RESEARCH CENTER

FIELD
Applied Mathematics, Computation and Simulation

Activity Report 2015

Section Partnerships and Cooperations

Edition: 2016-03-21

ACUMES Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Project BOUM

G. Costeseque holds a BOUM (SMAI) project on *"Homogeneization mathematical methods for traffic flow models"* with W. Salazar and M. Zaydan (LMI, INSA Rouen) and J.A. Firozaly (CERMICS, Ecole des Ponts ParisTech and LAMA, Univeristé Paris-Est Créteil).

7.1.2. Project SOKA

R. Duvigneau is coordinator of the project SOKA, funded by INSEP for 2014-2015. The objective is the modeling and optimization of racing canoes in the perspective of 2016 Olympic Games in Rio. Other partners are the Ecole Centrale de Nantes and FFCK (French Federation of Canoe-Kayak).

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. TraM3

Type: FP7
Defi: NC
Instrument: ERC Starting Grant
Objectif: NC
Duration: October 2010 - March 2016
Coordinator: Inria
Inria contact: Paola Goatin
Abstract: The project intends to investigate traffic phenomena from the macroscopic point of view, using models derived from fluid-dynamics consisting in hyperbolic conservation laws. The scope is to develop a rigorous analytical framework and fast and efficient numerical tools for solving optimization and control problems, such as queues lengths control or buildings exits design. See also: http://www-sop.inria.fr/members/Paola.Goatin/tram3.html

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.

LIRIMA

Associate Team involved in the IIL :

7.3.1.2. ANO

The LIRIMA team ANO : Numerical analysis of PDEs and Optimization is a partnership between Opale project and the EMI engineering college, Rabat / National Centre for Scientific and Technical Research (CNRST) Morocco. The Team leader is Prof. Rajae Aboulaïch, EMI. Other french participants are the Project Commands at Saclay, Palaiseau and the team-project DRACULA at Inria Lyon.

The ANO team is composed of ten senior researchers from Morocco and ten senior researchers from France and more than fifteen PhD students.

The themes investigated are biomathematics (Models for plants growth, cardiovascular and cerebral diseases, cardio image segmentation), mathematical finance (optimal portfolio, risk management, Islamic finance), and multiobjective optimization in structural mechanics.

7.3.2. Participation In other International Programs

- PHC PROCOPE Team *Transport Networks Modeling and Analysis*
  Duration : Jan. 2014- Dec. 2015
  Coordinator: P. Goatin (France), S. Göttlich (Germany)
  Other partner: University of Mannheim (Germany)
  Abstract: The proposed research cooperation focuses on the development and analysis of methods for time-dependent transport phenomena in complex systems. Such systems are given for example by traffic flow networks, production lines, gas and water networks, or chemical reactions. Our particular importance is to model physical processes according to their scale by suitable mathematical means. To this end a model hierarchy using a discrete description for the small scale effects and a continuous model to describe large scale phenomena is investigated. These novel and nonstandard approaches allow to incorporate detailed nonlinear dynamic behavior, which is currently not possible with the widely used classical mixed?integer linear approaches. Through the coupling of discrete and continuous models, both on the theoretical and the applied level, we will contribute to the quantification of uncertainty as well as on control problems for these systems. The modeling is achieved by first considering transport phenomena such as traffic, production, gas and water before controlling the systems. We analyze system properties and derive and implement efficient numerical algorithms for simulation and optimization purposes. In this setting, the proposed project yields a significant contribution for tackling large dynamical problems not only restricted to traffic management but also in other engineering areas.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

- H. Yoldas (May 2015, L'Aquila University): numerical study of a non-local version of Hughes' model for pedestrian flows.
- M. Pfirsching (September 2015): numerical schemes for non-local conservation laws.
- S. Villa (March-June 2015, Milano - Bicocca): moving bottlenecks in traffic flow.
- Z. Tabbakh (15 november- 15 december, EMI, Rabat) Modeling and optimization of lakes aeration process.

CAGIRE Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Predicting pressure losses in aeronautical fuel injectors

This is a 3-year programme, funded by Conseil Régional d'Aquitaine (call 2014) and two small-size companies, AD Industrie (Gurmençon, France) and GDTECH (Bordes, France). A one-year post-doc [YM] started in May 2015. 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.

9.2. National Initiatives

9.2.1. GIS Success

We are members of the CNRS GIS Success (Groupement d'Intérêt Scientifique) organised around the two major codes employed by the Safran group, namely AVBP and Yales 2. Apart our participation in the annual meeting of the GIS technical comittee, no specific technical activity has been devoted around those codes during 2015.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Participants: Vincent Perrier [responsible of the team contribution], Pascal Bruel [substitute], Simon Delmas [PhD].

Program: Propulsion

Project acronym: IMPACT-AE

Project title: Intelligent Design Methodologies for Low Pollutant Combustors for Aero-Engines

Duration: 01/11/2011 - 31/05/2016

Coordinator: Roll Royce Deutschland

Other partners:

- France: Insa of Rouen, ONERA, Snecma, Turbomeca.
- Germany: Rolls-Royce Deutschland, MTU Aeo Engine Gmbh, DLR, Technology Institute of Karlsruhe, University of Bundeswehr (Munich)
- Italy: AVIOPROP SRL, AVIO S.P.A., University of Florence
- United Kingdom: Rolls Royce PLC, Cambridge University, Imperial College of Science, Technology and Medecine, Loughborough University.

Abstract: The environmental benefits of low emission lean burn technology in reducing NOx emissions up to 80% will only be effective when these are deployed to a large range of new aero-engine applications. While integrating methodologies for advanced engine architectures and thermodynamic cycles. It will support European engine manufacturers to pick up and keep pace with the US competitors, being already able to exploit their new low emission combustion technology to various engine applications with short turn-around times. Key element of the project will be the development and validation of design methods for low emission combustors to reduce NOx and CO emissions by an optimization of the combustor aero-design process. Preliminary combustor design tools will be coupled with advanced parametrisation and automation tools. Improved heat transfer and NOx models will increase the accuracy of the numerical prediction. The contribution of our team is to create with AeroSol a direct numerical simulations (DNS) database relevant to the configuration of film cooling for subsequent improvement of RANS based simulations of isothermal and non isothermal wall flows with discrete mass transfer.

9.4. International Initiatives

- April-June 2015: A. Javadi (PhD student) from Chalmers University, Gothenburg, Sweden (3 months).

9.4.1. Informal International Partners

- Collaboration [PB, VP, YM] with E. Dick (University of Ghent, Belgium) on the development of schemes for the simulation of unsteady low Mach number flows.
- Collaboration [PB] with A. Allouhi, A. Jamil, Y. Mourad (Ecole Supérieure de Technologie of Fès, Marocco) related to solar driven cooling systems.
- Collaboration [PB] with A. Beketaeva and A. Naïmanova (Institute of Mathematics, Almaty, Kazakhstan) related to the simulation of supersonic flows.
- Collaboration [RM] with H. Nilsson and A. Javadi (University of Chalmers, Gothenburg, Sweden) on the development of RANS and hybrid RANS/LES for the turbomachinery computations.
- Collaboration [RM] with E. Juntasaro (King Mongkut's TU, Bangkok, Thailand) about the modeling of bypass transition.
- Collaboration [RM] with Tran Thanh Tinh and Anh Thi NGuyen (TU Ho Chi Minh City, Viet Nam) on temporal hybrid RANS/LES.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- April-June 2015: A. Javadi (PhD student) from Chalmers University, Gothenburg, Sweden (3 months).
- November 2015: Prof. Erik Dick from Ghent University (Belgium) (4 days).
- November 2015: Dr. A. Naïmanova from the Institute of Mathematics (Ministry of Education), Almaty, Kazakhstan (4 weeks).
- November-December 2015: N. Shakhan (PhD student) from Al Farabi University, Almaty, Kazakhstan (7 weeks).

CARDAMOM Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Title: TIDES: Robust simulation tools for non-hydrostatic free surface flows

Type: Apple à Projets Recherche du Conseil de la Région Aquitaine

Coordinator: M. Ricchiuto

Other partners: UMR EPOC (P. Bonneton)

Abstract: This project proposes to combine modern high order adaptive finite elements techniques with state of the art nonlinear and non-hydrostatic models for free sruface waves to provide an accurate tool for the simulation of near shore hydrodynamics, with application to the study and prediction of tidal bores. The Garonne river will be used as a case study. This project co-funds (50%) the PhD of A. Filippini.

9.2. National Initiatives

9.2.1. 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.

9.2.2. 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.

9.2.3. FUI Rodin

Title: Robust structural Optimization for Design in Industry (Rodin)

Type: FUI

Duration: July 2012 - July 2015

Coordinator: ALBERTELLI Marc (Renault)

Abstract: From the research point of view, the RODIN project will focus on: (1) extending level set methods to nonlinear mechanical or multiphysics models and to complex geometrical constraints, (2) developing algorithms for moving meshes with a possible change of topology, (3) adapting in a level-set framework second-order optimization algorithms having the ability of handling a large number of design variables and constraints.

The project will last 3 years and will be supported by a consortium of 7 partners: (1) 2 significant end-users, Renault and EADS, who will provide use-cases reflecting industrial complexity; (2) 3 academics partners, CMAP, J.-L. Lions laboratory and Inria of Bordeaux, who will bring expertise in applied mathematics, structural optimization and mesh deformation; (3) A software editor, ESI Group, who will provide mechanical software package and will pave the way of an industrialization; (4) A SME, Eurodecision, specialized in large-scale optimization.

9.2.4. 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 oxidization. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. STORM

Type: COOPERATION

Defi: NC

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: October 2013 - September 2016

Coordinator: SNECMA (France)

Partner: SNECMA SA (FR), AEROTEX UK LLP (UK), AIRBUS OPERATIONS SL (ES), Airbus Operations Limites (UK), AIRCELLE SA (FR), ARTTIC (FR), CENTRO ITALIANO RICERCHE AEROSPAZIALI SCPA (IT), CRANFIELD UNIVERSITY (UK), DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV (DE), EADS DEUTSCHLAND GMBH (DE), ONERA (FR), TECHSAPACE AERO SA (BE)

Inria contact: Héloise Beaugendre

Abstract: During the different phases of a flight, aircraft face severe icing conditions. When this ice then breaks away, and is ingested through the reminder of the engine and nacelle it creates multiple damages which have a serious negative impact on the operations costs and may also generate some incident issues. To minimise ice accretion, propulsion systems (engine and nacelle) are equipped with Ice Protection Systems (IPS), which however have themselves performance issues. Design methodologies used to characterise icing conditions are based on empirical methods and past experience. Cautious design margins are used non-optimised designs solutions. In addition, engine and nacelle manufacturers are now limited in their future architectures solutions development because of lack of knowledge of icing behaviour within the next generation of propulsive systems solutions, and of new regulations adopted that require aero engine manufacturers to address an extended range of icing conditions.

In this context that STORM proposes to: characterise ice accretion and release through partial tests ; Model ice accretion, ice release and ice trajectories ; Develop validated tools for runback ; characterise ice phobic coatings ; select and develop innovative low cost and low energy anti-icing and de-icing systems. Thus, STORM will strengthen the predictability of the industrial design tools and reduce the number of tests needed. It will permit lower design margins of aircraft systems, and thus reduce the energy consumption as well as prevent incidents and break downs due to icing issues.

9.3.2. Collaborations in European Programs, except FP7 & H2020

Program: OCEANEraNET

Project acronym: MIDWEST

Project title: Multi-fIdelity Decision making tools for Wave Energy SysTems

Duration: December 2015 - December 2018

Coordinator: Mario Ricchiuto

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

Abstract: 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.

9.4. International Initiatives

9.4.1. Inria International Labs

Inria@SiliconValley
Associate Team involved in the International Lab:

9.4.1.1. AQUARIUS2

Title: Advanced methods for uncertainty quantification in compressible flows

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Mechanical Engineering - Gianluca Iaccarino

Start year: 2014

See also: http://www.stanford.edu/group/uq/aquarius/index3.html

This research project deals with uncertainty quantification in computational fluid dynamics. Uncertainty Quantification (UQ) aims at developing rigorous methods to characterize the impact of limited knowledge on quantities of interest. Main objective of this collaboration is to build a flexible and efficient numerical platform, using intrusive methods, for solving stochastic partial differential equations. In particular, the idea is to handle highly non-linear system responses driven by shocks.

9.4.1.2. AMoSS

Title: Advanced Modeling on Shear Shallow Flows for Curved Topography : water and granular flows.

International Partner (Institution - Laboratory - Researcher):

Inria Sophia-Antipolis and University of Nice (France)

Inria Bordeaux and University of Bordeaux (France)

University of Marseille (France)

National Cheng Kung University, Tainan, Taiwan

National Taiwan University and Academia Sinica,Taipei, Taiwan

Duration: 2014 - 2016

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

Our objective is to generalize the promising modeling strategy proposed in G.L. Richard and S.L. Gavrilyuk 2012, to genuinely 3D shear flows and also take into account the curvature effects related to topography. Special care will be exercised to ensure that the numerical methodology can take full advantage of massively parallel computational platforms and serve as a practical engineering tool. At first we will consider quasi-2D sheared flows on a curve topography defined by an arc, such as to derive a model parameterized by the local curvature and the nonlinear profile of the bed. Experimental measurements and numerical simulations will be used to validate and improve the proposed modeling on curved topography for quasi-2D flows. Thereafter, we will focus on 3D flows first on simple geometries (inclined plane) before an extension to quadric surfaces and thus prepare the generalization of complex topography in the context of geophysical flows.

9.4.1.3. 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

University of Nottingham, Department of Mathematics : Dr. M.E. Hubbard. Collaboration on high order schemes for time dependent shallow water flows

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 ;

9.5. International Research Visitors

9.5.1. Visits of International Scientists

From april 2015 (up to april 2016), Tatsuya Watanabe (Department of Mathematics, Faculty of Science, Kyoto Sangyo University Motoyama,Kamigamo,Kita-Ku,Kyoto-City 603-8555,Japan) comes to visit Mathieu Colin. During his stay, T. Watanabe is funded by a JSPS-grant.
From 09/04/2015 to 24/04/2015 F. Morency () has visited us to work with H. Beaugendre on the construction of penalization methods for the analysis of de-anti icing systems.
From 01/06/2015 to 08/06/2015, T. Magin (von Karman Institute for Fluid Dynamics) has visited us to work with P.M. Congedo on the robust analysis of Reentry flows.
From 01/07/2015 to 28/07/2015 Prof. A. Kurganov (Tulane University, New Orleans) has visited us to work with M. Ricchiuto on semi-implicit time integration methods and adaptive mesh deformation techniques.

9.5.2. Visits to International Teams

In May 2015, P.M. Congedo visited the Uncertainty Quantification Laboratory in Stanford University. Andrea Cortesi visited NASA-Ames (California) in November-December 2015.

DEFI Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- H. Haddar is the DEFI coordinator of the ANR: Modelization and numerical simulation of wave propagation in metamaterials (METAMATH), program MN, 2011-2015. This is a joint ANR with POEMS, Inria Scalay Ile de France project team (Coordinator, S. Fliss), DMIA, Département de Mathématiques de l'ISAE and IMATH, Laboratoire de Mathématiques de l'Université de Toulon. https://www.rocq.inria.fr/poems/metamath
- J.R. Li is the coordinator of the Inria partner of the project "Computational Imaging of the Aging Cerebral Microvasculature", funded by ANR Program "US-French Collaboration". French Partners (Coordinating partner CEA Neurospin): CEA Neurospin (Coordinator Luisa Ciobanu), Inria Saclay (Coordinator Jing-Rebecca Li). US Partner: Univ of Illinois, bioengineering department (Coordinator Brad Sutton). Duration: Sept 2013- Sept 2016.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

- Partner 1: University of Bremen, Department of Math. (Germany)

  Joint PhD advising of T. Rienmuller, partly funded by French-German university. Correspondant: Armin Lechleiter.
- Partner 2: University of Goettingen, Department of Math. (Germany)

  Development of conformal mapping method to electrostatic inverse problems. Correspondant: Rainer Kress.

8.3. International Initiatives

8.3.1. Inria International Labs

- DEFI is the correpondnat of the LIRIMA Afrique team EPIC. The program ended in 2015. A followup is prepared in the framework of associate team program.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

QUASI

- Title: Qualitative Approaches to Scattering and Imaging
- International Partners (Institution - Laboratory - Researcher):
  - University of Delaware (United States) - Department of Mathematical Sciences (Department of Math) - Fioralba Cakoni
- 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 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

We had short visits (one week) of the following collaborators

- Fioralba Cakoni
- David Colton
- Ozgur Ozdemir
- Rainer Kress

8.4.1.1. Internships

- Guilherme Da Costa Sales
- Hoang Trong An TRAN

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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. AboutFlow

Type: PEOPLE
Instrument: Initial Training Network
Duration: 2012-2016
Coordinator: Jens-Dominik Mueller
Partner: Queen Mary University of London (UK)
Inria contact: Laurent Hascoët
Abstract: The aim of AboutFlow is to develop robust gradient-based optimisation methods using adjoint sensitivities for numerical optimisation of flows. http://aboutflow.sems.qmul.ac.uk/

8.2.1.2. UMRIDA

Type:AAT
Instrument:Aeronautics and Air Transport
Duration: 2013-2016
Coordinator: Charles Hirsch
Partner: Numeca S.A. (Belgium)
Inria contact: Alain Dervieux
Abstract: UMRIDA addresses major research challenges in Uncertainty Quantification and Robust Design: develop new methods that handle large numbers of simultaneous uncertainties and generalized geometrical uncertainties. Apply these methods to representative industrial configurations.

8.3. International Initiatives

8.3.1. Inria International Labs

Ecuador participates in the Joint Laboratory for Exascale Computing (JLESC) together with colleagues at Argonne National Laboratory. Laurent Hascoët attended the JLESC meeting in Bonn, Germany, december 2-5.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Krishna Narayanan from Argonne National Laboratory, september 21-25.

8.4.2. Internships

- Marcin Wyrozebski from Warsaw University of Technology, september 1-30.

8.4.3. Visits to International Teams

- Laurent Hascoët visited Argonne National Laboratory, april 13-23.

GAMMA3 Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

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

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

P. Laug participates in the GEOPRISM (GEOlogical resources PRotection and exploitation using Innovative Simulation Methods - Towards new generations of simulation technologies) project, submitted to H2020-FETOPEN-2014-2015-RIA. This project involves several Inria teams (Sage, Gamma3, Pomdapi, Coffee) and several European research centers and universities.

7.3. International Initiatives

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

7.3.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2014

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

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

7.4. International Research Visitors

7.4.1. Visits to International Teams

7.4.1.1. Sabbatical programme

Laug Patrick

Date: Sep 2014 - Aug 2015

Institution: Polytechnique Montréal (Canada)

IPSO Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR Programme blanc international (BLAN) LODIQUAS 2012-2015

Participants: Philippe Chartier, Florian Méhats, François Castella, Mohammed Lemou.

The project, entitled "LODIQUAS" (for: Low DImensional QUANtum Systems), received fundings for 4 postdocs (48 months) and one pre-doc (36 months). The whole project involves the following researchers : Norbert Mauser (Vienna), Erich Gornik (Vienna), Mechthild Thalhammer (Innsbruck), Christoph Naegerl (Innsbruck), Jörg Schmiedmayer (Vienna), Hans-Peter Stimming (Vienna),Francis Nier (Rennes), Raymond El Hajj (Rennes), Claudia Negulescu (Toulouse), Fanny Delebecque (Toulouse), Stéphane Descombes (Nice), Christophe Besse (Lille).
The expected scientific and technological progress brought by the present project are as follows.
Quantum technology as the application of quantum effects in macroscopic devices has an increasing importance, not only for far future goals like the quantum computer, but already now or in the near future. The present project is mainly concerned with the mathematical and numerical analysis of these objects, in conjunction with experimental physicists. On the side of fermions quantum electronic structures like resonant tunnelling diodes show well studied non classical effects like a negative differential resistance that are exploited for novel devices. On the side of bosons the creation and manipulation of Bose Einstein Condensates (the first creation of BECs by Ketterle et al merited a Nobel prize) has become a standard technique that allows to study fundamental quantum concepts like matter-wave duality with increasingly large objects and advanced quantum effects like decoherence, thermalization, quantum chaos. In state-of-the-art experiments e.g. with ultracold atoms in optical lattices the bosonic or fermionic nature of quantum objects can change and it makes a lot of sense to treat the models in parallel in the development of mathematical methods. The experimental progress in these fields is spectacular, but the mathematical modelling and analysis as well as the numerical simulation are lagging behind. Low dimensional models are mostly introduced in a heuristic way and there is also a need for systematic derivations and comparison with the 3-d models. To close the gap is a main goal of this project that aims to deliver reliable tools and programme packages for the numerical simulation of different classes of quantum systems modelled by partial differential equation of NLS type. Virtually all participants have a strong track record of international collaboration, they grew up with the concept of the European Research Area where science knows no boundaries and scientists used to work in different countries, as it was the case in a pronounced way in mathematics and in quantum physics in the thirties of the last century. The Pre- and Post-Docs to be funded by this project will be trained in this spirit of mobility between scientific fields and between places.
This project gave rise to the following scientific achievements
PhD students
Boris Pawilowski, has been hired as a PhD student, under the supervision of F. Nier and N. Mauser. His contract started october 2012, and the PhD thesis was defended on December 2015. His PhD subject is "Mean field limit for discrete models and nonlinear discrete Schrödinger equations".
Postdocs
Loïc Le Treust has been hired as a Postdoc, under the supervision of F. Méhats (main) and N. Mauser. His contract started October 2013, and it did last two years, in Rennes and Vienna.
Yong Zhang, under contract in Vienna, has been invited for several one month periods in Rennes. There are works in progress with F. Méhats and P. Chartier.
Kristelle Roidot, had a six months contract in Vienna, and this gave rise to works with N. Mauser, C. Klein, J.-C. Saut, S. Descombes.
Workshops

July 2012, kick-off meeting of the LODIQUAS project, WPI, Vienna (one week, approx. 40 people, amongst which most of the participants of the project).
February 2013, WPI, Vienna, with a similar organization as the kick-off meeting.
July 2013, WPI, Vienna. At the WPI for one week. "Quantized Vortices in Superfluidity and Superconductivity and Related Problems", organisers W. Bao, C. Bardos, Q. Du, N. Mauser.
September 2013, WPI Vienna, "Modified dispersion for dispersive equations and systems ", organisers R. Carles, Mauser, J.C. Saut.
September 2013, WPI Vienna, "Modified dispersion for dispersive equations and systems ", organisers R. Carles, Mauser, J.C. Saut.
October 2014, WPI Vienna, "Blow-up and Dispersion in nonlinear Schrödinger and Wave equations", organizers G. Lebeau, A. Jüngel, O. Ivanovici, J.-C. Saut, H.-P. Stimming.
December 2014, Saint-Malo, "Lodiquas Meeting", organisers F. Castella and P. Chartier.
December 2015, Dinard, "Joint Lodiquas and Ipso Meeting",

6.1.2. ANR MOONRISE: 2015-2019

Participants: Nicolas Crouseilles, Philippe Chartier, Florian Méhats, François Castella, Mohammed Lemou.

The project *Moonrise* submitted by F. 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, F. Castella, P. Chartier, N. Crouseilles and M. Lemou are members of the project Moonrise.

6.1.3. 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.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

6.2.1.1. Geopardi

Title: Numerical integration of Geometric Partial Differential Equations

Programm: FP7

Duration: September 2011 - August 2016

Coordinator: E. Faou

Inria contact: E. Faou

'The goal of this project is to develop new numerical methods for the approximation of evolution equations possessing strong geometric properties such as Hamiltonian systems or stochastic differential equations. In such situations the exact solutions endow with many physical properties that are consequences of the geometric structure: Preservation of the total energy, momentum conservation or existence of ergodic invariant measures. However the preservation of such qualitative properties of the original system by numerical methods at a reasonable cost is not guaranteed at all, even for very precise (high order) methods. The principal aim of geometric numerical integration is the understanding and analysis of such problems: How (and to which extend) reproduce qualitative behavior of differential equations over long time? The extension of this theory to partial differential equations is a fundamental ongoing challenge, which require the invention of a new mathematical framework bridging the most recent techniques used in the theory of nonlinear PDEs and stochastic ordinary and partial differential equations. The development of new efficient numerical schemes for geometric PDEs has to go together with the most recent progress in analysis (stability phenomena, energy transfers, multiscale problems, etc..) The major challenges of the project are to derive new schemes by bridging the world of numerical simulation and the analysis community, and to consider deterministic and stochastic equations, with a general aim at deriving hybrid methods. We also aim to create a research platform devoted to extensive numerical simulations of difficult academic PDEs in order to highlight new nonlinear phenomena and test numerical methods.'

6.2.1.2. EUROfusion 2015-2017

N. Crouseilles and M. Lemou are members of the EUROFusion project entitled "Enabling research project for the implementation of the fusion roadmap". The leader is E. Sonnendrücker (IPP Garching, Germany).

6.3. International Initiatives

6.3.1. Inria International Partners

6.3.1.1. Informal International Partners

Several IPSO members have international collaborations

- L. Einkemmer, University of Innsbruck. Collaboration on numerical schemes for Vlasov-Maxwell equations with N. Crouseilles and E. Faou.
- M. Thalhammer, University of Innsbruck. Collaboration on multi-revolution methods for the Schrödinger equation and Dirac equation with F. Méhats and P. Chartier.
- S. Jin, University of Madison. Collaboration on numerical schemes for highly-oscillatory problems with N. Crouseilles and M. Lemou.
- G. Vilmart, University of Geneva. Collaboration on uniformly accurate methods for highly-oscillatory problems with F. Méhats and P. Chartier
- F. Casas, University Jaume. Collaboration on splitting methods for Vlasov equations with N. Crouseilles and E. Faou.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

6.4.1.1. Internships

S. Jin (University of Madison) spent 2 months at IRMAR (University of Rennes) within the framework of the Labex H. Lebesgue semester "PDEs and long time behavior", to collaborate with N. Crouseilles and M. Lemou.

6.4.2. Visits to International Teams

6.4.2.1. Research stays abroad

- P. Chartier: invitation at the University of Geneva (Switzerland), by G. Vilmart (one month in July).
- F. Méhats: invitation at the University of Geneva (Switzerland), by G. Vilmart (one week).
- F. Méhats: invitation at the Beijing Computational Science Research Center (China), by W. Bao (10 days).
- M. Lemou: invitation at the University of Wisconsin-Madison (US), by S. Jin (two weeks, october 2015).
- M. Lemou: invitation at the University of Geneva (Switzerland), by G. Vilmart (two weeks, july 2015).
- A. Debussche participated to the semester "New challenges in PDE: Deterministic dynamics and randomness in high and infinite dimensional systems" at MSRI (Berckeley, US).

MATHERIALS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

The project-team is involved in several ANR projects:

- E. Cancès is involved in the ANR BECASIM, which is concerned with the numerical simulation of Bose-Einstein condensates. This ANR has been accepted in June 2012, and is coordinated by I. Danaila (Université de Rouen).
- T. Lelièvre is member of the ANR-project "STAB" (PI: I. Gentil, Université de Lyon).
- S. Boyaval's ANR proposal SEDIFLO, about the improvement of current numerical models of solid transport in rivers operating at large-scale for industrial purposes, by means of new non-Newtonian rheology equations, has been selected for funding as a JCJC (Jeunes Chercheuses Jeunes Chercheurs) grant.
- F. Legoll is a member of the ANR project CINE-PARA (PI: Y. Maday, Paris 6)
- the ANR COSMOS (PI: G. Stoltz) 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.

In addition, the project-team is participating in

- the GdR Quantum dynamics. This interdisciplinary research network is focused on physical and mathematical problems related to the time evolution of quantum systems (transport problems, nonequilibrium systems, etc),
- the GdR Shocks,
- the GdR Maths et entreprise,
- the GdR correl (correlated methods in electronic structure computations),
- the GdR Rest (rencontres de spectroscopie théorique).
- the GdR CoDFT (electronic structure computations using density functional theory).
- the GdR EGRIN
- the GdR MASCOT-NUM (stochastic methods for the analysis of numerical codes),

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

8.2. European Initiatives

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

8.3. International Initiatives

S. Boyaval has obtained a *Germaine de Staël* grant to pursue his research with A. Caboussat (Lausanne) about 3D numerical simulation 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 on the French side research teams from Université de Nancy, Université de Lyon and Inria Rennes.

MEMPHIS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The project members are activelly participating to the CPU cluster of excellence of Idex Bordeaux (http://cpu.labex.u-bordeaux.fr/).

9.2. National Initiatives

We belong to the GDR AMORE on ROMs.

9.2.1. Starting grants

A PEPS project ("Programme Exploratoire Premier Soutien"), initiated by Afaf Bouharguane, about Optimal Transport Theory. Angelo Iollo and Lisl Weynans are also involved in this project.

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 - May 2018

Coordinator: University of Bristol

Partners:

- Airbus Defence and Space (Germany)
- Dassault Aviation (France)
- Deutsches Zentrum fur 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 Cape Town (South Africa)
- University of Bristol (United Kingdom)
- Valeols (France)

Inria contact: Angelo IOLLO

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 defence 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 the MRGM lab. They are interesting 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 the power. This simulation is challenging 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 Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

With Rajat Mittal, of Johns Hopkins University, we collaborate on the simulation of complex biological flows that involve fluid- structure interactions with large deformations like fonation, heart beating, freely moving elastic capsules in blood vessels, fish-like swimming or flapping wings. A common journal paper in Bionspiration & Biomimetics has been issued so far. This collaboration will continue in the future.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Frédéric Gibou, from UC Santa Barbara, visited us in 2015. With the team of Frédéric Gibou we collaborate to develop general enough numerical models that allow a simplified geometrical and computational set up by the systematic use of hierarchical Cartesian meshes and monolithic models: multi-resolution schemes based on octree grid structures, refined grid patches, numerical zooms, overset.

Giovanni Russo, of the University of Catania, shares many of our scientific objectives: one of his past PhD students, Armando Cocco, has spent one year in Bordeaux dedicated to the parallelization of a multigrid cartesian solver. G. Russo has spent several weeks in Bordeaux as a visiting scientist at the Memphis team in 2015. This visit was dedicated to the study of new all-Mach schemes for conservative equations, guaranteeing accuracy and efficiency of the schemes used to solve problems where the time scales are those of the material velocities as opposed to acoustic wave time scales.

Gabriella Puppo, initially at the Politecnico di Torino and now at the university of Insubria, also visited us in 2015. We have an established collaboration with her to extend our approaches to rarefied gas dynamics, i.e., problems governed by the BGK equation. We have co-directed the PhD of Florian Bernard and we have now another co-direction, that of Emanuela Abbate, who will be studying relaxation equations for stiff problems of compressible non-linear elasticity.

Conglin Liu (univ. Harbin China), visited Charles-Henri Bruneau during the whole academic year 2014-2015. She had a grant from the Chinese Government.

9.5.1.1. Internships

Nadia Loy is an international internship from the university of Florence.

9.5.2. Visits to International Teams

With the team of Frédéric Gibou we collaborate to develop general enough numerical models that allow a simplified geometrical and computational set up by the systematic use of hierarchical Cartesian meshes and monolithic models: multi-resolution schemes based on octree grid structures, refined grid patches, numerical zooms, overset.

In this framework we have recently organized a commun workshop in Santa Barbara funded by the Idex initiative in Bordeaux.

MEPHYSTO Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR BECASIM

G. Dujardin and I. Lacroix are members 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 2016.

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

8.1.2. 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 behaviour 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.

8.1.3. MIS

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

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

Coordinator: Denis Bonheure.

Duration: January 2014 - December 2016.

Partner: Université libre de Bruxelles.

8.1.4. 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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. QUANTHOM

Title: Quantitative methods in stochastic homogenization

Programm: FP7

Duration: February 2014 - January 2019

Coordinator: Unibersité Libre de Bruxelles (Belgium)

Partner: Inria

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 I 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, I 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. I 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.'

8.3. International Initiatives

8.3.1. Informal International Partners

Felix Otto's group at Max Planck Institute for Mathematics in the Sciences.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Louis Huguet, MA1 internship from ENS Cachan, 3 months.

8.4.2. Visits to International Teams

8.4.2.1. Sabbatical programme

Denis Bonheure was awarded a "Mission scientifique du FNRS" (sabbatical).

8.4.2.2. Research stays abroad

Denis Bonheure was visiting professor (in the frame of his sabbatical year) at

- USP Sao Carlos, ICMC, Departamento de matematica
- Karlsruher Institut fuer Technologie (KIT), Institut fuer Analysis
- Pontificia Universidad Católica de Chile, Facultad de Matemáticas
- Instituto Superior Tecnico de Lisboa, Departamento de Matemática
- Université Aix-Marseille, Laboratoire d'Analyse, Topologie et Probabilités
- Universidad de Buenos Aires, Departamento de Matemática
- Università degli studi di Torino, Dipartimento di Matematica

Antoine Gloria spent two months at IHES (February–March 2015), as a guest of the Schlumberger chair of Felix Otto.

Christopher Shirley was invited by Pr. Nariyuki Minami and Pr. Fumihiko Nakano to Japan, from Nov. 26 to Dec. 13.

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/.

8.1.2. CNRS Mission pour l'interdisciplinarité (Défi Imag'In)

V. Duval and F-X. Vialard are members of the CAVALIERI project (CAlcul des VAriations pour L'Imagerie, l'Edition et la Recherche d'Images). This project, coordinated by V. Duval, aims at proposing new methods for comparing and reconstructing images relying on recent progress in the calculus of variations. Typical applications are co-segmentation, statistics transfer and interpolation, as well as tomographic reconstruction. A major emphasis is given on methods derived from (generalized) Optimal Transportation. See http://image.math.u-bordeaux1.fr/cavalieri/

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Gabriel Peyré is the principal investigator of the ERC project SIGMA-Vision (http://gpeyre.github.io/sigma-vision/), running in 2011-2016. This project tackles theory, numerics and applications at the interface between imaging sciences, optimization and neurosciences. It features in particular several contributions on sparse regularization techniques for inverse problems, and optimal transport approaches for color and texture image processing. This theoretical and numerical contributions are applied to compute vision, computer graphics and neurosciences of the visual brain.

8.3. International Initiatives

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

8.3.1.1. MOKALIEN

Title: Numerical Optimal Transportation in (Mathematical) Economics

International Partner (Institution - Laboratory - Researcher):

McGill University (Canada) - mathematics - Oberman Adam

Start year: 2014

See also: https://team.inria.fr/mokaplan/mokalien/

The team investigate new modelization and numerical resolution methods i using the theory of Optimal Transportation.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Jun Kitagawa (University of Toronto) visited Q. Mérigot and B. Thibert from June 1st to 10th, 2015. They worked on theoretical properties of Newton's algorithm for semi-discrete optimal transport problems arising in geometric optics.

Marco Cuturi (Kyoto Univ.) visited MOKAPLAN as invited professor at Paris-Dauphine during the summer 2015 (2 months), to work on applications of optimal transport to machine learning.

8.4.1.1. Internships

Kévin Degraux, a PhD candidate from the Université Catholique de Louvain (Belgium) has visited MOKAPLAN from November 2015 to January 2016. His work focusses on sparse signal reconstruction.

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Q. Mérigot visited Jose-Antonio Carrillo at Imperial College, to start a collaboration on the discretization of Wasserstein gradient flows using Voronoi diagrams.

F.-X. Vialard was invited for one month at the semester on geometric mechanics and stochastic analysis at EPFL Bernoulli institute in april to work with Darryl D. Holm and other researchers.

F.-X. Vialard was invited for the semester on Riemannian geometry in infinite dimension in Vienna in january and february.

G. Carlier has spent six month at U. Victoria visiting Prof. Martial Agueh.

Gabriel Peyré visited the laboratory of Marco Cuturi (Kyoto Univ.) as invited professor during April 2015, to work on applications of optimal transport to machine learning.

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. 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 Computação Científica (Brazil) - Coordenação 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. Liang Li, School of Mathematical Sciences, University of Electronic Science and Technology of China, Chengdu.

Dr. Maciej Klemm, University of Bristol, Communication Systems & Networks Laboratory, Centre for Communications Research, United Kingdom

Prof. Hugo Enrique Hernandez Figueroa, Universidade Estadual de Campinas, Faculdade de Engenharia Elétrica e de Computaçäo, Säo Paulo, and Prof. Carlos Henrique da Silva Santos, Instituto Federal de Educaçäo, Ciência e Tecnologia de Säo Paulo, Brazil

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

7.3.3. Participation In other International Programs

7.3.3.1. CNPq-Inria HOSCAR project

Participants: Reza Akbarinia [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Rossana Andrade [CSD/UFC], Hélène Barucq [MAGIQUE-3D project-team, Inria Bordeaux - Sud-Ouest], Alvaro Coutinho [COPPE/UFR], Julien Diaz [MAGIQUE-3D project-team, Inria Bordeaux - Sud-Ouest], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Antônio Tadeu Gomes [LNCC], Pedroedro Leite Da Silva Dias [LNCC, Coordinator of the project on the Brazilian side], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri [Coordinator of the project on the French side], Alexandre Madureira [LNCC], Nicolas Maillard [INF/UFRG], Florent Masseglia [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Marta Mattoso [COPPE/UFR], Philippe Navaux [INF/UFRG], Esther Pacitti [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Fabio Porto [LNCC], Bruno Raffin [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Pierre Ramet [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Jean-Louis Roch [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Patrick Valduriez [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Frédéric Valentin [LNCC].

Since July 2012, the team is coordinating the HOSCAR http://www-sop.inria.fr/hoscar Brazil-France collaborative project. he HOSCAR project is a CNPq - Inria collaborative project between Brazilian and French researchers, in the field of computational sciences. The project is also sponsored by the French Embassy in Brazil.

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models (Group 1), (ii) scientific data management (Group 2), and (iii) high-performance software systems (Group 3). Several Brazilian institutions are participating to the project among which: LNCC (Laboratório Nacional de Computaçäo Científica), COPPE/UFRJ (Instituto Alberto Luiz Coimbra de Pós-Graduaçäo e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), INF/UFRGS (Instituto de Informática, Universidade Federal do Rio Grande do Sul) and LIA/UFC (Laboratórios de Pesquisa em Ciência da Computaçäo Departamento de Computaçäo, Universidade Federal do Ceará). The French partners are research teams from several Inria research centers.

NANO-D Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

We have funding from the Rhone-Alpes region through an ARC6 grant for the development of parallel algorithms for adaptively restrained particle simulations. This grant is funding Krishna Kant Singh's PhD project.

8.2. National Initiatives

8.2.1. 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).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ADAPT

Type: ERC Starting Grant

Title: Theory and Algorithms for Adaptive Particle Simulation

Programm: FP7

Duration: September 2012 - August 2017

Coordinator: Inria

Inria contact: Stephane Redon

8.4. International Initiatives

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

8.4.1.1. PPI-3D

Title: Structure Meets Genomics

International Partner (Institution - Laboratory - Researcher):

Boston 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.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

- The Reiher group at ETH Zurich
- The Cherezov Lab, UCS USA
- The Katritch Lab, UCS USA
- ICS-5 FZJ Juelich, Juelich, Germany
- Laboratory for Advanced Studies of Membrane Proteins, MIPT, Moscow, Russia Laboratory of Structural Biology of G-protein Coupled Receptors, MIPT Moscow, Russia

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Aleksandr Katrutsa.

Subject: Convex relaxation for non-convex quadratic optimization problems with applications to side-chain prediction in protein structures.

Institution: MIPT Moscow, Russia.

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Emilie Neveu visited the Kozakov group at Stony Brook University, NY, USA for three weeks in November 2015.
- Alexandre Hoffmann visited the Kozakov group at Stony Brook University, NY, USA for two weeks in November 2015.

POEMS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- ANR project *METAMATH: modélisation mathématique et numérique pour la propagation des ondes en présence de métamatériaux.* Partners: EPI DEFI (Inria Saclay), IMATH-Université de Toulon, LJLL-Paris 6 University.
  Start : 12/01/2011, End : 11/30/2016. Administrator : Inria. Coordinator : Sonia Fliss.
- ANR project *CHROME: Chauffage , réflectométrie et Ondes pour les plasmas magnétiques*
  Partners: LJLL-Paris 6 University, Université de Lorraine
  Start : 10/01/2012, End : 10/01/2015 Administrator : Inria Coordinator for POEMS: Eliane Bécache
- ANR project *RAFFINE: Robustesse, Automatisation et Fiabilité des Formulations INtégrales en propagation d'ondes : Estimateurs a posteriori et adaptivité*
  Partners: EADS, IMACS, ONERA, Thales
  Start : January 2013. End : december 2016. Administrator : Inria. Coordinator: Marc Bonnet.
- ANR project *ARAMIS: Analyse de méthodes asymptotiques robustes pour la simulation numérique en mécaniques*
  Partners: Université de Pau, Université technologique de Compiègne
  Start : January 2013. End : December 2016. Administrator : Université de Pau. Participant for POEMS: 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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. 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.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Wilkins Aquino (Duke University)

Eric Chung (Chinese University of Hong Kong)

Bojan Guzina (University of Minnesota)

Sergei Nazarov (Saint-Petersburg University)

Jeronimo Rodriguez (University of Santiago de Compostela)

8.3.2. Participation In other International Programs

Groupement De Recherche Européen : GDRE-US

This European Research Network (GDRE) entitled *Wave Propagation in Complex Media for Quantitative and Non Destructive Evaluation* aims at giving opportunities for interactions between researchers on the occasion of informal meetings, workshops and colloquia, alternatively in France and in the UK. It linked groups of academics and researchers in Ultrasonic Wave Phenomena with each other, and with industrial research centres and companies. The teams involved focused particularly on the theoretical end of the research spectrum, and include mathematicians, physicists and engineers.

RAPSODI Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The PhD program of Ahmed Aït Hammou Oulhaj is partially supported (50%) by the Region Nord-Pas-de-Calais.

9.2. National Initiatives

9.2.1. ANR

C. Cancès is the coordinator of the ANR GEOPOR project. (https://www.ljll.math.upmc.fr/cances/ANR-GEOPOR/). 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

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 - December 2016.

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 gémométrique 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 - december 2016.

9.2.2. 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 behaviour 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.

9.2.3. PEPS égalité

I. Lacroix-Violet was the coordinator of the project *Theoretical and numerical study of the quantum Navier-Stokes system* supported by the Institute for Mathematical Sciences and Interaction (INSMI) of the French National Center for Research (CNRS) the in the framework of the PEPS égalité call for proposal. In this project, the members have considered the quantum Navier-Stokes equations with a linear density dependent viscosity from a numerical and a theoretical point of view. From a theoretical point of view, I. Lacroix-Violet, M. Gisclon and D. Bresch studied the limit of the system when the viscosity parameter tends to zero. This work is still en progress. From a numerical point of view, following the recent work of D. Bresch, F. Couderc, P. Noble et J.-P. Vila, I. Lacroix-Violet and A. Jüngel have tried to design some numerical methods for the simulation of the complete model.

Title: Theoretical and numerical study of the quantum Navier-Stokes system

Coordinator: I. Lacroix-Violet

Members-: M. Gisclon (Université Savoie Mont-Blanc) & A. Jüngel (Technische Universität Wien)

Duration: January 2015 June 2015

9.3. International Research Visitors

9.3.1. Visits of International Scientists

We have a long-time collaboration with Ansgar Jüngel’s research group from TU Wien. We hosted several PhD students during the last years and Ansgar Jüngel came for a one week research stay in 2015.

Patrick Dular from Liège University (Belgium) was invited in Lille from May, 15 to June, 15 on a Labex CEMPI support.

Ezzeddine Zahrouni from Nabeul University (Tunisia) was invited in Lille from Mai, 27 to Juin, 10 on a Lille University support.

9.3.2. Visits to International Teams

Thomas Rey visited Lorenzo Pareschi (March 9-14, 2015) and Giacomo Dimarco (June 23-27, 2015) in the Department of Mathematics and Computer Science of the University of Ferrara (Italy) to work on hyperbolic balance laws and on semi-lagrangian methods for the Boltzmann equation respectively.

APICS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Contract Provence Alpes Côte d'Azur (PACA) Region - Inria, BDO (no. 2014-05764) funding the research grant of C. Papageorgakis, see Sections 6.1.1 , 7.3 .

8.2. National Initiatives

8.2.1. 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 represent a perfect training ground to test, apply and adapt our work on matching problems (see Section 6.2).

8.2.2. 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 6.1 are instrumental for this purpose.

8.3. European Initiatives

8.3.1. 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.

8.4. International Initiatives

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

8.4.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

International Partner (Institution - Laboratory - Researcher):

MIT - Department of Earth, Atmospheric and Planetary Sciences (United States) - Benjamin Weiss

Start year: 2013
See also: http://www-sop.inria.fr/apics/IMPINGE/
The purpose of the associate team IMPINGE is to develop efficient algorithms to recover the magnetization distribution of rock slabs from measurements of the magnetic field above the slab using a SQUID microscope (developed at MIT). The US team also involves a group of Mathematicians at Vanderbilt Univ.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria 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).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Andrea Gombani (IEIIT-CNR, Padova, Italy, February 16-27).
- Michael Northington (Vanderbilt University, Nashville, Tennessee, USA, July 21-30).
- Vladimir Peller (Michigan State Univ., East Lansing, USA, September 2-30).
- Eduardo Lima (MIT, Boston, Massachusetts, USA, September 6-12).
- Isabella Sanders (MIT, Boston, Massachusetts, USA, September 6-12).

8.5.1.1. Internships

- Konstantinos Mavreas, Master 2 Computational Biology - UNSA (5 months), Dipole localization in Moon rocks from sparse magnetic data.

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

L. Baratchart was a visiting scientist at Indiana University-Purdue University at Indianapolis (IUPUI), November 2015.

8.6. 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), 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, 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 (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

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project eBacuss from the Persyval Labex, with C. Prieur (GIPSA Lab), B. Bidegarray (LJK Grenoble), L. Fesquet (TIMA Grenoble).

8.2. National Initiatives

8.2.1. ANR

- CHASLIM Chattering Free Sliding Mode Control: ANR BLAN 2011 BS03 007 01 (octobre 2011–octobre 2015), coordinator B. Brogliato.
- SLOFADYBIO Slow-fast dynamics applied to the biosciences (january 2015 – december 2016), coordinateur: Mathieu Desroches (Inria Rocquencourt).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. GEM

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

Programm: H2020

Type: ERC

Duration: September 2015 - September 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.

8.3.1.2. COMANOID

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - January 2019

Coordinator: CNRS (Lirmm)

Partners:

Airbus Groups (France)

Centre national de la recherche scientifique (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

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.

8.4. International Initiatives

8.4.1. Inria International Labs

Vincent Acary is on leave at Inria Chile from September 2014 to August 2016.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

We lead collaborations with several foreigh colleagues:

- Prof. Ryo Kikuuwe from Kyushu University, Japan.
- Prof. C. Liu from Peking University (PKU), Beijing, China [34].
- Prof. Thorsten Schindler from Munich Technical University.
- Prof. Nathan Krislock from North Illinois University [51].
- Prof. Yuli Starosvetsky, Technion Israel Institute of Technology.

8.4.3. Participation In other International Programs

Y. Starosvetsky (Technion, PI) and G. James (Co-PI) have been awarded a grant from the Pazi Foundation (Israel) on a 4-years project (2015-19) entitled *Experimental, computational and analytical study of wave propagation in 1D and 2D granular crystals mounted on the non-uniform elastic foundation with spatially and temporarily varying properties*.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Professor Ryo Kikuuwe from Kyushu University (Japan) visited BIPOP from 01 September 2014 to 31 March 2016.
- Professor Nathan Krislock from North Illinois University visited BIPOP in June/July 2015.

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

Acary Vincent

Date: Sep 2014 - Aug 2016

Institution: CMM (Chile)

COMMANDS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Axel Kröner, Frederic Bonnans: "Optimal control of partial differential equations using parameterizing manifolds, model reduction, and dynamic programming". Foundation Mathematique Jacques Hadamard/PGMO

9.2. International Initiatives

9.2.1. Inria International Labs

Participation to the Inria Chile laboratory.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

9.3.1.1. Internships

- Justina Jianatti (PhD student, U. Rosario, Argentina). Numerical algorithms for stochastic control problems. Supervised by F. Bonnans.
- Mandy Huo (now PhD at Caltech, USA): International internship of École Polytechnique on aspects of optimal control of bilinear equation. Supervised by A. Kroener.

9.3.2. Visits to International Teams

9.3.2.1. Explorer programme

Kröner Axel

Date: Jul 2015 - Aug 2015

Institution: University of California, Los Angeles (United States)

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

9.2. National Initiatives

9.2.1. ANR

An ANR Blanc SIMI 3 *Multidimensional Systems: Digression On Stabilities* (MSDOS) has started at the beginning of 2014. Its main goal is to constructively study stabilities and stabilization problems of (nonlinear) multidimensional systems. For more details, see http://www.lias-lab.fr/perso/nimayeganefar/doku.php. Alban Quadrat is the local leader for Inria Saclay.

9.2.2. Industrial-Academic Institute

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

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Sorin Olaru is coordinator of the European project FUTURUSM in the IEF scheme (Dr. Vasso Reppa as postdoctoral fellow).

Sorin Olaru is Principal investigator of the TEMPO ITN (Mohammed Laraba, Rajesh Koduri and Iris Ballesteros as PhD students financed by this training network within L2S).

9.3.2. Collaborations in European Programs, except FP7 & H2020

Program: GDRI (European research network founded by CNRS)

Project acronym: DelSys

Project title: Delay Systems

Duration: 2011-2015

Coordinator: Silviu Iulian Niculescu

Other partners: GIPSA-Lab and LAAS France, Ancona University Italy, Czech Technical University in Prague Czech Republic, Kent University Great-Britain, KTH Stockholm Sweden and KU Leuven Belgium.

Abstract: the aim of this GDRI is to bring together the main European teams which work in the fiels of Delay systems. This network meets once a year.

9.3.3. Collaborations with Major European Organizations

University of l'Aquila, Department of Electrical and Information Engineering (Italy)

Study of nonlinear systems with delay, (notably differential equations interconnected with difference equations) via Lyapunov-Krasovskii functionals.

Tel Aviv University, (Israel)

Stability analysis of nonlinear Partial Differential Equations, construction of observers (continuous/discrete obsevers for systems with delay, observers with convergence in finite time).

9.4. International Initiatives

Sorin Olaru is member of the LIA between several universities in Montreal Canada and Laboratoire des Signaux et Systèmes (L2S).

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- Kyushu Institute of Technology, Iizuka, Fukuoka and University of Kyoto, Kyoto, Japan.
- Louisiana State University, Baton Rouge, USA
- School of Electrical Engineering at the Tel-Aviv University
- Unicamp, Campinas, Brazil
- The University of Texas at Austn, Dept. of Aerospace Engineering & Engineering Mechanics
- University of Leeds, UK

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- S. Boatto, Feder. University Rio de Janeiro, Brazil, 20/06-07/10.
- G. Bitsoris, Univ of Patras, Greece.
- A. Fioravanti, UNICAMP Campinas, Brazil, 24/05-10/06.
- E. Fridman, University of Tel-Aviv, IsraÃ«l, 07/07-13/07.
- M. Hovd, NTNU Trondheim, 01/09-31/12.
- Y. Yamamoto, University of Kyoto, Japan, 03/09-11/11.

9.5.1.1. Internships

- Licence: Q. Renvoise, *Lemme de perturbation homologique et ses applications en théorie du contrôle*, 03-06, Ecole Normale Supérieure de Rennes. Supervisor: A. Quadrat.
- Master 2: Liu Xuemin, *control of models of bioreactors with delay and piecewise constant feedbacks*, University Paris-Sud/CentraleSupelec. Financial support: iCODE. Supervisor : Frédéric Mazenc.

GECO Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Project *Stabilité des systèmes à excitation persistante*, Program MathIng, Labex LMH, 2013-2016. This project is about different stability properties for systems whose damping is intermittently activated. The coordinator is Mario Sigalotti. The other members are Yacine Chitour and Guilherme Mazanti.
- iCODE is the Institute for Control and Decision of the Idex Paris Saclay. It was launched in March 2014 for two years until June 2016. We are involved in three actions funded by iCODE:
  - one action on control of quantum systems, in collaboration with Nicoals Boulant of Neurospin. The action is coordinated by Ugo Boscain;
  - one action on control of wave propagation on networks. The action is coordinated by Mario Sigalotti;
  - one action on switched system. The action is coordinated by Marianne Akian (and handled by MAXPLUS).
- Starting from the end of 2015, we obtained a grant by PGMO (Gaspard Monge Program for Optimisation and operational research) on Geometric Optimal Control. The grant duration is one year and is renewable for up to three years. The grant is coordinated by Luca Rizzi and Mario Sigalotti.

7.2. National Initiatives

7.2.1. 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.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

Program: ERC Starting Grant

Project acronym: GeCoMethods

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

Duration: 1/5/2010 - 1/5/2015

Coordinator: Ugo Boscain

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

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

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

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

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

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

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

7.4.2. Participation In other International Programs

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

I4S Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MAG2C-Pont Tabarly

Participant: Ivan Guéguen.

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.

The instrumentation auscultates globally the structure, a structural defect in a given location changes its modal parameters and thus the vibration behavior. Then it can be detected on any part of the structure with an accelerometer. These measures coupled with a wireless data transmission system type or wifi 3g will allow remote monitoring of the evolution of the structure. And where appropriate, to deploy when necessary, for maintenance. The different objectives are

- Experimentation on a bridge
- Equipment qualification in real conditions over the long term
- Apply different vibration processing algorithms
- Surveillance and Detection
- Measurement database

The instrument proposed is based on an accelerometer-based distributed network on the structure. This assembly is connected to a data acquisition system and a modem 3g for continuous measurements and remotely. The vibration will be collectable on the internet.

9.1.2. Project wind turbine in St Hilaire de Chaleon

Participant: Ivan Guéguen.

Type: GIS

Objectif: bridge instrumentation

Duration: Since 2014

Coordinator : LIRGEC

Partners: IFSTTAR

Inria contact: Ivan Guéguen

Abstract: The project deals with the instrumentation of the wind turbine.

The aim is firstly, to instrument the foundation before casting with continuous optical fibers, optical strain gauges, temperature sensors and accelerometers for a detailed analysis of the behavior of the founding quasi static and dynamic. In a second time to instrument the mast with accelerometers to the study by SSI under ambient vibration method. All of which should help better understand the global behavior of the structure.

9.1.3. Collaboration with GEM

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

Md Delwar Hossain Bhuyan has started a PhD on Damage localisation on offshore platforms, The thesis is co-directed by L. Mevel and F. Schoefs from GEM, Nantes, with supervision shared with M. Doehler and Y. Lecieux from GEM. It is funded by the Brittany region for 3 years.

9.2. National Initiatives

9.2.1. High speed rail track Instrumentation

Participant: Ivan Guéguen.

Type: IRT

Objectif: bridge 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

The instrumentation will include: A Weather station measures environmental conditions (temperature, precipitation on the site). Accelerometers, to monitor the dynamic behavior of the track, with measures at several levels: the hammer beams on top of the grave-bitumen layer, on top of the soil. These measures will include acceleration compare the dynamic response of a section with and without GB. Instrumentation of severe bitumen strain gauges for measuring the longitudinal and transverse tensile strains at the base of the UK, and temperature probes (top and bottom layer). This instrumentation will estimate the fatigue life of the GB, temperature changes in this layer, and will calculate a temperature equivalent to the layer of GB. Instrumentation subgrade by means of measurement gauges at the top of the vertical deformation of the soil, and TDR probes to measure changes in water content. Its objective is to measure the levels of distortion in the upper part of the soil, and their variations, in conjunction with the seasonal variations in water content. An anchored sensor, measuring the total deflection between the top of the GB and a reference point that is 4 m deep. This sensor will measure the total displacement of the structure beneath the ballast (GB + layer of granular soil leveling + support). These will also serve as a reference for comparison with the movements deducted from accelerometer measurements. Continuous optical fiber, to measure static permanent deformation in the transverse direction over the entire width of the structure at the base of the sub-layer. These optical fibers used to monitor deformation obtained following the transverse profile in the game with underlay in the UK (in ballast) and the part with underlay GNT (Differential settlement, appearance of a crack ...).

9.2.2. REPTILES

Participant: Jean Dumoulin.

Type: FUI

Objectif: Innovation for rehabilitation of potable water tubes

Duration: Since 11/2012

Coordinator: FREYSSINET

Inria contact: J. Dumoulin

Since 2012, within FUI Reptiles, J. Dumoulin was coordinator of the conception, study and development of a thermoplastic composite assembly system for water tubes reenforcement. Moreover, infrared thermography was used for active control. [37]

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. [43], [27] (http://sense-city.ifsttar.fr/)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Built to Specifications (Built2Spec)

Participants: Jean Dumoulin, Alexandre Nassiopoulos, Jordan Brouns.

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 a Horizon 2020 EU-funded project involving 20 European partners that seeks to reduce the gap between a building's designed and as-built energy performance. To do this, the project will put a new set of breakthrough technological advances for self-inspection checks and quality assurance measures into the hands of construction professionals. This collection of smart tools will help building stakeholders at all levels in meeting EU energy efficiency targets, new build standards and related policy goals.
Built2Spec will deliver a new set of tools:

- 3D and Imagery Tools
- Building Information Modelling (BIM)
- Smart Building Components
- Energy Efficiency Quality Checks
- Indoor Air Quality Tools
- Airtightness Test Tools with Air-pulse Checks
- Thermal Imaging Tools
- Acoustic Tools

All connected to a Virtual Construction Management Platform supporting the collection and sharing of all project data, from initial design to the delivery. During the project, this platform will be integrated into the operations of small and medium-sized enterprise (SME) contractors, large construction firms and end user clients directly within the consortium and work program activities, assuring systematic and scientific performance measures, feedback and powerful exploitation.

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. Collaboration with BAM, Berlin

Participants: Laurent Mevel, Michael Doehler, Eva Viefhues.

Eva Viefhues is currently student in BAM, Berlin. a PhD will start in 2016. Michael Doehler has visited a few times BAM in 2015 to prepare and plan the PhD.

9.3.2.2. Collaboration with CNR-IREA, Italy

Participants: Jean Dumoulin, Nicolas Le Touz.

This internship aims to identify defects in the interior walls, using thermal and electromagnetic reconstruction method, developed by IFSTTAR (in Bouguenais) for thermal and CNR-IREA (in Naples) for electromagnetism.

First, we make a numerical study for the two direct problems, with the resolution of the heat equation with finite elements, allowing a detailed study of how is made the assembly of matrices for a problem in two or three dimensions. A study of Maxwell's equations solving by using a centered finite difference method is also conducted for the direct problem of electromagnetism.

We also study the resolution of these inverse problems, in particular with the calculation of a functional gradient using the adjoint method for the thermal reconstruction, what allows the resolution of the problem with the Levenberg-Marquardt algorithm, and a study of the Born model for the electromagnetism problem.

Applications to the reconstructions of various types of defects are then lead. These different situations allow to highlight the stimuli, thermal of electrical, to bring to the system so that the reconstruction is made correctly. We could thus reconstruct defects in domains of various dimensions with thermal or electromagnetism highlighting the electrical (conductivity, permittivity and permeability), thermal (effusivity) and mathematical parameters (regularization terms) playing on the fidelity of the reconstruction.

A coupling of these two reconstruction methods is then carried out to improve the fidelity of the reconstructions realized with only one of these two methods. In the case of this coupling, the reconstruction get with GPR data provides a priori information to the thermal inverse problem allowing to get a better location of the defects.

9.3.2.3. 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.

9.3.2.4. MODRIO

Participants: Qinghua Zhang, Liangquan Zhang.

Type: ITEA2

Defi: Model Driven Physical Systems Operation

Objectif: To meet the evermore stringent safety and environmental regulations for power plants and transportation vehicles, system operators need new techniques to improve system diagnosis and operation.

Duration: June 2012 to November 2015

Coordinator: Daniel Bouskela (EDF)

Inria teams PARKAS, HYCOMS, I4S

Inria contact: B. Caillaud

Abstract: Open standards are necessary for different teams to cooperate by sharing compatible information and data. To meet the evermore stringent safety and environmental regulations for power plants and transportation vehicles, system operators need new techniques to improve system diagnosis and operation. Open standards are necessary for different teams to cooperate by sharing compatible information and data. The objective of the MODRIO project is to extend modeling and simulation tools based on open standards from system design to system diagnosis and operation. This project joined by partners from Austria, Belgium, Finland, France, Germany, Italy and Sweden has been selected by the board of Information Technology for European Advancement (ITEA 2). The involved Inria project-teams are PARKAS, HYCOMES and I4S. This project is funded from June 2012 to November 2015.

9.3.2.5. 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 technologies and structural performance".

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: This COST Action enhances the benefit of Structural Health Monitoring (SHM) by novel utilization of applied decision analysis on how to assess the value of SHM - even before it is implemented. This improves decision basis for design, operation and life-cycle integrity management of structures and facilitates more cost efficient, reliable and safe strategies for maintaining and developing the built environment to the benefit of society. SHM is increasingly applied for collecting information on loads and aggressive environments acting on structures, structural performances, deterioration processes and changes in the use of structures. However, there is an urgent need to establish a better understanding of the value of SHM before its implementation, together with practically applicable methods and tools for its quantification. This Action thus 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. The COST Action will be conducted with the support of the Joint Committee on Structural Safety (JCSS). The networks of researchers and industries established during COST Actions TU0601, C26, E55 and E24, the EU FP7 project IRIS, the Marie Curie Network SmartEn and the JCSS will ensure visibility, impact and dissemination.

9.4. International Initiatives

9.4.1. Collaboration with British Columbia University, Canada

Participants: Laurent Mevel, Michael Doehler, Saeid Allahdadian.

Saeid Allahdadian is currently 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 starting in 2016 for 3 years.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

S. Allahdadian from British Columbia University has visited us for a week in 2015.

Maxplus Team

9. Partnerships and Cooperations

9.1. Actions nationales/National Initiatives

9.1.1. ANR

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

9.1.2. Programme Gaspard Monge pour l'Optimisation

- Projet intitulé "Méthodes tropicales pour l'optimisation", responsable X. Allamigeon, faisant intervenir M. Akian, V. Boeuf, S. Gaubert, A.Hochart, R. Katz, et M. Skomra.
- Participation de Marianne Akian et Stéphane Gaubert au projet "STORY: Stochastic and Robust Optimization Network and Teaching", responsables: Laurent El Ghaoui (UC Berkeley) et Michel De Lara(CERMICS).

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

Projet "blanc" intitulé "Stabilité et stabilisation des systèmes commutés" (Oct. 2014-fin 2015), faisant intervenir M. Akian, X. Allamigeon, S. Gaubert, et des membres de EPI Geco, L2S, LIX, LSV (ENS Cachan), UVSQ.

9.2. Actions internationales/International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

Collaborations régulières dans le cadre des programmes internationaux ci-dessous, ainsi qu'avec:

- Michael Joswig (TU-Berlin), invité 3 mois en 2015 sur un poste rouge du CNRS.
- Ricardo Katz (Conicet et Cifasis, Argentine);
- Alexander Guterman (Moscow State University);
- Françoise Tisseur (Université de Manchester) qui participe à l'encadrement de la thèse d'Andrea Marchesini.

9.3. Accueils de chercheurs étrangers/International Research Visitors

9.3.1. Chercheurs étrangers/Visits of International Scientists

- Bas Lemmens (Univ. of Kent), 2 jours en mars.
- Brian Lins (Hampden-Sydney College), 2 jours en mars.
- Vassili Kolokoltsov (Warwick Univ.), 4 jours en juillet autour de SIAM CT.
- Visites d'un jour de Peter Butkovic (Univ. of Birmingham), Paul Van Dooren (Univ. Catholique de Louvain) et Francçoise Tisseur (Univ. of Manchester) en décembre (autour de la soutenance de thèse d'Andrea Marchesini).

9.3.2. Séjours à l'étranger/Visits to International Teams

9.3.2.1. Research stays abroad

- M. Akian, 1 semaine à Univ. of Bar Ilan en juin.
- A. Niv, 1 week in Birmingham (visit of P. Butkovic and S. Sergeev) in March 2015, few days in Aberdeen (visit of Z. Izhakian) in April 2015, and 2 weeks in Bar-Ilan Univ. (visit of L. Rowen and R. Adin) in June 2015.

MCTAO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- The "région" *Provence Alpes Côte d'Azur* (PACA) partially supports Helen Heninger's PhD . The other part comes from Thales Alenia space, see section 7.1 .
- The "région" *Provence Alpes Côte d'Azur* (PACA) partially supports Jérémy Rouot's PhD.

8.2. National Initiatives

8.2.1. ANR

Weak KAM beyond Hamilton-Jacobi (WKBHJ). Started march, 2013, duration: 4 years. Ludovic Rifford is in the scientific comitee.

Géométrie et transport optimal de mesure (GMT). Ludovic Rifford is a member.

8.2.2. Others

Bernard Bonnard and Ludovic Rifford participate in the GDR MOA, a CNRS network on Mathematics of Optimization and Applications. http://gdrmoa.univ-perp.fr/.

Jean-Baptiste Caillau is in the board of governors of the group SMAI-MODE (http://smai.emath.fr/spip.php?article338).

Jean-Baptiste Caillau is a member of the Centre de Compétences Techniques (CCT) Mécanique orbitale du CNES

Jean-Baptiste Caillau is the corresponding member in Dijon for the Labex AMIES (http://www.agence-maths-entreprises.fr/).

8.3. European Initiatives

8.3.1. ANR/DFG franco-german project

Exploring the physical limits of spin systems: A challenge in medical imaging (Explosys). Started October, 2014, duration: 4 years.

Bernard Bonnard is a member of this project. The coordinators are Dominique Sugny (Dijon) and Stefen Glaser (Munich). The budget is approximately 500 K€.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Velimir Jurdjevic (University of Toronto), 1 month, September-October, 2015.

8.4.2. Visits to International Teams

Ludovic Rifford stayed at Center for Mathematical Modeling, Universidad de Chile, Santiago (Chili), 6 months in March-August, 2015.

NECS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PEPS META-TRAM

META-TRAM is a PEPS-CNRS project funded for two years (2013-2015). It aims at studying tensor methods for analyzing traffic data. Indeed, for a better management of mobility in modern cities (avoid or better control episodes of congestion, accurately predict traffic trends, finely analyze urban and suburban trips via multimodal networks), it is necessary to develop appropriate analytic tools that integrate multimodality and heterogeneity of networks from inherently multidimensional measures. Three areas are studied: tensor modeling for estimating origin-destination matrices, dynamic clustering flow and synthesis of distributed algorithms adapted to large volume of data, diversity of sensors, and their spatial dispersion. This project involves also I3S Lab (Sophia Antipolis) and CRAN (Nancy).

9.1.2. Projet exploratoire Persyval LOCATE-ME

LOCATE-ME (LOcalization teChniques for pedestriAn navigaTion based on inErtial MEasurements in indoor environments) is a Persyval project funded from April 2014 to August 2015. It aims at proposing a new and fresh look on innovative technologies for localization. It constructs the scientific foundations for development of a prototype of a pedestrian indoor localization system, which has the ability to monitor and track the positions of pedestrians in an indoor environment, where GPS is not available. LOCATE-ME brings some answers on how to advance the current pedestrian navigation solutions for the critical domains, using robust software. The specific contribution of LOCATE-ME is the development of a novel fusion algorithm merging two different methods of localization (INS and SHS) to obtain a concrete improvement on tracking position. This project involves also Tyrex team (LIG, Inria Grenoble). The collaboration has also included a visit to Grenoble of Valérie Renaudin (IFSTTAR, Nantes), in March 2015.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. 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

9.3. International Initiatives

9.3.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

9.3.1.1. COMFORT

Title: COntrol and FOrecasting in Transportation networks

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Mechanical Engineering - Roberto Horowitz

Start year: 2014

See also: http://necs.inrialpes.fr/v2/pages/comfort/EA_homepage_COMFORT.html

COMFORT addresses open issues for Intelligent Transportation Systems (ITS). The goal of these systems is to use information technologies (sensing, signal processing, machine learning, communications, and control) to improve traffic flow, as well as enhance the safety and comfort of drivers. It has been established over the past several decades, through field studies and many scholarly publications, that the tools of ITS can significantly improve the flow of traffic on congested freeways and streets. Traffic operators can manage the system in a top-down fashion, for example, by changing the speed limit on a freeway, or by controlling the flow on the onramps (ramp metering). Individual drivers can also affect traffic conditions from the bottom up, by making decisions based on reliable predictions. These predictions must be provided by a centralized system that can evaluate the decisions based on global information and sophisticate modeling techniques. It is now crucial to develop efficient algorithms for control and prediction that are well adapted to current and emerging sensing and communication technologies. The areas of traffic modeling and calibration, state estimation, and traffic control remain central to this effort. Specifically, COMFORT addresses issues related to model validation and development of new traffic forecasting and distributed control algorithms. The efficiency of the derived methods will be assessed using large networks simulators and real data obtained from the Californian and the Grenoble's testbed.

9.3.2. Participation In other International Programs

9.3.2.1. 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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Prof. Subrhakanty Dey (University of Uppsala, Sweden) visited the team from June 6th to July 7th, for reserach discussions, in particular with F. Garin and A. Kibangou on privacy issues in cyber-physical systems.
- Prof. Gerhard Hancke (Dept of Electrical, Electronic and Computer Engineering, University of Pretoria, South Africa) visited the team and the Doctoral college of UGA in order to set up student exchange program in July 2015.
- Prof. Paolo Frasca (University of Twente, Enschede, The Netherlands) visited the team for two weeks in October, for research discussions with team members, and in particular with C. Canudas de Wit on open problems in social dynamics related to traffic drivers.
- Prof. Joao Cesar Moura Mota (Universidade Federal do Ceara, Brazil) visited the team in December 2015 within the framework of the French-Brazilian CAPES-COFECUB project TICO-MED.

9.4.1.1. Internships

- Tomas Manuel Pippia from University of Pavia, Italy, made his reserach internship for his master thesis in the team, from March to July.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

- A. Kibangou visited UC Berkeley during the BIS workshop (Berkeley-Inria-Stanford, May 12-15). During this stay, A. Kibangou participated as a member for the panel dedicated to Urban mobility. He had discussions with G. GOMES (UC Berkeley) on different topics about traffic including flow prediction and interfacing traffic micro-simulator such as AIMSUM with Matlab.
- C. Canudas de Wit visited UC Berkeley for a week in October. He had research meetings with faculty and students at ITS an PATH, and in particular with prof. Horowitz and dr. Gomes. On Oct 23rd he gave an invited lecture at Institute of Tranpsortation Studies (ITS) and the Transportation Program of the Civil and Enviromental Engineering Department at the University of California, Berkeley, in the ITS tranpsortation seminar program.
- Various team members attended the IPAM Long Program New Directions in Mathematical Approaches for Traffic Flow Management (http://www.ipam.ucla.edu/programs/long-programs/new-directions-in-mathematical-approaches-for-traffic-flow-management), at UCLA, Los Angeles. IPAM long programs are a collection of one-week workshops, intertwined with study periods, where participants are encouraged to pursue their own research while interacting with other participants.
  - A. Ladino, 26 Sept. to 24 Oct. (Workshops I Mathematical Foundations of Traffic and II Traffic Estimation, and a study period)
  - P. Grandinetti, 25 Oct. to 20 Nov. (Workshops III Traffic Control and IV Decision Support for Traffic, and a study period)
  - C. Canudas de Wit, Oct. 10-16 and 25-31 (Workshops II Traffic Estimation and III Traffic Control)
  - F. Garin, Oct. 25-30 (Workshop III Traffic Control)

NON-A Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project ARCIR «Estimation distribuée de systèmes dynamiques en réseaux», coordinator Prof. Mihaly Petreczky, URIA – Mines de Douai, 2013–2015
- CPER CIA, "Internet of Things", 2011–2015
- CPER CISIT (becoming ELSAT 2020 in 2015), "Campus international sur la securite et intermodalite de transport", project "CONTRAERO" with LML and IEMN, 2011–2015 (becoming CONTRATECH 2016-2020 with LML, IEMN, LAMIH and ONERA)

8.2. National Initiatives

- ANR project Finite4SoS (Finite time control and estimation for Systems of Systems), coordinator Prof. Wilfrid Perruquetti (NON-A team, Inria): 2015-2020
- ANR project WaQMoS (Coastal waters quality surveillance using bivalve mollusk-based sensors), coordinator Dr. Denis Efimov (NON-A team, Inria): 2015-2020
- ANR project TourboTouch (High-performance touch interactions), coordinator Prof. Géry Casiez (MJOLNIR team, Inria): 2014-2019
- ANR project ChaSliM (Chattering-free Sliding Modes), coordinator Prof. B. Brogliato (BIBOP team, Inria): 2012-2015
- ANR project ROCC-SYS (Robust Control of Cyber-Physical Systems), coordinator Dr. L. Hetel: 2013-2018
- ANR project MSDOC (Multidimentional System: Digression od Stability), coordinator Bachelier Olivier (Poitiers University) : 2014-2017
- 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).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

- UCoCoS "Understanding and Controling Complex Systems", European Joint Doctorate, starting from April 2016, partners KU Leuven (Belgium), TU/e (Netherlands) and Centrale Lille (France).

8.4. International Initiatives

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

- Associate team with Norwegian University of Science and Technology (Tronheim, Norway) and UMEA university (Sweden), 2013-2016
  Subject: “Dynamical precision improvement for industrial robots”

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

- Tel Aviv University, Israel
- Sliding Mode Control Lab., UNAM, Mexico
- Department Control Automatico, CINVESTAV-IPN, Mexico
- National Polytechnic Institute, Mexico
- Department of Control Systems and Informatics, Saint Petersburg State University of Information Technologies Mechanics and Optics (ITMO), Russia

8.4.3. Participation In other International Programs

- CNRS GDRI DelSys (http://www.cnrs.fr/ins2i/spip.php?article1799)

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Professor Arie Levant, Tel Aviv University, Israel (Inria, 4 months)
- Professor Emilia Fridman, Tel Aviv University, Israel (Ecole Centrale de Lille, 1 month)
- Dr. Francisco Bejarano, National Polytechnic Institute, Mexico (Ecole Centrale de Lille, 1 month)

8.5.1.1. Internships

- Ivan De Jesus Salgado Ramos, National Polytechnic Institute, Mexico, till Apr 2015
  Subject:PID control design based on the different differentiation techniques

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Gang Zheng, 2 months visit to Nanjing University of Sicence and Technology

QUANTIC Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Emergences-Ville de Paris program, QuMotel project

This project, entitled "Quantum memory for microwaves: towards quantum error correction and quantum state teleportation" and led by François Mallet, started on september 2013 and will run till september 2016. It is composed of the members of the QUANTIC project-team. In this project we plan to develop a decoherence free quantum memory with the tools of circuit quantum electrodynamics. This crucial device is still missing in any implementations of quantum information processing. It aims at capturing, in an efficient manner, the quantum information encoded by flying photons, protect this information over long times, and release it on demand towards a desired channel. The realization of this memory is based on a high quality factor cavity connected to a superconducting circuit performing three-wave mixing. We will entangle the memory state with a propagating microwave signal, then use it to perform quantum teleportation from one memory to another, generate Schrödinger cat states in the memory and realize quantum error correction protocols in order to stabilize a cat state in the memory for an arbitrary time.

7.1.2. PSL structuring project TOCOSUQI*

In the framework of the creation of the QUANTIC project-team, we have benefited from a 2-year PSL* funding from september 2013 to August 2015. The PSL* project TOCOSUQI (Tools of the control of superconducting quantum circuits) aims at developing new system theory tools for preparing, manipulating and protecting non-classical states of a microwave field in the framework of quantum Josephson circuits and circuit quantum electrodynamics, and applying them directly in the experiments. This project was led by Benjamin Huard.

7.2. National Initiatives

7.2.1. ANR project GEARED

This three-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 and Benjamin Huard (QUANTIC project-team), 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 TIQS

This three-year young researcher ANR project, entitled "Thermodynamics of quantum information with superconducting circuits" and led by Benjamin Huard was run between September 2012 and August 2015. We realized two versions of Maxwell's demon either classical or quantum, and based on superconducting circuits. This opens the way to different types of thermal machines in the quantum regime. In addition, we developed the best amplifier that is non-degenerate at radiofrequency in terms of noise and bandwidth. Finally, we have demonstrated experimentally the duality between preparation and post-selection in quantum mechanics.

7.2.3. ANR project EMAQS

Pierre Rouchon is a participant to this "Projet Blanc" entitled "Evaluation and Manipulation At Quantum Scale" EMAQS. This 4-year project started on January 2012. The participants of the project are Karine Beauchard (coordinator, ENS-Rennes), Vahagn Nersesyan and Jean-Pierre Puel (univ. Versailles), Gabriel Turinici and Julien Salomon (univ. Paris-Dauphine), Grigoriu Andrea and Yvon Maday (univ Pierre et Marie Curie), Michel Brune (College de France) and Claude Le Bris (Ecole des Ponts, Matherials project-team). The project is based on 3 thematic axis: open loop control, feedback stabilization and estimation with a specific effort towards quantum systems of infinite dimension and/or subject to decoherence.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Partner 1: University of Padova

Alain Sarlette has been pursued a fruitful collaboration with the group of Francesco Ticozzi on “dynamical systems aspects of quantum systems”. A novel line of work in the direction of quantum thermalization and quantum random walks has been explored, in the framework of the PhD of S. Apers (Ghent University) supervised by A. Sarlette. Further joint work for the future is planned about among others generalized Markovian feedback and, reservoir engineering, and linear Lyapunov functions for quantum systems. F. Ticozzi has visited us for one week.

Partner 2: Ghent University.

A. Sarlette is collaborating with applied mathematicians interested in quantum control at UGent (Dirk Aeyels, Lode Wylleman, Gert De Cooman) in the framework of thesis co-supervisions. One PhD student is co-supervised with Dirk Aeyels in the framework of Belgian Inter-University Attraction Poles “Dynamical Systems, Control and Optimization” network 2013-2017. A second PhD student is also co-supervised with Dirk Aeyels in the framework of Chinese Scholarship Council and Flanders Research Fund grant “Developing control mechanisms to counter biases and drifts in coordination”, 2013-2016. Finally, benefiting from a UGent starting grant on “Coordination control algorithms inspired from nonlinear PDEs and lattices”, 2013-2017, Alain Sarlette also supervises a third PhD student at Ghent University.

Partner 3: University of Liverpool.

P. Rouchon is collaborating with Jason Ralph from the Department of Electrical Engineering and Electronics at the University of Liverpool on the numerical schemes for efficient quantum filtering in real-time feedback strategies. These collaborations have recently led to a publication in Physical Review A [23].

7.4. International Initiatives

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

Pierre Rouchon is a participant to the Inria associate Team CDSS with principal Inria investigator, François Dufour of the Inria Team Project CQFD on the topic "Control of dynamic systems subject to stochastic jumps".

7.4.2. Inria International Partners

7.4.2.1. Informal International Partners

Partner 1: University of Yale

The long-term collaborations with the teams of Michel H. Devoret, Robert J. Schoelkopf, Liang Jiang and Steven M. Girvin, enforced through a two year sabbatical visit of Mazyar Mirrahimi at Yale university, have led to a set of contributions ranging from the theoretical analysis and performance optimization of ongoing experiments on weak quantum measurements [74] and preparation of non-classical field states through single photon Kerr effect [77] to the design of new experiments on single qubit cooling [69] and stabilization of maximally entangled states of superconducting qubits [8] by reservoir engineering techniques. Through these collaborations, Zaki Leghtas and Mazyar Mirrahimi have introduced a new direction for hardware-efficient universal quantum computation [84], [93]. These theoretical proposals have already led to groundbreaking experiments [10], [9], [4]. We are intending to formalize these collaborations through the creation of an Inria associated team in the framework of Inria@EastCoast program.

Partner 2: University of SaoPaulo and Federal University of Santa Catarina

Pierre Rouchon is collaborating with P. S. Pereira da Silva (Escola Politécnica – PTC, University of SaoPaulo, Brazil) and H. B. Silveira Federal (University of Santa Catarina (UFSC), Florianópolis, Brazil) on the system theory problems behind the experiment on the feedback stabilization of the photon box. These collaborations have recently led to a publication in IEEE Conference on Decision and Control [33].

7.5. International Research Visitors

7.5.1. Visits to International Teams

7.5.1.1. Research stays abroad

Mazyar Mirrahimi spent four months in the Quantronics Laboratory of Michel H. Devoret and in the Rob Schoelkopf Lab at Yale University. In this framework Joachim Cohen also spent three months in the same group. Finally, Nicolas Didier also spent two weeks at Yale University and two weeks at the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara.

SPHINX Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- David Dos Santos Ferreira is the coordinator (PI) of a Young Researcher Programme of the French National Research Agency (ANR) :
  Project Acronym : iproblems
  Project Title : Inverse Problems
  Duration : 48 months (2013-2017)
  Abstract: Inverse problems is a field in full expansion as shown by the numerous resident programs hosted in the different research institutes throughout the world, several striking breakthroughs achieved in the recent years and the flow of PhD students attracted by the subject. Strong groups and schools have appeared in Finland, the United States and Japan. In spite of its history in Analysis and Partial differential equations (in particular in microlocal analysis and control theory, both fields having strong interactions with Inverse Problems), the emergence of an organised group of mathematicians interested in the theoretical aspects of inverse problems has not yet occured in France. The ambition of this proposal is to structure a core of analysts with a strong interest in this field, to help them investigate several central questions related to geometric and analytic inverse problems, and to favor interactions between them, as well as with foreign partners and experts in the field.
  Inverse problems deal with the recovery of an unknown quantity, typically a coefficient in a partial differential equation, from knowledge of specific measurements, for instance the Cauchy data on the solutions of the given equation. They are motivated by applications to Physical Sciences but give rise to many interesting and challenging mathematical problems which lie at the crossroad of analysis (partial differential equations, harmonic and microlocal analysis, control theory, etc.) and geometry (Riemannian and Lorentzian geometries). This project mainly focuses on Caldero´n's inverse conductivity problem and other closely related geometric and analytic problems. In particular, it aims at investigating identifiability issues for anisotropic problems, but also in the case where only partial data is available, as well as stability issues for those problems. It will also consider injectivity problems on geodesic ray transforms.
- 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
  Duration: 36 months (starting on may 1st, 2014)
  URL: http://www-sop.inria.fr/nachos/projects/tecser/index.php/Main/HomePage
- Xavier Antoine is member of the project BoND.
  Project Acronym: BoND
  Project Title: Boundaries, Numerics and Dispersion.
  Coordinator: Sylvie Benzoni
  Duration: 48 months (starting on october 15th, 2013)
  URL: http://bond.math.cnrs.fr

9.2. International Initiatives

9.2.1. Informal International Partners

Most of the SPHINX members are involved in long term cooperation with international partners. The most important one at this time is our informal partnership with Université de Liège (Belgium). In particular, the recently released software program GetDDM, is based on the paper [25] co-authored by Xaver Antoine and Christophe Geuzaine.

DOLPHIN Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- CPER “data” (2015-2020) : co-leader of a workpackage “Research infrastructure”. The objective is to support research related to data science including high performance computing for combinatorial optimization using the Grid’5000 grid infrastructure.
- ELSAT (2015-2019) of CPER (Contrat Plan Etat Région) : transversal research action “Planning and scheduling of maintenance logistics in transportation”.
- PPF (Bioinformatics) : This national program within the University of Lille 1 deals with solving bioinformatics and computational biology problems using combinatorial optimization techniques.
- PPF HPC (High performance computing) : the objective is to support the coordination in terms of scientific animation, training, equipement and patnership development related to simulation and high performance computing. This action is granted 17K€ per year by University Lille 1.

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, Université Lille 2, CHRU Lille, CHRU Montpelier, CHICL, Alicante (7 partners) (2014-2017) - Coordinator -
- 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).

9.3. European Initiatives

9.3.1. Collaborations in European Programs, except FP7 & H2020

Program: COST

Project acronym: cHiPSet

Project title: High-Performance Modelling and Simulation for Big Data Applications

Duration: 01 2015 - 01 2018

Coordinator: Joanna Kolodziej

Other partners: organisme, labo (pays): Spain, Poland, Germany, France, Luxembourg, italy, ...

Abstract: The Big Data era poses a critically difficult challenge and striking development opportunities in High-Performance Computing (HPC): how to efficiently turn massively large data into valuable information and meaningful knowledge. Computationally effective HPC is required in a rapidly-increasing number of data-intensive domains, such as Life and Physical Sciences, and Socio-economical Systems.

Modelling and Simulation (MS) offers suitable abstractions to manage the complexity of analysing Big Data in various scientific and engineering domains. Unfortunately, Big Data problems are not always easily amenable to efficient MS over HPC. Also, MS communities may lack the detailed expertise required to exploit the full potential of HPC solutions, and HPC architects may not be fully aware of specific MS requirements.

Therefore, there is an urgent need for European co-ordination to facilitate interactions among data-intensive MS and HPC experts, ensuring that the field, which is strategic and of long-standing interest in Europe, develops efficiently - from academic research to industrial practice. This Action will provide the integration to foster a novel, coordinated Big Data endeavour supported by HPC. It will strongly support information exchange, synergy and coordination of activities among leading European research groups and top global partner institutions, and will promote European software industry competitiveness

9.3.2. Collaborations with Major European Organizations

University of Luxembourg: (Luxembourg)

Energy aware scheduling in Cloud computing systems

9.4. International Initiatives

9.4.1. Inria International Labs projects

- Collaboration with University of Mons (UMONS). The collaboration consists mainly in the joint supervision of three Ph.D theses: the thesis of Rudi Leroy defended on November 19th, 2015, the thesis of Jan Gmys started last year, and the thesis of Gautier Vaillant started in September 2015.

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

9.4.2.1. 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.

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

- Memorandum of Understanding between Shinshu University (Nagano, Japan) and Inria, signed on March 2014.

9.4.3.2. Informal International Partners

- University of Coimbra, Portugal.
- IRIDIA, Université Libre de Bruxelles.
- Cologne University of Applied Sciences, Germany.
- Leiden University, Netherlands.
- UMONS University and Tractebel company, Belgium.
- EMI - Univ. Rabat, Morocco.
- Univ. Oviedo, Spain.
- Univ. Istanbul, Turkey.
- University of KULAK Team Codes (Belgium) - Data science for Optimization
- University of KENT (UK) - Knowledge and Optimization
- University of Aberdeen (UK) - Fitness landscape, representation and performance
- University of British Columbia, Canada
- University of Münster, Germany

9.4.4. Participation In other International Programs

- JSPS-MEXT project on Evolutionary multi-objective optimization, landscape analysis, and search performance, with Shinshu University, Nagano, Japan (2013—2016).
- Excellencia project(2015-2017) with University of Valencia (Spain) and University of Oviedo (Spain) on intelligent techniques for robust scheduling and energy-aware transportation systems.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Hernan Aguirre, Shinshu University, Nagano, Japan
- Prof. Kiyoshi Tanaka, Shinshu University, Nagano, Japan
- Fabio Daolio [PostDoc, Shinshu University, Nagano, Japan, from Sept 2014 to Sept 2015]
- Saúl Zapotecas-Martínez [PostDoc, Shinshu University, Nagano, Japan, from Nov 2014 to Dec 2015]
- Prof. Qingfu Zhang, CityU, Hong-Kong
- Dr. Oliver Schuetze, CINVESTAV-IPN, Mexico
- Prof. H-J. Siegel (Univ. Colorado, USA)
- Prof. R. Ellaia (EMI, Morocco)

- Prof. A. Tchernik (Mexico)
- Prof. B. Gendron (Canada)
- Dr. Myriam Delgado (Federal University of Technology of Paraná, Brazil), 1 week, December 2015
- Tiago-Carneiro Pessoa [Universidade Federal do CEARA, Brazil, from 09/2015 to 08/2016]

9.5.1.1. Internships (Master & PhD)

- Tiago-Carneiro Pessoa [Phd student from Universidade Federal do CEARA, Brazil. from Sept 2015 to Jan 2017].
- Juan Palacios Alonso (Univ. Oviedo Spain).
- Igor Machado Coelho (Univ. Fluminense Brazil).

9.5.1.2. Research stays abroad

- A. Liefooghe, May 2015, Shinshu University, Nagano, Japan.
- A. Liefooghe, Dec 2015, Shinshu University, Nagano, Japan.
- M-E Marmion, C. Dhaenens, invited at Shinshu University (1 week, february 2015)
- E-G. Talbi, Mar 2015, Univ. Murcia, Spain.
- E-G. Talbi, Juin 2015, EMI, Univ. Agdal Rabat, Morocco.
- E-G. Talbi, Jul 2015, Univ. Luxembourg.

GEOSTAT Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Conseil Regional Aquitaine Project CAVERNOM (ref. 9129): *Cardiac Arrythmia Complexity and Variability by Means of Robust Nonlinear Methods*. One year.

9.2. National Initiatives

- ICARODE [2013-2016]. Participants : Hussein Yahia, Oriol Pont, Véronique Garçon, Joel Sudre, Antonio Turiel, Christine Provost [LOCEAN]. 4-year contract, CNES-NASA funding, started 2013. Title: *ICARODE: Integration and cascading for high resolution ocean dynamics*. Project leader: H. Yahia.
- PhD grant provided by CNES and Conseil Regional Aquitaine, in collaboration with Laboratoire d'Astrophysique de Bordeaux. Starting: end 2016. Subject: understanding the dynamics of galatic dust clouds and their relation with star formation process.
- PhD grant for C. Artnana from UPMC University, under co-supervision with H. Yahia and C. Provost (LOCEAN, Paris).

9.3. International Initiatives

- The Toubkal project "Caractérisation multi-capteurs et suivi spatio-temporel de l'Upwelling sur la côte atlantique marocaine par imagerie satellitaire", led by K. Daoudi, has been accepted. The partners in this project are: Faculté des sciences de Rabat, Centre Royal de Télédetection Spatiale, Mercator-Ocean and Geostat.

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

9.3.1.1. OPTIC

Title: Optimal inference in Complex and Turbulent data.

International Partner (Institution - Laboratory - Researcher):

IITR (India), Department of Electronics and Communication Engineering: Dharmendra Singh

Start year: 2014

See also: https://optic.bordeaux.inria.fr/.

The OptIC associated team is co-managed by Prof. D. Singh (IIT Roorkee) and N. Brodu, H. Yahia (Inria Geostat).

The OptIC associated team targets the extension and development of a strong collaboration between Inria Geostat team and Indian Institute of Technology Roorkee, Dept of Electronics and Computer Engineering (Prof. D. Singh's group) on non-linear Signal Processing for Universe Sciences, with a strong emphasis on data fusion in Earth Observation and monitoring. Non-linear Physics puts strong evidence of the fundamental role played by multiscale hierarchies in complex and turbulent data: in these data, the information content is statistically localized in geometrical arrangements in the signal's domain, while such geometrical organization is not attainable by classical methods in linear signal processing. This is one of the major drawbacks in the classical analysis of complex and turbulent signals. The goal of this associated team is to show that inference of physical variables along the scales of complex and turbulent signals can be performed through optimal multiresolution analysis performed on non-linear features and data extracted from the signals,

resulting in novel and powerful approaches for data fusion between different acquisitions (in temporal/spatial/spectral resolutions). This program needs both strong expertise in the physical processes beyond the acquisitions and the application of non-linear physics ideas on the behavior of the acquired physical phenomena. The proposal will focus on specific applications in Earth Observation and monitoring for which the Indian partner has developed a very strong expertise, notably in its knowledge and use of the physical processes in remote sensing acquisitions. This partnership is an extremely interesting and high potential collaboration between two teams which focus separately either on the acquisition of the physical processes or their analysis by Complex Systems and non-linear physics methodologies. The recent results obtained in super-resolution by GEOSTAT promises strong applications to a much wider range of Universe Sciences problems, notably with a strong emphasis on data fusion between the physical variables acquired on related but different acquisitions. OptiC builds on a collaboration between Inria and IIT ROORKEE teams, added with partners in Universe Sciences and earth observation (ONERA, CNRS) already involved in research actions with Geostat.

9.3.1.2. Summary of work done in 2015

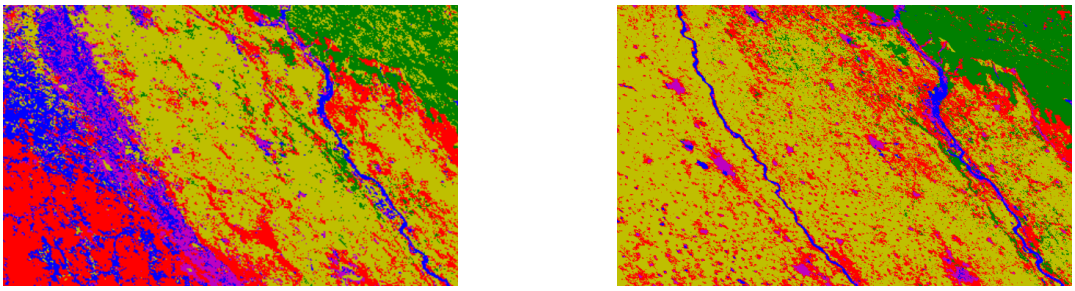

Figure 7. Left: nearest neighbors classification with the original 500m data, showing a cross-validated accuracy of 0.81±0.03. Right: results on the superresolved 250m data, accuracy of 0.83±0.02. Although the performance did not improve significantly on the reference points, the generalization capabilities are greatly enhanced: water regions (river, right, and canal, left) are well recognized, together with villages (magenta dots) and bare soil (red) adequatly spotting the lanscape instead of the incorrect zones on the lower-left at 500m. The other two classes are crops/small vegetation (yellow) and dense/tropical vegetation (green). The region is a MODIS sinusoidal projection around Roorkee.

- The public availability of low-resolution MODIS data is cost-effective, but limited in precision. Some applications, such as land monitoring and anomaly detection, must not only operate on objects smaller than provided in the freely available data, but also offer a high level of confidence in the classified land occupation. We are working on both aspects:
- Augmenting numerically the resolution of the images. This can be done with different methods, out of which two are currently explored in our team. The first relies on wavelet decompositions, with an attempt at preserving the spatial structure around each pixel (e.g. edges). This is typically done by propagating the high-frequency components to higher wavelet decomposition level through some interpolation mechanism, plus artifact-reduction steps. The second method considers a sub-pixel mixing model which is fit from all multispectral bands. The assumption is that, irrespectively of the reflectance of natural elements at each wavelength, the proportion of these elements is a physical property shared through all spectral bands. Then, unmixing is performed in order to estimate the best sub-pixels. See figure 7 .
- Resolution-augmented images are then exploited for classification. We use by field measurements, in

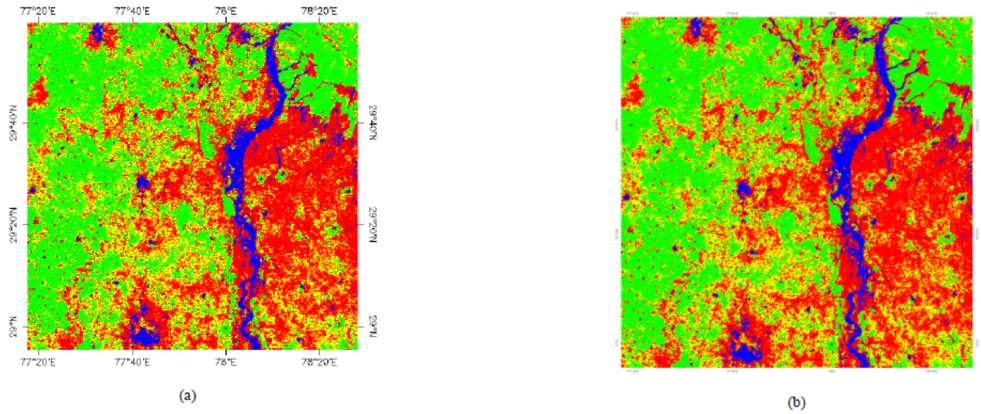

Figure 8. Classified MODIS image (a) Low resolution (b) after resolution enhancement.

order to provide the ground truth for a corpus of well-registered locations, which together encompass a wide variety of objects (e.g. urban, crops, etc). We then train our super-resolution algorithms, and quantitatively assess our super-resolved maps on how well they improve the performance of land classification. As the final accuracy results from the interplay between the considered feature space and the classification method itself, we quantify both aspects with cross-validated data sets. We have tested state of art classification methods (SVM, decision trees, probabilistic models, nearest neighbors, etc…). Classification accuracy is improved by the used of superresolved images but, more importantly, so are the generalization ability of the classifiers. This is shown in the following two images, demonstrating the improvement in land recognition between the use of the original 500m MODIS data and the superresolved 250m data.

- A wavelet based resolution enhancement technique has been crtically analyzed to see the effect of it on resolution enhancemnt modified discrete wavelet transform and interpolation based technique is proposed for enhancing the resolution of satellite images having low resolution in such a way that a highly resolved satellite image can be obtained without losing any image information. The advent of DWT has given a major impetus to many techniques based on achieving super resolution starting with a single low resolution image. In the proposed method, DWT is employed on the input satellite image to decompose it into sub-bands then the high frequency subbands and the input low resolution satellite image have been interpolated to obtain four interpolated images which are later combined after minor alterations to the interpolated input image using IDWT. The quantitative peak signal-to-noise ratio (PSNR) and classification results show that the resolution has been enhanced to a good scale without losing any information content present in the satellite image. The quality assessment parameters also illustrate the supremacy of the proposed technique over the conventional techniques. Results are shown in fig 8 .
- A technique based on feature extarction has been attempted to apply in the low resolution satellite data by which a land cover monitoring system can be developed. Moderate resolution imaging spectroradiometer (MODIS) data is a good resource for land cover monitoring as it is freely available data, having high temporal frequency and spatial resolutions 250 m, 500m and 1000m. MODIS being optical satellite data suffers from various atmospheric and cloud disturbances due to which, feature extraction and land cover interpretation using MODIS data is a significant and challenging task. In the past various features like spectral indices (EVI, SAVI, GEMI, PAVI etc), fourier based features, wavelet based features were extracted for land cover classification from MODIS data but the role of

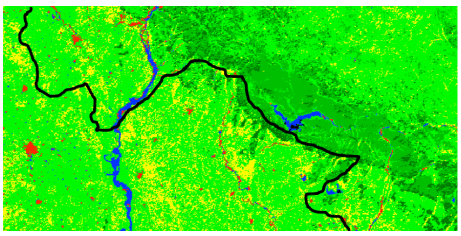

Figure 9. Classification MODIS image by developed approach.

texture descriptors and color features in land cover analysis has not been focussed, which has the potential to provide a new stage of land cover discrimination. Therefore, the objective of this work was to explore the applicability of MODIS composite data for land cover monitoring by texture and color features extraction. Various texture features and descriptors like GLCM (Gray Level Co-occurrence Matrix) measures, LBP (Local Binary Pattern), EHD (Edge Histogram Descriptor), gabor wavelets and color features like Red-Green-Blue (RGB) color space, Hue-Saturation-Value (HSV) color space, Hue-Min-Max-Difference (HMMD) color space, MPEG-7 Dominant Color Descriptor (DCD), MPEG-7 Color Structure Descriptor (CSD) and MPEG-7 Scalable Color Descriptor (SCD) were extracted. These color features were extracted over the artificial-color image obtained by mapping band2 (infrared band), NDVI (Normalized Vegetation Index) and band1 (red band) to the red, green and blue (RGB) color channels, respectively. It is observed that the extracted features are giving quite good results for land cover identification and classification. This infers that in near future these features could play a major role in the development of the land monitoring system using MODIS data. A clssified result of Roorkee region of India is shown in fig 9 which has the overall classification accuracy approx. 82%.

- An another approach based on KLT (Kanade-Lucas-Tomasi) tracker has also been explored to apply on the Phased Array L-Band Synthetic Aperture Radar (PALSAR) satellite image for adapative monitoring the land cover changes. It is observed that KLT tracking algorithm has good potential to be used as monitoring of vegetation in less time without applying time consuming image registration technique.
  Related publications: link to list of publications on OPTIC web site.

INOCS Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

ANR project Transports Terrestres Durable "RESPET - Gestion de réseaux de service porte-à-porte efficace pour le transport de marchandises", in collaboration with LAAS (Toulouse), DHL, JASSP, LIA (Univ. Avignon) (2011-2015).

6.1.2. National Initiatives (Belgium)

Combinatorial Optimization: Meta-heuristics and Exact Methods (2012-2017, coordinator: Bernard Fortz (GOM-ULB/INOCS-Inria). Study and modeling of combinatorial optimization problems; Advancements in algorithmic techniques; Implementation of solution methods for large-scale, practically relevant problems.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

Program: BEWARE FELLOWSHIPS Academia

Project acronym: PARROT

Project title: Planning Adapter performing ReRouting and Optimization of Timing

Duration: 10/2014 - 09/2017

Coordinator: Martine Labbé (ULB)

Other partners: INFRABEL (Belgique).

Abstract: The Belgian railway company needs a new tool for the trains which have to be rescheduled when the company must do some maintenance operations on the network. The difficulties are the number of constraints, the size of the network, the quantity of trains and many other features related to the Belgian railway system. These difficulties imply that some choices have to be made to balance the quantity of work feasible in the 3 years project. After developing an interface between the INFRABEL database and the framework used in this project, a first model (MIP) will be implemented and then tested.

6.2.2. Collaborations in European Programs, except FP7 & H2020

Program: JPI Urban Europe

Project acronym: e4-share

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

Duration: 11/2014 - 10/2017

Coordinator: Markus Leitner (U. Vienna, Austria)

Other partners:

- AIT, Vienna, Austria
- GOM, Université Libre de Bruxelles (Inria/INOCS)
- Department of Electrical, Electronics and information Engineering, Alma Mater University of Bologna, Italy
- iC consulenten Ziviltechniker GesmbH, Vienna, Austria

Abstract: Car-sharing systems and the usage of electric cars become increasingly popular among urban citizens. Thus, providing vast opportunities to meet todays 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.

The project e4-share (Models for Ecological, Economical, Efficient, Electric Car-Sharing) runs from October 2014 to October 2017 and is funded by FFG, INNOVIRIS and MIUR via Joint Programme Initiative Urban Europe. The project comprises an interdisciplinary team of five partners from Austria, Belgium and Italy.

6.3. International Initiatives

6.3.1. Informal International Partners

- CIRRELT, GERAD, Montreal (P. Marcotte, G. Savard, M. Gendreau, G. Laporte, B. Gendron, ..)
- University of Maastricht (Stan Van Hoesel)
- Politecnico di Milano (Edouardo Amaldi)
- University of Lisbon (Luis Gouveia)
- University of Aveiro (Cristina Requejo)
- University of Sevilla (Justo Puerto)
- University of Chile (Fernando Ordonez)

MISTIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **PERSYVACT projects.**
  MISTIS is involved in the 3-year project-team Oculo Nimbus, funded (250 keuros for the whole project) by the PERSYVAL labex (https://persyval-lab.org/en), with other teams from local laboratories, LJK, GIPSA-Lab and LPNC. The goal of this research project is to develop tools for analyzing eye-movement data.

  MISTIS is also involved in another action (2015-2018) recently granted Persyvact2 action supported by the Persyval Labex for 3.5 years. This project is a follow-up of the Persyvact Exploratory labex project. Persyvact2 consists of about 20 researchers from different laboratories, GIPSA-lab, LJK and TIMC-IMAG and different fields related to data science (statistics, machine learning, image and signal processing). Our contribution and involvement will lie essentially in a Graph signal processing work package with application in neuroscience for which we are planning to hire a PhD student with S. Achard (GIPSA-Lab). Persyvact2 also intends to organize scientific events and an international workshop during its lifetime. Persyvact2 will contribute, with other teams of Persyval, to enhance the international visibility of data science in Grenoble. The financial support for the consortium is of 250 keuros.
- **Grenoble Pole Cognition (2013-15).** We received in 2015 2.5 keuros from the Grenoble Pole Cogntion, http://www.grenoblecognition.fr/, for collaborative projects involving the GIN and the Pixyl startup. This funding was used this year for the internship of Priscillia Previtero on brain MRI analysis.
- MISTIS participates in the weekly statistical seminar of Grenoble. Jean-Baptiste Durand is in charge of the organization and several lecturers have been invited in this context.

9.2. National Initiatives

9.2.1. Defi Imag'IN CNRS

Defi Imag'IN MultiPlanNet (2015-2016). 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 made in the HUMAVIPS project. The CNRS support for the network is of 20 keuros.

9.2.2. 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).

9.2.3. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

European H2020 RESSTORE (2015-2018). F. Forbes is involved in this multi-center Stroke European H2020 project including 20 partners. F. Forbes will contribute through the Pixyl startup which will receive 70 keuros as a subcontractor. RESSTORE stands for REgenerative Stem cell therapy for STroke in Europe. It is part of the Clinical research on regenerative medicine program. It will involve a phase 2 trial with 300 patients imaged at 4 time points over a 3 year timeframe. Pixyl will provide automatic stroke lesion segmentations.

9.4. International Initiatives

9.4.1. Inria International Labs

LIRIMA

Associate Team involved in the International Lab:

9.4.1.1. SIMERGE

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

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LERSTAD - Abdou Kâ Diongue

Start year: 2015

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

The objective of the associate team is to federate some researchers from LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger) and Mistis (Inria Grenoble Rhône-Alpes). The associate team will consolidate the existing collaborations between these two laboratories. Since 2010, the collaborations have been achieved through the co-advising of two PhD theses.They have led to three publications in international journals. The associate team will also involve 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. We aim at developing two research themes: 1) Spatial extremes with application to management of extreme risks and 2) Classification with application to global epidemiology.

9.4.2. Inria International Partners

9.4.2.1. 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 Washington in Seattle, the Russian Academy of Science in Moscow, and more recent partners like IDIAP involved in the past HUMAVIPS project, Université Gaston Berger in Senegal and Universities of Melbourne and Brisbane in Australia. We also work at turning other current European contacts, *e.g.* at EPFL (A. Roche at University Hospital Lausanne and Siemens Healthcare), into more formal partnerships.

The main international collaborations that we are currently trying to develop are with:

- Fabrizio Durante, Free University of Bozen-Bolzano, Italy.
- K. Qin and D. Wraith from RMIT in Melbourne, Australia and Queensland University of Technology in Brisbane, Australia.
- E. Deme and S. Sylla from Gaston Berger university and IRD in Senegal.
- Alexandre Nazin and Russian Academy of Science in Moscow, Russia.
- Alexis Roche and University Hospital Lausanne/Siemens Healthcare, Advanced Clinical Imaging Technology group, Lausanne, Switzerland.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Researchers

- Seydou Nourou Sylla (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for four months.
- El Hadji Deme has been hosted by the MISTIS team for 3 weeks.
- Abdelhakim Necir (University Biskra, Algeria) has been hosted for 2 weeks.

9.5.1.2. Internships

Sebastian Torres Leiva (Master, from Feb 2015 until June 2015)

Subject: Extreme value modelling of some glacial processes in Chilean Andes.

Institution: UTFSM - Universidad Tecnica Federico Santa Maria, Valparaiso, Chile

MODAL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Christophe Biernacki has some contracts and/or PhD theses with regional companies: Arcelor-Mittal (thesis), Auchan (contract), PIXEO (contract and thesis), Cylande (contract).

9.1.1. Collaborations within PSo-Innov

Participant: Sophie Dabo.

Sophie Dabo is a member of the regional emergent project *Précarité, Solidarité, vers un accompagnement innovant des personnes en difficultés d'une association spécialisée* with the LGI2A, CRIL, Discontinuité, LEM, APSA-Pas-de-Calais and coordinator: Issam Nouaouri (issam.nouaouri@univ-artois.fr).

9.1.2. MPAGenomics2

Participants: Samuel Blanck, Guillemette Marot.

During the 'Plan Cancer 2' period, eight SIRICs ('Site de Recherche Intégrée sur le Cancer') were created in France, including the SIRIC ONCOLille. This last one financed the project MPAGenomics2, coordinated by Guillemette Marot, to biologically validate on cohorts of patients suffering from leukaemia the tools developed by the Development Technological Action MPAGenomics. The project lasted five months and other partners were Functional Genomics platform from Univ. Lille 2, INSERM UMR-S 1172 and biology pathology center of Lille hospital.

9.2. National Initiatives

9.2.1. ANR ClinMine

Participants: Julien Jacques, Cristian Preda, Vincent Vandewalle.

Modal team is member of ClinMine ANR project (http://www.lifl.fr/ClinMine/pmwiki/index.php) in charge with statistical methdology. Collaborators : LIFL, CHRU Lille, CHU Montpellier, ALICANTE, GHICL.

9.2.2. ANR Imagiweb

Participant: Julien Jacques.

Julien Jacques is member of Imagiweb ANR project (http://mediamining.univ-lyon2.fr/people/velcin/imagiweb/) as member of the ERIC laboratory (Univ. de Lyon).

9.2.3. ANR Calibration

Participant: Alain Celisse.

Alain Celisse is a member of the Calibration ANR project (https://sites.google.com/site/anrcalibration/anr-calibration) in charge with statistical methdology. Collaborators : Select, ENS Cachan, Université Paris-Sud, Université Nice, Université Paul Sabatier de Toulouse.

9.2.4. Working groups

Christophe Biernacki is the president (since 1012) of the data mining and learning group of the French statistical association (SFdS, http://www.sfds.asso.fr/)

Sophie Dabo belongs to the working groups

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

Guillemette Marot belongs to the StatOmique working group

Julien Jacques belongs to the Working Group on Model Based Clustering (University of Washington)

Benjamin Guedj belongs to the following GdR of CNRS: ISIS (local referee for Inria Lille - Nord Europe), MaDICS, MASCOT-NUM (local referee for Inria Lille - Nord Europe).

Alain Celisse belongs to the Statistics for Systems Biology group (SSB) in Paris.

Alain Celisse belongs to a working group on change-point detection with people from Lancaster university (UK).

9.3. International Initiatives

9.3.1. SIMERGE

Participant: Sophie Dabo.

SIMERGE is a LIRIMA project-team started in January 2015. It includes researchers from

Mistis, Inria Grenoble - Rhône-Alpes, 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

LEM lab, Lille Economie et Management, Université Lille 1, 2, 3

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Benjamin Guedj regularly collaborates with Olivier Wintenberger from Københavns Universitet (KU, Denmark).

9.4. International Research Visitors

Benjamin Guedj regularly collaborates with Olivier Wintenberger from Københavns Universitet (KU, Denmark).

9.4.1. Visits of International Scientists

Sylvain Robbiano (March 2015 - University College London, UK) and Pierre Alquier (April 2015 - ENSAE ParisTech, France) have visited Benjamin Guedj. Those two visits have been followed by the submission of two research papers (Nov. 2015 and Jan. 2016, respectively).

9.4.1.1. Internships

Siddharth Sharma Siddharth

Date: Nov 2015 - May 2016

Institution: LNM Institute of Information Technology (India)

Supervisor: Guillemette Marot

REALOPT Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

We have received support from the regional authorities (Region Aquitaine) for a research project on the planning under uncertainty. A postdoc, Agnès Leroux, has been recruited on this project. She currently develops dynamic programming approaches for scheduling problems and their application to building planning for phytosanitary treatments.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. 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/

9.2.1.2. ANR SONGS (ANR 11 INFRA 13)

The goal of the SONGS project is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management. The contribution of RealOpt in this project revolves around enabling peer-to-peer simulation, and providing use cases for Cloud Comupting simulations.
See also: http://infra-songs.gforge.inria.fr/

9.3. International Initiatives

9.3.1. Inria Associate Team

9.3.1.1. SAMBA

Title: Synergies for Ameliorations and Mastering of Branch-and-Price Algorithms

International Partner (Institution - Laboratory - Researcher):

Universidade Federal Fluminense (Brazil) & Universidad Adolfo Ibanez (Chile)

Start year: 2011-13 and 2014-16

See also: https://realopt.bordeaux.inria.fr/?page_id=573

SAMBA is a research project between the Inria project team ReAlOpt (Bordeaux, France), the ADT-Lab Pontifícia Universidade Católica do Rio de Janeiro, and the LOGIS at the Universidade Federal Fluminense. The project is supported by Inria under the "associate team" framework for an initial period of three years (2011-2013) and was renewed for another three years period (2014-2016) with additional partners at the Operations Research and Complex Systems Group School of Business, Universidad Adolfo Ibanez, Chile, and the LIRMM at the University of Montpellier.

Quantitative models are important tools for strategic, tactical, and operational decision-making. Many underlying optimization problems are discrete in nature. They are modeled as linear programs with integer variables, so called Mixed Integer Programs (MIP). Their solution is es- sentially based on enumeration techniques, which is notoriously difficult given the huge size ofthe solution set. Powerful generic commercial solvers for MIP are available, but despite continuous progress, the existing tools can be overwhelmed when problem complexity or size increases.

Decomposition approaches are primary tools to expand the capabilities of MIP solution techniques. When the application presents a decomposable constraint system, the so-called "Dantzig-Wolfe decomposition" consists in reformulating the problem as a selection of a specific solution for each individual subsystems that together satisfy the linking constraints. In practice, the individual subsystem solutions are brougth in the formulation in the course of the opti- mization if they can lead to improvement in the objective value. On the other hand, "Benders' decomposition applies when the the application presents a decomposable system of variables, as traditional in stocahstic two-stage optimization models where main decisions are taken prior to knowing the realization ofr random data, while second stage decision are adjusments that can be done once the true value of data is revealed. In this context, one solves the first stage model and check a posteriori the feasibilility of the second stage. In case the second stage is infeasible, a constraint on the first stage variables is induced that aim to account for the cause of second stage infeasibility, and the processus reiterates.

Both of these decomposition approaches are perceived as requiring an application specific implementation for tractability in scaling-up to real-life applications. Our research aim at developing generic methods for these and algorithmic enhancements to can yield significant speed-ups in practice and have sound theoretical basis. Such research includes methodological developments (such as stabilization techniques for improved convergence, preprocessing rules, dynamic aggregation-and-disagregation), algorithms strategies (such as mutli-column/cut generation strategies, pre-evaluation of enumerated subproblem strategies – so-called strong branching), and efficient implementations (code re-engineering of our software platform BaPCod).

Beyond the methodological developments, our motivations are to set new benchmarks on standard combinatorial problems and industrial applications. In particular, we proceed to extend our techniques to the context of dynamic optimization. In a stochastic environment, the aim is to build a planning that are robust to perturbations in the sense that it can be adapted dynamically in reaction to the observed changes in the predicted data.

The project builds on the accumulated experience of both the Brazilian, the Chilean and the French teams that have done pioneering work in tackling complex applications and deriving generic solution strategies using this decomposition approach.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Alexander Lazarev (Russia) visited us in Bordeaux in January 2015.
- Eduardo Uchoa (Brasil) visited us in Bordeaux on the second week of January 2015.
- Michael Poss visited us in Bordeaux on the first week of May 2015.
- Eduardo Moreno (Chile) visited us in Bordeaux for 10 days in November 2015.

9.4.2. Visits to International Teams

9.4.2.1. Sabbatical programme

Sadykov Ruslan

Date: Aug 2015 - Jul 2016

Institution: Universidade Federal Fluminense (Brazil)

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Pascal Massart co-organizes a working group at ENS (Ulm) on statistical learning.

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

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 Seattle (USA).

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research stays abroad

Jean-Michel Poggi visited Anestis Antoniadis at the University of Cape Town (South Africa), Department of Statistical Sciences, 16-26 February 2015

SEQUEL Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Participant: Olivier Pietquin.

- *Title*: Sniper, Guerrilla, Shark, Razor et les autres
- *Type*: PICTANOVO
- *Coordinator*: Association P.A.S. (Emmanuelle Grangier)
- *Duration*: 2015
- *Abstract*:

  "Sniper, Guerrilla, Shark et les autres" is an interactive physical setting as well as a choreographic performance for four dancers /performers and two types of robots behaving as a swarm (some of them flying, others being on the floor). The context is high frequency trading from which emerges a world where human performers and non-humanoid robots live together. Their behaviour are depending on the same basic rules working at a non-temporal scale and a macro-temporal scale of share prices fluctuation.

9.2. National Initiatives

9.2.1. ANR ExTra-Learn

Participants: Alessandro Lazaric, Jérémie Mary, Rémi Munos, 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 focused on how to effectively transfer knowledge from an external expert as in apprenticeship learning. This is an important step towards automatic transfer because it digs into the problem of how knowledge of an expert can be integrated into the learning process. This investigation led to the publication of two papers at IJCAI'15. In 2015 a number of activities has also started. Ronan Fruit has been recruited for a PhD started in December. The main focus of the PhD will be related to transfer in multi-armed bandit, in particular in systems which are non-stationary where the task can change multiple times. Pierre-Victor Chaumier will start a long internship on transfer in RL with focus on applications to Atari games. Romain Warlop started in July a Cifre PhD (co-supervised by A. Lazaric, J. Mary, and Ph. Preux) with focus on how to use transfer learning in recommendation systems. We expect these activities to significantly advance the research in the project within 2016.

9.2.2. ANR KEHATH

Participant: Olivier Pietquin.

- *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.

9.2.3. ANR MaRDi

Participants: Olivier Pietquin, Bilal Piot.

- *Acronym*: MaRDi
- *Title*: Man-Robot Dialogue
- *Type*: ANR
- *Coordinator*: Univ. Lille 1 (Olivier Pietquin)
- *Duration*: 2012-2016
- *Other partners*: Laboratoire d'Informatique d'Avignon (LIA), CNRS - LAAS (Toulouse), Acapela group (Toulouse)
- *Abstract*: In the MaRDi project, we study the interaction between humans and machines as a situated problem in which human users and machines share the same environment. Especially, we investigate how the physical environment of robots interacting with humans can be used to improve the performance of spoken interaction which is known to be imperfect and sensible to noise. To achieve this objectif, we study three main problems. First, how to interactively build a multimodal representation of the current dialogue context from perception and proprioception signals. Second, how to automatically learn a strategy of interaction using methods such as reinforcement learning. Third, how to provide expressive feedbacks to users about how the machine is confident about its behaviour and to reflect its current state (also the physical state).

9.2.4. National Partners

- Inria Bordeaux - Sud-Ouest
  - B.Piot and O.Pietquin worked with T.Munzer and M.Lopes on Inverse Reinforcement Learning with Relational Domains. It led to a publication in IJCAI 2015 [24].
- CentraleSupélec
  - B.Piot and O.Pietquin worked with M.Geist on Inverse Reinforcement Learning with Relational Domains and Dialogue Management. It led to a conference publication in IJCAI 2015 [24] and a workshop publication in MLIS 2015 [29].
- Inria Nancy - Grand Est
  - J.Perolat, B.Piot and O.Pietquin worked with Bruno Scherrer on Stochastic Games. It led to a conference publication in ICML 2015 [28].
- CMLA - ENS Cachan.
  - Julien Audiffren *Collaborator*
    M. Valko, A. Lazaric, and M. Ghavamzadeh work with Julien on Semi-Supervised Apprenticeship Learning. We finalized and published a max-entropy algorithm that outperforms the approach without unlabeled data.
- LTCI, Institut Télécom-ParisTech, France.
  - Charanpal Dhanjal, Stefan Clemençon*Collaborator*
    Romaric Gaudel collaborates with Charanpal and Stefan since 2010 on topics related to *Matrix Factorization*. In the past we applied our work to sequential recommendation and to sequential clustering. This year, the collaboration has led to a publication in AAAI'15 conference [16].

9.3. European Initiatives

9.3.1. Collaborations in European Programs, except FP7 & H2020

9.3.1.1. CHIST-ERA IGLU

Participants: Olivier Pietquin, Bilal Piot, Jérémie Mary.

Program: CHIST-ERA

Project acronym: IGLU

Project title: Interactive Grounding of Language Generation

Duration: 10/2015 - 9/2018

Coordinator: Jean-Rouat (Univ. Sherbrooke)

Other partners: Univ. Lille, CRIStAL (France) - Inria, Flowers (France) - UMONS, Numédiart (Belgium) - KTH, TMH (Sweden) - Universidad de Zaragoza, I3A (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.

9.4. International Initiatives

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

9.4.1.1. CWI

In the end of 2015 SEQUEL started an Inria Associate team with CWI, Amsterdam. This project is called "Universal algorithms for sequential forecasting and bandit problems" and is led by Daniil Ryabko from the SEQUEL side, and by Peter Grunwald from the CWI side.

9.4.1.2. EduBand

Title: Educational Bandits

International Partner (Institution - Laboratory - Researcher):

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

Inria investigators: A. Lazaric, M. Valko

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.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

9.4.2.1.1. Montanuniverstat Leoben

Montanuniverstat Leoben (MUL), Austria, is an international partner of SEQUEL. The work in 2015 has been mostly on representation learning in reinforcement learning. The partnership involves Ronald Ortner and Peter Auer on the MUL side.

9.4.2.2. Informal International Partners

+ University of California Irvine (USA)

  Anima Anandkumar *Collaborator*

  A. Lazaric collaborates with A. Anandkumar on the use of spectral methods for reinforcement learning.

+ Politecnico di Milano (Italy)

  Nicola Gatti *Collaborator*

  A. Lazaric finalized a work with N. Gatti on the application of MAB on sponsored search auctions and mechanism design.

+ Universität Potsdam (Germany)

  Alexandra Carpentier *Collaborator*

  M. Valko collaborates with A. Carpentier on scaling bandits to large dimensions and structures.

+ Adobe Research, California

  Branislav Kveton *Collaborator*
  M. Valko and B. Kveton collaboration for sequential learning at recommendation for the entertainment content that features diversity.

+ Boston University, USA

  Venkatesh Saligrama *Collaborator*
  M. Valko, R. Munos collaborated with V. Saligrama and M. Hanawal, on cost-effective spectral sensing, useful in radars.

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Sabbatical programme

Ryabko Daniil

Date: Jan 2014 - Jan 2015

Institution: CMM (Chile)

SIERRA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR: Calibration

Participant: Sylvain Arlot.

Titre: Statistical calibration

Coordinator: University Paris Dauphine

Leader: Vincent Rivoirard

Other members: 34 members, mostly among CEREMADE (Paris Dauphine), Laboratoire Jean-Alexandre Dieudonné (Université de Nice) and Laboratoire de Mathématiques de l'Université Paris Sud

Instrument: ANR Blanc

Duration: Jan 2012 - Dec 2015

Total funding: 240 000 euros

Webpage: https://sites.google.com/site/anrcalibration/

9.1.2. CNRS: BeFast

Participant: Sylvain Arlot.

Titre: BeFast

Coordinator: University Lille 1

Leader: Alain Celisse

Other members: Tristan Mary-Huard, Guillem Rigaill, Guillemette Marot, and Julien Chiquet.

Instrument: PEPS

Duration: Mar 2015 – Dec 2015

Total funding: 9 000 euros

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. SIPA

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Duration: May 2011 - May 2016

Coordinator: A. d'Aspremont (CNRS)

Abstract: Interior point algorithms and a dramatic growth in computing power have revolutionized optimization in the last two decades. Highly nonlinear problems which were previously thought intractable are now routinely solved at reasonable scales. Semidefinite programs (i.e. linear programs on the cone of positive semidefinite matrices) are a perfect example of this trend: reasonably large, highly nonlinear but convex eigenvalue optimization problems are now solved efficiently by reliable numerical packages. This in turn means that a wide array of new applications for semidefinite programming have been discovered, mimicking the early development of linear programming. To cite only a few examples, semidefinite programs have been used to solve collaborative filtering problems (e.g. make personalized movie recommendations), approximate the solution of combinatorial programs, optimize the mixing rate of Markov chains over networks, infer dependence patterns from multivariate time series or produce optimal kernels in classification problems. These new applications also come with radically different algorithmic requirements. While interior point methods solve relatively small problems with a high precision, most recent applications of semidefinite programming in statistical learning for example form very large-scale problems with comparatively low precision targets, programs for which current algorithms cannot form even a single iteration. This proposal seeks to break this limit on problem size by deriving reliable first-order algorithms for solving large-scale semidefinite programs with a significantly lower cost per iteration, using for example subsampling techniques to considerably reduce the cost of forming gradients. Beyond these algorithmic challenges, the proposed research will focus heavily on applications of convex programming to statistical learning and signal processing theory where optimization and duality results quantify the statistical performance of coding or variable selection algorithms for example. Finally, another central goal of this work will be to produce efficient, customized algorithms for some key problems arising in machine learning and statistics.

9.2.1.2. SpaRTaN

Title: Sparse Representations and Compressed Sensing Training Network

Type: FP7

Defi: NC

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

9.2.1.3. 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.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Visit from Chiranjib Bhattacharyya, Indian Institute of Science, Bangalore, May 2014.

9.3.1.1. Internships

Visit from Raman Sankaran, Indian Institute of Science, Bangalore, January 2014.

TAO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **TIMCO**, 2012-2015 (432 kEuros)
  Coordinator: Bull SAS
  Participants: Cécile Germain-Renaud, Julien Nauroy, Karima Rafes, Lovro Ilisajic, Gaetan Marceau Caron
- **ROM** *Model Reduction and Multiphysics Optimization*, 2014-2016 (50 Keuros)
  Coordinator: IRT System X
  Participants: Marc Schoenauer, Michèle Sebag, François Gonard (PhD)
- **ISN** *A Collaborative Filtering Approach to Matching Job Openings and Job Seekers*, 2013-2016 (105 kEuros)
  Related to Thomas Schmitt's PhD (funded by ISN).
  Participants: Michèle Sebag, Thomas Schmitt
- **AutoML** *An empirical approach to Machine Learning*, 2014-2017 (104 kEuros)
  Related to Sourava Mishra's PhD
  Participants: Michèle Sebag, Balazs Kégl, Sourava Mishra
- **ReMODeL** *Rewarded Multimodal Online Deep Learning*, 2015-2016 (31,5 kEuros)
  This project lies at the junction of reinforcement learning, deep learning, computational neuroscience and developmental robotic fields. It is closely related to the transversal DIGITEO robotic theme, Roboteo.
  Participants: Michèle Sebag, Mathieu Lefort, Alexander Gepperth
- **AMIQAP**, 2015-2016 (12 months of Postdoctoral fellow). Project funded by ISN
  Participants: Philippe Caillou, Michèle Sebag

9.2. National Initiatives

- **SIMINOLE** 2010-2015 (1180kEuros, 250kEuros for TAO). Large-scale simulation-based probabilistic inference, optimization, and discriminative learning with applications in experimental physics, ANR project, Coordinator B. Kégl (CNRS LAL).

  Participants: Emmanuel Benazera, Nikolaus Hansen, Marc Schoenauer, Cécile Germain-Renaud
- **NUMBBO** 2012-2016 (290kEuros for TAO). Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers, ANR project, Coordinator Anne Auger, Inria. Other partners: Dolphin, Inria Lille, Ecole des Mines de Saint-Etienne, TU Dortmund
  Participants: Anne Auger, Nikolaus Hansen, Marc Schoenauer, Ouassim Ait ElHara
- **ACTEUR** 2014-2018 (236kEuros). Cognitive agent development for urban simulations, ANR project, Coordinator P. Taillandier (IDEES, Univ Rouen).

  Participants: Philippe Caillou

9.2.1. Other

- **POST** 2014-2018 (1,220 MEuros, including 500 kEuros for a 'private' cluster). Platform for the optimization and simulation of trans-continental grids
  ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie)
  Coordinator: ARTELYS
  Participants: Olivier Teytaud, Marie-Liesse Cauwet, Jérémie Decock, Sandra Cecilia Astete Morales, David L. Saint-Pierre, J. Decock

- **E-LUCID** 2014-2017 (194 kEuros)
  Coordinator: Thales Communications & Security S.A.S
  Participants: Marc Schoenauer, Cyril Furtlehner
- **FSN ADAMME** 2015-2018 (258 kEuros)
  Coordinator: Bull SAS
  Participants: Marc Schoenauer, Yann Ollivier, Gaetan Marceau Caron, Guillaume Charpiat, Cécile Germain-Renaud, Michèle Sebag
- **CNES contract** 2015-2017 (70 kEuros)
  Coordinator: Manuel Grizonnet (CNES) & Yuliya Tarabalka (Inria Sophia-Antipolis, Titane team)
  Participants: Guillaume Charpiat

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

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

  Participants: Gregory Grefenstette

9.3.2. Collaborations with Major European Organizations

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

9.4. International Initiatives

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

9.4.1.1. CIADM

Title: Computational intelligence and Decision making

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2015

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

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

9.4.1.2. s3-bbo

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

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2015

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

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

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

9.4.2. Inria International Partners

9.4.2.1. 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, 400 k$-AUS.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Holger Hoos, University of British Columbia, Canada, 3 weeks in February 2015, follow-up of his 3-months visit at Fall 2014, funded my MSR-Inria joint lab.
- Isabelle Guyon, Chalearn. April-July 2015, 1 month by University Paris Sud, 3 months with TIMCO.
- Youhei Akimoto, Shinshu University, September 2015, a month funded by Digiteo.
- Aditya Gopalan, Indian Institute of Science Bangalore, April 2015, three weeks funded by Digiteo.
- Edgar Galvan Lopez, University College Dublin, April 2015 - March 2016, funded with the ELEVATE Fellowship, the Irish Research Council's Career Development Fellowship co-funded by Marie Curie Actions.

9.5.1.1. Internships

Lin Ching-Nung

Date: Apr - Oct 2015

Institution: NDHU (Taiwan)

Supervisor: Olivier Teytaud

ASPI Project-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. International research visitors

7.3.1. Visits to international teams

François Le Gland has been invited by Joaquín Míguez to visit the department of signal theory and communications of Universidad Carlos III de Madrid, in February 2015.

CQFD Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MATCHABLE project

Matchable is a startup incubated at IRA (Incubateur Régional d'Aquitaine) since Mars 2014. This startup predicts how players will behave, who is likely to spend money, who you should target with promotions/product placement, and who the developer has to pay attention to in order to prevent churners. The members of CQFD have supervised two masters internships and a postdoctoral researcher, granded by two PEPS contracts from AMIES.

9.1.2. Inter-LabEx project between CPU and TRAIL

The topic of the project is "Advanced statistical methods for analysis of multidimensional databases of human brain imaging". The project focuses on the analysis of variability factors driving hemispheric specialization (HS) of the brain, a human specific character, for which a dedicated database has recently been built by GIN (Neurofunctional Imaging Group from L). GIN provides the database and pe./irabotrforms genotyping of fifty loci potentially affecting HS. The "Probability and Statistics" group (EPS) from the LabEx CPU works on the methodological developments of statistical tools to analyze these high dimensional data. Interactions between GIN and EPS allow to identify and to characterize the best variables, to perform additional analyses, and to suggest appropriate additional variables, especially in the case of the voxel being implemented. GIN is also involved in the interpretation of the statistical results generated throughout the project.

Dr Solveig Badillo has been hired as Postdoctoral researcher in may 2014 on this project for 20 months.

9.1.3. GIS ALBATROS, HUMO (HUman MOnitoring) project

Approche interdisciplinaire de l'évaluation de l'état cognitif de l'utilisateur. Participants: Jean-Marc André, Liliana Audin Garcia, Veronique Lespinet, Frédérique Faïta, Jérôme Sarraco, Pierrick Legrand.

Le but de ce micro-projet et de valider un protocole de recueil, traitement, et interprétation des données physiologiques pour l'évaluation de l'état de l'utilisateur. Les objectifs en sont :

- Mise en place d'un protocole de recueil de données reposant sur un des modèles théoriques classiques en psychologie cognitive (ex. modèle de la mémoire de travail, modèle attentionnel, etc.) pour servir de base à la comparaison des états cognitifs (comparaison de 2 conditions expérimentales reconnues en terme de performances cognitives).
- Mise en oeuvre d'une diversité de capteurs physiologiques conduisant au recueil de signaux variés durant les conditions expérimentales issus des protocoles de psychologie cognitive.
- Conduire une analyse statistique multivariée avec les tests existants permettant de tirer des informations quant à la structure des paramètres de monitoring.
- Discriminer les variables pertinentes : choix des signaux à retenir ; efficacité/pertinence vs diversité
- Etablir et décrire le lien éventuel de significativité entre les données physiologiques recueillies et l'état cognitif de l'utilisateur.

9.1.4. EMG analysis

Participants: Luis Herrera, Eric Grivel, Gregory Barrière, Marie chavent, Pierrick Legrand

L'analyse spectrale et temporelle des activités électromyographiques (EMGs, activités musculaires) occupe une place importante dans l'aide au diagnostic de pathologies sensorimotrices chez l'homme. Néanmoins, les outils actuellement utilisés en EMGs (transformée de Fourier notamment) demeurent limités et dans certains cas obsolètes pour le diagnostic différentiel de certaines pathologies. Tel est le cas par exemple de la maladie de Parkinson, du tremblement essentiel et de troubles cérébelleux qui s'accompagnent de tremblements similaires en termes de fréquence et d'amplitude. Notre projet, qui s'inscrit à la convergence de plusieurs disciplines (mathématiques, traitement du signal, neurobiologie et neurologie), vise à enrichir la quantité d'information pouvant être extraite des signaux EMGs à l'aide d'outils d'analyse à la pointe en matière de traitement du signal, avec pour objectif d'identifier des signatures EMG spécifiques de chaque pathologie et utilisables pour le diagnostic différentiel.

9.2. National Initiatives

9.2.1. ANR ADAPTEAU

The ANR project ADAPTEAU has been obtained for the period 2012-2016.

ADAPTEAU aims to contribute to the analysis and management of global change impacts and adaptation patterns in River-Estuarine Environments (REEs) by interpreting the scientific challenges associated with climate change in terms of: i) scale mismatches; ii) uncertainty and cognitive biases between social actors; iii) interdisciplinary dialogue on the "adaptation" concept; iv) critical insights on adaptive governance and actions, v) understanding the diversity of professional, social and economic practices vis-à-vis global change. The project aims to build an integrative and interdisciplinary framework involving biophysical and social sciences, as well as stakeholders and civil society partners. The main objective is to identify adaptive strategies able to face the stakes of global change in REEs, on the basis of what we call 'innovative adaptation options'.

We consider the adaptation of Social-Ecological Systems (SES) through the expected variations of the hydrological regimes (floods / low-flow) of the Garonne-Gironde REE—a salient issue in SW France, yet with a high potential for genericity The ADAPTEAU project will be organised as follows:

- Achieve and confront socio-economic and environmental assessments of expected CC impacts on the Garonne-Gironde river-estuarine continuum (task 1);
- Identify the emerging 'innovative adaptation options' endorsed by various social, economic, political actors of the territory (depolderisation, 'room for rivers' strategies, changes in economic activities, agricultural systems or social practices), then test their environmental, economic and social robustness through a selected subset (task 2);
- Scientists, representatives from administrators and civil society collaborate to build adaptation scenarios, and discuss them in pluralistic arenas in order to evaluate their social and economic feasibility, as well as the most appropriate governance modes (task 3).
- Disseminate the adaptation strategies to academics and managers, as well as to the broader society (task 4).

  The expected results are the definition and diffusion of new regional-scale reference frameworks for the discussion of adaptation scenarios in REE and other SESs, as well as action guidelines to better address climate change stakes.

The CQFD team work on tasks 1 and 3.

9.2.2. ANR Piece

ANR Piece (2013-2016) of the program *Jeunes chercheuses et jeunes chercheurs* of the French National Agency of Research (ANR), lead by F. Malrieu (Univ. Tours). The 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 of complex 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, modeling) 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.

9.2.3. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

IRSES ACOBSEC

Project reference: 612689 Funded under: FP7-PEOPLE

Coordinator : Pierrick Legrand

Participants :

Université Victor Segalen Bordeaux II participation ended

Université de Bordeaux

Fundacao da Faculdade de Ciencias da Universidade de Lisboa Portugal

Universidad de Extremadura Spain

INESC ID - Instituto de Engenharia de Sistemas e Computadores, Investigacao e Desenvolvimento em Lisboa Participation ended

Over the last decade, Human-Computer Interaction (HCI) has grown and matured as a field. Gone are the days when only a mouse and keyboard could be used to interact with a computer. The most ambitious of such interfaces are Brain-Computer Interaction (BCI) systems. BCI's goal is to allow a person to interact with an artificial system using brain activity. A common approach towards BCI is to analyze, categorize and interpret Electroencephalography (EEG) signals in such a way that they alter the state of a computer. ACoBSEC's objective is to study the development of computer systems for the automatic analysis and classification of mental states of vigilance; i.e., a person's state of alertness. Such a task is relevant to diverse domains, where a person is required to be in a particular state. This problem is not a trivial one. In fact, EEG signals are known to be noisy, irregular and tend to vary from person to person, making the development of general techniques a very difficult scientific endeavor. Our aim is to develop new search and optimization strategies, based on evolutionary computation (EC) and genetic programming (GP) for the automatic induction of efficient and accurate classifiers. EC and GP are search techniques that can reach good solutions in multi-modal, non-differentiable and discontinuous spaces; and such is the case for the problem addressed here. This project combines the expertise of research partners from five converging fields: Classification, Neurosciences, Signal Processing, Evolutionary Computation and Parallel Computing in Europe (France Inria, Portugal INESC-ID, Spain UNEX, Bordeaux university, Sciences University of Lisbon) and South America (Mexico ITT,

CICESE). The exchange program goals and milestones give a comprehensive strategy for the strengthening of current scientific relations amongst partners, as well as for the construction of long-lasting scientific relationships that produce high quality theoretical and applied research.

9.3.2. Collaborations in European Programs, except FP7 & H2020

Program: MTM2012-31393

Project acronym: NMMDP

Project title: Numerical methods for Markov decision processes

Duration: 01/2013 - 12/2015

Coordinator: Tomas Prieto-Rumeau

Other partners: 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: MTM2012-31393) for three years to support the scientific collaboration between Tomas Prieto-Rumeau, Jonatha Anselmi and François Dufour. This research project is concerned with numerical methods for Markov decision processes (MDPs). Namely, we are interested in approximating numerically the optimal value function and the optimal controls for different classes of constrained and unconstrained MDPs. Our methods are based on combining the linear programming formulation of an MDP with a discretization procedure referred to as quantization of a probability distribution, underlying the random transitions of the dynamic system. We are concerned with optimality criteria such as the total expected cost criterion (for finite horizon problems) and, on the other hand, the total expected discounted cost and the average cost optimality criteria (for infinite horizon problems).

9.4. International Initiatives

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

9.4.1.1. CDSS

Title: Control of Dynamic Systems Subject to Stochastic Jumps

International Partner (Institution - Laboratory - Researcher):

Universidade de São Paulo (Brazil) - Departamento de Matemática Aplicada e Estatística (ICMC) - Costa Eduardo

Start year: 2014

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

The main goals of this joint team CDSS is to study the control of dynamic systems subject to stochastic jumps. Three topics will be considered throughout the next 3 years. In the first topic we study the control problem of piecewise-deterministic Markov processes (PDMP?s) considering constraints. In this case the main goal is to obtain a theoretical formulation for the equivalence between the original optimal control of PDMP?s with constrains and an infinite dimensional static linear optimization problem over a space of occupation measures of the controlled process. F. Dufour (CQFD, Inria) and O. Costa (Escola Politécnica da Universidade de São Paulo, Brazil) mainly carry out this topic. In the second topic we focus on numerical methods for solving control and filtering problems related to Markov jump linear systems (MJLS). This project will allow a first cooperation between B. de Saporta (Univ. Montpellier II) and E. Costa (Universidade de São Paulo, Brazil). The third research subject is focused on quantum control by using Lyapunov-like stochastic methods conducted by P. Rouchon (Ecole des Mines de Paris) and P. Pereira da Silva (Escola Politécnica da Universidade de São Paulo, Brazil).

9.4.2. Inria International Partners

9.4.2.1. 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.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Tomas Prieto-Rumeau (Department of Statistics and Operations Research, UNED, Madrid, Spain) visited the team during 2 weeks in 2015. 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 2015 supported by the Associate Team Inria: CDSS.

Alexey Piunovskiy (University of Liverpool) visited the team during 5 weeks in 2015. The main subject of the collaboration is the linear programming approach for Markov Decision Processes. This research was supported by the Clusters d'excellence CPU.

9.5.1.1. Internships

- Emigdio Z. Flores: 1 months, hosted by P. Legrand
- Luis Herrera: 3 months, hosted by P. Legrand

MATHRISK Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR Stab 2013-2016, Participant : B. Jourdain, Partners : Lyon 1, Paris-Dauphine
- ANR Cosmos 2015-2018, Participant: B. Jourdain ; Partners : Ecole des Ponts, Telecom, INIRIA Rennes and IBPC

9.1.2. Competitivity Clusters

Pôle Finance Innovation.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

- Center of Excellence program in Mathematics and Life Sciences at the Department of Mathematics, University of Oslo, Norway, (B. Øksendal).
- Department of Mathematics, University of Manchester (Tusheng Zhang, currently in charge of an EU-ITN program on BSDEs and Applications).
- Kensas University (Yaozhong Hu)
- 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).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Oleg Kudryavtsev, Rostov University (Russia), 2 months
- Xiao Wei, Beijing university, 2 months

9.3.1.1. Internships

- Houzhi Li (April to July 2015): Study and implementation in Premia of the 4/2 stochastic volatility model proposed by M. Grasselli; adviser A. Alfonsi

9.3.2. Visits to International Teams

9.3.2.1. Research stays abroad

- A. Alfonsi IPAM, UC Los Angeles , invited by René Carmona (April 13- 23)
- A. Sulem: Participation to the "Stochastics in Environmental and Financial Economics" program, Centre of Advanced Studies of the Norwegian Academy of Sciences and Letters, Oslo,Spring 2015.

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).
- A. Lejay is member of the ANR H2MNO4 (Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology, ANR Cosinus, 2012–2015) coordinated by Joceyline Erhel (IRISA, Rennes).
- E. Tanré is member of the ANR SloFaDyBio (Slow Fast Dynamics in Biology, ANR-14-CE25-0019, 2015-2017) coordinated by M. Desroches (EPI NEUROMATHCOMP, Inria Sophia Antipolis).

9.1.2. Contract with ADEME

Participants: Mireille Bossy, Sélim Kraria.

Modéol Since April 2013, M. Bossy was the coordinator of the MODÉOL collaboration project funded by the French Environment and Energy Agency (ADEME), and involving the IPSL (CNRS) and the French company Maïa Eolis. The overall goal of the project concerns the modeling and prediction of wind potential in France, in particular the quantification of uncertainties and the analysis of multi-scale variability.

Concerning the Inria workpackage, in collaboration with Antoine Rousseau, from the team LEMON, we completed the SDM code with complex terrain description. We also improved the downscaling procedure that allows SDM to downscale its own simulation outputs.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

- J. Inglis is a member of the European project MatheMACS (European Union Seventh Framework Programme no. 318723).

9.3. International Initiatives

9.3.1. Inria International Labs

Inria Chile
Associate Team involved in the International Lab:

9.3.1.1. ANESTOC-TOSCA

Title: Stochastic modelling of biology and renewable energies

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (Chile) - ANESTOC Center (ANESTOC) - Rebolledo Rolando

Start year: 2014

See also: http://www.anestoc.cl/es/?page_id=1112

This French-Chilean Associated Team deals with stochastic modeling and simulation issues for renewable energies (wind and waves) and neurosciences. It is a follow-up of a long collaboration in which each of the side takes benefit from the other side know-how and structures. This project aims at transfering and valuing to Chilean companies the results of researches on renewable energies, mainly wind prediction at the windfarm's scale and waves energy potential of a site using video.

Mireille Bossy is managing the WINDPOS project, in collaboration with Antoine Rousseau (LEMON team) and two engineers of Inria Chile, Cristian Paris and Jacques Morice. Based on the stochastic Lagrangian modeling of the wind at small scale (see SDM SOFTWARE), WINDPOS aims to develop a wind farm simulator software, able to provide fine statistical information for the managing of electricity production.
This year the WINDPOS project focused on the validation of the approach by comparison with measurements. We also tested the simulation of a 10 mills farm in complexe terrain with strong elevation.

Antoine Lejay is working with Rolando Rebolledo (PUC) on the stochastic modeling of the Oscillating Water Column to transform waves into energy.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- L. Beznea (Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucarest) has been visiting TOSCA Nancy for 10 days in March.
- B. Cloez (INRA Montpellier) has been visiting TOSCA Nancy for 3 days in January.
- J. Claisse (Ecole Polytechnique) has been visiting TOSCA Nancy for 3 days in January.
- F. Campillo (LEMON team, Inria Sophia) has been visiting TOSCA Nancy for one week in August.
- M. Andrade Resptrepo (Univ. Paris 7) has been visiting TOSCA Nancy for 3 days in December.
- The TOSCA *seminar* organized by J. Inglis and A. Richard in Sophia Antipolis has received the following speakers: Cédric Bernardin (Laboratoire Dieudonné, Université Nice Sophia-Antipolis), Romuald Elie (Ceremade, Université Paris Dauphine), Roberta Evangelista (NEUROMATHCOMP-TOSCA, Inria Sophia-Antipolis), José R. León (Inria Grenoble, UCV de Venezuela), Soledad Torres (CIMFAV – Valparaiso, Chile), Arnulf Jentzen (ETH Zurich), Marielle Simon (PUC, Rio de Janeiro), Philip Protter (Columbia University), Jean-François Jabir (CIMFAV – Valparaiso, Chile), Sean Ledger (University of Oxford), Alexandre Brouste (Université du Maine, Le Mans).

9.4.1.1. Internships

CHIKHAOUI Maroua

Subject: Gestion de risque de portefeuille : Estimation de VaR et CVaR

Date: May 2015 - Sept. 2015

Institution: ESPRIT (Ecole Supérieure Privée d'Ingénierie et de Technologie, Tunisie) et Polytech'Nice-Sophia.

CORMIER Quentin

Subject: Réseaux de neurones à décharge avec phénomènes de plasticité

Date: Oct. 2015 - Feb. 2016

Institution: ENS Lyon.

EVANGELISTA Roberta

Subject: A stochastic model of gamma phase modulated orientation selectivity

Date: May 2015 - Sept. 2015

Institution: the Master in computational neuroscience, at the BCCN Berlin.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

- A. Richard has spent two weeks in Valparaíso and Santiago (Chile) in January, and two weeks in Santiago in June, working with R. Rebolledo and S. Torres.