project aims at porting to an industrial level the numerical codes developed by the MEMPHIS team. The different collaboration with industrial partners have highlighted the need of new numerical tools to simulate high complexity phenomena such as atmospheric reentries, multi-material flows or fund-structure interactions, but also to highly automatize the numerical simulation workflow to save engineer time. The research codes developed in the MEMPHIS team could match perfectly to this need thanks to:

- the various innovative multi-physics models implemented
- the use of Hierarchical Cartesian schemes that automatize the treatment of moving geometry with accuracy
- the development of schemes suitable for High Parallel Computing.

This year, the project has been submitted to the DGDT, the Inria department in charge of technological transfert, and has been granted an engineer for 6 months as well as the support of IT-Translation.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

EU research projects were and will be a privileged instrument of diffusion and transfer of our results. The AEROGUST H2020 project involves aeronautical industry (Airbus, Dassault, Piaggio..) and research labs (University of Bristol, DLR, NLR, University of Cape Town) and is dedicated to modeling of aerodynamic gust response for applications. We take part in this project by developing simulation models for unsteady aeroelastic problems and data-driven reduced-order models. We played a similar role for the past in the FP7 project FFAST with the same partners.

9.3.1.1. AEROGUST

Title: Aeroelastic Gust Modelling

Programm: H2020

Duration: May 2015 - April 2018

Coordinator: University of Bristol

Partners:

Airbus Defence and Space (Germany)

University of Cape Town (South Africa)

Dassault Aviation (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Stichting Nationaal Lucht- en Ruimtevaartlaboratorium (Netherlands)

Numerical Mechanics Applications International (Belgium)

Optimad Engineering S.R.L. (Italy)

Piaggio Aero Industries Spa (Italy)

The University of Liverpool (United Kingdom)

University of Bristol (United Kingdom)

Valeol (France)

Inria contact: Angelo IOLLO and Michel Bergmann

Encounters with atmospheric turbulence are a vitally important in the design and certification of many manmade structures such as aircraft and wind turbines. Gusts cause rapid changes in the flow about the structures which leads to rigid and flexible unsteady responses. Knowledge of aircraft/gust interactions is therefore vital for loads estimation during aircraft design as it impacts on control systems and often defines the maximum loads that these structures will experience in service. At present industry typically uses the linear doublet lattice method with static loads corrections from expensive wind tunnel data. The wind tunnel data is created using the final aerodynamic surface in the predicted cruise shape. This means that gust loads come relatively late when the design options have been narrowed. Increased competition and environmental concerns are likely to lead to the adoption of more flexible materials and the consideration of novel configurations, in which case the linear assumptions of the current gust loads process will become unacceptable. To introduce non-linearity into the gust loads process without significantly increasing the cost and time, this project has three main objectives: to carry out investigations using CFD so that the non-linearities in gust interactions are understood; to create a gust loads process that does not require wind tunnel data and hence reduces the need for wind tunnel testing; to develop updated reduced order models for gust prediction that account for non-linearity at an acceptable cost. These investigations will reduce the need for expensive wind tunnel testing and hence lead to time and cost savings at the design stage therefore ensuring that the European aerospace and defense industry remain competitive in the future. The wind turbine industry has similar concerns, with gusts and wind shear restricting the locations available for wind farms. The project will also address these issues using common methodology.

9.3.2. Collaborations with Major European Organizations

Partner 1: Chalmers University (Sweden)

This activity is complemented by several international interactions, in particular with Chalmers University in order to converge towards the real implementation of new control technologies on cars, buses and trucks.

Partner 2: Optimad Engineering , Torino (Italy)

We have a crucial partnership with Optimad Engineering, a spin-off of the Politecnico di Torino. This society has implemented in industrial codes several schemes that we have developed for the past. In exchange, we have access to these codes. One example is Pablo, an octree managing parallel library (http://www.optimad.it/products/pablo/). Three former PhD students at Inria are presently employed in Optimad and several others have spent or will spend a research period in this company in order to get acquainted with code architecture and massive parallelism. This company represents for us an ideal partner for the actual industrial feedback on our methods. As mentioned, we plan to create a local start-up in close collaboration with Optimad. This start-up will respond to actual industrial needs by specific software packages built starting from open source tools that are made available to the applied research community via a consortium. Florian Bernard has been recruited in Memphis for two years with the objective of bringing to a higher maturity level a set of modules developed within the team. He plans to fully invest himself in the creation of the start-up. As for the consortium, we are discussing with several partners including Cineca (Italy HPC center) and Optimad about how to structure such a mutual effort. The Storm Inria team is included in the discussions as a possible partner.

Partner 3: W4E (Wave for Energy) (Italy)

One project is the design of an ISWEC (Inertial See Wave Energy Converter) in collaboration with W4E (Wave for Energy), Optimad and others. The ISWEC is a floater prototype that can extract energy form the sea waves. The mechanism is based on a gyroscope that is rotating due to the passive motion of the floater. This prototype is actually tested in the Mediterranean sea in Italy. We will develop the numerical simulation as well as the shape optimization of the ISWEC.

Partner 4: MRGM (Maladies Rares : Génétique et Métabolisme), Bordeaux University (France)

We develop a collaboration with the MRGM lab. They are interested in the swimming of a zebrafish larvae under genetic modifications. One aim is to quantify the power spent by such fishes to swim after a stimuli reaction. The numerical simulation we develop can help computing integral quantities such as the power. This simulation is challenging due to the coupling several methods like image treatment (from movies given by MRGM), optimal transport and numerical simulations.

Partner 5: CRPP (Centre de recherche Paul Pascal), LOF (Laboratoire du Futur) and LOMA (Laboratoire Ondes et Matière d'Aquitaine) labs, Bordeaux University, France.

We established collaborations with physics and chemistry labs in Bordeaux, namely the CRPP, the LOF and the LOMA. They are concerned with the behavior of many passive (CRPP and LOF) and active (LOMA) particles in an incompressible flow. With these partners, we intend to use a combined experimental and computational approach to calibrate models in the case of dilute and concentrated suspensions. The numerical simulations of such particles can help to understand some underlying phenomena at the particles scale and thus to develop mesoscopic models for the whole system (PhD of Baptiste Lambert, oct. 2015).

9.4. International Research Visitors

9.4.1. Visits to International Teams

We have obtained a grant from the Idex Bordeaux of $10keuro$ to start a collaboration with Charbel Farhat of Stanford University on ROMs.

MEPHYSTO Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. ANR BECASIM

G. Dujardin is a member of the ANR BECASIM project (http://becasim.math.cnrs.fr/). This ANR project gathers mathematicians with theoretical and numerical backgrounds together with engineers. The objective is to develop numerical methods to accurately simulate the behavior of Bose-Einstein condensates.

Title: Simulation numérique avancée pour les condensats de Bose-Einstein.

Type: Modèles Numériques - 2012.

ANR reference: ANR-12-MONU-0007.

Coordinator: Ionut DANAILA, Université de Rouen.

Duration: January 2013 - December 2017.

Partners: Université Lille 1, UPMC, Ecole des Ponts ParisTech, Inria-Nancy Grand-Est, Université Montpellier 2, Université Toulouse 3.

5.1.2. ANR EDNHS

M. Simon is a member of the ANR EDNHS project.

Title: Diffusion de l'énergie dans des système hamiltoniens bruités.

Type: Défi de tous les savoirs (DS10) 2014.

ANR reference: ANR-14-CE25-0011.

Coordinator: Cédric Bernardin, Université de Nice.

Duration: October 2014 - October 2019.

5.1.3. Labex CEMPI

Title: Centre Européen pour les Mathématiques, la Physique et leurs Interactions.

Coordinator: Stephan De Bièvre.

Duration: January 2012 - December 2019.

Partners: Laboratoire Paul Painlevé and Laser physics department (PhLAM), Université Lille 1.

The "Laboratoire d'Excellence" Centre Européen pour les Mathématiques, la Physique et leurs interactions (CEMPI), a project of the Laboratoire de Mathématiques Paul Painlevé and the Laboratoire de Physique des Lasers, Atomes et Molécules (PhLAM), was created in the context of the "Programme d'Investissements d'Avenir" in February 2012.

The association Painlevé-PhLAM creates in Lille a research unit for fundamental and applied research and for training and technological development that covers a wide spectrum of knowledge stretching from pure and applied mathematics to experimental and applied physics.

One of the three focus areas of CEMPI research is the interface between mathematics and physics. This focus area encompasses three themes. The first is concerned with key problems of a mathematical, physical and technological nature coming from the study of complex behavior in cold atoms physics and non-linear optics, in particular fibre optics. The two other themes deal with fields of mathematics such as algebraic geometry, modular forms, operator algebras, harmonic analysis and quantum groups that have promising interactions with several branches of theoretical physics.

5.1.4. PEPS “Jeunes Chercheurs”

M. Simon obtained a CNRS grant "PEPS Jeunes Chercheurs" for a project in collaboration with Oriane Blondel (Université Lyon 1), Clément Erignoux (IMPA, Rio de Janeiro) and Makiko Sasada (Tokyo University).

5.1.5. MIS

Incentive Grant for Scientific Research (MIS) of the Fonds National de la Recherche Scientifique (Belgium).

Title: Patterns, Phase Transitions, 4NLS & BIon.

Coordinator: D. Bonheure.

Duration: January 2014 - December 2016.

Partner: Université libre de Bruxelles.

5.1.6. PDR

Research Project (PDR) of the Fonds National de la Recherche Scientifique (Belgium).

D. Bonheure is co-investigator of this PDR.

Title: Asymptotic properties of semilinear systems.

Coordinator: Christophe Troestler (UMons).

Duration: July 2014 - June 2018.

Partner: Université de Mons, Université catholique de Louvain, Université libre de Bruxelles.

5.2. European Initiatives

5.2.1. FP7 & H2020 Projects

5.2.1.1. QUANTHOM

Title: Quantitative methods in stochastic homogenization.

Programm: FP7.

Duration: February 2014 - August 2017.

Coordinator: Inria.

Partner: Département de mathématique, Université Libre de Bruxelles (Belgium).

Inria contact: Antoine Gloria.

This proposal deals with the development of quantitative tools in stochastic homogenization, and their applications to materials science. Three main challenges will be addressed. First, a complete quantitative theory of stochastic homogenization of linear elliptic equations will be developed starting from results we recently obtained on the subject combining tools originally introduced for statistical physics, such as spectral gap and logarithmic Sobolev inequalities, with elliptic regularity theory. The ultimate goal is to prove a central limit theorem for solutions to elliptic PDEs with random coefficients. The second challenge consists in developing an adaptive multiscale numerical method for diffusion in inhomogeneous media. Many powerful numerical methods were introduced in the last few years, and analyzed in the case of periodic coefficients. Relying on my recent results on quantitative stochastic homogenization, we have made a sharp numerical analysis of these methods, and introduced more efficient variants, so that the three academic examples of periodic, quasi-periodic, and random stationary diffusion coefficients can be dealt with efficiently. The emphasis of this challenge is put on the adaptivity with respect to the local structure of the diffusion coefficients, in order to deal with more complex examples of interest to practitioners. The last and larger objective is to make a rigorous connection between the continuum theory of nonlinear elastic materials and polymer-chain physics through stochastic homogenization of nonlinear problems and random graphs. Analytic and numerical preliminary results show the potential of this approach. We plan to derive explicit constitutive laws for rubber from polymer chain properties, using the insight of the first two challenges. This requires a good understanding of polymer physics in addition to qualitative and quantitative stochastic homogenization.

5.2.2. HyLEF

M. Simon is a collaborator of the ERC HyLEF project.

- Title: Hydrodynamic Limits and Equilibrium Fluctuations: universality from stochastic systems.
- Duration: May 2017 - April 2022.
- Coordinator: P. Gonçalves, Instituto Superior Técnico, Lisbon.
- A classical problem in the field of interacting particle systems (IPS) is to derive the macroscopic laws of the thermodynamical quantities of a physical system by considering an underlying microscopic dynamics which is composed of particles that move according to some prescribed stochastic, or deterministic, law. The macroscopic laws can be partial differential equations (PDE) or stochastic PDE (SPDE) depending on whether one is looking at the convergence to the mean or to the fluctuations around that mean.

  One of the purposes of this research project is to give a mathematically rigorous description of the derivation of SPDE from different IPS. We will focus on the derivation of the stochastic Burgers equation (SBE) and its integrated counterpart, namely, the KPZ equation, as well as their fractional versions. The KPZ equation is conjectured to be a universal SPDE describing the fluctuations of randomly growing interfaces of 1d stochastic dynamics close to a stationary state. With this study we want to characterize what is known as the KPZ universality class: the weak and strong conjectures. The latter states that there exists a universal process, namely the KPZ fixed point, which is a fixed point of the renormalization group operator of spacetime scaling 1:2:3, for which the KPZ is also invariant. The former states that the fluctuations of a large class of 1d conservative microscopic dynamics are ruled by stationary solutions of the KPZ.

  Our goal is threefold: first, to derive the KPZ equation from general weakly asymmetric systems, showing its universality; second, to derive new SPDE, which are less studied in the literature, as the fractional KPZ from IPS which allow long jumps, the KPZ with boundary conditions from IPS in contact with reservoirs or with defects, and coupled KPZ from IPS with more than one conserved quantity. Finally, we will analyze the fluctuations of purely strong asymmetric systems, which are conjectured to be given by the KPZ fixed point.

5.3. International Initiatives

5.3.1. Inria International Partners

5.3.1.1. Informal International Partners

Max Planck Institute for Mathematics in the Sciences: long-term collaboration with Felix Otto on stochastic homogenization.
University of Umea: long-time collaboration with David Cohen on numerical methods for the numerical integration of stochastic evolution problems.

5.4. International Research Visitors

5.4.1. Research Stays Abroad

M. Simon spent three weeks in Berkeley University, visiting Pr. Alan Hammond (July 2017).
M. Simon spent two weeks at Braga University, as a guest of P. Gonçalves (September 2017).

MOKAPLAN Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

J-D. Benamou is the coordinator of the ANR ISOTACE (Interacting Systems and Optimal Transportation, Applications to Computational Economics) ANR-12-MONU-0013 (2012-2016). The consortium explores new numerical methods in Optimal Transportation AND Mean Field Game theory with applications in Economics and congested crowd motion. Check https://project.inria.fr/isotace/.
J-D. Benamou and G. Carlier are members of the ANR MFG (ANR-16-CE40-0015-01). Scientific topics of the project: Mean field analysis Analysis of the MFG systems and of the Master equation Numerical analysis Models and applications
J-D. Benamou G. Carlier F-X. Vialard and T. Gallouët are members of ANR MAGA (ANR-13-JS01-0007-01). The Monge-Ampère equation is a fully nonlinear elliptic equation, which plays a central role in geometry and in the theory of optimal transport. However, the singular and non-linear nature of the equation is a serious obstruction to its efficient numerical resolution. The first aim of the MAGA project is to study and to implement discretizations of optimal transport and Monge-Ampère equations which rely on tools from computational geometry (Laguerre diagrams). In a second step, these solvers will be applied to concrete problems from various fields involving optimal transport or Monge-Ampère equations such as computational physics: early universe reconstruction problem, congestion/incompressibility constraints economics: principal agent problems, geometry: variational problems over convex bodies, reflector and refractor design for non-imaging optics
T. Gallouët is member of the ANR GEOPOR Scientific topic: geometrical approach, based on Wasserstein gradient flow, for multiphase flows in porous media. Theory and Numerics.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- J-D. Benamou is a member of the ITN ROMSOC (Nov. 2017-Nov.2021).
- Andrea Natale has a PRESTIGE Post-Doc Fellowship.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

The following people visited MOKAPLAN during 2016.

- Alfred Galichon (Courant), Teresa Radice (Naples), Gaoyue Guo (Oxford) visited G. Carlier at inria in 2017
- Simone di Marino (Pisa)

NACHOS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Inria Project Lab

7.1.1.1. C2S@Exa (Computer and Computational Sciences at Exascale)

Participants: Olivier Aumage [STORM project-team, Inria Bordeaux - Sud-Ouest], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri [Coordinator of the project], Jean-François Méhaut [CORSE project-team, Inria Grenoble - Rhône-Alpes], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is coordinating the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

7.1.2. ANR project

7.1.2.1. TECSER

Participants: Emmanuel Agullo [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Xavier Antoine [CORIDA project-team, Inria Nancy - Grand-Est], Patrick Breuil [Nuclétudes, Les Ulis], Thomas Frachon, Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri, Ludovic Moya, Guillaume Sylvand [Airbus Group Innovations].

Type: ANR ASTRID

Duration: May 2014 - April 2017

Coordinator: Inria

Partner: Airbus Group Innovations, Inria, Nuclétudes

Inria contact: Stéphane Lanteri

Abstract: the objective of the TECSER project is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. DEEP-ER

Title: Dynamic Exascale Entry Platform - Extended Reach

Program: FP7

Duration: October 2013 - September 2016

Coordinator: Forschungszentrum Juelich Gmbh (Germany)

Partner: Intel Gmbh (Germany), Bayerische Akademie der Wissenschaften (Germany), Ruprecht-Karls-Universitaet Heidelberg (Germany), Universitaet Regensburg (Germany), Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V (Germany), Eurotech Spa (Italy), Consorzio Interuniversitario Cineca (Italy), Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain), Xyratex Technology Limited (United Kingdom), Katholieke Universiteit Leuven (Belgium), Stichting Astronomisch Onderzoek in Nederland (The Netherlands) and Inria (France).

Inria contact: Stéphane Lanteri

Abstract: the DEEP-ER project aims at extending the Cluster-Booster Architecture that has been developed within the DEEP project with a highly scalable, efficient, easy-to-use parallel I/O system and resiliency mechanisms. A Prototype will be constructed leveraging advances in hardware components and integrate new storage technologies. They will be the basis to develop a highly scalable, efficient and user-friendly parallel I/O system tailored to HPC applications. Building on this I/O functionality a unified user-level checkpointing system with reduced overhead will be developed, exploiting multiple levels of storage. The DEEP programming model will be extended to introduce easy-to-use annotations to control checkpointing, and to combine automatic re-execution of failed tasks and recovery of long-running tasks from multi-level checkpoint. The requirements of HPC codes with regards to I/O and resiliency will guide the design of the DEEP-ER hardware and software components. Seven applications will be optimised for the DEEP-ER Prototype to demonstrate and validate the benefits of the DEEP-ER extensions to the Cluster-Booster Architecture.

7.2.1.2. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

- Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)
- Commissariat A L Energie Atomique et Aux Energies Alternatives (France)
- Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)
- Consiglio Nazionale Delle Ricerche (Italy)
- The Cyprus Institute (Cyprus)
- Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)
- Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)
- Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)
- Forschungszentrum Julich (Germany)
- Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany)
- University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

The aim of the present proposal is to establish an Energy Oriented Centre of Excellence for computing applications, (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

7.2.1.3. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partner: Barcelona Supercomputing Center (Spain), Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas - CIEMAT (Spain), REPSOL SA (Spain), Iberdrola Renovables Energia SA (spain), Lancaster University (United Kingdom), COPPE/UFRJ - Universidade Federal do Rio de Janeiro (Brazil), LNCC (Brazil), INF/UFRGS - Universidade Federal do Rio Grande do Sul (Brazil), CER/UFPE - Universidade Federal de Pernambuco (Brazil), PETROBRAS (Brazil), TOTAL SA (France), and Inria (France).

Inria contact: Stéphane Lanteri

Abstract: This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO2 emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial

applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

7.3. International Initiatives

7.3.1. Inria Associate Teams not involved in an Inria International Labs

7.3.1.1. HOMAR

Title: High performance Multiscale Algorithms for wave pRopagation problems

International Partner (Institution - Laboratory - Researcher):

Laboratório Nacional de Computaçao Científica (Brazil) - Coordenaçao de Matemática Aplicada e Computaciona - Frédéric Valentin

Start year: 2015

See also: http://www-sop.inria.fr/nachos/index.php/Main/HOMAR

The general scientific context of the collaboration proposed in the HOMAR project is the study of time dependent wave propagation problems presenting multiscale features (in space and time). The general goal is the design, analysis and implementation of a family of innovative high performance numerical methods particularly well suited to the simulation of such multiscale wave propagation problems. Mathematical models based on partial differential equations (PDE) embedding multiscale features occur in a wide range of scientific and technological applications involving wave propagation in heterogeneous media. Electromagnetic wave propagation and seismic wave propagation are two relevant physical settings that will be considered in the project. Indeed, the present collaborative project will focus on two particular application contexts: the interaction of light (i.e. optical wave) with nanometer scale structure (i.e. nanophotonics) and, the interaction of seismic wave propagation with geological media for quantitative and non destructive evaluation of imperfect interfaces.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

Prof. Kurt Busch, Humboldt-Universität zu Berlin, Institut für Physik, Theoretical Optics & Photonics

Prof. Martijn Wubs, Technical University of Denmark (DTU), Structured Electromagnetic Materials Theory group

Dr. Urs Aeberhard and Dr. Markus Ermes, Theory and Multiscale Simulation, IEK-5 Photovoltaik, Forschungszentrum Jülich, Germany

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Prof. Liang Li, School of Mathematical Sciences, University of Electronic Science and Technology of China, Chengdu. From March 2016 to February 2017.

Dr. Antonio Tadeu Gomez and Dr. Frédéric Valentin, LNCC, Petropolis, Brazil. From December 15, 2016 to February 15, 2017.

7.4.2. Visits to International Teams

Claire Scheid, guest researcher's stays, KIT, Karlsruhe, financed by the CRC 1173 "Wave phenomena: analysis and numerics": 3 weeks from 12 June to 6 July 2017, and 5 weeks from 19 November to 23 December 2017.

NANO-D Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

In 2015, NANO-D had funding from one ANR program:

- **ANR Modeles Numeriques (MN)**: 180,000 Euros over four years (2011-2015). This project, coordinated by NANO-D (S. Grudinin), gathers biologists and computer scientists from three research groups: Dave Ritchie at LORIA, Valentin Gordeliy at IBS (total grant: 360,000 Euros).

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

6.2.1.1. ADAPT

Title: Theory and Algorithms for Adaptive Particle Simulation

Programm: FP7

Duration: September 2012 - August 2017

Coordinator: Inria

Inria contact: Stephane Redon

'During the twentieth century, the development of macroscopic engineering has been largely stimulated by progress in digital prototyping: cars, planes, boats, etc. are nowadays designed and tested on computers. Digital prototypes have progressively replaced actual ones, and effective computer-aided engineering tools have helped cut costs and reduce production cycles of these macroscopic systems. The twenty-first century is most likely to see a similar development at the atomic scale. Indeed, the recent years have seen tremendous progress in nanotechnology - in particular in the ability to control matter at the atomic scale. Similar to what has happened with macroscopic engineering, powerful and generic computational tools will be needed to engineer complex nanosystems, through modeling and simulation. As a result, a major challenge is to develop efficient simulation methods and algorithms. NANO-D, the Inria research group I started in January 2008 in Grenoble, France, aims at developing efficient computational methods for modeling and simulating complex nanosystems, both natural and artificial. In particular, NANO-D develops SAMSON, a software application which gathers all algorithms designed by the group and its collaborators (SAMSON: Software for Adaptive Modeling and Simulation Of Nanosystems). In this project, I propose to develop a unified theory, and associated algorithms, for adaptive particle simulation. The proposed theory will avoid problems that plague current popular multi-scale or hybrid simulation approaches by simulating a single potential throughout the system, while allowing users to finely trade precision for computational speed. I believe the full development of the adaptive particle simulation theory will have an important impact on current modeling and simulation practices, and will enable practical design of complex nanosystems on desktop computers, which should significantly boost the emergence of generic nano-engineering.'

6.2.2. Collaborations with Major European Organizations

Partner 1: Institut Laue-Langevin, SANS platform (France)

Partner 2: European Synchrotron Radiation Facility, SAXS platform (France)

The topic of collaboration is the development and validation of novel computational methods for small-angle scattering experiments.

6.3. International Initiatives

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

6.3.1.1. PPI-3D

Title: Structure Meets Genomics

International Partner (Institution - Laboratory - Researcher):

Stony Brook University (United States) - Dima Kozakov

Start year: 2015

See also: https://team.inria.fr/nano-d/research/ppi-3d-structure-meets-genomics/

Protein–protein interactions are integral to many mechanisms of cellular control, and therefore their characterization has become an important task for both experimental and computational approaches in systems biology. Genome-wide proteomics studies provide a growing list of putative protein-protein interactions, and demonstrate that most if not all proteins have interacting partners in the cell. A fraction of these interaction has been reliably established, however, one can only identify whether two proteins interact and, in the best cases, which are the individual domains mediating the interaction. A full comprehension of how proteins bind and form complexes can only come from high-resolution three-dimensional structures. While the most complete structural characterization of a complex is provided by X-ray crystallography, protein-protein hetero-complexes constitute less than 6%Â§ of protein structures in the Protein Data Bank. Thus, it is important to develop computational methods that, starting from the structures of component proteins, can determine the structure of their complexes.

The basic problem of predictive protein docking is to start with the structures (or sequences) of unbound component proteins A and B, and to obtain computationally a model of the bound complex AB, as detailed structural knowledge of the interactions facilitates understanding of protein function and mechanism. Our current docking approaches performs ab initio docking of the two structures without the use of any additional information. The goal of this proposal is to speed up docking approaches to tackle genome-scale problems, and utilize additional information on interactions, sequences, and structures that is available for virtually any protein.

This project includes several methodological and application research directions: 1) Developing fast sampling approaches; 2) Development of new scoring functions; 3) Integrative approaches for structure determination.

Overall, during the course of the project we will (i) jointly develop new methodology and algorithms in the field of genomic-scale protein complex prediction; (ii) provide server-based applications built upon services of the Boston team; (iii) and finally develop modular applications coded inside the SAMSON software platform created by the Inria team.

6.3.2. Participation in Other International Programs

6.3.2.1. International Initiatives

BIOTOOLS

Title: Novel Computational Tools for Structural Bioinformatics

International Partner (Institution - Laboratory - Researcher):

MIPT (Russia (Russian Federation)) - Vadim Strijov

Duration: 2016 - 2020

Start year: 2016

6.4. International Research Visitors

6.4.1. Visits of International Scientists

- Dima Kozakov, Professor at the University of Stony Brook, visited Nano-D for 2 weeks in July 2017.
- Dzmitry Padhorny, PhD candidate at the University of Stony Brook, visited Nano-D for 2 weeks in July 2017.
- Mikhail Ignatov, PhD candidate at the University of Stony Brook, visited Nano-D for 2 weeks in June 2017.

6.4.1.1. Internships

Mikhail Karasikov

Date: 1/08/2016 - 30/01/2017

Institution: Skolkovo Reseach Center / MIPT Moscow (Russia (Russian Federation))

Supervisor: Sergei Grudinin

POEMS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

9.2. National Initiatives

9.2.1. ANR

- 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)

Juan Pablo Borthagaray (Univ. of Maryland, College Park, USA)

Fioralba Cakoni (University of Rutgers)

Maxence Cassier (Columbia University)

Camille Carvalho (UC Merced, Merced, USA)

Christophe Geuzaine (Université de Liège)

Bojan Guzina (University of Minnesota)

Marcus Grote (Universitaet Basel)

Sergei Nazarov (Saint-Petersburg University)

Jeronimo Rodriguez (University of Santiago de Compostela)

Adrien Semin (BTU Cottbus)

Ricardo Weder (Universidad Nacional Autonoma, Mexico)

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

RAPSODI Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- The region Haut-de-France supported financially the organization of the FVCA8 conference.
- The PhD program of Ahmed Ait Hammou Oulhaj is partially supported (50%) by the region Haut-de-France (formerly Nord–Pas-de-Calais).

8.2. National Initiatives

8.2.1. ANR

C. Cancès is the coordinator of the ANR GEOPOR project (http://www.agence-nationale-recherche.fr/Project-ANR-13-JS01-0007). This project aims to study realistic models for complex porous media flows from a variational point of view, and to take advantage of this new approach to design and analyze some efficient numerical methods.

Title: Approche géométrique pour les écoulements en milieux poreux : théorie et numérique.

Type: Jeunes Chercheuses Jeunes Chercheurs SIMI 1- 2013

ANR Reference: ANR-13-JS01-0007-01

Coordinator: Clément Cancès, Inria Lille - Nord Europe.

Duration: January 2014 – June 2017

C. Chainais-Hillairet is a member of the ANR MOONRISE project (http://moonrise.math.cnrs.fr/). The MOONRISE project aims at exploring modeling, mathematical and numerical issues originating from the presence of high oscillations in nonlinear PDEs mainly from the physics of nanotechnologies and from the physics of plasmas.

Title: Modèles, Oscillations et schémas numériques.

Type: Fondements du numérique (DS0705) - 2014

ANR reference: ANR-14-CE23-0007

Coordinator: Florian MEHATS, Université de Rennes 1.

Duration: October 2014 - September 2019.

B. Merlet is a member of the ANR GEOMETRYA project (https://www.ljll.math.upmc.fr/lemenant/GEOMETRYA/). The GEOMETRYA project addresses several problems within the framework of geometric measure theory, from both theoretical and numerical viewpoints. Most of these problems are derived from the modeling of physical phenomenons. The main topics are: the Geometric Measure Theory in singular metric spaces, the Plateau problem, the Mumford-Shah functional, irrigation and branched transport problems, the Willmore energy.

Title: Théorie géométrique de la mesure et applications

Type: Blanc SIMI 1 - 2012

ANR reference: ANR-12-BS01-0014

Coordinator: Hervé Pajot, Université Joseph Fourier (Grenoble).

Duration: january 2013 - june 2017.

I. Lacroix is the local coordinator at Université Lille 1 of the ANR BECASIM project (http://becasim.math.cnrs.fr/). This ANR project gathers mathematicians with theoretical and numerical backgrounds together with engineers. The objective is to develop numerical methods to accurately simulate the behavior of Bose-Einstein condensates.

Title: Simulation numérique avancée pour les condensats de Bose-Einstein.

Type: Modèles Numériques - 2012

ANR reference: ANR-12-MONU-0007

Coordinator: Ionut DANAILA, Université de Rouen.

Duration: January 2013 - November 2017.

8.2.2. Labex CEMPI

Title: Centre Européen pour les Mathématiques, la Physique et leurs interactions

Coordinator: Stephan De Bièvre.

Duration: January 2012 - December 2019.

Partners: Laboratoire Paul Painlevé and Laser physics department (PhLAM), Université Lille 1.

The "Laboratoire d'Excellence" Centre Européen pour les Mathématiques, la Physique et leurs interactions (CEMPI), a project of the Laboratoire de Mathématiques Paul Painlevé and the Laboratoire de Physique des Lasers, Atomes et Molécules (PhLAM), was created in the context of the "Programme d'Investissements d'Avenir" in February 2012.

The association Painlevé-PhLAM creates in Lille a research unit for fundamental and applied research and for training and technological development that covers a wide spectrum of knowledge stretching from pure and applied mathematics to experimental and applied physics.

One of the three focus areas of CEMPI research is the interface between mathematics and physics. This focus area encompasses three themes. The first is concerned with key problems of a mathematical, physical and technological nature coming from the study of complex behavior in cold atoms physics and non-linear optics, in particular fibre optics. The two other themes deal with fields of mathematics such as algebraic geometry, modular forms, operator algebras, harmonic analysis and quantum groups that have promising interactions with several branches of theoretical physics.

8.2.3. Microturbu Project

B. Merlet and T. Rey were both members of the Microturbu project. This project, headed by Stephan De Bièvre, was supported by the interdisciplinarity mission of the CNRS in 2017. Its purpose was to strengthen the collaborations between applied mathematicians from the Paul Painlevé laboratory and physicists from the PhLAM laboratory.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

We have a long time collaboration with Ansgar Jüngel team from TU Wien. He visited Lille on January 9–13, 2017. His PhD Student, Anita Gerstenmayer came for the third time in Lille on July 3–7, 2017.

Ezzeddine Zahrouni (Univ. Carthage, Tunisia) was invited in Lille in May 2017 thanks to a support of the Labex CEMPI.

APICS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Contract Provence Alpes Côte d'Azur (PACA) Region - Inria, BDO (no. 2014-05764) funding the research grant of C. Papageorgakis, see Sections 5.1.3 , 6.1.2 .
- The team participates in the project WIMAG (Wave IMAGing) funded by the Idex UCA^{Jedi}. It aims at identifying and gathering the research and development by partners of UCA involved in wave imaging systems. Other partners are UNS and CNRS (GéoAzur, I3S, LEAT, LJAD), together with Orange Labs. We forecast to co-advise an internship together with members of the LEAT team ISA http://leat.unice.fr/pages/activites/isa.html.
- The team co-advises a PhD (G. Bose) with the CMA team of LEAT (http://leat.unice.fr/pages/activites/cma.html) funded by the Labex UCN@Sophia on the co-conception of Antennas and Filters.
- The team participates in the transverse action C4PO funded by the Idex UCA^{Jedi}. This "Center for Planetary Origin" brings together scientists from various fields to advance and organize Planetary Science at the the University of Nice, and supports research and teaching initiatives within its framework.
- The team also participates in the project ToMaT, "Multiscale Tomography: imaging and modeling ancient materials, technical traditions and transfers", funded by the Idex UCA^{Jedi} ("programme structurant Matière, Lumière, Interactions"). This project brings together researchers in archaeological, physical, and mathematical sciences, with the purpose of modeling and detecting low level signals in 3D images of ancient potteries. They will co-advise together a post-doctoral researcher (starting March 2018). The concerned scientists are from CEPAM-CNRS, Nice http://www.cepam.cnrs.fr/spip.php?article40, the team Morpheme, CNRS-I3S-Inria http://www.inria.fr/equipes/morpheme, and IPANEMA, CNRS, Ministère de la Culture et de la Communication, Université Versailles Saint Quentin http://ipanema.cnrs.fr/.

7.2. National Initiatives

7.2.1. ANR Cocoram

The ANR (Astrid) project Cocoram (Co-design et co-intégration de réseaux d'antennes actives multi-bandes pour systèmes de radionavigation par satellite) started January 2014. We are associated with three other teams from XLIM (Limoges University), geared respectively towards filters, antennas and amplifiers design. The core idea of the project is to realize dual band reception an emission chains by co-conceiving the antenna, the filters, and the amplifier. We are specifically in charge of the theoretical design of the filters, matching the impedance of a bi-polarized dual band antenna. This is a perfect training ground to test, apply and adapt our work on matching problems (see Section 5.2).

7.2.2. ANR MagLune

The ANR project MagLune (Magnétisme de la Lune) has been approved July 2014. It involves the Cerege (Centre de Recherche et d'Enseignement de Géosciences de l'Environnement, joint laboratory between Université Aix-Marseille, CNRS and IRD), the IPGP (Institut de Physique du Globe de Paris) and ISTerre (Institut des Sciences de la Terre). Associated with Cerege are Inria (Apics team) and Irphe (Institut de Recherche sur les Phénomènes Hors Équilibre, joint laboratory between Université Aix-Marseille, CNRS and École Centrale de Marseille). The goal of this project (led by geologists) is to understand the past magnetic activity of the Moon, especially to answer the question whether it had a dynamo in the past and which mechanisms were at work to generate it. Apics participates in the project by providing mathematical tools and algorithms to recover the remanent magnetization of rock samples from the moon on the basis of measurements of the magnetic field it generates. The techniques described in Section 5.1 are instrumental for this purpose.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Apics is part of the European Research Network on System Identification (ERNSI) since 1992. System identification deals with the derivation, estimation and validation of mathematical models of dynamical phenomena from experimental data.

7.4. International Initiatives

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

7.4.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

International Partner (Institution - Laboratory - Researcher):

Massachusetts Institute of Technology (United States) - Department of Earth, Atmospheric and Planetary Sciences - Benjamin P. Weiss

Start year: 2016

See also: http://www-sop.inria.fr/apics/IMPINGE/

The associate team IMPINGE is concerned with the inverse problem of recovering a magnetization distribution from measurements of the magnetic field above rock slabs using a SQUID microscope (developed at MIT). The application domain is to Earth and planetary sciences. Indeed, the remanent magnetization of rocks provides valuable information on their history. This is a renewal of the previous Associate Team IMPINGE that ended 2015. The US team also involves a group of Mathematicians at Vanderbilt University (see Section 5.1.1).

7.4.2. Inria International Partners

7.4.2.1. Informal International Partners

MIT-France seed funding is a competitive collaborative research program ran by the Massachusetts Institute of Technology (Cambridge, Ma, USA). Together with E. Lima and B. Weiss from the Earth and Planetary Sciences dept. at MIT, Apics obtained two-years support from the above-mentioned program to run a project entitled: “Development of Ultra-high Sensitivity Magnetometry for Analyzing Ancient Rock Magnetism”

NSF Grant L. Baratchart, S. Chevillard and J. Leblond are external investigators in the NSF Grant 2015-2018, “Collaborative Research: Computational methods for ultra-high sensitivity magnetometry of geological samples” led by E.B. Saff (Vanderbilt Univ.) and B. Weiss (MIT).

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Cauê Borlina (MIT, Boston, Massachusetts, USA, Apr. 24-28).
- Nattapong Bosuwan (Mahidol University, Bangkok, Thailand, May-Aug.).
- Briceyda Delgado Lopez (PhD student, Cinvestav, Queretaro, Mexico, Jan.-Mar.).
- Bernard Hanzon (Univ. Cork, Ireland, Apr.-Jun.).
- Douglas Hardin (Vanderbilt University, Nashville, Tennessee, USA, Apr. 24-28).
- Eduardo Lima (MIT, Boston, Massachusetts, USA, Apr. 24-28).
- Mateusz Rusiniak (BESA GmbH, Gräfelfing, Germany, Dec. 15).
- Ioannis Stratis (National and Kapodistrian University of Athens, Greece, Dec. 14-15).
- Carsten Wolters (University of Münster, Germany, Dec. 14-15).

7.5.1.1. Internships

- Gautier Dervaux (IMT Atlantique, Brest, France, Jul.-Aug.).

7.5.2. Visits to International Teams

7.5.2.1. Research Stays Abroad

L. Baratchart spent the fall semester 2017 at Vanderbilt University, Nashville, Tennessee, teaching a course on inverse problems and pursuing research with with D. Hardin, E.B. Saff and C. Villalobos, as well as E. Lima, all members of the Inria associate team IMPINGE

7.6. List of international and industrial partners

- Collaboration under contract with Thales Alenia Space (Toulouse, Cannes, and Paris), CNES (Toulouse), XLIM (Limoges), University of Bilbao (Universidad del País Vasco / Euskal Herriko Unibertsitatea, Spain), BESA company (Munich), Flextronics.
- Regular contacts with research groups at UST (Villeneuve d'Asq), Universities of Bordeaux-I (Talence), Orléans (MAPMO), Aix-Marseille (CMI-LATP), Nice Sophia Antipolis (Lab. JAD), Grenoble (IJF and LJK), Paris 6 (P. et M. Curie, Lab. JLL), Inria Saclay (Lab. Poems, ENSTA), IMT Atlantique (Institut Mines-Télécom., Brest), Cerege-CNRS (Aix-en-Provence), CWI (the Netherlands), MIT (Boston, USA), Vanderbilt University (Nashville USA), Steklov Institute (Moscow), Michigan State University (East-Lansing, USA), Texas A&M University (College Station USA), Indiana University-Purdue University at Indianapolis, St Louis University (St Louis, Missouri, USA), Cinvestav (Queretaro, Mexico), Politecnico di Milano (Milan, Italy), University of Trieste (Italy), RMC (Kingston, Canada), University of Leeds (UK), of Maastricht (the Netherlands), of Cork (Ireland), Vrije Universiteit Brussel (Belgium), TU-Wien and Universität Wien (Austria), TFH-Berlin (Germany), ENIT (Tunis), KTH (Stockholm), University of Cyprus (Nicosia, Cyprus), University of Macau (Macau, China), SIAE Microelettronica (Milano).
- The project is involved in the GDR-project AFHP (CNRS), in the ANR (Astrid program) project Cocoram (with XLIM, Limoges, and DGA), in the ANR (Défis de tous les savoirs program) project MagLune (with Cerege, IPGP, ISTerre, Irphe), in a MIT-France collaborative seed funding, in the Associate Inria Team IMPINGE (with MIT, Boston), and in a NSF grant (with Vanderbilt University and MIT).

BIPOP Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Christophe Prieur and Bernard Brogliato are coordinator and member (respectively) of the Labex Persyval project e-Baccuss (2016-2018).
- Pierre-Brice Wieber is co-coordinator of the Labex Persyval project RHUM (2015-2018).

9.2. National Initiatives

- Vincent Acary and Bernard Brogliato are members of the Inria IPL Modeliscale (coordinator: Benoit Caillaud, Inria Rennes).
- Vincent Acary and Bernard Brogliato are members of the FUI project Modeliscale (coordinator: Benoit Caillaud, Inria Rennes).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. GEM

Title: from GEometry to Motion, inverse modeling of complex mechanical structures

Programm: H2020

Type: ERC

Duration: September 2015 - August 2020

Coordinator: Inria

Inria contact: Florence BERTAILS-DESCOUBES

With the considerable advance of automatic image-based capture in Computer Vision and Computer Graphics these latest years, it becomes now affordable to acquire quickly and precisely the full 3D geometry of many mechanical objects featuring intricate shapes. Yet, while more and more geometrical data get collected and shared among the communities, there is currently very little study about how to infer the underlying mechanical properties of the captured objects merely from their geometrical configurations. The GEM challenge consists in developing a non-invasive method for inferring the mechanical properties of complex objects from a minimal set of geometrical poses, in order to predict their dynamics. In contrast to classical inverse reconstruction methods, my proposal is built upon the claim that 1/ the mere geometrical shape of physical objects reveals a lot about their underlying mechanical properties and 2/ this property can be fully leveraged for a wide range of objects featuring rich geometrical configurations, such as slender structures subject to frictional contact (e.g., folded cloth or twined filaments). To achieve this goal, we shall develop an original inverse modeling strategy based upon a/ the design of reduced and high-order discrete models for slender mechanical structures including rods, plates and shells, b/ a compact and well-posed mathematical formulation of our nonsmooth inverse problems, both in the static and dynamic cases, c/ the design of robust and efficient numerical tools for solving such complex problems, and d/ a thorough experimental validation of our methods relying on the most recent capturing tools. In addition to significant advances in fast image-based measurement of diverse mechanical materials stemming from physics, biology, or manufacturing, this research is expected in the long run to ease considerably the design of physically realistic virtual worlds, as well as to boost the creation of dynamic human doubles.

9.3.1.2. COMANOID

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: CNRS (Lirmm)

Partners:

Centre national de la recherche scientifique (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Airbus Groups (France)

Universita Degli Studi di Roma Lapienza (Italy)

Inria contact: Francois Chaumette

COMANOID investigates the deployment of robotic solutions in well-identified Airbus airliner assembly operations that are laborious or tedious for human workers and for which access is impossible for wheeled or rail-ported robotic platforms. As a solution to these constraints a humanoid robot is proposed to achieve the described tasks in real-use cases provided by Airbus Group. At a first glance, a humanoid robotic solution appears extremely risky, since the operations to be conducted are in highly constrained aircraft cavities with non-uniform (cargo) structures. Furthermore, these tight spaces are to be shared with human workers. Recent developments, however, in multi-contact planning and control suggest that this is a much more plausible solution than current alternatives such as a manipulator mounted on multi-legged base. Indeed, if humanoid robots can efficiently exploit their surroundings in order to support themselves during motion and manipulation, they can ensure balance and stability, move in non-gaited (acyclic) ways through narrow passages, and also increase operational forces by creating closed-kinematic chains. Bipedal robots are well suited to narrow environments specifically because they are able to perform manipulation using only small support areas. Moreover, the stability benefits of multi-legged robots that have larger support areas are largely lost when the manipulator must be brought close, or even beyond, the support borders. COMANOID aims at assessing clearly how far the state-of-the-art stands from such novel technologies. In particular the project focuses on implementing a real-world humanoid robotics solution using the best of research and innovation. The main challenge will be to integrate current scientific and technological advances including multi-contact planning and control; advanced visual-haptic servoing; perception and localization; human-robot safety and the operational efficiency of cobotics solutions in airliner manufacturing.

9.4. International Initiatives

9.4.1. Inria International Labs

- Inria-Chile: two engineers supervised by Vincent Acary (Stephen Sinclair and Salomé Candela)

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Jozsef Kovecses (McGill University, Mechanical Engineering).
- Alexandre Derouet-Jourdan (OLM Digital, Japan).

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	:	10,000 Euro (for 2016-17), 7,000 Euro (for 2017-2018)
PI	:	Axel Kröner, U. Humboldt and Inria
Period	:	$2015 - 2018$
Members	:	Frédéric Bonnans (Inria Saclay and CMAP, École Polytechnique), Mickaël Chekroun (UCLA, Los Angeles), Martin Gubisch (U. of Konstanz), Honghu Liu (Virginia Tech), Karl Kunisch (University of Graz), Hasnaa Zidani (ENSTA ParisTech).

9.2. National Initiatives

9.2.1. IPL

9.2.1.1. Cosy

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

9.2.1.2. Algae in Silico

Inria Project Lab ALGAE IN SILICO (started in 2014) is dedicated to provide an integrated platform for numerical simulation of microalgae “from genes to industrial process“. The project has now reached a stage where we can tackle the optimization aspects. Commands is currently joining the IPL, in the following of our previous collaborations with teams Modemic and Biocore on bioreactors, see [35], [23]

9.3. International Research Visitors

9.3.1. Internships

Joao Miguel Machado, from FGV (Rio de Janeiro), spent his master internship in our team from sept-dec 2017, working with F. Bonnans and M.S. Aronna (EMAP-FGV) on the second order necessary and sufficient optimality conditions for optimal control problems of ODEs with broken extremals, i.e., with discontinuous control. We are currently extending the classical theory to the case of a jump between interior and boundary values for the control.

DISCO Project-Team

9. Partnerships and Cooperations

9.1. 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 was to provide a refined coupled model of healthy and cancer cell dynamics in AML whose (stability) analysis may enable evaluation of polychemiotherapies delivered in the case of AML which have a high level of Flt-3 duplication (Flt-3-ITD).

9.2. National Initiatives

9.2.1. 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 CentraleSupélec and gathers about 20 people (academic and industrial researchers, PhD students, post-doctoral researchers).

9.3. European Initiatives

9.3.1. 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. Frieburg, 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 Communityâs 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.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

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: **PHC BRANCUSI 2017 (Romania)**

Project acronym: ProCo

Project title: Systems with propagation: New approaches in control design for oscillation quenching

Duration: January 2016 - December 2018

Coordinator: Islam Boussaada (France) et Daniela Danciu (Romania)

Abstract: The project aims to building a unitary framework for the modeling, the analysis and the control of distributed-parameters systems (DPS) described by hyperbolic partial differential equations in one space variable and non-standard boundary conditions. This main objectives are modeling of DPS and the corresponding functional differential equations, the construction of reduced-order models approximating DPS by both numerical and computational modeling, the design of new control methods for oscillations quenching in DPS.

Program: **PHC CARLSO FINLEY 2017 (Cuba)**

Project title: MODELISATION ET COMMANDE POUR LE PROCESSUS DE CRYOCONSERVATION.

Duration: June 2017 - December 2017

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

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

Program: **COST Action**

Project acronym: FRACTAL

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

Duration: November 2016 - October 2020

Coordinator: Jaroslav Koton Czech Republic

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

9.4. International Initiatives

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

Frédéric Mazenc is the co-supervisor together with Hitay Ozbay of a PhD Student of Bilkent University (Turkey).

9.4.1. Inria International Partners

9.4.1.1. 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
- Blikent University, Turkey
- Universidad de Chile, Chile
- School of Mathematics, University of Leeds, U.K.
- University Federale Rio de Janeiro, Brazil
- UNICAMP, Brazil
- Kyoto University, Japan

9.4.2. Participation in Other International Programs

9.4.2.1. 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.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Stefanella Boatto, Federale University Rio de Janeiro, Brazil, 1 January-31 December.

André Fioravanti, UNICAMP, Sao Paulo, Brazil, 7 January-28 February.

Yutaka Yamamoto, Kyoto University, Japan, 17 May -2 August.

Hitay Ozbay, Bilkent University, Turkey, 15 November 2017 - 18 November 2017.

9.5.2. Visits to International Teams

Stefanella Boatto visited the Department of Mathematics, Universidade de Lisboa, Portugal, 19-23 June 2017. Frédéric Mazenc visited the Department of Mathematics of the Louisiana State University, Baton Rouge USA, 2 April - 14 April 2017, the Departamento de Ingeniaria de Control y Robotico of the Universidad Nacional Autonoma de Mexico, Mexico-city 14 August 2017 - 16 August and 18 August - 27 August 2017, the Laboratoire Franco-Mexicain d'Informatique et d'Automatique (LAFMIA), Mexico-City, 17 August 2017, Universidad de Chile, Santiago de Chile, 15 October 2017 to 28 October 2017.

GECO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Starting from the end of 2015, we have been funded by PGMO (Gaspard Monge Program for Optimisation and operational research) through a grant on Geometric Optimal Control. The grant is coordinated by Mario Sigalotti.

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. Coordinator: Thomas Chambrion (Nancy).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Program: ERC Proof of Concept

Project acronym: ARTIV1

Project title: An artificial visual cortex for image processing

Duration: From April 2017 to September 2018.

Coordinator: Ugo Boscain

Abstract: The ERC starting grant GECOMETHODS, on which this POC is based, tackled problems of diffusion equations via geometric control methods. One of the most striking achievements of the project has been the development of an algorithm of image reconstruction based mainly on non-isotropic diffusion. This algorithm is bio-mimetic in the sense that it replicates the way in which the primary visual cortex V1 of mammals processes the signals arriving from the eyes. It has performances that are at the state of the art in image processing. These results together with others obtained in the ERC project show that image processing algorithms based on the functional architecture of V1 can go very far. However, the exceptional performances of the primary visual cortex V1 rely not only on the particular algorithm used, but also on the fact that such algorithm ?runs? on a dedicated hardware having the following features: 1. an exceptional level of parallelism; 2. connections that are well adapted to transmit information in a non-isotropic way as it is required by the algorithms of image reconstruction and recognition. The idea of this POC is to create a dedicated hardware (called ARTIV1) emulating the functional architecture of V1 and hence having on one hand a huge degree of parallelism and on the other hand connections among the CPUs that reflect the non-isotropic structure of the visual cortex V1. Such a hardware that we plan to build as an integrated circuit with an industrial partner will be a veritable artificial visual cortex. It will be fully programmable and it will be able to perform many biomimetic image processing tasks that we expect to be exceptionally performant. ARTIV1 will come to the marked accompanied by some dedicated software for image reconstruction and image recognition. However we expect that other applications will be developed by customers, as for instance softwares for optical flow estimation or for sound processing.

8.4. International Initiatives

8.4.1. 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.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Andrei Agrachev (SISSA, Italy) has been visiting the GECO team for one year, ending in June 2017.

8.5.1.1. Internships

Gontran Lance has made an internship in GECO, under the supervision of Mario Sigalotti and Emmanuel Trélat on the turnpike phenomenon in the orbital transfer problem.

I4S Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MONEOL

Participants: Ivan Guéguen, Guillaume Gautier, Laurent Mevel.

Type: CEAtech PDL

Objectif: Modal analysis of wind turbines using new sensors

Duration: 09/2015 to 11/2017.

Coordinator: Louis Marie Cotineau (IFSTTAR)

Inria contact: Guillaume Gautier

Abstract: The MONEOL project aims to demonstrate the feasibility of using Morphosense as a vibration monitoring system for wind turbines. It is proposed to set up a demonstrator consisting of a monitoring system placed in the mast of the wind turbine, a vibration analysis system and a visualization of the vibratory state at the CEA-Tech premises, located on the Technocampus Ocean of Nantes allowing to visualize in real time (quasi) the modal deformations of the mast of the wind turbine.

The MONEOL (Wind turbine monitoring) project was concluded in September 2017. Morphosense ribbon was deployed on the mast of a wind turbine. Morphosense validation was conducted through the comparison with a classical vibration monitoring system. The relevance regarding the use of such a system was highlighted, especially due to reduced installation time. SSI algorithms, including modal parameters and damage identification, were implemented inside the Morphosense. Actually, wind turbine health condition is displayed in real time through a web page.

9.1.2. Interactive Communication (InterCom): Massive random access to subsets of compressed correlated data

Participants: Jean Dumoulin, Antoine Crinière, Frederic Gillot.

Type: Labex COMINLABS

Objectif: Massive random access to large-scale sensor network (Smart Cities)

Duration: Since November 2016 to Nov. 2019.

Coordinator :Aline Roumy, Thomas Maugey (Sirocco), Jean Dumoulin (I4S)

Partners: Elsa Dupraz (Lab-STICC), Aline Roumy (IRISA, Sirocco team), Michel Kieffer (L2S), Thomas Maugey(IRISA, Sirocco team), CentraleSupelec, Univ. Paris Sud.

Inria contact: Jean Dumoulin

Abstract: This project aims to develop novel compression techniques allowing massive random access to large databases. Indeed, we consider a database that is so large that, to be stored on a single server, the data have to be compressed efficiently, meaning that the redundancy/correlation between the data have to be exploited. The dataset is then stored on a server and made available to users that may want to access only a subset of the data. Such a request for a subset of the data is indeed random, since the choice of the subset is user-dependent. Finally, massive requests are made, meaning that, upon request, the server can only perform low complexity operations (such as bit extraction but no decompression/compression).

Algorithms for two emerging applications of this problem will be developed: Free-viewpoint Television (FTV) and massive requests to a database collecting data from a large-scale sensor network (such as Smart Cities) in which I4S is involved.

9.1.3. MAG2C-Pont Tabarly

Participants: Ivan Guéguen, Jean Dumoulin.

Type: GIS

Objectif: bridge instrumentation

Duration: Since 2014

Coordinator: LIRGEC

Partners: IFSTTAR, CSTB, Nantes Métropole, Université de Nantes

Inria contact: Ivan Guéguen

Abstract: The project deals with the instrumentation of the Tabarly Bridge. In collaboration with Nantes Métropole, CSTB, and Université de Nantes, instrumentation of both dynamical and InfraRed properties of an operational bridge are investigated. These measures coupled with a wireless data transmission system will allow remote monitoring of the evolution of the structure. Objective is to couple different kind of measurement to achieve thermo-vibration monitoring of the structure. This is a big milestone for the team and our objective to mix thermo-vibration data.

9.1.4. MAG2C-MOSIWIND (MOnitoring of Structural Integrity of an onshore WIND turbine slab foundation and tower)

Participants: Xavier Chapeleau, Ivan Guéguen.

Type: GIS

Objectif: MOnitoring of Structural Integrity of an onshore WIND turbine slab foundation and tower

Duration: Since 2015

Coordinator : LIRGEC

Partners: IFSTTAR, CSTB, Nantes Métropole, Université de Nantes, ECN, Valorem, Valréa and Valémo

Inria contact: Xavier Chapeleau

Abstract: The project deals with the instrumentation of an onshore WIND turbineâs slab foundation and tower. The aim is to experiment sensors and methods for structural integrity monitoring of an onshore wind turbine under real conditions and to qualify them over long term. Before casting, the concrete slab foundation (20m in diameter, 3.85m high, 450m3 of concrete, 48T of reinforcement) was first instrumented with continuous optical fibers, optical strain gauges, temperature sensors and accelerometers. Afterwards, accelerometers were placed in the mast. Data obtained by these different sensors will help, on the one hand, to monitor changes in the dynamic behavior of the structure in order to verify that they remain within the limits fixed during the design and, on the other hand, to detect any damage that could be critical for the safety of the structure. For this, SSI methods under ambient vibration will be applied. Since July 2017, only the data of accelerometers measurements are logged periodically. The installation of systems of measurements for distributed fiber optics sensors and optical strains gauges remains to be done as soon as it can be possible to access to the wind turbine .

9.1.5. Collaboration with GeM

Participants: Laurent Mevel, Michael Doehler, Md Delwar Hossain Bhuyan.

Md Delwar Hossain Bhuyan has done his PhD on damage localisation on civil structures in collaboration with GeM (Institute of Civil and Mechanical Engineering), Université de Nantes. The thesis is co-directed by L. Mevel, and F. Schoefs from GeM, with supervision shared with M. Doehler and Y. Lecieux from GeM. It is funded by the Brittany region for 3 years and has been successfully defended in November 2017.

9.1.6. Collaboration with IETR

Participants: Vincent Le Cam, David Pallier.

The thesis is directed by Sébastien Pillement at IETR. It is funded by RFI WISE Electronique Professionnelle within the SENTAUR project.

The subject of the thesis is to study, implement and propose a deterministic and reliable dating solution for wireless sensor networks. This solution must take into account both the risks of loss of synchronization signals, environmental hazards and the desire to achieve the most sober possible solution in energy.

9.2. National Initiatives

9.2.1. High speed rail track instrumentation

Participant: Ivan Guéguen.

Type: IRT

Objective: rail track SHM

Duration: 11/2014 to 11/2018

Coordinator: RAILENIUM

Partners: IFSTTAR, EIFFAGE, RFF, LGCgE

Inria contact: Ivan Guéguen

Abstract: This project aims to orchestrate multiple sections of a high-speed route (classical section with granular layer, transition zone). The proposed instrumentation concerns all the different layers of the structure, and is designed to allow monitoring of the overall track behavior. Using accelerometers and weather station, this instrumentation will estimate the fatigue life and temperature changes in the track.

9.2.2. ANR Resbati

Participants: Ludovic Gaverina, Jean Dumoulin.

Type: ANR

Objectif: In-situ measurements of thermal wall resistance

Duration: 10/2016 to 10/2019

Coordinator: Laurent Ibos

Partners : IFSTTAR, CERTES, CEREMA, CSTB, LNE, THEMACS, AFNOR

Inria contact: Jean Dumoulin

Abstract: RESBATI is an applied research project whose objective is to develop a field measurement device that meets precise specifications to systematically measure the level of thermal insulation of building walls. The preferred metrological tool is infrared thermography.

9.2.3. Equipex Sense-City

Participants: Jean Dumoulin, Laurent Mevel, Antoine Crinière.

Through the ADT Cloud2SM, participation of I4S in SenseCity was possible. IFSTTAR's SensorBox developed by Jean Dumoulin was installed and presented at SEnseCity Kick off and is installed on-site. Cloud2IR and Cloud2SM software have been deployed within the ADT of A. Crinière. (http://sense-city.ifsttar.fr/)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Built to Specifications (Built2Spec)

Participant: Jean Dumoulin.

Type: Horizon 2020

Defi: Model Driven Physical Systems Operation

Objectif: Reduce the gap between a building?s designed and as-built energy performance.

Duration: January 2015 to January 2019

Coordinator: Manager and project head : NOBATEK, Germain Adell. For CERMA : Marjorie Musy

Inria teams I4S

Inria contact: J. Dumoulin

Partners: Consortium of 20 Public and Industrial actors

Website: http://built2spec-project.eu/

Abstract: Built to Specifications (Built2Spec) is involving 20 European partners that seeks to reduce the gap between a building designed and as-built energy performance. To do this, the project put a new set of breakthrough technological advances for self-inspection checks and quality assurance measures into the hands of construction professionals. The project aims to deliver Building Information Modelling (BIM) and Thermal and 3D Imaging Tools among others.

The project is in collaboration with formers members of the team, Alexandre Nassiopoulos and Jordan Brouns, now working at Ecotropy, SME.

9.3.1.2. INFRASTAR(Innovation and Networking for Fatigue and Reliability Analysis of Structures – Training for Assessment of Risk)

Participants: Xavier Chapeleau, Antoine Bassil.

Call: H2020-MSCA-ITN-2015 (Horizon 2020 â Marie-Sklodowska Curie Actions â Innovative Training Networks)

Type of Action: MSCA-ITN-ETN

Objectif: Reduce the gap between a building?s designed and as-built energy performance.

Duration: 48 months since 2016 May 1st

Coordinator: Odile Abraham (IFSTTAR)

Academic and industrial Partners: IFSTTAR, UNIVERSITY OF AALBORG, BAM, EPFL, GuD Consult Gmbh, COWI A/S, NeoStrain, PHIMECA

Inria contact: X. Chapeleau

Website: http://infrastar.eu/

Abstract: The aim of INFRASTAR project is to develop tools combining modeling and measurements for the prediction of the fatigue behavior of concrete structures (bridges and foundations of wind turbines) with the ultimate objective of establishing an efficient strategy for inspection and reinforcement operations. In the second half of 2016, 12 young researchers were recruited to carry out and cross-examine research on monitoring and auscultation (WP 1), structural models (WP 2) and reliability of approaches for decision-making (WP 3). In this project, a phd student (Antoine Bassil) was recruited (Nov. 2016) on the fatigue monitoring of concrete structure by fibre-optic sensors. During the first 6 months of the thesis, a State of the Art on the use of fiber optic sensors for structural health monitoring in civil engineering was done and mostly by focusing on distributed optical fiber sensor's technology (DOFS) for crack detection in concrete. This State of the Art shows that distributed optical fiber sensor can localize accurately cracks in concrete if they propagate across the sensor. However, the quantification of the crack widths by distributed optical fiber sensor remains a scientific challenge. Indeed, it is necessary to take into account of the mechanical strain transfer of the fiber sensor. Now, the second part of the phd student work is to develop a theoretical model for the mechanical strain transfer function and to validate it by experimental tests. The main milestone of the modelling to overcome is to take into account of slippage and elasto-plastic effects

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. COST Action TU 1402

Participants: Michael Doehler, Laurent Mevel.

L. Mevel is member of the management committee of the COST Action.

M. Doehler is co-leader of working group 2 "SHM strategies and structural performance" and member of the steering committee.

Type: COST

Objectif: Quantifying the value of structural health monitoring

Duration: 11/2014 - 11/2018

Coordinator: S. Thoens (DTU Denmark)

Partner: 23 countries, see http://www.cost.eu/COST_Actions/tud/Actions/TU1402

Inria contact: Laurent Mevel

Abstract: Since 2014, until 2018, the COST Action has altogether around 120 participants from over 25 countries. This Action aims to develop and describe a theoretical framework, together with methods, tools, guidelines, examples and educational activities, for the quantification of the value of SHM. Progress of the action is presented in [40].

9.3.2.2. PROCOPE 37826QE

Participants: Michael Doehler, Laurent Mevel, Eva Viefhues.

Type: PHC PROCOPE

Objectif: Statistical damage localization for civil structures

Duration: 01/2017 - 12/2018

Coordinator: M. Doehler

Partner: BAM German Federal Institute for Materials Research and Testing

Inria contact: M. Doehler

Abstract: Our main objective is the development of a theoretically solid damage localization method that does not only work in simulations and lab experiments, but on structures in the field under real operational conditions. This German-French mobility grant is in support of Eva Viefhues' PhD thesis.

9.3.3. Collaborations with Major European Organizations

9.3.3.1. European Research Network on System Identification (ERNSI)

Participants: Qinghua Zhang, Michael Doehler, Laurent Mevel.

The I4S project-team is involved in the activities of the European Research Network on System Identification (ERNSI) federating major European research teams on system identification. Modeling of dynamical systems is fundamental in almost all disciplines of science and engineering, ranging from life science to process control. System identification concerns the construction, estimation and validation of mathematical models of dynamical physical or engineering phenomena from experimental data.

9.3.4. Other European Programs

9.3.4.1. Innobooster

Participants: Michael Doehler, Laurent Mevel.

Together with SVS, we got the Danish Innobooster innovation grant for industrial research and transfer. In 2017, the grant was awarded to transfer methods for the identification of mode shapes and their uncertainty [30] to SVS' ARTeMIS software.

9.4. International Initiatives

9.4.1. Informal International Partners

9.4.1.1. Collaboration with CNR, Italy

Participants: Jean Dumoulin, Nicolas Le Touz.

Non destructive testing on outdoor structures by coupling infrared thermography with ground penetrating radar is one of the topic addressed in this collaboration. A new one about TerHertz is starting. A proposal for associated lab is currently drafted.

9.4.1.2. Collaboration with British Columbia University, Canada

Participants: Laurent Mevel, Michael Doehler, Saeid Allahdadian.

Saeid Allahdadian was PhD student of professor Carlos Ventura in Vancouver. Following our recent papers, Michael Doehler has been invited to co-supervise the PhD of Saeid Allahdadian. The thesis has been defended this year.

9.4.1.3. Collaboration with BAM, Germany

Participants: Laurent Mevel, Michael Doehler, Eva Viefhues.

Eva Viefhues is currently PhD student of Laurent Mevel and Michel Doehler in Berlin, financed by BAM. M. Doehler is also associate researcher of the BAM institut since 2016.

9.4.1.4. Collaboration with Politecnico di Milano, Italy

Participants: Michael Doehler, Francesco Giordano.

During COST Action TU 1402 and professor M.P. Limongelli's research stay at IFSTTAR, collaboration with Politecnico di Milano has started, resulting in several joint publications in 2016 and 2017. PhD student F. Giordano has started at Politecnico Milano in November 2017 under the direction of M.P. Limongelli, M. Doehler is co-supervising.

9.4.1.5. Collaboration with Technical University of Denmark (DTU)

Participant: Michael Doehler.

During COST Action TU 1402 and previously at BAM, collaboration with Sebastian Thöns from DTU in Denmark started on risk analysis and SHM based reliability updating. Also, DTU's PhD student Lijia Long is involved [36].

9.4.1.6. Collaboration with Aalborg University, Denmark

Participant: Michael Doehler.

Together with Structural Vibration Solutions, collaboration with Aalborg University (professor Lars Damkilde, Department of Civil Engineering) has started during the PhD of Szymon Gres on damage detection methods [32].

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Within the PROCOPE mobility grant, E. Viefhues and F. Hille from BAM, Germany, visited Inria for one week each.

Prof. Xingwen Liu from Southwest University of China visited the I4S team for one week.

9.5.2. Visits to International Teams

Within the PROCOPE mobility grant and the collaboration in L. Long's PhD thesis with S. Thöns, M. Doehler spent 4 weeks at BAM, Germany.

Within the IFSTTAR foreign affair department grant and the existing collaboration, J. Dumoulin spent 2 weeks at Laval University, Canada.

Within the H2020 INFRASTAR Project A. Bassil spent 3 months at BAM.

MCTAO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Weak KAM beyond Hamilton-Jacobi (WKBHJ). Started 2013 (decision ANR-12-BS01-0020 of December 19, 2012), duration: 4 years. L. Rifford is in the scientific committee.

Sub-Riemannian Geometry and Interactions (SRGI). Started 2015 (decision ANR-15-CE40-0018), duration: 4 years. L. Rifford is a member.

Intéractions Systèmes Dynamiques Équations d'Évolution et Contrôle (ISDEEC). Started 2016 (decision ANR-16-CE40-0013), duration: 4 years. L. Rifford is a member.

Maximic: optimal control of microbial cells by natural and synthetic strategies. Started 2017, duration: 4 years. J.-B. Caillau, L. Giraldi, J.-B. Pomet are members.

8.1.2. Others

The McTAO team participates in the GdR MOA, a CNRS network on Mathematics of Optimization and Applications.

PGMO grant (2016-2017) on "Metric approximation of minimizing trajectories and applications" (PI J.-B. Caillau). This project involves colleagues from Université Paris Dauphine and has funding for one year, including one intership (M2 level).

PGMO grant (2017-2019) on “Algebro-geometric techniques with applications to global optimal control for Magnetic Resonance Imaging (MRI)”. B. Bonnard, A. Nolot and J. Rouot participate in this project, the PI is O. Cots, from ENSEIHHT, Toulouse.

J.-B. Caillau is associate researcher of the team of the CNRS team Parallel Algorithms & Optimization team at ENSEEIHT, Univ. Toulouse.

Défi InfIniti CNRS project, Control and Optimality of Magnetic Microrobot, (PI L. Giraldi). Started 2017, duration: 1 years. This project involves colleagues from Université Paris 6, from University of York (UK) and University of Padova (Italie). Y. El Alaoui Faris, C. Moreau, L. Giraldi, J.-B. Pomet are members.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: FCT (Fundação para a Ciência e a Tecnologia, Portugal)

Project acronym: None

Project title: Extremal spectral quantities and related problems

Duration: 2016-2019

Coordinator: P. Freitas

Other partners: Inria, Univ. Luxembourg, Univ. Lisbon, Prague Czech Technical Univ., Univ. Bern

Abstract: The purpose of this project is to combine analytic, geometric and computational techniques to study extremal values of different spectral quantities, such as individual eigenvalues, functions of these eigenvalues and some global spectral quantities. More specifically, some of the objects under consideration are the possible extremal sets of the first eigenvalue of the Laplacian with Robin boundary conditions, for which team members have recently shown that the ball is no longer an optimiser for large negative values of the boundary parameter, thus providing a counter-example to a 1977 conjecture, finite combinations of eigenvalues of the Laplace and Schrödinger operators, the functional determinant associated with these operators and the spectral abscissa of the (non self-adjoint) operator associated with the damped wave equation. To handle these problems a wide range of methods is required, including those from geometric analysis, functional analysis, control theory, numerical analysis, etc.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Hermes Gadhêla (Univ. of York), November, 2017. Collaboration on PDE vs ODE models for elastic swimmers.
Izhar Or (Technion), September, 2017. Collaboration on magnetic micro-swimmers.
Sorin Sabau (Tokai Univ.), November, 2017. Collaboration on Finsler geometry.
Romain Serra (Univ. of Strathclyde, Glasgow), October, 2017. Collaboration on space mechanics.
Martha Zoppello (University of Padova), February, 2017. Collaboration on magnetic micro-swimmers.

NECS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ProCyPhyS

ProCyPhyS is a one year project funded by University Grenoble Alps, MSTIC department, with the aim to study privacy in cyberphysical system. A post-doc (H. Nouasse) has been hired to perform analysis of privacy protection through system-theoretic measures. We are interested with cyber-physical systems that can be viewed as systems of interconnected entities which are locally governed by difference equations of partial differential equations, namely intelligent transportation systems and indoor navigation. A first approach to analyze privacy preservation is to study observability of the overall system, see [8] where a large family of non-observable networks have been characterized for homogeneous systems of consensus type. In this approach, the network structure immunizes the overall system. A second approach, consists in adding information (noise) to the sensitive one: that is the differential privacy concept that leads to differential filtering where the aim is to develop an estimator that is robust enough according to the added noise [46]. In ProCyPhyS the main goal is to make the system partially nonobservable. The idea is to compress the state space while adding noise to the sensitive information in a smarter way.

8.1.2. Control of Cyber-Social Systems (C2S2)

C2C2 is a two year project funded by the University Grenoble Alpes, MSTIC department. Evolving from recent research on network systems, this exploratory project has the objective to concentrate on "cyber-social" systems, that is, complex systems with interacting social and technological components. A strong motivation for this novel research direction comes from the need for innovative tools for the management of vehicular traffic. In this application, state-of-the-art approaches concentrate on hard control actions, like traffic lights: instead, future management methods should exploit soft control actions aimed at controlling the traffic demand, that is, the aggregated behaviors of the drivers.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. SPEEDD (Scalable ProactivE Event-Driven Decision making)

Type: STREP

Objective: ICT-2013.4.2a – Scalable data analytics – Scalable Algorithms, software frameworks and viualisation

Duration: Feb. 2014 to Jan. 2017.

Coordinator: National Centre of Scientific Research 'Demokritos' (Greece)

Partners: IBM Israel, ETH Zurich (CH), Technion (Israel), Univ. of Birmingham (UK), NECS CNRS (France), FeedZai (Portugal)

Inria contact: C. Canudas de Wit

Abstract: SPEEDD is developing a prototype for robust forecasting and proactive event-driven decision-making, with on-the-fly processing of Big Data, and resilient to the inherent data uncertainties. NECS leads the intelligent traffic-management use and show case.

See also: http://speedd-project.eu

8.2.1.2. Scale-FreeBack

Type: ERC Advanced Grant

Duration: Sep. 2016 to Aug. 2021

Coordinator: C. Canudas de Wit

Inria contact: C. Canudas de Wit

Abstract: The overall aim of Scale-FreeBack is to develop holistic scale-free control methods of controlling complex network systems in the widest sense, and to set the foundations for a new control theory dealing with complex physical networks with an arbitrary size. Scale-FreeBack envisions devising a complete, coherent design approach ensuring the scalability of the whole chain (modelling, observation, and control). It is also expected to find specific breakthrough solutions to the problems involved in managing and monitoring large-scale road traffic networks. Field tests and other realistic simulations to validate the theory will be performed using the equipment available at the Grenoble Traffic Lab center (see GTL), and a microscopic traffic simulator replicating the full complexity of the Grenoble urban network.

See also: http://scale-freeback.eu

8.3. International Initiatives

8.3.1. Participation in Other International Programs

8.3.1.1. TICO-MED

TicoMed (Traitement du signal Traitement numérique multidimensionnel de l'Information avec applications aux Télécommunications et au génie Biomédical) is a French-Brazilian project funded by CAPES-COFECUB. It started in February 2015 with University of Nice Sophia Antipolis (I3S Laboratory), CNAM, SUPELEC, University of Grenoble Alpes (Gipsa-Lab), Universidade Federal do Ceara, Universidade Federal do Rio de Janeiro, and Universidade Federal do Santa Catarina as partners.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Dr. Walter Musakwa from Univ. of Johannesburg (South Africa) visited the team in August 2017 for working with A. Kibangou on analysis on cycling data collected in Johannesburg and setting up a MoA between UGA and UJ.

Prof. Olga Quintero Montoya, from Universidad EAFIT (Colombia) visited teh team from May 2017 until June 2017 to work with C. Canudas de Wit on traffic flow problems.

Pr. Marcello L.R. de Campos (Federal Univ. of Rio de Janeiro, Brazil) visited the team in October 2017 in the framework of the TICO-MED project.

Dr. Paola Goatin (Inria Sophia Antipolis) visited the team in September to work with M. L. Delle Monache on traffic flow modeling and control using conservation laws.

F. Acciani (U. Twente, Netherlands) visited the team in November 2017 to work with P. Frasca.

W. S. Rossi (U. Twente, Netherlands) visited the team in November 2017 to work with P. Frasca.

Professor Per-Olof Gutman visited the on February 9th and 10th 2017. he gave two talks on "Modelling of and Controller Design for a Virtual Skydiver" and "Dynamic model for estimating the Macroscopic Fundamental Diagram" to the NeCS team. He exchanged ideas with Carlos Canudas de Wit, Paolo Frasca and Giacomo Casadei.

Professor Ioannis Paschalidis visited the team on September 2017. He gave a talk "Inverse Equilibrium Problems and Price-of-Anarchy Estimation in Transportation Networks". He exchanged ideas with Carlos Canudas De Wit, Paolo Frasca and Stephane Mollier.

8.4.1.1. Research Stays Abroad

A. Kibangou visited the University of Johanesburg (UJ) in March and October 2017. During his stay, he gave lectures to students of Department of Town and Regional Planning of UJ on Mobility and traffic management.

A. Kibangou visited University of Cape Town (UCT) in October 2017. During his stay, he gave a lecture to students and researchers of Control department of UCT.

Federica Garin spent three weeks in Lund, Sweden, in June, for the LCCC Focus Period on Large-Scale and Distributed Optimization (http://www.lccc.lth.se/index.php?page=june-2017-optimization)

Paolo Frasca visited the University of Cagliari, Cagliari, Italy in April–May 2017.

M. L. Delle Monache visited Rutgers University (USA) in June 2017. During her stay they worked on control of traffic with conservation laws.

NON-A Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Project ARCIR ESTIREZ “Estimation distribuée de systèmes dynamiques en réseaux”, coordinators: D. Efimov, M. Petreczky, 2013-2017.
- CPER DATA 2016-2020 (involved in two projects: “FIT” related to the wireless robots and sensors network and “DATA”, related to platform). FIT includes our robotic activity and DATA corresponds to our computation need in fluid mechanics as well as possible security issues in the ControlHub development platform.
- ELSAT20202 (Ecomobilité, Logistique, Sécurité, Adaptabilité dans les Transports) is a Regional consortium gathering aeronautics (ONERA), micro/nano technologies (IEMN), control sciences (Non-A) and fluid mechanics (LAMIH, LML) and working on technologies and methods for the active control of separated flows.

9.2. National Initiatives

- ANR project Finite4SoS (Finite time control and estimation for Systems of Systems), coordinator: W. Perruquetti, 2015-2020.
- ANR project WaQMoS (Coastal waters quality surveillance using bivalve mollusk-based sensors), coordinator: D. Efimov, 2015-2019.
- ANR project TurboTouch (High-performance touch interactions), coordinator: G. Casiez (MJOLNIR team, Inria), 2014-2018.
- ANR project ROCC-SYS (Robust Control of Cyber-Physical Systems), coordinator: L. Hetel (CNRS, EC de Lille), 2013-2018.
- ANR project MSDOS (Multidimensional System: Digression on Stability), coordinator: Nima Yeganefar (Poitiers University), 2014-2018.
- We are also involved in several technical groups of the GDR MACS (CNRS, "Modélisation, Analyse de Conduite des Systèmes dynamiques", see http://www.univ-valenciennes.fr/GDR-MACS), in particular: Technical Groups "Identification", "Time Delay Systems", "Hybrid Systems", "Complex Systems, Biological Systems and Automatic Control," and "Control in Electrical Engineering".
- Model-free control: collaborations with the startup ALIEN SAS (created by C. Join and M. Fliess).

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

Partner 1: KULeuven, labo 1 (Belgium)
Supervisor: W. Michiels
Partner 2: TU/Eindhoven, labo 1 (The Netherlands)
Supervisor: H. Nijmeijer
Partner 3: Centrale Lille, labo 1 (France)
Supervisor: J.-P. Richard

H2020 project UCoCoS (“Understanding and Controlling of Complex Systems”, 2016-2020) is a European Joint Doctorate aiming at creating a framework for complex systems, and at defining a common language, common methods, tools and software for the complexity scientist. It strongly relies on a control theory point of view. Six ESR (early stage researchers) perform a cutting-edge project, strongly relying on the complementary expertise of the 3 academic beneficiaries and benefiting from training by 4 non-academic partners from different sectors. ESR1: Analytical and numerical bifurcation analysis of delay-coupled systems; ESR2: Estimation in complex systems; ESR3: Grip on partial synchronization in delay-coupled networks; ESR4: Reduced modelling of large-scale networks ; ESR5: Network design for decentralized control ; ESR6: Networks with event triggered computing. Non-A is firstly invested on ESR 2 (Haik Silm), 4 (Quentin Voortman), 5 (Deesh Dileep), 6 (Jijju Thomas).

9.4. International Initiatives

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

9.4.1.1. HoTSMoCE

Title: Homogeneity Tools for Sliding Mode Control and Estimation

International Partner (Institution - Laboratory - Researcher):

UNAM (Mexico), Departamento de Ingeniería de Control y Robótica, Leonid Fridman

Start year: 2016

See also: https://team.inria.fr/non-a/asso-team-hotsmoce/

The team Non-A is developing an estimation theory, built around differential algebra and operational calculation on the one hand, and high gain algorithms (such as sliding mode) on the other hand. The Mexican partner team comes from "Sliding Mode Control" laboratory of UNAM. There exists a strong intersection of interests of both teams (application of homogeneity for design of sliding mode control and estimation algorithms, and analysis of finite-time stability). That is why there exists a long history of collaboration between these two teams. The goal of the project is development of control and estimation algorithms converging in fixed or in finite time by applying the last generation sliding mode techniques and the homogeneity theory. The project realization is planned in the form of short-time visits of permanent staff and visits of PhD students for a long period of stay. Such visits are very important for young scientists, and also help Non-A team to prepare and find good PhDs/post-docs for future.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- Emilia Fridman, Tel Aviv University, Israel
- Leonid Fridman, UNAM, Mexico
- Jaime Moreno, UNAM, Mexico
- Johannes Schiffer, Leeds University, UK
- ITMO University, Saint-Petersburg, Russia
- Eva Zerz, Aachen University, Germany

9.4.3. Participation in Other International Programs

PHC Amadeus “Computer Algebra and Functional Equations”, 2016-2017, with the University of Limoges (XLIM) and the University of Linz (Austria).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Leonid Fridman, UNAM, Mexico
- Petteri Laakkonen, Tampere University of Technology, Finland, 11–14/12/2017

9.5.2. Visits to International Teams

G. Zheng visited two weeks at Wuhan University (China) in July 2017.

9.5.2.1. Research Stays Abroad

G. Zheng held a visiting professor position in Nanjing University of Science and Technology (China) for one month stay in August 2017.

QUANTIC Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Emergences-Ville de Paris program, ENDURANCE project

In the framework of the Ville de Paris program “EMERGENCES”, Zaki Leghtas has received a funding for his research program "Multi-photon processes in superconducting circuits for quantum error correction". This grant of 232k euros over 4 years will complement the ANR project of the same name obtained last year. Using this funding, we will purchase all the microwave and nano-fabrication equipment and consumables for the experiment based at ENS.

7.1.2. DIM SIRTEQ, PhD fellowship

In the framework of the project “DIM SIRTEQ Domaine d’intérêt Majeur: Science et Ingénierie Quantique” of Ile de France Region, we have received 18 months of PhD fellowship. This completes the funding from ANR GEARED of the PhD thesis of J. Guillaud, who has started his PhD under the supervision of M. Mirrahimi and P. Rouchon in September 2017.

7.1.3. Programme Math-PSL, Postdoctoral fellowship

In the framework of the programme Math-PSL of PSL Research University, we have resceived a 12 month postdoctoral fellowship. Paolo Forni has been hired as a postdoc on this funding.

7.2. National Initiatives

7.2.1. ANR project GEARED

This four-year collaborative ANR project, entitled “Reservoir engineering quantum entanglement in the microwave domain” and coordinated by Mazyar Mirrahimi, started on October 2014. The participants of the project are Mazyar Mirrahimi, François Mallet (QUANTIC project-team), Benjamin Huard (ENS Lyon), Daniel Esteve and Fabien Portier (Quantronics group, CEA Saclay), Nicolas Roch and Olivier Buisson (Institut Neel, Grenoble). This project deals with robust generation of entanglement as a key resource for quantum information processing (quantum simulation, computation and communication). The entangled states are difficult to generate and sustain as interaction with a noisy environment leads to rapid loss of their unique quantum properties. Through Geared we intend to investigate different complementary approaches to master the entanglement of microwave photons coupled to quantum superconducting circuits.

7.2.2. ANR project ENDURANCE

In the framework of the ANR program “Accueil de chercheur de haut niveau”, Zaki Leghtas has received a funding for his research program "Multi-photon processes in superconducting circuits for quantum error correction". This grant of 400k euros has allowed us to purchase the experimental equipment to build a new experiment based at ENS.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Partner 1: ENS Lyon

We are pursuing our interdisciplinary work about quantum control from theoretical aspects in direct collaboration with existing experiments (ENS Lyon) with the group of Benjamin Huard, former member of the QUANTIC team. Joint papers are published and underway. We are in particular working on the proper combination of two model reduction techniques in their experimental context: adiabatic elimination and Rotating-Wave Approximation. An ANR-JCJC project has been deposited by Alain Sarlette on this subject, with Benjamin Huard as external supporting collaborator.

Partner 2: University of Padova

Alain Sarlette has been pursuing a fruitful collaboration with the group of Francesco Ticozzi on dynamical systems aspects of quantum systems. Common work on the theory of quantum random walks is being finalized and we are working out a concrete plan about next possible steps.

Partner 3: Ghent University.

A. Sarlette is collaborating with applied mathematicians interested in quantum control at his former institution UGent (Dirk Aeyels, Lode Wylleman, Gert De Cooman) in the framework of thesis co-supervisions. Two students are in their last year PhD, in particular Simon Apers is finalizing a thesis centered around Quantum Walks, also in collaboration with Partner 2. A master student in applied physics has started an internship in 2017.

7.4. International Initiatives

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

TAQUILLA is an Inria associate team (between Quantic team and Yale university) with principal Inria investigator, Mazyar Mirrahimi, and principal Yale investigator Michel Devoret. In this framework, L. Verney, J. Guillaud and M. Mirrahimi visited Yale for respectively, 2, 3 and 4 months.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

P. S. Pereira da Silva (Escola Politécnica, PTC, University of SaoPaulo, Brazil) made a 2-week visit (July 3 to July 14) to investigate with Pierre Rouchon motion planning issues based on Lyapunov tracking for quantum gate generations.

7.5.2. Visits to International Teams

7.5.2.1. Research Stays Abroad

In the framework of TAQUILLA associate team, Mazyar Mirrahimi spent four months in the Quantronics Laboratory of Michel H. Devoret and in the Rob Schoelkopf Lab at Yale University. Also, in this same framework Jérémie Guillaud and Lucas Verney spent respectively three months and two months in the same group.

SPHINX Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- **Project Acronym :** iproblems
  Project Title : Inverse Problems
  Coordinator : David Dos Santos Ferreira
  Duration : 48 months (2013-2017)
  Partner: Institut Élie Cartan de Lorraine
  URL: http://www.agence-nationale-recherche.fr/Projet-ANR-13-JS01-0006
- **Project Acronym :** IFSMACS
  Project Title : Fluid-Structure Interaction: Modeling, Analysis, Control and Simulation
  Coordinator: Takéo Takahashi
  Participants: Julien Lequeurre, Alexandre Munnier, Jean-François Scheid, Takéo Takahashi
  Duration : 48 months (starting on October 1st, 2016)
  Other partners: Institut de Mathématiques de Bordeaux, Inria Paris, Institut de Mathématiques de Toulouse
  Abstract: The aim of this project is to analyze systems composed by structures immersed in a fluid. Studies of such systems can be motivated by many applications (motion of the blood in veins, fish locomotion, design of submarines, etc.) but also by the corresponding challenging mathematical problems. Among the important difficulties inherent to these systems, one can quote nonlinearity, coupling, free-boundaries. Our objectives include asymptotic analyses of FSIS, the study of controllability and stabilizability of FSIS, the understanding of locomotion of self-propelled structures and the analyze and development of numerical tools to simulate fluid-structure system.
  URL: http://ifsmacs.iecl.univ-lorraine.fr/
- Xavier Antoine is member of the project TECSER funded by the French armament procurement agency in the framework of the Specific Support for Research Works and Innovation Defense (ASTRID 2013 program) operated by the French National Research Agency.
  Project Acronym: TECSER
  Project Title : Nouvelles techniques de résolution adaptées à la simulation haute performance pour le calcul SER
  Coordinator: Stéphane Lanteri (Inria, NACHOS project-team)
  Duration: 36 months (starting on May 1st, 2014)
  Other partners: EADS (France Innovation Works Dep.), NUCLETUDES
  URL: http://www-sop.inria.fr/nachos/projects/tecser/index.php/Main/HomePage
- **Project Acronym:** BoND
  Project Title: Boundaries, Numerics and Dispersion.
  Coordinator: Sylvie Benzoni (Institut Camille Jordan, Lyon, France)
  Participant: Xavier Antoine
  Duration: 48 months (starting on October 15th, 2013)
  URL: http://bond.math.cnrs.fr

- Xavier Antoine is the local coordinator of the ANR project BECASIM.
  Project acronym: BECASIM
  Project Title: Bose-Einstein Condensates: Advanced SIMulation Deterministic and Stochastic Computational Models, HPC Implementation, Simulation of Experiments.
  Coordinator: Ionut Danaila (Université de Rouen, France)
  Participant: Xavier antoine
  Duration: 48 months (plus an extension of 12 months, until November 2017)
  Other partners: Laboratoire de Mathématiques Raphaël Salem, (Université de Rouen); Laboratoire Jacques-Louis Lions (Université Pierre et Marie Curie); Centre de Mathématiques Appliquées (Ecole Polytechnique); Centre d'Enseignement et de Recherche en Mathématiques et Calcul Scientifique (École des Ponts ParisTech); Loria; Laboratoire Paul Painlevé (Université Lille 1) et Inria-Lille Nord-Europe; Institut de Mathématiques et de Modélisation de Montpellier (Université Montpellier 2)
  URL: http://becasim.math.cnrs.fr
- **Project Acronym:** QUACO
  Project title: use of geometrical tools for the control of quantum system and application to MRI.
  Coordinator: Thomas Chambrion
  Duration: 48 months (starting January 1st 2018).
- **Project acronym:** ISDEEC
  Project title: Interaction entre Systèmes Dynamiques, Equations d'Evolution et Contrôle
  Coordinator: Romain Joly
  Participant: Julie Valein
  Other partners: Institut Fourier, Grenoble; Département de Mathématiques d'Orsay
  Duration: 36 months (2017-2020)
  URL: http://isdeec.math.cnrs.fr/

9.1.2. CNRS

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

9.2. International Initiatives

9.2.1. Participation in Other International Programs

D. Dos Santos Ferreira and J.-F. Scheid are members of the PHC Utique program ...

Program: PHC Utique

Project title: Équations aux Dérivées Partielles Déterministes et Stochastiques

Duration: January 2017-January 2020

Other partners: Laboratoire de Modélisation De´terministe et Ale´atoire (LAMDA), École Supérieure des Sciences et de la Technologie de Hammam Sousse (ESSTHS), Université de Sousse, Tunisie.

Abstract: The main objective of this project is to study some systems of Ordinary Differential Equations (ODE) and Partial Differential Equations (PDE) in a deterministic and stochastic frameworks with analytical, numerical, probabilistic or statistical methods. A typical system considered in this project is the modeling and the numerical simulations of the myocardial infarction (heart attack). This phenomenon is studied as a fluid/structure interaction type process between the blood, the cholesterol deposit along the walls of an artery and the rupture of the atherosclerotic plaque formed by the cholesterol.

This is a project for a French-Tunisian collaboration and it involved a PhD thesis co-advised by J.-F. Scheid.

J. Valein is member of the project ICoPS:

Program: MATH-AmSud

Project acronym: ICoPS

Project title: Inverse and control problems for physical systems

Duration: 01/2017-12/2018

Coordinators: Alberto Mercado (Valparaíso, Chile), Emmanuelle Crépeau (Versailles), Daniel Alfaro (Rio de Janeiro, Brasil), Ivonne Rivas (Colombia)

Other partners: Centre Automatique et Systèmes (École des Mines de Paris), LAAS (Toulouse), Instituto de Matemática, Estadística e Física (Universidade Federal do Rio Grande do Sul, Brasil), Departamento de Matemáticas y Estadística, (Universidad Icesi, Pance, Cali, Colombia)

Abstract: We propose to study well-posedness, control properties, and coefficient inverse problems for partial differential equations appearing in models for several phenomena. We intend to study the inverse problems of recovering some coefficients in the previously mentioned equations, and also in nonlinear dispersive waves on trees, which appears for instance in model for the cardiovascular system. We intend to study numerical approximations, using numerical schemes like Galerkin, colocation, finite difference, among others. Finally, this proposal includes the determination of the reachable states in a control problem of KdV equation.

9.3. International Research Visitors

J.-F. Scheid has been visitor of the l'ESSTHS (Hammam-Sousse, Tunisia) for two weeks (work related to the thesis of Imen JBILI) and course on numerical methods for the Navier-Stokes equations).

9.3.1. Visits of International Scientists

Sorin Micu (University of Craiova) was an invited professor (University of Lorraine) from 12/01/2017 to 12/02/2017.

TROPICAL Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Projet ANR MALTHY (Méthodes ALgébriques pour la vérification de modèles Temporisés et HYbrides), responsable T. Dang. Partenaires : Verimag, CEA LIST, Inria Rennes, Inria Saclay, VISEO/Object Direct.
- Projet ANR DEMOCRITE ("DEmonstrateur d'un MOteur de Couverture des Risques sur un TErritoire), responsable Emmanuel Lapébie (CEA). Partenaires : CEA-GRAMAT, BSPP, Inria Saclay (Maxplus), Institut PPRIME - UPR3346 (CNRS, Univ. Poitiers, ISAE-ENSMA), IPSIS, SYSTEL, ARMINES-E.M. Alès-ISR, CERDACC (Univ. de Haute-Alsace).

9.1.2. Programme Gaspard Monge pour l'Optimisation

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

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

- Collaboration with Ricardo D. Katz, CIFASIS-CONICET, Rosario (Argentina). Research invitation at CMAP during 2 months.

9.2.2. Participation in International Programs

- Collaboration with Gleb Koshevoy, Poncelet Laboratory, Moscow (research invitation of Gleb Koshevoy at CMAP during 2 months, research invitation of Stéphane Gaubert at Poncelet Laboratory during 1 week).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Gleb Koshevoy (Russian Academy of Siences), Feb-March, 2017.
- Shmuel Friedland (University of Illinois at Chicago), one week in May 2017.
- Zheng Qu (Hong Kong University), June-July 2017
- Zheng Hua (Hong Kong University), June-July 2017
- Rajendra Bhatia (Indian Statistical Institute, New Delhi), 1 week in Dec 2017.
- Floris Claassens (University of Kent), 1 week in Dec 2017.

DOLPHIN Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- CPER "data" (2015-2020): This project is jointly supported by the government together with the region. The Advanced Data Science and Technology (Data) CPER project aims to conduct a research program on data intelligence at a high international level in a strong synergy with the regional economic fabric and to set up a research infrastructure in line with the associated challenges. It focuses on three areas of research: Internet of Things, Intelligence of Data and Knowledge, High Performance Computing (HPC) and Optimization, and four main levers: (i) research infrastructure, (ii) attractiveness - particularly researchers from EPST, (iii) demonstrators, (iv) Transfer for innovation to SMEs. Dolphin (N. Melab) is the scientific leader of the HPC and optimization scientific area and the research infrastructure lever (Grid'5000 part). The budget for this part is 1.2M€. C. Dhaenens is coordinator of the project for the University of Lille.
- CPER ELSAT (2015-2019) of CPER (Contrat Plan Etat Région): transversal research action "Planning and scheduling of maintenance logistics in transportation".

9.2. National Initiatives

9.2.1. ANR

- ANR project Modèles Numériques "NumBBO - Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers" (2012-2016) in collaboration with Inria Saclay, TAO team, Ecole des Mines de St. Etienne, CROCUS team, and TU Dortmund University, Germany (2012-2016)
- ANR project TECSAN (Technologies pour la Santé) "ClinMine - Optimisation de la prise en Charge des Patients à l'Hôpital", in collaboration with University Lille 1, University Lille 2, Inria, CHRU Lille, CHICL, Alicante (6 partners) (2014-2017) - Coordinator C. Dhaenens
- Bilateral ANR/RGC France/Hong Kong PRCI "Big Multiobjective Optimization" (2016-2021) in collaboration with City University of Hong Kong
- PGMO project "Towards a Complexity Theory for Black-Box Optimization", together with Carola Doerr (CNRS, LIP6), Benjamin Doerr (Ecole Polytechnique), Anne Auger, Nikolaus Hansen (both Inria Saclay), Timo Koetzing (University of Jena, Germany), Johannes Lengler (ETH Zurich, Switzerland), and Jonathan Rowe (The University of Birmingham, UK), (2014-2016)
- PGMO project "Demand side management in smart grids", together with EDF, (2015-2017)
- PGMO project "Multi-home Demand side management in micro grids", together with EDF, (2017-2019)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: H2020

Project acronym: SYNERGY

Project title: Synergy for Smart Multi-Objective Optimisation

Duration: 02 2016 - 01 2019

Coordinator: Jožef Stefan Institute (JSI), Ljubljana, Slovenia

Other partners: University of Lille (France), Cologne University of Applied Sciences (Germany)

Abstract: Many real-world application areas, such as advanced manufacturing, involve optimization of several, often time-consuming and conflicting objectives. For example, they require the maximization of the product quality while minimizing the production cost, and rely on demanding numerical simulations in order to assess the objectives. These, so-called multi-objective optimization problems can be solved more efficiently if parallelization is used to execute the simulations simultaneously and if the simulations are partly replaced by accurate surrogate models.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: COST CA15140

Project acronym: ImAppNIO

Project title: Improving applicability of nature-inspired optimization by joining theory and practice

Duration: 2016-2019

Coordinator: Thomas Jansen

Abstract: The main objective of the COST Action is to bridge this gap and improve the applicability of all kinds of nature-inspired optimisation methods. It aims at making theoretical insights more accessible and practical by creating a platform where theoreticians and practitioners can meet and exchange insights, ideas and needs; by developing robust guidelines and practical support for application development based on theoretical insights; by developing theoretical frameworks driven by actual needs arising from practical applications; by training Early Career Investigators in a theory of nature-inspired optimisation methods that clearly aims at practical applications; by broadening participation in the ongoing research of how to develop and apply robust nature-inspired optimisation methods in different application areas.

9.3.3. Collaborations with Major European Organizations

University of Luxembourg: (Luxembourg)

Energy aware scheduling in Cloud computing systems

University of Oviedo: (Spain)

Optimization under uncertainty for fuzzy flow shop scheduling

University of Elche and University of Murcia: (Spain)

Matheuristics for DEA

9.4. International Initiatives

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

9.4.1.1. MOHA

Title: Mixed Multi-objective Optimization using Hybrid Algorithms: Application to smart grids

International Partner (Institution - Laboratory - Researcher):

> Ecole Mohammadia d'Ingénieurs (Morocco) - LERMA (Laboratoire d'Etudes et de Recherches en Mathématiques Appliquées) - Rachid Ellaia

Start year: 2016

See also: https://ocm.univ-lille1.fr/~talbi/momh/

The key challenge of this project is to propose new optimization models and new hybrid algorithms to the demand side management of smart grids in a context of uncertainty and in the presence of several conflicting objectives.

Those complex optimization problems are also characterized by the presence of both continuous and discrete variables. We need to design new efficient optimization algorithms combining state-of-the-art exact and metaheuristic algorithms from the global optimization and combinatorial optimization communities

9.4.1.2. s3-bbo

Title: Threefold Scalability in Any-objective Black-Box Optimization (s3-bbo)

International Partner (Institution - Laboratory - Researcher):

Shinshu University, Japan

Duration: 2015-2017

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

The main scientific goals of this collaboration is to theoretically derive, analyze, design, and develop scalable evolutionary and other stochastic local search 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. This research will allow us to design, control, predict, analyze and optimize parameters of recent complex, large-scale, and computationally expensive systems, providing the basic support for problem solution and decision-making in a variety of real world applications. For single-objective continuous optimization, we want to theoretically derive variants of the state-of-the-art CMA-ES with linear time and space complexity scalings with respect to the number of variables. We will exploit the information geometry framework to derive updates using parametrization of the underlying family of probability distribution involving a linear number of components. The challenges are related to finding good representations that are theoretically tractable and meaningful. For the design of robust algorithms, implementing the derived updates, we plan to follow the same approach as for the design of CMA-ES. For multi- and many-objective optimization, we will start by characterizing and defining new metrics and methodologies to analyze scalability in the objective space and in terms of computational resources. The first challenge is to accurately measure the impact of adding objectives on the search behavior and on the performance of evolutionary multi- and many- objective optimization (EMyO) algorithms. The second challenge is to investigate the new opportunities offered by large-scale computing platforms to design new effective algorithms for EMyO optimization. To this end, we plan to follow a feature-based performance analysis of EMyO algorithms, to design new algorithms using decomposition-based approaches, and to investigate their mapping to a practical parallel and distributed setting.

9.4.1.3. Informal International Partners

- Collaboration with Université de Mons (UMONS). The collaboration consists mainly in the joint supervision of the Phd thesis of Jan Gmys started in 2014.
- University of Coimbra, Portugal
- University of Lisbon, Portugal
- University of Manchester, United Kingdom
- University of Elche, Spain

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Fred Glover (University of Colorado, USA), Feb 2017
- Prof. Rachid Ellaia (EMI, Univ. Rabat, Morocco), Nov 2017
- Prof. Oliver Schutez (CINVESTAV, Mexico), Nov 2017
- Manuel López-Ibáñez, Manchester University (United Kingdom), June 2017
- Kiyoshi Tanaka, Shinshu University (Japan), March 2017
- Qingfu Zhang, City University (Hong Kong), April 2017
- Manuel López-Ibáñez, Manchester University (United Kingdom), June 2017
- Kiyoshi Tanaka, Shinshu University (Japan), March 2017
- Qingfu Zhang, City University (Hong Kong), April 2017

9.5.1.1. Internships

- Oliver Cuate, CINVESTAV, Mexico
- Jihene Serrar, EMI, Morocco
- Zineb Hattab, EMI, Morocco

9.5.2. Visits to International Teams

9.5.2.1. Sabbatical programme

Prof. El-Ghazali Talbi has been at Sabbatical from the University of Lille (2016-2017) visiting many Universities at International level (USA, Spain, Italy, Mexico, Morocco, Luxembourg, ...).

9.5.2.2. Research Stays Abroad

- B. Derbel: University of Lisbon (Portugal), 2 months
- A. Liefooghe: Shinshu University (Japan), 1 month, May 2017
- B. Derbel: Shinshu University (Japan), 1 month, June-July 2017
- E-G. Talbi: EMI, University of Rabat (Morocco), 1 month, 2017
- E-G. Talbi, JSI, Ljubljana (Slovenia), 1 month, 2017

GEOSTAT Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

GEOSTAT is working with the following regional partners:

- CNRS LOMA (Laboratoire Ondes et Matière d'Aquitaine) and RAS Institute (Russia): collaboration on the analysis/modeling of heartbeat physiological time series (A. Arneodo, E. Gerasimova, F. Argoul).
- GEOSTAT has a decade-long close scientific collaboration with team SYSCO2 (LEGOS LAboratoryUMR 5566): V. Garçon, B. Dewitte, J. Sudre.
- Laboratoire d'Astrophysique de Bordeaux (S. Bontemps, N. Schneider, GENESIS project).
- Collaboration with L. Bourrel (GET Toulouse / IRD) and F. Frappart (GET/UMR EPOC)Flood monitoring in Equator.
- With Bruno Castelle (EPOC).
- With D. Gibert (OSUR) on signal and image processing.
- CHU Bordeaux : Prof. Wassilios Meissner (IMN), Dr. Solange Milhé de Saint Victor (service ORL).
- CHU Toulouse : Dr. Anne Pavy Le traon (service Neurologie), Prof. Virginie Woisard (service ORL).
- IRIT : Prof. Régine André-Obrecht, Dr. Julie Mauclair.
- IMT (Institut de Mathématique de Toulouse) : Dr. Sébastien Déjean, Dr. Laurent Risser.
- Mercator Océan: Dr. A. El Moussaoui. UMR EPOC).

9.2. National Initiatives

- ANR project *Voice4PD-MSA*, led by K. Daoudi, which targets the differential diagnosis between Parkinson's disease and Multiple System Atrophy. The total amount of the grant is 468555 euros, from which GeoStat has 203078 euros. The duration of the project is 42 months. Partners: CHU Bordeaux (Bordeaux), CHU Toulouse, IRIT, IMT (Toulouse).
- PhD grant for C. Artnana from UPMC University, under co-supervision with H. Yahia and C. Provost (LOCEAN, Paris).
- PhD grant for G. Singh from IIT Roorkee, under co-supervision with D. Singh (IIT Roorkee).
- The PHC-Toubkal project "Caractérisation multi-capteurs et suivi spatio-temporel de l'Upwelling sur la côte atlantique marocaine par imagerie satellitaire", led by K. Daoudi, is in its second year. The partners in this project are: Faculté des sciences de Rabat, Centre Royal de Télédetection Spatiale, Mercator-Ocean and GEOSTAT.
- GEOSTAT is a member of ISIS (Information, Image & Vision) and AMF (Multifractal Analysis) GDRs.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: supported by Deutsche Forschungsgemeinde (DFG) and the Agence national de recherche (ANR).

Project acronym: GENESIS.

Project title: GENeration and Evolution of Structures in the ISm.

Duration: start 1.5. 2017, 3 years.

Coordinator: N. Schneider (I. Physik, Cologne).

Other partners: Cologne (R. Simon, N. Schneider, V. Ossenkopf, M. Roellig), LAB (S. Bontemps, A. Roy, L. Bonne, F. Herpin, J. Braine, N. Brouillet, T. Jacq), ATN Canberra (Australia), LERMA Paris (France), MPIfR Bonn (Germany), CEA Saclay (France), ITA/ZAH Heidelberg (Germany), Institute of Astronomy, Cardiff (UK), ESO (Germany, Chile), CfA Harvard (USA), IPAG Grenoble (France), Argelander Institut Bonn (Germany), CASS San Diego (USA), University of Sofia (Bulgaria).

Abstract: The formation of stars is intimately linked to the structure and evolution of molecular clouds in the interstellar medium (ISM). We propose to explore this link with a new approach by combining far infrared maps of dust (Herschel) and cooling lines(C+ with SOFIA) with molecular line maps. Dedicated analysis tools will be used and developed to analyze the maps and compare them to simulations in order to identify for the underlying physical processes. This joint project relies on the complementary expertise of the members of the Cologne KOSMA group (structure identification methods and SOFIA), the Bordeaux LAB star formation group (Herschel and spectro-imaging maps), and the Bordeaux GEOSTAT team of Inria. To understand the genesis of stars, it is necessary to disentangle the relative importance of gravity, turbulence, magnetic fields, and radiation from diffuse gas, to molecular clouds and collapsing cores, and to study the role of filaments. Using innovative new analying tools developed by the GeoStat team, we will analyze the Herschel images as well as new spectro-imaging surveys from ground-based telescopes, and THz spectroscopy using SOFIA. The comparison with similar analysis on simulated clouds will allow us to derive the underlying physical process which explains cloud evolution and the formation of dense structures. The project does not aim at a full understanding of star formation within 3 years, but it constitutes an important step forward as it will make systematic use of a wealth of existing, yet not fully exploited archival data, carefully chosen new observations, and sophisticated tools to analyze and interpret the data. As such, it will shed new light on how molecular clouds and stars form and may well be the starting point for many studies to follow.

9.4. International Initiatives

9.4.1. Inria International Partners

Funding from French-Indian IFCAM program (Visit of Prof. D. Singh in GEOSTAT, 2017).

9.4.1.1. Informal International Partners

- Visit of N. Brodu to Univ. UC Davis in the team of Prof. J. Crutchfield. Setting up of a collaboration on a formalism of statistical reconstruction from dynamic empirical data; the formalism involves markovian automata called Epsilon machines. The internal states of these machine correspond to equivalence classes of a physical system having similar causal relations.
- Laboratory LRIT from Rabat University (K. Minaoui, D. Aboutajdine).

9.4.2. Participation in Other International Programs

Participation in the IFCAM project with India (funding of the visit of Prof. D. Singh in 2017).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- N. Schneider (Cologne University, GENESIS project).
- Prof. D. Singh (IIT roorkee, on CEFIPRA-CNRS funding). Duration: 8 weeks, August and December 2017. Co-supervision of G. Singh PhD stdudent, scientific collaboration with N. Brodu and K. Daoudi.

9.5.1.1. Internships

- G. Li. Master2, University Paris-Saclay.
- Q. Robin. Engineer, INP-Grenble.
- F. G. Satsou. Master1, University Bordeaux 1.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

June-July 2017: PhD student A. El Aouni was invited in the MERCATOR project by A. Moussaoui in the framework of the Toubkal project on ocean modeling.

INOCS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The ELSAT research program addresses the issues involved in sustainable transportation and mobility. Within ELSAT, INOCS is involved on two projects devoted to hybrid optimization methods in logistics and to city logistics in collaboration with LAMIH (University of Valenciennes), LGI2A (University of Artois) and LEOST (IFSTTAR). ELSAT is supported by the CPER 2015-2020 (State-Region Contract).

9.2. National Initiatives

9.2.1. ANR

ANR project PI-Commodality "Co-modal freight transportation chains: an approach based on physical internet" in collaboration with CGS-ARMINES (Paris), LAAS (Toulouse), DHL (2016 - 2018). The PI-co-modality project aims to design new sustainable logistic services between preset origins and destinations. It is based on innovative approaches both in terms of: 1) Logistics and transportation services: by considering the PI-internet approach, specifically: mesh logistics and transportation networks based on available capacities, by designing consistent integrated co-modal chains; 2) Methodology: by addressing the underlying problems according to two approaches: centralized and decentralized, by proposing news realistic models relevant for practitioner taking into account the consistency, by developing state-of-the-art decision making algorithms.

9.2.2. National Initiatives (Belgium)

Combinatorial Optimization: Meta-heuristics and Exact Methods (2012-2017), coordinator: Bernard Fortz (GOM-ULB/INOCS-Inria). Inter-university Attraction Pole funded by the Belgian Federal Science Policy Office. Study and modeling of combinatorial optimization problems; Advancements in algorithmic techniques; Implementation of solution methods for large-scale, practically relevant problems.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: TD1207

Project title: Mathematical Optimization in the Decision Support Systems for Efficient and Robust Energy Networks

Duration: 04/2014 - 04/2017

Coordinator: Thorsten Koch (ZIB, Germany)

INOCS partners: Bernard Fortz, Martine Labbé

Abstract: Energy Production and Distribution (EP&D) is among the biggest challenges of our time, since energy is a scarce resource whose efficient production and fair distribution is associated with many technical, economical, political and ethical issues like environmental protection and people health. EP&D networks have rapidly increased their size and complexity, e.g. with the introduction and interconnection of markets within the EU. Thus, there is an increasing need of systems supporting the operational, regulatory and design decisions through a highly inter-disciplinary approach, where experts of all the concerned fields contribute to the definition of appropriate mathematical models. This is particularly challenging because these models require the simultaneous use of many different mathematical optimization tools and the verification by experts of the underlying engineering and financial issues. The COST framework is instrumental for this Action to be able to coordinate the inter-disciplinary efforts of scientists and industrial players at the European level.

Program: JPI Urban Europe

Project acronym: e4-share

Project title: Models for Ecological, Economical, Efficient, Electric Car-Sharing

Duration: 10/2014 - 09/2017

Coordinator: Markus Leitner (University of Vienna, Austria)

Other partners:

- Austrian Institute of Technology, Austria
- Université Libre de Bruxelles (INOCS), Belgium
- University of Bologna, Italy
- tbw research GesmbH, Austria

Abstract: Car-sharing systems and the usage of electric cars become increasingly popular among urban citizens. Thus, providing vast opportunities to meet today's challenges in terms of environmental objectives, sustainability and living quality. Our society needs to manage a transformation process that ultimately shall lead to fewer emissions and less energy consumption while increasing the quality of public space available. In e4-share, the team will lay the foundations for efficient and economically viable electric car-sharing systems by studying and solving the optimization problems arising in their design and operations. A main goal is to derive generic methods and strategies for optimized planning and operating in particular for flexible variants which best meet preferences of customers but impose nontrivial challenges to operators. This project will develop novel, exact and heuristic, numerical methods for finding suitable solutions to the optimization problems arising at the various planning levels as well as new, innovative approaches considering these levels simultaneously.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. BIPLOS

Title: BIlevel Problems in LOgistics and Security

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Instituto Sistemas Complejos de Ingeieria (ISCI) - Ordonez Fernando

Start year: 2017

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

This projet is devoted to bilevel optimisation problems with application in the security and logistics domains. Stackelberg games, including one defender and several followers, and competitive location problems will be considered. Mixed integer linear optimisation models and efficient algorithms to solve them will be developed.

Related publications: [29], [11], [66].

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

9.4.2.1. North-European associated team

Title: Physical-internet services for city logistics

International Partner (Institution - Laboratory - Researcher):

Norwegian School of Economics - Stein Wallace

Start year: 2017

In this project, we consider an urban logistic terminal and new logistics services which could be developed according to a Physical Internet approach. The main objective is to evaluate the services using optimization models created within the project. We are developing optimization models to identify win-win cooperation between carriers based on supply and demand. We aim to explore how to include stochasticity in the description of the supplies and demands, as well as travel times, and to what extent the plans within a day can improve by such knowledge. The second task is to develop solution algorithms for these models. These are real scientific challenges as we are facing stochastic mixed integer problems.

9.4.3. Inria International Partners

9.4.3.1. Informal International Partners

Department of Statistics and Operations Research, University of Vienna, Austria.
Centre for Quantitative Methods and Operations Management, HEC-Liège, Belgique.
Interuniversity Centre on Entreprise Networks, Transportation and Logistics (CIRRELT), Montreal, Canada.
Department of Industrial Engineering, Universidad de Talca, Curicó, Chile.
Instituto Sistemas Complejos de Ingeniería (ISCI), Santiago, Chile.
The Centre for Business Analytics, University College Dublin, Ireland.
Department of Electrical, Electronic, and Information Engineering, University of Bologna, Italy.
Department of Electrical and Information Engineering, University of Padova, Italy.
Department of Mathematics, University of Aveiro, Portugal.
Department of Statistics and Operations Research, University of Lisbon, Portugal.
Instituto de Matemáticas, University of Seville, Spain.
Departamento de Estadística e Investigación Operativa, Universidad de Murcia, Spain.
Dipartimento di Matematica, Universita degli studi di Padova, Italy.

9.4.4. Participation in Other International Programs

STIC Algérie, University of Oran, Algeria.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Visiting Professors and Ph.D. students

Claudio Arbib, Professor at Università degli Studi dell'Aquila, Feb 2017.
Victor Bucarey, Postdoctoral researcher at Universidad de Chile, Dec 2017.
Paula Carroll, Professor at Centre for Business Analytics, School of Business, University College Dublin, Sep 2017.
Sebastián Dávila, Ph.D. student at Universidad de Chile, Dec 2017.
Bernard Gendron, Professor at Université de Montréal, Nov 2017.
Anton Kleywegt, Professor at Georgia Institue of Technology, from Jun 2017 until Jul 2017.
Marina Leal, Ph.D. student at Universidad de Sevilla, from Jun until Oct 2017.
Paulo Macedo, Ph.D. student at Universidade Federal do Ceará, from Mar 2017 until Jul 2017.
Vladimir Marianov, Professor at Pontificia Universidad Católica de Chile, from Nov until Dec 2017.
Alfredo Marín, Professor at Universidad de Murcia, Oct 2017.
Fernando Ordónez, Professor at Universidad de Chile, Sep 2017.
Juan José Palacios Alonso, Professor at Universidad de Oviedo, from Sep until Dec 2017.
Mercedes Pelegrin Garcia, Ph.D. student at Universidad de Murcia, from Sep 2017 until Dec 2017.

9.5.1.2. Internships

Juan Alejandro Gomez Herrera, Ecole Polytechnique de Montréal, from Apr 2017 until Jul 2017.
Sebastien Michel, Centrale Lille, from Jun 2017 until Sep 2017.
Luis Salazar Zendeja, University of Monterrey, Mexico, from Apr 2017 until Aug 2017.
Grégoire Pellissier, Université Blaise Pascal, Clermont-Ferrand, from June 2017 until Sept 2017.

MISTIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Grenoble Idex projects

MISTIS is involved in a newly accepted transdiciplinary project **NeuroCoG**.

F. Forbes is also responsible for a work package in another project entitled **Grenoble Alpes Data Institute**.

MISTIS is also involved in a newly accepted cross-disciplinary project (CDP) RISK@UGA.

- The main objective of the RISK@UGA project is to provide some innovative tools both for the management of risk and crises in areas that are made vulnerable because of strong interdependencies between human, natural or technological hazards, in synergy with the conclusions of Sendai conference. The project federates a hundred researchers from Human and Social Sciences, Information & System Sciences, Geosciences and Engineering Sciences, already strongly involved in the problems of risk assessment and management, in particular natural risks.
- The NeuroCoG project aims at understanding the biological, neurophysiological and functional bases of behavioral and cognitive processes in normal and pathological conditions, from cells to networks and from individual to social cognition. No decisive progress can be achieved in this area without an aspiring interdisciplinary approach. The interdisciplinary ambition of NeuroCoG is particularly strong, bringing together the best scientists, engineers and clinicians at the crossroads of experimental and life sciences, human and social sciences and information and communication sciences, to answer major questions on the workings of the brain and of cognition. One of the work package entitled InnobioPark is dedicated to Parkinson's Disease. The PhD thesis of Veronica Munoz Ramirez is one of the three PhDs in this work package.
- The Grenoble Alpes Data Institute aims at undertaking groundbreaking interdisciplinary research focusing on how data change science and society. It combines three fields of data-related research in a unique way: data science applied to spatial and environmental sciences, biology, and health sciences; data-driven research as a major tool in Social Sciences and Humanities; and studies about data governance, security and the protection of data and privacy. In this context, two 2-years multi-disciplinary projects were granted in November 2017 to Mistis in collaboration respectively with Team Necs from Inria and Gipsa-lab (DATASAFE project: understanding Data Accidents for TrAffic SAFEty) and with IPAG and Univ. Paris Sud Orsay (Regression techniques for Massive Mars hyperspectral image analysis from physical model inversion), 9 keuros each.
- Also in the context of the Grenoble Alpes Data Institute, Julyan Arbel and Stéphane Girard were awarded a funding from IRS (Initiatives de Recherche Stratégique) for a research project dedicated to extreme and Bayesian statistics, 8 keuros.

9.1.2. Competitivity Clusters

The MINALOGIC VISION 4.0 project:MISTIS is involved in a three-year (2016-19) project. The project is led by VI-Technology, a world leader in Automated Optical Inspection (AOI) of a broad range of electronic components. The other partners are the G-Scop Lab in Grenoble and ACTIA company based in Toulouse. Vision 4.0 (in short Vi4.2) is one of the 8 projects labeled by Minalogic, the digital technology competitiveness cluster in Auvergne-Rhône-Alpes, that has been selected for the Industry 4.0 topic in 2016, as part of the 22nd call for projects of the FUI-Régions, for a total budget of the project of 3,4 Meuros.

Today, in the printed circuits boards (PCB) assembly industry, the assembly of electronic cards is a succession of ultra automated steps. Manufacturers, in constant quest for productivity, face sensitive and complex adjustments to reach ever higher levels of quality. Project VI4.2 proposes to build an innovative software solution to facilitate these adjustments, from images and measures obtained in automatic optical inspection (AOI). The idea is - from a centralized station for all the assembly line devices - to analyze and model the defects finely, to adjust each automatic machine, and to configure the interconnection logic between them to improve the quality. Transmitted information is essentially of statistical nature and the role of sc mistis is to identify which statistical methods might be useful to exploit at best the large amount of data registered by AOI machines. Preliminary experiments and results on the Solder Paste Inspection (SPI) step, at the beginning of the assembly line, helped determining candidate variables and measurements to identify future defects and to discriminate between them. More generally, the idea is to analyze two databases at both ends (SPI and Component Inspection) of the assembly process so as to improve our understanding of interactions in the assembly process, find out correlations between defects and physical measures and generate accordingly proactive alarms so as to detect as early as possible departures from normality.

9.1.3. CNRS fundings

- **Defi Mastodons, La qualité des données dans le Big Data (2015-17)**. S. Girard is involved in a 2-year project entitled “Classification de Données Hétérogènes avec valeurs manquantes appliquée au Traitement des Données Satellitaires en écologie et Cartographie du Paysage” [53], the other partners being members of Modal (Inria Lille Nord-Europe) or ENSAT-Toulouse. The total funding is 17,5 keuros.
- Stéphane Girard and Julyan Arbel were awarded a funding from TelluS-Insmi (with IPAG and Univ. Paris-Descartes), for a 1-year project entitled “unsupervised classification in high dimension", 7000 euros.
- **Defi Imag’IN MultiPlanNet (2015-2017).** This is a 2-year project to build a network for the analysis and fusion of multimodal data from planetology. There are 8 partners: IRCCYN Nantes, GIPSA-lab Grenoble, IPAG Grenoble, CEA Saclay, UPS Toulouse, LGL Lyon1, GEOPS University Orsay and Inria Mistis. F. Forbes is in charge of one work package entitled *Massive inversion of multimodal data*. Our contribution will be based on our previous work in the VAHINE project on hyperspectral images and recent developments on inverse regression methods. The CNRS support for the network is of 20 keuros. A 2-day workshop was organized in November 2017 in Grenoble, on the analysis of multimodal data for planets observation and exploration.

9.1.4. GDR Madics

Apprentissage, opTimisation à Large-échelle et cAlcul diStribué (ATLAS). Mistis is participating to this action supported by the GDR in 2016 (3 keuros).

9.1.5. Networks

MSTGA and AIGM INRA (French National Institute for Agricultural Research) networks: F. Forbes is a member of the INRA network called AIGM (ex MSTGA) network since 2006, http://carlit.toulouse.inra.fr/AIGM, on Algorithmic issues for Inference in Graphical Models. It is funded by INRA MIA and RNSC/ISC Paris. This network gathers researchers from different disciplines. F. Forbes co-organized and hosted 2 of the network meetings in 2008 and 2015 in Grenoble.

9.2. International Initiatives

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

9.2.1.1. SIMERGE

Title: Statistical Inference for the Management of Extreme Risks and Global Epidemiology

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LERSTAD - Abdou Ka Diongue

Starting year: 2015

See also: http://mistis.inrialpes.fr/simerge

Entered in the LIRIMA in January 2015, this team federates researchers from LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger), on the one part, and MISTIS (Inria Grenoble Rhône-Alpes) on the other part. This project consolidates the existing collaborations between these two Laboratories.

The team also involves statisticians from EQUIPPE laboratory (Economie QUantitative Intégration Politiques Publiques Econométrie, Université de Lille) and associated members of Modal (Inria Lille Nord-Europe) as well as an epidemiologist from IRD (Institut de Recherche pour le Développement) at Dakar.

The following two research themes are developed : (1) Spatial extremes with application to management of extreme risks ; (2) Classification with application to global epidemiology.

9.2.2. Inria International Partners

9.2.2.1. Informal International Partners

The context of our research is also the collaboration between MISTIS and a number of international partners such as the statistics department of University of Michigan, in Ann Arbor, USA, the statistics department of McGill University in Montreal, Canada, Université Gaston Berger in Senegal and Universities of Melbourne and Brisbane in Australia.

The main active international collaborations in 2017 are with:

- F. Durante, Free University of Bozen-Bolzano, Italy.
- K. Qin, H. Nguyen and D. Wraith resp. from Swinburne University and La Trobe university in Melbourne, Australia and Queensland University of Technology in Brisbane, Australia.
- E. Deme and S. Sylla from Gaston Berger university and IRD in Senegal.
- M. Stehlik from Johannes Kepler Universitat Linz, Austria and Universidad de Valparaiso, Chile.
- M. Houle from National Institute of Informatics, Tokyo, Japan.
- N. Wang and C-C. Tu from University of Michigan, Ann Arbor, USA.
- R. Steele, from McGill university, Montreal, Canada.
- Guillaume Kon Kam King, Stefano Favaro, Igor Prünster, University of Turin, Italy.
- Bernardo Nipoti, Trinity College Dublin, Ireland.
- Yeh Whye Teh, Oxford University, UK.
- Stephen Walker, University of Texas at Austin, USA.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Seydou Nourou Sylla (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for two months.
- Aboubacrène Ahmad (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for two months.
- Hien Nguyen from La Trobe university, Melbourne Australia, has been hosted for 2 days.

9.3.2. Visits to International Teams

9.3.2.1. Research Stays Abroad

- F. Forbes spent 2 weeks in April 2017 in Australia, visiting Brisbane and Melbourne universities.
- J. Arbel spent 3 months at the University of Texas at Austin.

MODAL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Main partners of bilille

Participant: Guillemette Marot.

Bilille, the bioinformatics platform of Lille, officially gathers from Nov. 2015 a few bioinformaticians, biostatisticians and bioanalysts from the following teams:

EA2694 (Univ. Lille, CHRU, Inria)

FRABIO, FR3688 (Univ. Lille,CNRS)

CBP / GFS (Univ. Lille, CHRU)

TAG (Univ. Lille, CNRS, INSERM, Institut Pasteur de Lille)

U1167 (Univ. Lille, CHRU, INSERM et Institut Pasteur de Lille)

U1011 (Univ. Lille, INSERM)

UMR8198 (Univ. Lille, CNRS)

LIGAN PM (Univ. Lille, CNRS)

BONSAI (Inria, Univ. Lille, CNRS).

These last teams are thus the main partners of Modal concerning biostatistics for bioinformatics. Guillemette Marot is the co-head of the platform and works in close collaboration with the following people for the leadership of the scientific strategy related to the platform:

H. Touzet, BONSAI, UMR 9189 (co-head of bilille)

P. Touzet, UMR 8198 (deputy head of bilille)

V. Chouraki, U1167

M. Figeac, CBP / GFS

D. Hot, TAG

V. Leclère, Insitut Charles Viollette

M. Lensink, UMR 8576.

9.1.2. Collaborations of the year linked to bilille, the bioinformatics and bioanalysis platform

Participants: Guillemette Marot, Vincent Vandewalle.

Guillemette Marot and Vincent Vandewalle have supervised the data analysis part or support in biostatistics tools testing for the following research projects involving engineers from bilille (only the names of the principal investigators of the project are given even if several partners are sometimes involved in the project):

UMR 8576, E. Goulas, FLAM project

JPARC, M.H. David, AGI-HOX project

JPARC, M.C. Chartier-Harlin, RNA-Seq meta-analysis

U1003, D. Gkika, TRP canals screening

UMR 1167, F. Pinet, INCA-Network project.

9.1.3. Coordinator of the regional (Haut-De-France) project

Participant: Sophie Dabo-Niang.

Sophie Dabo-Niang is the coordinator of the regional (Haut-De-France) project "Bridging cell biomechanical phenotype and their biological expressions for Cancer diagnosis (STATE-CELL)". It is a project in partnership with Modal-Inria, LIMMS UMI 2820, LEM UMR 9221, Yncrea Hauts de France, INSERM U908. This project is submitted to I-SITE ULNE, SUSTAIN proposals 2017.

9.2. National Initiatives

9.2.1. Programme of Investments for the Future (PIA)

Bilille is a member of two PIA "Infrastructures en biologie-santé":

France Génomique (https://www.france-genomique.org/spip/?lang=en)

IFB, French Institute of Bioinformatics (https://www.france-bioinformatique.fr/en)

As leader of the platform, Guillemette Marot is thus involved in these networks.

9.2.2. RHU PreciNASH

Participant: Guillemette Marot.

Acronym: PreciNASH

Project title: Non-alcoholic steato-hepatitis (NASH) from disease stratification to novel therapeutic approaches

Coordinator: F. Pattou

Duration: 5 years

Partners: FHU Integra and Sanofi

PreciNASH, project coordinated by Pr. F. Pattou (UMR 859, EGID), aims at better understanding non alcoholic stratohepatitis (NASH) and improving its diagnosis and care. In this RHU, Guillemette Marot supervises a 2 years post-doc, as her team EA 2694 is member of the FHU Integra. EA 2694 is involved in the WP1 for the development of a clinical-biological model for the prediction of NASH. Other partners of the FHU are UMR 859, UMR 1011 and UMR 8199, these last three teams being part of the labex EGID (European Genomic Institute for Diabetes). Sanofi is the main industrial partner of the RHU PreciNASH. The whole project will last 5 years (2016-2021).

9.2.3. ANR

9.2.3.1. ANR ClinMine

Participants: Cristian Preda, Vincent Vandewalle.

ClinMine Project-2014-2017

ANR project (ANR TECSAN - Technologie de la santé)

Main coordinator of the project: Clarisse Dhaenens, CRIStAL, USTL

7 partners - EA 1046 (Maladie d'Alzheimer et pathologies vasculaires, Faculté de Médecine, Lille), EA 2694 (Centre d'Etudes et de Recherche en Informatique Médicale - Faculté de Médecine, Lille), MODAL (Inria LNE), Alicante (Entreprise), CHRU de Montpelier, GHICL (Groupe Hospitalier de l'Institut Catholique de Lille), CRIStAL, USTL.

9.2.3.2. ANR TheraSCUD2022

Participant: Guillemette Marot.

Acronym: TheraSCUD2022

Project title: Targeting the IL-20/IL-22 balance to restore pulmonary, intestinal and metabolic homeostasis after cigarette smoking and unhealthy diet

Coordinator: P. Gosset

Duration: 3 years

Partners: CIIL Institut Pasteur de Lille and UMR 1019 INRA Clermont-Ferrand

TheraSCUD2022, project coordinated by P. Gosset (Institut Pasteur de Lille), studies inflammatory disorders associated with cigarette smoking and unhealthy diet (SCUD). Guillemette Marot is involved in this ANR project as head of bilille platform, and will supervise 1 year engineer on integration of omic data. The duration of this project is 3 years (2017-2020).

9.2.4. Working groups

Sophie Dabo-Niang belongs to the following working groups:

- STAFAV (STatistiques pour l'Afrique Francophone et Applications au Vivant)
- ERCIM Working Group on computational and Methodological Statistics, Nonparametric Statistics Team
- Ameriska

Benjamin Guedj belongs to the following working groups (GdR) of CNRS:

- ISIS (local referee for Inria Lille - Nord Europe)
- MaDICS
- MASCOT-NUM (local referee for Inria Lille - Nord Europe).

Guillemette Marot belongs to the StatOmique working group.

9.2.5. Other initiatives

Participants: Serge Iovleff, Cristian Preda, Vincent Vandewalle.

Serge Iovleff is the head of the project CloHe granted in 2016 by the Mastodons CNRS challenge "Big data and data quality". The project is axed on the design of classification and clustering algorithms for mixed data with missing values with applications to high spatial resolution multispectral satellite image time-series. Website. Cristian Preda and Vincent Vandewalle are also members of the CloHe project.

9.3. International Initiatives

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

9.3.1.1. Equipes associées nord-européennes

Participants: Christophe Biernacki, Benjamin Guedj.

Benjamin Guedj and Christophe Biernacki pursue a two years collaboration as "Equipes associées nord-européennes" with the Irish team "INSIGHT". The Centre for Data Analytics INSIGHT is about the size of Inria Lille - Nord Europe and is the main Irish research facility in Statistics and Machine Learning. It is focused on the next generation of machine learning (ML) and statistics (Stat) algorithms that can operate on large-scale dynamic data. Nial FRIEL (NF) is the leader of the ML/Stat axis of INSIGHT, Brendan MURPHY (BM) is a professor. The topic of this project is to manage statistical models inflation by the mean of model clustering.

Benjamin Guedj and Christophe Biernacki visited NF and BM in Dublin once in 2017 to progress in the current collaboration.

9.3.1.2. EMC and CIMPA

Participant: Sophie Dabo-Niang.

EMS (European Mathematical Society): Sophie Dabo-Niang is a nominated member of EMS-CDC (Committee of Developing counties). She will be vice-chair of this committee in 2018.

CIMPA (International Center of Pure and Applied Mathematics): Sophie Dabo-Niang is a nominated member of CIMPA.

9.3.1.3. SIMERGE

Participants: Sophie Dabo-Niang, Serge Iovleff.

Sophie Dabo-Niang and Serge Iovleff are members of SIMERGE, a LIRIMA project-team (January 2015-December 2017). It includes researchers from Mistis (Inria Grenoble - Rhône-Alpes, France) and Inria-MODAL (Lille Nord de France), LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger, Sénégal), IRD (Institut de Recherche pour le Développement, Unité de Recherche sur les Maladies Infectieuses et Tropicales Emergentes, Dakar, Sénégal) and LEM lab (Lille Economie et Management, University of Lille). This project is submitted for renewal with a new partner (Institut Paster of Dakar, Senegal).

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Participant: Benjamin Guedj.

Benjamin Guedj collaborates with Wouter Koolen (CWI, Netherlands), Peter Grünwald (CWI & Leiden University, Netherlands).

Benjamin Guedj collaborates with Olivier Wintenberger (KU, Denmark).

9.4. International Research Visitors

9.4.1. Visits to International Teams

Participant: Pascal Germain.

Pascal Germain will visit to "Groupe de recherche en apprentissage automatique de l'Université Laval" (Québec, Canada) to work with Professor François Laviolette from 11/12/2017 to 20/12/2017.

RANDOPT Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- PGMO project "NumBER: Numerical Black Box Optimization for Energy Applications", in collaboration with EDF, financing the postdoc of Asma Atamna, project length: 2 years (2016–2018), PI: Anne Auger
- PGMO project "AESOP: Algorithms Expensive Simulation-Basd Optimization Problems", a project involving several researchers from CentraleSupelec, Ecole des Mines de St.-Etienne, INRA Toulouse, JSI (Slovenia), Safran, Ruhr-Universität Bochum (Germany), and TU Dortmund University (Germany), project length: 2 years (2017–2019), PI: Dimo Brockhoff

8.2. National Initiatives

8.2.1. ANR

- ANR project "NumBBO: Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers", with partners DOLPHIN team (till 2016), Ecole des Mines de St.-Etienne and TU Dortmund University (Germany), Anne Auger was PI of this project which had a total budget of 660kEUR (2012–2017)
- ANR project "Big Multiobjective Optimization (BigMO)", Dimo Brockhoff participates in this project through the Inria team BONUS in Lille (2017–2020)

8.3. International Initiatives

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

8.3.1.1. 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.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

- We are collaborating with Shinshu University and particularly Youhei Akimoto through our joint associate team.

8.3.2.2. Informal International Partners

- We are collaborating with Tea Tušar from the Josef-Stefan Institute in Ljubljana, Slovenia for extending and maintaining our COCO platform and on benchmarking in general.
- We are collaborating with Jun.-Prof. Tobias Glasmachers from the Ruhr-Universität Bochum in Germany on runtime analysis of adaptive stochastic algorithms.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Filip Matzner from Charles University Prague (Czech Republic) - Visit of one month in November 2017 to work on Evolution Strategies for reinforcement learning and classification problems.
- Prof. Dr. Youhei Akimoto from Shinhu University (Japan) - Visit of one month in November 2017 to work on several projects related to theory and algorithm design for large-scale optimization.
- Dr. Alexandre Chotard from KTU (Sweden) - Visit of one month in November 2017 to work on adaptive MCMC.
- Dr. Tea Tušar from the Josef-Stefan Institute (Slovenia) - Visit of one week in November 2017 to work on our projects around (multiobjective) blackbox optimization benchmarking.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

- Anne Auger and Dimo Brockhoff visited Jun.-Prof. Tobias Glasmachers and Prof. Günter Rudolph in Dortmund from April 10 till April 14, 2017

REALOPT Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Solhar (ANR-13-MONU-0007)

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computing platforms equipped with accelerators. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool. The focus of RealOpt in this project is on the scheduling aspect. Indeed, executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.
See also: http://solhar.gforge.inria.fr/

9.2. International Initiatives

9.2.1. Inria International Partners

In the follow-up of our 6 year Inria Associate Team project SAMBA , we have set an important research collaboration with Brazil (Universidade Federal Fluminense, Pontificia Universidade Catolica do Rio de Janeiro) and Chile (Universidad Adolfo Ibanez). This results in joint publications and frequent visits, including long stay by research students.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Teobaldo LEITE BULHOES, from Universidade Federal Fluminense (Niteroi, Brazil), visited the team from October 23rd to December 13th 2017.
- Orlando Rivera Letelier, from (Universidad Adolfo Ibanez, Chile, visited the team for January 2017.
- Eduardo UCHOA, from Universidade Federal Fluminense (Niteroi, Brazil), visited the team during two weeks from November 5th to 18th 2017.
- Xuding ZHU, from Zhejiang Normal University (Jinhua, China) visited the team during one month in June 2017.

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.

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 Perugia, Italy

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

Kevin Bleakley stayed at the Pasteur Institute, Cambodia, while working on several collaborations in dengue fever research, from late 2016 until early 2017.

SEQUEL Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR BoB

Participants: Rémi Bardenet, Michal Valko.

- *Title*: Bayesian statistics for expensive models and tall data
- *Type*: National Research Agency
- *Coordinator*: CNRS (Rémi Bardenet)
- *Duration*: 2016-2020
- *Abstract*:

  Bayesian methods are a popular class of statistical algorithms for updating scientific beliefs. They turn data into decisions and models, taking into account uncertainty about models and their parameters. This makes Bayesian methods popular among applied scientists such as biologists, physicists, or engineers. However, at the heart of Bayesian analysis lie 1) repeated sweeps over the full dataset considered, and 2) repeated evaluations of the model that describes the observed physical process. The current trends to large-scale data collection and complex models thus raises two main issues. Experiments, observations, and numerical simulations in many areas of science nowadays generate terabytes of data, as does the LHC in particle physics for instance. Simultaneously, knowledge creation is becoming more and more data-driven, which requires new paradigms addressing how data are captured, processed, discovered, exchanged, distributed, and analyzed. For statistical algorithms to scale up, reaching a given performance must require as few iterations and as little access to data as possible. It is not only experimental measurements that are growing at a rapid pace. Cell biologists tend to have scarce data but large-scale models of tens of nonlinear differential equations to describe complex dynamics. In such settings, evaluating the model once requires numerically solving a large system of differential equations, which may take minutes for some tens of differential equations on today's hardware. Iterative statistical processing that requires a million sequential runs of the model is thus out of the question. In this project, we tackle the fundamental cost-accuracy trade-off for Bayesian methods, in order to produce generic inference algorithms that scale favourably with the number of measurements in an experiment and the number of runs of a statistical model. We propose a collection of objectives with different risk-reward trade-offs to tackle these two goals. In particular, for experiments with large numbers of measurements, we further develop existing subsampling-based Monte Carlo methods, while developing a novel decision theory framework that includes data constraints. For expensive models, we build an ambitious programme around Monte Carlo methods that leverage determinantal processes, a rich class of probabilistic tools that lead to accurate inference with limited model evaluations. In short, using innovative techniques such as subsampling-based Monte Carlo and determinantal point processes, we propose in this project to push the boundaries of the applicability of Bayesian inference.

9.1.2. ANR Badass

Participants: Odalric Maillard, Émilie Kaufmann.

- *Title*: BAnDits for non-Stationarity and Structure
- *Type*: National Research Agency
- *Coordinator*: Inria Lille (O. Maillard)
- *Duration*: 2016-2020

- *Abstract*: Motivated by the fact that a number of modern applications of sequential decision making require developing strategies that are especially robust to change in the stationarity of the signal, and in order to anticipate and impact the next generation of applications of the field, the BADASS project intends to push theory and application of MAB to the next level by incorporating non-stationary observations while retaining near optimality against the best not necessarily constant decision strategy. Since a non-stationary process typically decomposes into chunks associated with some possibly hidden variables (states), each corresponding to a stationary process, handling non-stationarity crucially requires exploiting the (possibly hidden) structure of the decision problem. For the same reason, a MAB for which arms can be arbitrary non-stationary processes is powerful enough to capture MDPs and even partially observable MDPs as special cases, and it is thus important to jointly address the issue of non-stationarity together with that of structure. In order to advance these two nested challenges from a solid theoretical standpoint, we intend to focus on the following objectives: *(i)* To broaden the range of optimal strategies for stationary MABs: current strategies are only known to be provably optimal in a limited range of scenarios for which the class of distribution (structure) is perfectly known; also, recent heuristics possibly adaptive to the class need to be further analyzed. *(ii)* To strengthen the literature on pure sequential prediction (focusing on a single arm) for non-stationary signals via the construction of adaptive confidence sets and a novel measure of complexity: traditional approaches consider a worst-case scenario and are thus overly conservative and non-adaptive to simpler signals. *(iii)* To embed the low-rank matrix completion and spectral methods in the context of reinforcement learning, and further study models of structured environments: promising heuristics in the context of e.g. contextual MABs or Predictive State Representations require stronger theoretical guarantees.

  This project will result in the development of a novel generation of strategies to handle non-stationarity and structure that will be evaluated in a number of test beds and validated by a rigorous theoretical analysis. Beyond the significant advancement of the state of the art in MAB and RL theory and the mathematical value of the program, this JCJC BADASS is expected to strategically impact societal and industrial applications, ranging from personalized health-care and e-learning to computational sustainability or rain-adaptive river-bank management to cite a few.

9.1.3. ANR ExTra-Learn

Participants: Alessandro Lazaric, Jérémie Mary, Michal Valko.

- *Title*: Extraction and Transfer of Knowledge in Reinforcement Learning
- *Type*: National Research Agency (ANR-9011)
- *Coordinator*: Inria Lille (A. Lazaric)
- *Duration*: 2014-2018
- *Abstract*: ExTra-Learn is directly motivated by the evidence that one of the key features that allows humans to accomplish complicated tasks is their ability of building knowledge from past experience and transfer it while learning new tasks. We believe that integrating transfer of learning in machine learning algorithms will dramatically improve their learning performance and enable them to solve complex tasks. We identify in the reinforcement learning (RL) framework the most suitable candidate for this integration. RL formalizes the problem of learning an optimal control policy from the experience directly collected from an unknown environment. Nonetheless, practical limitations of current algorithms encouraged research to focus on how to integrate prior knowledge into the learning process. Although this improves the performance of RL algorithms, it dramatically reduces their autonomy. In this project we pursue a paradigm shift from designing RL algorithms incorporating prior knowledge, to methods able to incrementally discover, construct, and transfer "prior" knowledge in a fully automatic way. More in detail, three main elements of RL algorithms would significantly benefit from transfer of knowledge. *(i)* For every new task, RL algorithms need exploring the environment for a long time, and this corresponds to slow learning processes for large environments. Transfer learning would enable RL algorithms to dramatically reduce the exploration

of each new task by exploiting its resemblance with tasks solved in the past. *(ii)* RL algorithms evaluate the quality of a policy by computing its state-value function. Whenever the number of states is too large, approximation is needed. Since approximation may cause instability, designing suitable approximation schemes is particularly critical. While this is currently done by a domain expert, we propose to perform this step automatically by constructing features that incrementally adapt to the tasks encountered over time. This would significantly reduce human supervision and increase the accuracy and stability of RL algorithms across different tasks. *(iii)* In order to deal with complex environments, hierarchical RL solutions have been proposed, where state representations and policies are organized over a hierarchy of subtasks. This requires a careful definition of the hierarchy, which, if not properly constructed, may lead to very poor learning performance. The ambitious goal of transfer learning is to automatically construct a hierarchy of skills, which can be effectively reused over a wide range of similar tasks.

- *Activity Report*: Research in ExTra-Learn continued in investigating how knowledge can be transferred into reinforcement learning algorithms to improve their performance. Pierre-Victor Chaumier did a 4 months internship in SequeL studying how to perform transfer neural networks across different games in the Atari platform. Unfortunately, the preliminary results we obtained were not very positive. We investigated different transfer models, from basic transfer of a fully trained network, to co-train over multiple games and retrain with initialization from a previous network. In most of the cases, the improvement from transfer was rather limited and in some cases even negative transfer effects appeared. This seems to be intrinsic in the neural network architecture which tends to overfit on one single task and it poorly generlizes over alternative tasks. Another activity was related to the study of macro-actions in RL. We proved for the first time under which conditions macro-actions can actually improve the learning speed of an RL exploration-exploitation algorithm. This is the first step towards the automatic identification and construction of useful macro-actions across multiple tasks.

9.1.4. ANR KEHATH

Participants: Olivier Pietquin, Alexandre Bérard.

- *Acronym*: KEHATH
- *Title*: Advanced Quality Methods for Post-Edition of Machine Translation
- *Type*: ANR
- *Coordinator*: Lingua & Machina
- *Duration*: 2014-2017
- *Other partners*: Univ. Lille 1, Laboratoire d'Informatique de Grenoble (LIG)
- *Abstract*: The translation community has seen a major change over the last five years. Thanks to progress in the training of statistical machine translation engines on corpora of existing translations, machine translation has become good enough so that it has become advantageous for translators to post-edit machine outputs rather than translate from scratch. However, current enhancement of machine translation (MT) systems from human post-edition (PE) are rather basic: the post-edited output is added to the training corpus and the translation model and language model are re-trained, with no clear view of how much has been improved and how much is left to be improved. Moreover, the final PE result is the only feedback used: available technologies do not take advantages of logged sequences of post-edition actions, which inform on the cognitive processes of the post-editor. The KEHATH project intends to address these issues in two ways. Firstly, we will optimise advanced machine learning techniques in the MT+PE loop. Our goal is to boost the impact of PE, that is, reach the same performance with less PE or better performance with the same amount of PE. In other words, we want to improve machine translation learning curves. For this purpose, active learning and reinforcement learning techniques will be proposed and evaluated. Along with this, we will have to face challenges such as MT systems heterogeneity (statistical and/or rule-based), and ML scalability so as to improve domain-specific MT. Secondly, since quality prediction (QP) on MT outputs is

crucial for translation project managers, we will implement and evaluate in real-world conditions several confidence estimation and error detection techniques previously developed at a laboratory scale. A shared concern will be to work on continuous domain-specific data flows to improve both MT and the performance of indicators for quality prediction. The overall goal of the KEHATH project is straightforward: gain additional machine translation performance as fast as possible in each and every new industrial translation project, so that post-edition time and cost is drastically reduced. Basic research is the best way to reach this goal, for an industrial impact that is powerful and immediate.

9.1.5. PEPS Project BIO

Participants: Émilie Kaufmann, Lilian Besson.

- *Title*: Bandits pour l'Internet des Objets
- *Type*: CNRS PEPS project
- *Coordinator*: CNRS (E. Kaufmann)
- *Duration*: april-december 2017
- *Abstract*: (in French) Dans le but d'améliorer le qualité et de minimiser les coûts énergétiques des communications entre les objets communicants et leurs stations de base, nous cherchons dans ce projet à adapter les avancées récentes du domaine de la radio intelligente à la spécificité des communications de type Internet des Objets. Vu l'engorgement du spectre fréquentiel, il est nécessaire pour ces objets d'apprendre à détecter de manière adaptative quand et sur quelle fréquence communiquer. Nous proposons pour cette tâche l'utilisation d'algorithmes dits de bandit à plusieurs bras, déjà connus dans le contexte de la radio intelligente, mais pas toujours adaptés à la spécificité des communications pour l'Internet des Objets. Nous introduirons de nouveaux algorithmes de bandit multi-joueurs, traduisant la coordination nécessaire entre les multiples objets en plus de l'apprentissage de la qualité des canaux fréquentiel. Ensuite nous envisagerons une nouvelle modélisation, de type bandit adversarial, pour décrire les communications dans des standards comme LoRa où les objets reçoivent des messages de confirmation des stations de bases, conduisant à des algorithmes minimisant la latence de ces communications.

9.1.6. National Partners

- ENS Paris-Saclay
  - M. Valko collaborated with V. Perchet on structured bandit problem. They co-supervise a PhD student (P. Perrault) together.
- Institut de Mathématiques de Toulouse
  - E. Kaufmann collaborated with Aurélien Garivier on sequential testing and structured bandit problems.
- CentraleSupélec Rennes
  - E. Kaufmann co-advises Lilian Besson, who works at CentraleSupélec with Christophe Moy. Christophe, Lilian and Émilie worked together on a PEPS project about bandits for Internet Of Things. One paper was published to the CROWNCOM conference, and another has been submitted to the ALT conference.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. H2020 BabyRobot

Program: H2020

Project acronym: BabyRobot

Project title: Child-Robot Communication and Collaboration

Duration: 01/2016 - 12/2018

Coordinator: Alexandros Potamianos (Athena Research and Innovation Center in Information Communication and Knowledge Technologies, Greece)

Other partners: Institute of Communication and Computer Systems (Greece), The University of Hertfordshire Higher Education Corporation (UK), Universitaet Bielefeld (Germany), Kunlgliga Tekniska Hoegskolan (Sweden), Blue Ocean Robotics ApS (Denmark), Univ. Lille (France), Furhat Robotics AB (Sweden)

Abstract: The crowning achievement of human communication is our unique ability to share intentionality, create and execute on joint plans. Using this paradigm we model human-robot communication as a three step process: sharing attention, establishing common ground and forming shared goals. Prerequisites for successful communication are being able to decode the cognitive state of people around us (mindreading) and building trust. Our main goal is to create robots that analyze and track human behavior over time in the context of their surroundings (situational) using audio-visual monitoring in order to establish common ground and mind-reading capabilities. On BabyRobot we focus on the typically developing and autistic spectrum children user population. Children have unique communication skills, are quick and adaptive learners, eager to embrace new robotic technologies. This is especially relevant for special eduation where the development of social skills is delayed or never fully develops without intervention or therapy. Thus our second goal is to define, implement and evaluate child-robot interaction application scenarios for developing specific socio-affective, communication and collaboration skills in typically developing and autistic spectrum children. We will support not supplant the therapist or educator, working hand-inhand to create a low risk environment for learning and cognitive development. Breakthroughs in core robotic technologies are needed to support this research mainly in the areas of motion planning and control in constrained spaces, gestural kinematics, sensorimotor learning and adaptation. Our third goal is to push beyond the state-of-the-art in core robotic technologies to support natural human-robot interaction and collaboration for edutainment and healthcare applications. Creating robots that can establish communication protocols and form collaboration plans on the fly will have impact beyond the application scenarios investigated here.

9.2.1.2. CHIST-ERA DELTA

Participants: Michal Valko, Émilie Kaufmann.

Program: CHIST-ERA

Project acronym: DELTA

Project title: Dynamically Evolving Long-Term Autonomy

Duration: October 2017 - December 2021

Coordinator: Anders Jonsson (PI)

Inria coPI: Michal Valko

Other partners: UPF Spain, MUL Austria, ULG Belgium

Abstract: Many complex autonomous systems (e.g., electrical distribution networks) repeatedly select actions with the aim of achieving a given objective. Reinforcement learning (RL) offers a powerful framework for acquiring adaptive behaviour in this setting, associating a scalar reward with each action and learning from experience which action to select to maximise long-term reward. Although RL has produced impressive results recently (e.g., achieving human-level play in Atari games and beating the human world champion in the board game Go), most existing solutions only work under strong assumptions: the environment model is stationary, the objective is fixed, and trials end once the objective is met. The aim of this project is to advance the state of the art of fundamental research in lifelong RL by developing several novel RL algorithms that relax the above assumptions. The new algorithms should be robust to environmental changes, both in terms of the observations that

the system can make and the actions that the system can perform. Moreover, the algorithms should be able to operate over long periods of time while achieving different objectives. The proposed algorithms will address three key problems related to lifelong RL: planning, exploration, and task decomposition. Planning is the problem of computing an action selection strategy given a (possibly partial) model of the task at hand. Exploration is the problem of selecting actions with the aim of mapping out the environment rather than achieving a particular objective. Task decomposition is the problem of defining different objectives and assigning a separate action selection strategy to each. The algorithms will be evaluated in two realistic scenarios: active network management for electrical distribution networks, and microgrid management. A test protocol will be developed to evaluate each individual algorithm, as well as their combinations.

9.2.1.3. CHIST-ERA IGLU

Program: CHIST-ERA

Project acronym: IGLU

Project title: Interactively Grounded Language Understanding

Duration: 11/2015 - 10/2018

Coordinator: Jean Rouat (Université de Sherbrooke, Canada)

Other partners: UMONS (Belgique), Inria (France), Univ-Lille (France), KTH (sweden), Universidad de Zaragoza (Spain)

Abstract: Language is an ability that develops in young children through joint interaction with their caretakers and their physical environment. At this level, human language understanding could be referred as interpreting and expressing semantic concepts (e.g. objects, actions and relations) through what can be perceived (or inferred) from current context in the environment. Previous work in the field of artificial intelligence has failed to address the acquisition of such perceptually-grounded knowledge in virtual agents (avatars), mainly because of the lack of physical embodiment (ability to interact physically) and dialogue, communication skills (ability to interact verbally). We believe that robotic agents are more appropriate for this task, and that interaction is a so important aspect of human language learning and understanding that pragmatic knowledge (identifying or conveying intention) must be present to complement semantic knowledge. Through a developmental approach where knowledge grows in complexity while driven by multimodal experience and language interaction with a human, we propose an agent that will incorporate models of dialogues, human emotions and intentions as part of its decision-making process. This will lead anticipation and reaction not only based on its internal state (own goal and intention, perception of the environment), but also on the perceived state and intention of the human interactant. This will be possible through the development of advanced machine learning methods (combining developmental, deep and reinforcement learning) to handle large-scale multimodal inputs, besides leveraging state-of-the-art technological components involved in a language-based dialog system available within the consortium. Evaluations of learned skills and knowledge will be performed using an integrated architecture in a culinary use-case, and novel databases enabling research in grounded human language understanding will be released.

9.3. International Initiatives

9.3.1. With CWI

Title: Non-parametric sequential prediction project

Centrum Wiskunde & Informatica (CWI), Amsterdam (NL) - Peter Grünwald

Duration: 2016 - 2018

Start year: 2016

Abstract: The aim is to develop the theory of learning for sequential decision making under uncertainty problems.

In 2017, this collaboration involved D. Ryabko, É. Kaufmann, J. Ridgway, M. Valko, O. Maillard. A post-doc funded by Inria has been recruited in Fall 2016.

https://project.inria.fr/inriacwi/projects/non-parametric-sequential-prediction-project/

9.3.2. EduBand

Title: Educational Bandits

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Department of Computer Science, Theory of computation lab - Emma Brunskill

Start year: 2015

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

Education can transform an individual's capacity and the opportunities available to him. The proposed collaboration will build on and develop novel machine learning approaches towards enhancing (human) learning. Massive open online classes (MOOCs) are enabling many more people to access education, but mostly operate using status quo teaching methods. Even more important than access is the opportunity for online software to radically improve the efficiency, engagement and effectiveness of education. Existing intelligent tutoring systems (ITSs) have had some promising successes, but mostly rely on learning sciences research to construct hand-built strategies for automated teaching. Online systems make it possible to actively collect substantial amount of data about how people learn, and offer a huge opportunity to substantially accelerate progress in improving education. An essential aspect of teaching is providing the right learning experience for the student, but it is often unknown a priori exactly how this should be achieved. This challenge can often be cast as an instance of decision-making under uncertainty. In particular, prior work by Brunskill and colleagues demonstrated that reinforcement learning (RL) and multi-arm bandit (MAB) can be very effective approaches to solve the problem of automated teaching. The proposed collaboration is thus intended to explore the potential interactions of the fields of online education and RL and MAB. On the one hand, we will define novel RL and MAB settings and problems in online education. On the other hand, we will investigate how solutions developed in RL and MAB could be integrated in ITS and MOOCs and improve their effectiveness.

9.3.3. Allocate

Participants: Pierre Perrault, Julien Seznec, Michal Valko, Émilie Kaufmann, Odalric Maillard.

Title: Adaptive allocation of resources for recommender systems

Inria contact: Michal Valko

International Partner (Institution - Laboratory - Researcher):

Univertät Potsdam, Germany A. Carpentier

Start year: 2017

We plan to improve a practical scenario of *resource allocation in market surveys*, such as product appraisals and music recommendation. In practice, the market is typically divided into segments: geographic regions, age groups, ...These groups are then queried for preference with some fixed rule of a number of queries per group. This testing is *costly and non-adaptive*. The reason is some groups are easier to estimate than others, but this is impossible to know a priori. Our challenge is **adaptively allocate the optimal number of samples** to each group and improve the efficient of market studies, by providing *sample-efficient* solutions.

9.3.4. Informal International Partners

Adobe Research

Branislav Kveton *Collaborator*

Zheng Wen *Collaborator*

Sharan Vaswani *Collaborator*

M. Valko collaborated with Adobe Research on online influence maximization in social networks. This led to a publication in NIPS 2017.

Massachusetts Institute of Technology

Victor-Emmanuel Brunel *Collaborator*

M. Valko collaborated with V.-E. Brunel on the estimation of low rank determinantal point processes useful for diverse recommender systems.

Univertät Potsdam

Alexandra Carpentier *Collaborator*

M. Valko collaborated with A. Carpentier on adaptive estimation of the block-diagonal matrices with application to market segmentations. This collaboration formalized in September 2017 by creating a north-european associate team.

University of California, Berkeley

Victor Gabillon *Collaborator*

M. Valko collaborated with V. Gabillon on the sample complexities in unknown type of environments.

University of Southern California

Haipeng Luo *Collaborator*

M. Valko collaborated with H. Luo on online submodular minimization.

Adobe Research

Mohammad Ghavamzadeh *Collaborator*

A. Lazaric collaborated with Adobe Research on active learning for accurate estimation of linear models. This led to a publication in ICML 2017.

Stanford University

Carlos Riquelme *Collaborator*

A. Lazaric collaborated with Carlos Riquelme on active learning for accurate estimation of linear models. This led to a publication in ICML 2017.

Stanford University

Emma Brunskill *Collaborator*

A. Lazaric collaborated with Emma Brunskill on exploration-exploitation with options in reinforcement learning. This led to a publication in NIPS 2017.

University of California, Irvine

Anima Anandkumar *Collaborator*

Kamyar Azzizade *Collaborator*

A. Lazaric collaborated with A. Anandkumar and K. Azzizade on exploration-exploitation with in reinforcement learning with state clustering. This led to a submission to AI&Stats 2018.

University of Leoben

Ronald Ortner *Collaborator*

A. Lazaric collaborated with R. Ortner on exploration-exploitation in reinforcement learning with regularized optimization. This will lead to a submission to ICML 2018.

Politecnico di Milano

Marcello Restelli *Collaborator*

Matteo Pirotta collaborate with M. Restelli on several topics in reinforcement learning. This will lead to publications to ICML 2017 and NIPS 2017.

Lancaster University

B. Balle *Collaborator*

O. Maillard collaborated on spectral learning of Hankel matrices. This led to a publication at ICML.

Mila, Université de Montréal

A. Courville *Collaborator*

F. Strub and O. Pietquin collaborate on deep reinforcement learning for language acquisition. This led to several papers at IJCAI, CVPR, and NIPS, as well as the guesswhat?! dataset and protocol, and the HOME dataset.

Uberlandia University, Brasil

C. Felicio *Collaborator*

Ph. Preux supervises this PhD on recommendation systems. This led to the defense of C. Felicio and a paper at UMAP.

9.3.5. International Initiatives

SequeL

Title: The multi-armed bandit problem

International Partner (Institution - Laboratory - Researcher):

University of Leoben (Austria) Peter Auer

Duration: 2014 - 2018

Start year: 2014

In a nutshell, the collaboration is focusing on nonparametric algorithms for active learning problems, mainly involving theoretical analysis of reinforcement learning and bandits problems beyond the traditional settings of finite-state MDPs (for RL) or i.i.d. rewards (for bandits). Peter Auer from University of Leoben is a worldwide leader in the field, having introduced the UCB approach around 2000, along with its finite-time analysis. Today, SequeL is likely to be the largest research group working in this field in the world, enjoying worldwide recognition. SequeL and P. Auer's group have been collaborating for a couple of years now; they have co-authored papers, visited each other (sabbatical stay, post-doc), coorganized workshops; the STREP Complacs partially funds this very active collaboration.

9.3.6. International Initiatives

Contextual multi-armed bandits with hidden structure

Title: Contextual multi-armed bandits with hidden structure

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) – Aditya Gopalan

Duration: 2015 - 2017

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

- Harm de Vries, PhD stduent, University of Montreal, Canada, Jan-Jun 2017
- Mohammad Sadegh Talebi Mazraeh Shahi, PhD student, KTH Royal Institute of Technology, Sweden, Jun-Sep 2017
- Xuedong Shang, master student, ENS Rennes, Feb–Jun 2017
- Iuliia Olkhovskaia, master student, Moscow Institute of Physics and Technology, Russia, Feb–Jul 2017
- Georgios Papoudakis, master student, Aristotle University of Thessalnoniki, Greece, May–Sep 2017
- Subhojyoti Mukherjee, master student, Indian Institute of technology, Sep-Nov 2017
- Mahsa Asadi, Shiraz University, Iran, Sep-Dec 2017

SIERRA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- A. d'Aspremont: IRIS, PSL "Science des données, données de la science".

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- **ITN Spartan**
  Title: Sparse Representations and Compressed Sensing Training Network
  Type: FP7
  Instrument: Initial Training Network
  Duration: October 2014 to October 2018
  Coordinator: Mark Plumbley (University of Surrey)
  Inria contact: Francis Bach
  Abstract: The SpaRTaN Initial Training Network will train a new generation of interdisciplinary researchers in sparse representations and compressed sensing, contributing to Europe's leading role in scientific innovation. By bringing together leading academic and industry groups with expertise in sparse representations, compressed sensing, machine learning and optimisation, and with an interest in applications such as hyperspectral imaging, audio signal processing and video analytics, this project will create an interdisciplinary, trans-national and inter-sectorial training network to enhance mobility and training of researchers in this area. SpaRTaN is funded under the FP7-PEOPLE-2013-ITN call and is part of the Marie Curie Actions — Initial Training Networks (ITN) funding scheme: Project number - 607290
- **ITN Macsenet**
  Title: Machine Sensing Training Network
  Type: H2020
  Instrument: Initial Training Network
  Duration: January 2015 - January 2019
  Coordinator: Mark Plumbley (University of Surrey)
  Inria contact: Francis Bach
  Abstract: The aim of this Innovative Training Network is to train a new generation of creative, entrepreneurial and innovative early stage researchers (ESRs) in the research area of measurement and estimation of signals using knowledge or data about the underlying structure. We will develop new robust and efficient Machine Sensing theory and algorithms, together methods for a wide range of signals, including: advanced brain imaging; inverse imaging problems; audio and music signals; and non-traditional signals such as signals on graphs. We will apply these methods to real-world problems, through work with non-Academic partners, and disseminate the results of this research to a wide range of academic and non-academic audiences, including through publications, data, software and public engagement events. MacSeNet is funded under the H2020-MSCA-ITN-2014 call and is part of the Marie Sklodowska- Curie Actions — Innovative Training Networks (ITN) funding scheme.

- **ERC Sequoia**
  Title: Robust algorithms for learning from modern data
  Programm: H2020
  Type: ERC
  Duration: 2017-2022
  Coordinator: Inria
  Inria contact: Francis BACH
  Abstract: Machine learning is needed and used everywhere, from science to industry, with a growing impact on many disciplines. While first successes were due at least in part to simple supervised learning algorithms used primarily as black boxes on medium-scale problems, modern data pose new challenges. Scalability is an important issue of course: with large amounts of data, many current problems far exceed the capabilities of existing algorithms despite sophisticated computing architectures. But beyond this, the core classical model of supervised machine learning, with the usual assumptions of independent and identically distributed data, or well-defined features, outputs and loss functions, has reached its theoretical and practical limits. Given this new setting, existing optimization-based algorithms are not adapted. The main objective of this project is to push the frontiers of supervised machine learning, in terms of (a) scalability to data with massive numbers of observations, features, and tasks, (b) adaptability to modern computing environments, in particular for parallel and distributed processing, (c) provable adaptivity and robustness to problem and hardware specifications, and (d) robustness to non-convexities inherent in machine learning problems. To achieve the expected breakthroughs, we will design a novel generation of learning algorithms amenable to a tight convergence analysis with realistic assumptions and efficient implementations. They will help transition machine learning algorithms towards the same wide-spread robust use as numerical linear algebra libraries. Outcomes of the research described in this proposal will include algorithms that come with strong convergence guarantees and are well-tested on real-life benchmarks coming from computer vision, bioin- formatics, audio processing and natural language processing. For both distributed and non-distributed settings, we will release open-source software, adapted to widely available computing platforms.

8.3. International Initiatives

8.3.1. BigFOKS2

Title: Learning from Big Data: First-Order methods for Kernels and Submodular functions

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Computer Science Department - Chiranjib Bhattacharyya

Start year: 2016

See also: http://mllab.csa.iisc.ernet.in/indo-french.html

Recent advances in sensor technologies have resulted in large amounts of data being generated in a wide array of scientific disciplines. Deriving models from such large datasets, often known as “Big Data”, is one of the important challenges facing many engineering and scientific disciplines. In this proposal we investigate the problem of learning supervised models from Big Data, which has immediate applications in Computational Biology, Computer vision, Natural language processing, Web, E-commerce, etc., where specific structure is often present and hard to take into account with current algorithms. Our focus will be on the algorithmic aspects. Often supervised learning problems can be cast as convex programs. The goal of this proposal will be to derive first-order methods which can be effective for solving such convex programs arising in the Big-Data setting. Keeping this broad goal in mind we investigate two foundational problems which are not well addressed in existing literature. The first problem investigates Stochastic Gradient Descent Algorithms in the context of First-order methods for designing algorithms for Kernel based prediction functions on Large Datasets. The second problem involves solving discrete optimization problems arising in Submodular formulations in Machine Learning, for which first-order methods have not reached the level of speed required for practical applications (notably in computer vision).

8.4. International Research Visitors

8.4.1. Internships

- Marwa El Halabi, from Jan. until Apr. 2017, EPFL, Lausanne, Switzerland
- Jonathan Weed, from Mar. 2017 until May 2017, MIT, US
- Alfredo Zermini, from Mar 2017 until June 2017, University of Surrey, UK
- Billy Tang, visited from Sept. 2017 until Dec. 2017, University of Edimburgh, UK

TAU Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

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

9.1.2. Others

- **ROM***Model Reduction and Multiphysics Optimization* 2014-2017 (50 Keuros)
  Coordinator: IRT System X
  Participants: Marc Schoenauer, Michèle Sebag, François Gonard (PhD)
- **MAJORE***A Collaborative Filtering Approach to Matching Job Openings and Job Seekers*, 2013-2017 (105 kEuros)
  Thomas Schmitt's PhD (funded by ISN).
  Participants: Philippe Caillou, Michèle Sebag, Thomas Schmitt (PhD)
- **AMIQAP** 2015-2017 (12 months of Postdoctoral fellow). Qualité de vie au travail.
  Project funded by ISN
  Partners: Mines-Telecom SES, RITM (Univ. Paris Sud) and *La Fabrique de l'Industrie*
  Extended for 6 months in 2018 via a donation from *La Fabrique de l'Industrie*
  Participants: Philippe Caillou, Olivier Goudet, Isabelle Guyon, Michèle Sebag, Paola Tubaro, Diviyan Kalainathan (PhD)
- **Nutriperso** 2017-2018, 37 kEuros. Personalized recommendations toward healthier eating practices.
  U. Paris-Saclay IRS (*Initiative de Recherche Stratégique*)
  Partners: INRA (coordinator), INSERM, Agro Paristech, Mines Telecom
  Participants: Philippe Caillou, Flora Jay, Michèle Sebag, Paola Tubaro
- **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 (in 2017, after Olivier Teytaud left): Vincent Berthier (PhD defended in Dec.), Marc Schoenauer
- **E-LUCID** 2014-2017 (194 kEuros)
  Coordinator: Thales Communications & Security S.A.S
  Participants: Marc Schoenauer, Cyril Furtlehner, Luis Marti
- **PIA ADAMME** 2015-2018 (258 kEuros)
  Coordinator: Bull SAS
  Participants (in 2017): Marc Schoenauer, Guillaume Charpiat, Cécile Germain-Renaud, Yasmina Bouzbiba, Etienne Brame

- **CNES contract** 2015-2017 (70 kEuros)
  Coordinator: Manuel Grizonnet (CNES) & Yuliya Tarabalka (Inria Sophia-Antipolis, Titane team)
  Participant: Guillaume Charpiat
- **NEXT** 2017-2021 (675 kEuros). Simulation, calibration, and optimization of regional or urban power grids
  ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie)
  Coordinator: ARTELYS
  Participants Isabelle Guyon, Marc Schoenauer, Michèle Sebag, Victor Berger (PhD), Herilalaina Rakotoarison (PhD), Berna Bakir Batu (Post-doc)
- **BRAINTIME** 2017 (7 kEuros) Défi exploratoire interdisciplinaire de l'appel INFINITE (CNRS) concerning the functional connectome dynamics of the brain.
  Coordinator: Andrea Brovelli (CNRS), Institut de Neurosciences de la Timone (INT)
  Participants Aurélien Decelle, Cyril Furtlehner
- **CDS DeepGenetics** 2017 (6mois, 3k euros), Deep Learning for Population Genetics.
  funded by Center for Data Science
  Coordinators: Flora Jay and Guillaume Charpiat
  Participants: Théophile Sanchez (master internship)

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

See.4C 2016-2017 (2.7 kEuros). SpatiotEmporal ForEcasting: Coopetition to meet Current Cross-modal Challenges
Participants: Isabelle Guyon

9.2.2. Collaborations with Major European Organizations

MLSpaceWeather 2015-2019. Coupling physics-based simulations with Artificial Intelligence.
Coordinator: CWI
Participants: Michèle Sebag, Aurélien Decelle, Cyril Furtlehner, Mhamed Hajaiej

ESA Tender 2015-2017
Coordinator: Bart Boonacker (TNO)
Participant: Marc Schoenauer, Dejan Tusar

9.3. International Initiatives

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

9.3.1.1. MDG-TAO

Title: Data-driven simulations for Space Weather predictions

International Partner: CWI (Netherlands) – Multiscale Dynamics Group – Enrico Camporeale

Start year: 2017

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

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

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

9.3.2.2. Informal International Partners

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

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- **Edgar Galvan Lopez** University College Dublin, April 2015 - April 2017, funded by the ELEVATE Fellowship, the Irish Research Council's Career Development Fellowship co-funded by Marie Curie Actions. Now Lecturer at Maynooth University, Ireland.

9.4.1.1. Internships

- **Tomas Lungenstrass** June 2016 - June 2017, self-funded, collaboration with Inria Chile. Worked on magnetic storm prediction under A. Decelle's, C. Furtlehner's and M. Sebag's supervision.

ASPI Team

7. Partnerships and Cooperations

7.1. Regional initiatives

7.1.1. Stochastic Model-Data Coupled Representations for the Upper Ocean Dynamics (SEACS) — inter labex project

Participants: François Le Gland, Valérie Monbet.

January 2015 to December 2017.

This is a joint research initiative supported by the three labex active in Brittany, CominLabs (Communication and Information Sciences Laboratory), Lebesgue (Centre de Mathématiques Henri Lebesgue) and LabexMER (Frontiers in Marine Research).

This project aims at exploring novel statistical and stochastic methods to address the emulation, reconstruction and forecast of fine–scale upper ocean dynamics. The key objective is to investigate new tools and methods for the calibration and implementation of novel sound and efficient oceanic dynamical models, combining

- recent advances in the theoretical understanding, modeling and simulation of upper ocean dynamics,
- and mass of data routinely available to observe the ocean evolution.

In this respect, the emphasis will be given to stochastic frameworks to encompass multi–scale/multi–source approaches and benefit from the available observation and simulation massive data. The addressed scientific questions constitute basic research issues at the frontiers of several disciplines. It crosses in particular advanced data analysis approaches, physical oceanography and stochastic representations. To develop such an interdisciplinary initiative, the project gathers a set of research groups associated with these different scientific domains, which have already proven for several years their capacities to interact and collaborate on topics related to oceanic data and models. This project will place Brittany with an innovative and leading expertise at the frontiers of computer science, statistics and oceanography. This transdisciplinary research initiative is expected to resort to significant advances challenging the current thinking in computational oceanography.

7.2. National initiatives

7.2.1. Computational Statistics and Molecular Simulation (COSMOS) — ANR challenge Information and Communication Society

Participant: Frédéric Cérou.

Inria contract ALLOC 9452 — January 2015 to December 2017.

The COSMOS project aims at developing numerical techniques dedicated to the sampling of high–dimensional probability measures describing a system of interest. There are two application fields of interest: computational statistical physics (a field also known as molecular simulation), and computational statistics. These two fields share some common history, but it seems that, in view of the quite recent specialization of the scientists and the techniques used in these respective fields, the communication between molecular simulation and computational statistics is not as intense as it should be.

We believe that there are therefore many opportunities in considering both fields at the same time: in particular, the adaption of a successful simulation technique from one field to the other requires first some abstraction process where the features specific to the original field of application are discarded and only the heart of the method is kept. Such a cross–fertilization is however only possible if the techniques developed in a specific field are sufficiently mature: this is why some fundamental studies specific to one of the application fields are still required. Our belief is that the embedding in a more general framework of specific developments in a given field will accelerate and facilitate the diffusion to the other field.

7.2.2. Advanced Geophysical Reduced–Order Model Construction from Image Observations (GERONIMO) — ANR programme Jeunes Chercheuses et Jeunes Chercheurs

Participant: Patrick Héas.

Inria contract ALLOC 8102 — March 2014 to February 2018.

The GERONIMO project aims at devising new efficient and effective techniques for the design of geophysical reduced–order models (ROMs) from image data. The project both arises from the crucial need of accurate low–order descriptions of highly–complex geophysical phenomena and the recent numerical revolution which has supplied the geophysical scientists with an unprecedented volume of image data. Our research activities are concerned by the exploitation of the huge amount of information contained in image data in order to reduce the uncertainty on the unknown parameters of the models and improve the reduced–model accuracy. In other words, the objective of our researches to process the large amount of incomplete and noisy image data daily captured by satellites sensors to devise new advanced model reduction techniques. The construction of ROMs is placed into a probabilistic Bayesian inference context, allowing for the handling of uncertainties associated to image measurements and the characterization of parameters of the reduced dynamical system.

7.3. European initiatives

7.3.1. Molecular Simulation: Modeling, Algorithms and Mathematical Analysis (MSMaths) — ERC Consolidator Grant

Participant: Mathias Rousset.

January 2014 to December 2019.

PI: Tony Lelièvre, Civil Engineer in Chief, Ecole des Ponts Paris-Tech.

Note that $1/3$ of Mathias Rousset research activities are held within the MSMath ERC project.

With the development of large–scale computing facilities, simulations of materials at the molecular scale are now performed on a daily basis. The aim of these simulations is to understand the macroscopic properties of matter from a microscopic description, for example, its atomistic configuration.

In order to make these simulations efficient and precise, mathematics have a crucial role to play. Indeed, specific algorithms have to be used in order to bridge the time and space scales between the atomistic level and the macroscopic level. The objective of the MSMath ERC project is thus to develop and study efficient algorithms to simulate high–dimensional systems over very long times. These developments are done in collaboration with physicists, chemists and biologists who are using these numerical methods in an academic or industrial context.

In particular, we are developping mathematical tools at the interface between the analysis of partial differential equations and stochastic analysis in order to characterize and to quantify the metastability of stochastic processes. Metastability is a fundamental concept to understand the timescale separation between the microscopic model and the macroscopic world. Many algorithms which aim at bridging the timescales are built using this timescale separation.

7.3.2. Design of Desalination Systems Based on Optimal Usage of Multiple Renewable Energy Sources (DESIRES) — ERANETMED NEXUS–14–049

Participant: Valérie Monbet.

January 2016 to December 2018.

This project is funded by the ERA–NET Initiative ERANETMED (Euro–Mediterranean Cooperation through ERA–NET Joint Activities and Beyond). It is a collaboration with Greece, Tunisia and Marocco, coordinated by Technical University of Crete (TUC). The French staff includes: Pierre Ailliot (Université de Bretagne Occidentale, Brest), Denis Allard (INRA Avignon), Anne Cuzol (Université de Bretagne Sud, Vannes), Christophe Maisondieu (IFREMER Brest) and Valérie Monbet.

The aim of DESIRES is to develop an Internet–based, multi–parametric electronic platform for optimum design of desalination plants, supplied by renewable energy sources (RES). The platform will rely upon (i) a solar, wind and wave energy potential database, (ii) existing statistical algorithms for processing energy-related data, (iii) information regarding the inter-annual water needs, (iv) a database with the technical characteristics of desalination plant units and the RES components, and (v) existing algorithms for cost effective design, optimal sizing and location selection of desalination plants.

7.4. International initiatives

7.4.1. Rare event simulation in epidemiology — PhD project at université de Ziguinchor

Participants: Ramatoulaye Dabo, François Le Gland.

This is the subjet of the PhD project of Ramatoulaye Dabo (université Assane Seck de Ziguinchor and université de Rennes 1).

The question here is to develop adaptive multilevel splitting algorithms for models that are commonly used in epidemiology, such as SIR (susceptible, infectious, recovered) models [26], or more complex compartmental models. A significant advantage of adaptive multilevel splitting is its robustness, since it does not require too much knowledge about the behavior of the system under study. An interesting challenge would be to understand how to couple the algorithm with numerically efficient simulation methods such as τ–leaping [35]. Complexity bounds and estimation error bounds could also be studied.

7.5. International research visitors

7.5.1. Visits to international teams

Patrick Héas has been invited to present his work on 3D wind field reconstruction by infrared sounding, at EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites) in Darmstadt in February 2017.

CQFD Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Piece (2013-2017) of the program Jeunes chercheuses et jeunes chercheurs of the ANR

Piecewise Deterministic Markov Processes (PDMP) are non-diffusive stochastic processes which naturally appear in many areas of applications as communication networks, neuron activities, biological populations or reliability ofcomplex systems. Their mathematical study has been intensively carried out in the past two decades but many challenging problems remain completely open. This project aims at federating a group of experts with different backgrounds (probability, statistics, analysis, partial derivative equations, modelling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

9.1.2. ANR StocMC (2014-2018) of the program Project Blanc of the ANR

The involved research groups are Inria Rennes/IRISA Team SUMO; Inria Rocquencourt Team Lifeware; LIAFA University Paris 7; Bordeaux University.
The aim of this research project is to develop scalable model checking techniques that can handle large stochastic systems. Large stochastic systems arise naturally in many different contexts, from network systems to system biology. A key stochastic model we will consider is from the biological pathway of apoptosis, the programmed cell death.

9.1.3. ANR BNPSI: Bayesian Non Parametric methods for Signal and Image Processing

Statistical methods have become more and more popular in signal and image processing over the past decades. These methods have been able to tackle various applications such as speech recognition, object tracking, image segmentation or restoration, classification, clustering, etc. We propose here to investigate the use of Bayesian nonparametric methods in statistical signal and image processing. Similarly to Bayesian parametric methods, this set of methods is concerned with the elicitation of prior and computation of posterior distributions, but now on infinite-dimensional parameter spaces. Although these methods have become very popular in statistics and machine learning over the last 15 years, their potential is largely underexploited in signal and image processing. The aim of the overall project, which gathers researchers in applied probabilities, statistics, machine learning and signal and image processing, is to develop a new framework for the statistical signal and image processing communities. Based on results from statistics and machine learning we aim at defining new models, methods and algorithms for statistical signal and image processing. Applications to hyperspectral image analysis, image segmentation, GPS localization, image restoration or space-time tomographic reconstruction will allow various concrete illustrations of the theoretical advances and validation on real data coming from realistic contexts.

9.1.4. Gaspard Monge Program for Optimisation and Operational Research (2017-2018)

The involved research groups are Inria Bordeaux Sud-Ouest Team CQFD and Thales Optronique. This new collaboration with Thales Optronique that started in October 2017 is funded by the Fondation Mathématique Jacques Hadamard. This is the continuation of the PhD Thesis of A. Geeraert. The objective of this project is to optimize the maintenance of a multi-component equipment that can break down randomly. The underlying problem is to choose the best dates to repair or replace components in order to minimize a cost criterion that takes into account costs of maintenance but also the cost associated to the unavailability of the system for the customer. In the PhD thesis of A. Geeraert, the model under consideration was rather simple and only a numerical approximation of the value function was provided. Here, our objective is more ambitious. A more realistic model will be considered and our aim is to provide a tractable quasi-optimal control strategy that can be applied in practice to optimize the maintenance of such equipments.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

- Program: Direcion General de Investigacion Cientifica y Tecnica, Gobierno de Espana
- Project acronym: GAMECONAPX
- Project title: Numerical approximations for Markov decision processes and Markov games
- Duration: 01/2017 - 12/2019
- Coordinator: Tomas Prieto-Rumeau, Department of Statistics and Operations Research, UNED (Spain)
- Abstract:

  This project is funded by the Gobierno de Espana, Direcion General de Investigacion Cientifica y Tecnica (reference number: MTM2016-75497-P) for three years to support the scientific collaboration between Tomas Prieto-Rumeau, Jonatha Anselmi and Francois Dufour. This research project is concerned with numerical approximations for Markov decision processes and Markov games. Our goal is to propose techniques allowing to approximate numerically the optimal value function and the optimal strategies of such problems. Although such decision models have been widely studied theoretically and, in general, it is well known how to characterize their optimal value function and their optimal strategies, the explicit calculation of these optimal solutions is not possible except for a few particular cases. This shows the need for numerical procedures to estimate or to approximate the optimal solutions of Markov decision processes and Markov games, so that the decision maker can really have at hand some approximation of his optimal strategies and his optimal value function. This project will explore areas of research that have been, so far, very little investigated. In this sense, we expect our techniques to be a breakthrough in the field of numerical methods for continuous-time Markov decision processes, but particularly in the area of numerical methods for Markov game models. Our techniques herein will cover a wide range of models, including discrete- and continuous-time models, problems with unbounded cost and transition rates, even allowing for discontinuities of these rate functions. Our research results will combine, on one hand, mathematical rigor (with the application of advanced tools from probability and measure theory) and, on the other hand, computational efficiency (providing accurate and ?applicable? numerical methods). In this sense, particular attention will be paid to models of practical interest, including population dynamics, queueing systems, or birth-and-death processes, among others. So, we expect to develop a generic and robust methodology in which, by suitably specifying the data of the decision problem, an algorithm will provide the approximations of the value function and the optimal strategies. Therefore, the results that we intend to obtain in this research project will be of interest for researchers in the fields of Markov decision processes and Markov games, both for the theoretical and the applied or practitioners communities

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

Tree-Lab, ITT. TREE-LAB is part of the Cybernetics research line within the Engineering Science graduate program offered by the Department of Electric and Electronic Engineering at Tijuana's Institute of Technology (ITT), in Tijuana Mexico. TREE-LAB is mainly focused on scientific and engineering research within the intersection of broad scientific fields, particularly Computer Science, Heuristic Optimization and Pattern Analysis. In particular, specific domains studied at TREE-LAB include Genetic Programming, Classification, Feature Based Recognition, Bio-Medical signal analysis and Behavior-Based Robotics. Currently, TREE-LAB incorporates the collaboration of several top researchers, as well as the participation of graduate (doctoral and masters) and undergraduate students, from ITT. Moreover, TREE-LAB is actively collaborating with top researchers from around the world, including Mexico, France, Spain, Portugal and USA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Tomas Prieto-Rumeau (Department of Statistics and Operations Research, UNED, Madrid, Spain) visited the team during 2 weeks in 2017. The main subject of the collaboration is the approximation of Markov Decision Processes.

Oswaldo Costa (Escola Politécnica da Universidade de São Paulo, Brazil) collaborate with the team on the theoretical aspects of continuous control of piecewise-deterministic Markov processes. He visited the team during two weeks in 2017.

MATHRISK Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- ANR Cosmos 2015-2018, Participant: B. Jourdain ; Partners : Ecole des Ponts, Telecom, Inria Rennes and IBPC

8.1.2. Competitivity Clusters

Pôle Finance Innovation.

8.2. International Initiatives

8.2.1. Informal International Partners

- Center of Excellence program in Mathematics and Life Sciences at the Department of Mathematics, University of Oslo, Norway, (B. Øksendal).
- Kings College, London (R. Dumitrescu)
- Department of Mathematics, University of Manchester (Tusheng Zhang, currently in charge of an EU-ITN program on BSDEs and Applications).
- Kensas University (Yaozhong Hu)
- Cornell University, ORIE department (Andreea Minca)
- Mannheim University (Alexander Schied, Chair of Mathematics in Business and Economics, Department of Mathematics)
- Roma Tor Vergata University (Lucia Caramellino)
- Ritsumeikan University (A. Kohatsu-Higa).

8.3. International Research Visitors

- Oleg Kudryavtsev, Rostov University (Russia)
- Martino Grasselli, Padova University,

8.3.1. Visits of International Scientists

8.3.1.1. Internships

- Adel Cherchali (June to August 2017): Multilevel Monte-Carlo methods for nested expectations. Supervisor: A. Alfonsi.

- Zeqi Chen (ENSTA), May -July , Supervisor: A. Zanette

- Mohamed Homed, April-September, Supervisor: A. Zanette

- Xinglong Tian (ENSTA), May-July 2017, Supervisor: A. Zanette

- Sebastien Villette, April-October, Supervisor: A. Zanette

TOSCA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, 2014–2018) coordinated by F. Hamel (Univ. Aix-Marseille).

9.1.2. ITMO project

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

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Program: FP7

Project acronym: HBP

Project title: The Human Brain Project

Duration: April 2016 - March 2018 (second part)

Coordinator: EPFL

Other partners: see the webpage of the project.

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

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. International Initiatives

ECOS Discrelongmem

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

International Partner (Institution - Laboratory - Researcher):

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

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

Duration: 2016 - 2018

Start year: 2016

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- E. Mordecki (Universidad de la Reppublica, Uruguay) has been visiting Nancy for two months in February-March 2017.

9.4.1.1. Internships

- Ahmed Amine Barnicha

  Subject: Modelling avalanches

  Date: Sept. 2017 - June 2018 (research project)

  Institution: Écoles des Mines de Nancy.
- Quentin Cormier

  Subject: Study of the limit equation associated to a model of interacting neurons

  Date: May 2017 - Aug. 2017

  Institution: Université Pierre et Marie Curie.
- Djibril Gueye

  Subject: Analyse de modèles markoviens couplés pour la température régionalisée

  Date: July 2017 - Oct. 2017

  Institution: AIMS- Senegal.
- Marie Muzzolon

  Subject: Estimation sans paramètres et simulation de Monte Carlo pour les processus ponctuels marqués : lien entre les méthodes ABC et les méthodes de type gradient stochastique.

  Date: April 2017 - Sept. 2017 (research project)

  Institution: Université de Lorraine.
- Fares Omari

  Subject: Analyse de modèles markoviens couplés pour la température régionalisée

  Date: July 2017 - Oct. 2017

  Institution: ENSIIE.
- Medhi Talbi

Subject: Optimisation de portefeuille par une approche de type champ moyen

Date: :March 2017 - July 2018 (research project)

Institution: École Normale Supérieure Paris-Saclay.

9.4.1.2. Research Stays Abroad

- M. Deaconu has been invited one week in February to the Institute of Mathematics of the Romanian Academy, Bucarest, by Lucian Beznea.
- C. Fritsch spent three days in Munich in June to start a collaboration with Mehdi Gharasoo (Institute of Groundwater Ecology).
- D. Talay was an invited Professor at Columbia University (New York) in June. He gave a course on ergodic diffusion processes.
- E. Tanré have spent two weeks in Valparaíso (Chile) in December within the ECOS program (PIs: E. Tanré, S. Torres), working with S. Torres (Univ. of Valparaiso).