RESEARCH CENTER

FIELD
Applied Mathematics, Computation and Simulation

Activity Report 2014

Section Partnerships and Cooperations

Edition: 2015-06-01

BACCHUS Team

6. Partnerships and Cooperations

6.1. 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.

6.2. National Initiatives

6.2.1. Inria Project Lab

6.2.1.1. C2S@Exa - Computer and Computational Scienecs at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is participating to 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.

6.2.1.2. 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.

6.2.1.2.1. 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.

6.2.1.2.2. ANR UFO

Title: Uncertainty quantification For compressible fluid dynamics and Optimisation.

Type: ANR

Duration: 36 months

Starting date : 1st June 2011

Coordinator: Remi Abgrall (Inria Bordeaux Sud-Ouest)

Abstract: This project deals with the simulation and the optimization of stochastic flows where the uncertainties can be both in the data and in the models. The focus will be on handling the uncertainties coming from the turbulence models or thermodynamics models in dense-gas flows. Since the thermodynamic models for dense-gas flows are not well-known, it is mandatory to compute the probability density functions of some quantities of interest by starting from the experimental data. Several methods have been developed for both reducing the global computational cost and increasing the accuracy in the statistics computation.

6.2.1.2.3. 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.

6.2.1.3. PEPS

Title On a new mathematical and numerical approach for simulations in coastal engineering

Type : PEPS IDEX-CNRS

Duration : 12 months

Starting : Date May 2013

Coordinator : M. Colin

Abstract : The modeling of free surface flows is a major challenge in coastal engineering and its understanding is crucial if one wants to predict the impact of large-scale phenomena such as Tsunami propagations for example. The aim of this project is to provide pertinent and efficient numerical asymptotic models describing fluid flows in view of producing a computational plate-form. We will give a particular attention to scalar models in order to describe wave breaking in the near-shore region. Finally , we will introduce a new method to obtain numerical asymptotic models which consists in inverting the usual paradigm

Full models→Asymptotic models→Numerical scheme.

6.2.1.4. APP Bordeaux 1

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

Type : Project Bordeaux 1

Duration : 36 months

Starting : September 2014

Coordinator : M. Colin

Abstract : Because of their high strength and low weight, ceramic-matrix composite materials (CMCs) are the focus of active research, for aerospace and energy applications involving high temperatures. Though based on brittle ceramic components, these composites are not brittle due to the use of a fiber/matrix interphase that manages to preserve the fibers from cracks appearing in the matrix. The lifetime-determining part of the material is the fibers, which are sensitive to oxidation; when the composite is in use, it contains cracks that provide a path for 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.

6.3. European Initiatives

6.3.1. FP7 & H2020 Projects

6.3.1.1. 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: Heloise 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.

6.4. International Initiatives

6.4.1. Inria Associate Teams

6.4.1.1. AQUARIUS2

Title: Uncertainty quantification and numerical simulation of high Reynolds number flows

International Partner (Institution - Laboratory - Researcher):

Stanford University (ÉTATS-UNIS)

Duration: 2011 - 2016

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

This research project deals with uncertainty quantification and numerical simulation of high Reynolds number flows. It represents a challenging study demanding accurate and efficient numerical methods. It involves the Inria team BACCHUS and the groups of Pr. Charbel Farhat from the Department of Aeronautics and Astronautics and Pr. G. Iaccarino from the Department of Mechanical Engineering at Stanford University. The first topic concerns the simulation of flows when only partial information about the physics or the simulation conditions (initial conditions, boundary conditions) is available. In particular we are interested in developing methods to be used in complex flows where the uncertainties represented as random variables can have arbitrary probability density functions. The second topic focuses on the accurate and efficient simulation of high Reynolds number flows. Two different approaches are developed (one relying on the XFEM technology, and one on the Discontinuous Enrichment Method (DEM), with the coupling based on Lagrange multipliers). The purpose of the proposed project is twofold : i) to conduct a critical comparison of the approaches of the two groups (Stanford and Inria) on each topic in order to create a synergy which will lead to improving the status of our individual research efforts in these areas ; ii) to apply improved methods to realistic problems in high Reynolds number flow.

6.4.1.2. 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.

6.4.2. Inria International Partners

6.4.2.1. Informal International Partners

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

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

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

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 ;

6.4.3. Participation In other International Programs

6.4.3.1. Inria-CNPq

In the context of the HOSCAR project jointly funded by Inria and CNPq, coordinated by Stéphane LANTERI on the French side, François Pellegrini and Pierre Ramet have participated in a joint workshop in Petrópolis last September. A collaboration is envisioned regarding parallel graph partitioning algorithms for data placement in the context of big data applications.

6.5. International Research Visitors

6.5.1. Visits of International Scientists

- Prof. B. Muller (Norwegian University of Science and Technology) has been hosted for a sabbatical from January to May. During his stay he has interacted with P. Congedo and M.G. Rodio on the milling of compressible multiphase flows ;
- Prof. A.I. Delis (Technical University of Crete) has been hosted during the whole month of September (funding from the mathematics department invited professors campaign, university of Bordeaux). During his stay he worked with M. Ricchiuto on the set up of a robust code-to-code comparison strategy for long wave run-up ;
- A. Larat (CNRS, EM2C lab Paris) has been hosted for a month during November and December to work with M. Ricchiuto on space time Galerkin schemes for KdV type equations.

Besides these longer stays, this year we have hosted several of our collaborators such as K. AOKI (Kyoto University), E. Miglio (Politecnico di Milano), S. Blaise (University of Louvain la Neuve), C. Eskilsson (Chalmers University), A.-P. Engsig-Karup (DTU Compute), and many others.

6.5.1.1. Research stays abroad

In the context of the associated team AQUARIUS2, three 1-month visits have been done during September-October 2014 in Stanford University (Pietro Marco Congedo, Maria Giovanna Rodio, Francesca Fusi).

CAGIRE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. 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, MMP (Gurmençon, France) and GDTECH (Bordes, France). A one-year post-doc will be recruited beginning of 2015. The objective is to investigate the possibility of using advanced RANS or hybrid RANS-LES approaches to better predict the pressure losses in injector.

8.2. National Initiatives

8.2.1. 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.No specific activity has been devoted around those codes during 2014.

8.3. European Initiatives

8.3.1. 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 - 31/10/2015

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 od Science, Technology and Medecine, Loughborough University.

Abstract: The environmental benefits of low emissions lean burn technology in reducing NOx emissions up to 80only 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 emissions 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.

8.4. International Initiatives

8.4.1. Informal International Partners

- Collaboration [RM] with the M. Hadziabdic (International university of Sarajevo, Bosnia and Herzegovina) on the turbulence and heat transfer modelling of jets impinging on a heated, rotating disk.
- Collaboration [RM] with the A.T. Nguyen (University of Vietnam-Ho Chi Minh City) on the development of a new hybrid RANS/LES method based on temporal filtering.
- Collaboration [RM] with E. Juntasaro (King Mongkut's University of Technology North Bangkok, Thailand) on the modelling of transition to turbulence.
- Collaboration [RM] with S. Lardeau (CD-Adapco, London, UK) on the development of an industrial version of the EB-RSM model and its implementation in the commercial CFD software STAR-CCM+.
- 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) on energy issues related to transition and phase change materials.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- June 2014 (5 days): Prof. Erik Dick from Ghent University (Belgium) concerning the development of low Mach number schemes.
- July 2014 (10 days) Dr. Paulo Correia from Evora University (Portugal) concerning the possibility of cooperating with the Cagire team.

8.5.2. Visits to International Teams

- University of Calabria (Italy): [YM] and [PB] stayed during three days there and met Dr Carmine de Bartolo, Fr Alessandra Nigro and Prof. Francesco Bassi (University of Bergame) to discuss the possibility of a future cooperation.
- University of Evora (Portugal): [PB] stayed there during five days paying back his visit to Dr Correia who came to Pau in July. Dr Correia is willing to work with the Cagire team on the topic of synthetic turbulence generation.

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.

Partner 3: University of Genova, Department of Math. (Italy)

Development of qualitative methods in inverse scattering problems. Correspondant: Michele Piana.

8.3. International Initiatives

8.3.1. Inria International Labs

- H. Haddar is member and the Inria correspondant of EPIC, an Inria team of LIRIMA Afrique.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

Title: Qualitative Approaches to Scattering and Imaging (QUASI)

International Partner (Institution - Laboratory - Researcher):

University of Delaware, Department of Mathematical Sciences (USA)

Duration: since 2013

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

8.3.3. Participation In other International Programs

- Olivier Pantz is in charge of the french side of the PHC (Hubert Curien Project) *Sur l'étude de quelques problèmes d'équations aux dérivées partielles issus de la physique* (with H. Zorgati of the University of Tunis in charge for the Tunisian side).

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
- Drossos Gintides
- Ozgur Ozdemir
- Rainer Kress
- Armin Lechleiter
- Nicolas Chaulet

8.4.1.1. Internships

- Shixu Meng
- Jacob Rezac
- Irena de Teresa-Trueba
- Thi Minh Phuong Nguyen
- Afa Saaidi

8.4.1.2. Research stays abroad

- H. Haddar spent one month research visit to the University of Sfax in October 2014.

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 Gamma team, 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. The turn-around time must be acceptable for industrial readiness. UMRIDA will apply these methods to representative industrial configurations.

8.3. International Initiatives

8.3.1. Inria International Labs

Ecuador participates in the Joint Laboratory for Petascale Computing (JLPC) together with our colleagues at Argonne National Laboratory. In 2014, Ecuador was local organizer of the 11th workshop of the JLPC in Sophia-Antipolis, june 9-11, and of the PUF summer school on HPC systems, june 12-13.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Krishna Narayanan, from Argonne National Laboratory, visited Ecuador twice, on april 14-18 and on november 20-28
- Trond Steihaug, from University of Bergen (Norway), visited Ecuador from june 2 to june 27.
- Jan Hueckelheim, from Queen Mary University of London, did a secondment for the AboutFlow project with the Ecuador team from september 22 to november 21.

8.4.2. Visits to International Teams

- Laurent Hascoët visited Argonne National Laboratory from may 13 to may 23.
- Ala Taftaf did a secondment for the AboutFlow project with Queen Mary University of London from april 7 to june 6.

GAMMA3 Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

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

6.2. European Initiatives

6.2.1. 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.

6.3. International Initiatives

6.3.1. Inria Associate Teams

6.3.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

Mississippi State University (ÉTATS-UNIS)

Duration: 2014 - 2016

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.

6.4. International Research Visitors

6.4.1. Visits to International Teams

6.4.1.1. Sabbatical programme

Laug Patrick

Date: Sep 2014 - Aug 2015

Institution: Polytechnique Montréal (Canada)

The main scientific objectives are twofold: the reconstruction of a 3D space or scene from multiple images, and the parallelization of the mesh generation of multiface models on multicore processors.

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, Francois 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).
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.

6.1.2. ANR MOONRISE: 2015-2019

Participants: Nicolas Crouseilles, Philippe Chartier, Florian Méhats, Francois 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. ANR Programme blanc GYPSI: 2010-2014

Participant: Nicolas Crouseilles.

Leader: Ph. Gendrih.

The full description is available at https://sites.google.com/site/anrgypsi/

6.1.4. ANR Programme blanc E2T2: 2010-2014

Participant: Nicolas Crouseilles.

Leader: P. Beyer

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

6.2.1.1. Geopardi

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

Duration: September 2011 - August 2016

Coordinator: E. Faou

Inria contact: E. Faou

6.2.2. Collaborations in European Programs, except FP7 & H2020

6.2.2.1. Verification of global gyrokinetic codes and development of new algorithms for gyrokinetic and kinetic codes

Project acronym: EUROFusion CfP-WP14-ER-01/IPP-03: 2014

Project title: verification of global gyrokinetic codes and development of new algorithms for gyrokinetic and kinetic codes

Duration: 2013-2014

Participants: N. Crouseilles and M. Lemou

Coordinator:E. Sonnendrücker

6.2.2.2. Enabling Research Project for the implementation of the fusion roadmap

Project acronym: EUROFusion

Project title: Enabling Research Project for the implementation of the fusion roadmap

Duration: 2015-2017

Participants: N. Crouseilles and M. Lemou

Coordinator:E. Sonnendrücker

6.3. International Research Visitors

6.3.1. Visits of International Scientists

- L. Einkemmer, University of Innsbruck, two weeks, november 2014.
- Y. Zhang, WPI, Vienna, 3 months.

6.3.2. Visits to International Teams

6.3.2.1. Research stays abroad

- N. Crouseilles visited the group of P. Coelho (Universitad tecnico de Lisboa, Portugal), one week (november 2014).
- M. Lemou and N. Crouseilles visited the India Institute of Science at Bangalore (India): from december 2d to december 17th, 2013. Visited team: around Raghurama Rao.
- M. Lemou visited the Wisconsin university, Madison (USA): from February 1st to February 16th, 2014. Visited team: around Shi Jin.
- P. Chartier, M. Lemou and F. Méhats visited the university of San Sebastien, Pays Basque (Spain): from June 8th to June 13th 2014.

MATHERIALS Team

7. Partnerships and Cooperations

7.1. National Initiatives

The team is involved in several ANR projects:

- the ANR MANIF focuses on the mathematical and numerical analysis of electronic structure models, such as, in particular, the Kohn-Sham model. It includes two research teams: researchers from the JL Lions Laboratory (Paris 6) and the MATHERIALS team. It is coordinated by E. Cancès.
- 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).
- C. Le Bris participates to the ANR EMAQS. The scientist in charge is Karine Beauchard.
- T. Lelièvre is member of the ANR-project "STAB" (PI: I. Gentil, Université de Lyon).
- The team also benefited from a NEEDS interdisciplinary funding from CNRS on numerical methods for the simulation of defects in materials

In addition, the 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 CoDFT (electronic structure computations using density functional theory).

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

7.2. European Initiatives

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

7.3. International Initiatives

T. Lelièvre, G. Stoltz and F. Legoll participate to 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.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

J. Weare (University of Chicago) has been invited for a one month stay (February-March 2014) with the support of the Labex Bezout.

7.4.2. Visits to International Teams

F. Legoll, T. Lelièvre and G. Stoltz have visited the group of K. Schulten (Urbana-Champaign) on January 27-30, 2014

MC2 Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Angelo Iollo is belongs to the Aerospace Valley committee IGPC. He is monitoring the project ECOSEA for the fnrae http://www.fnrae.org/.

8.2. National Initiatives

8.2.1. ANR MEMOVE

Participants: Thierry Colin, Angelo Iollo, Clair Poignard, Olivier Saut, Lisl Weynans.

Part of the team (M.Colin, T.Colin, A.Iollo, C.Poignard, O.Saut and L. Weynans) is involved in the consortium MEMOVE coordinated by MC2 (coordinator C. Poignard), and which begins at the beginning of 2012. This consortium is composed of four partners (the Vectorology and Anticancer therapies team at the IGR, the bioengineering laboratory AMPERE of Lyon and the Department of mathematics of Versailles). It aims at developing electropermeabilization models from the cell scale to the tissue scale. This project focuses on quite long pulses (from micro- to milli-pulses) compared with the ANR consortium INTCELL that has begun in December 2010. The main goal is to provide multi-scale modelling of "classical" eletroporation, in order to obtain numerical tools that can help from one side the biologists to understand the electropermeabilization process when "non standard" pulses are applied, and from the other side it eventually aims at providing tools for the physicians to optimize the pulse delivering when the electrochemotherapy is used.

8.2.2. French-German cooperative consortium SmartOnline

Participants: Angelo Iollo, Iraj Mortazavi.

- Program: ANR & BMBF
- Project acronym: SmartOnline
- Project title: Online security management toolkit for water distribution networks.
- Duration: 04/2012-04/2015
- Coordinator: Olivier Piller (IRSTEA)
- Other partners: Irstea, Veolia, ENGES, CU Strasbourg, BW Berlin, TZW Dresden, 3S Consult, Franhoefer.
- Abstract: The main objective of the project SMaRT-OnlineWDN is the development of an online security management toolkit for water distribution networks that is based on sensor measurements of water quality as well as water quantity. Its field of application ranges from detection of deliberate contamination, including source identification and decision support for effective countermeasures, to improved operation and control of a WDN under normal and abnormal conditions (dual benefit).

8.2.3. Plan Cancer METASTASIS

Participants: Sébastien Benzekry, Thierry Colin, Clair Poignard, Olivier Saut.

- Program: Plan Cancer: Systems Biology
- Project acronym: METASTASIS
- Project title: Modeling the Interaction of the (Metastasis) Vascular/Tumor Niche Using a Systems Biology Approach
- Duration: 2013-2015
- Coordinator: A. Bikfalvi (Biologie, Bordeaux University)

8.2.4. Plan Cancer MIMOSA

Participants: Sébastien Benzekry, Thierry Colin, Clair Poignard, Olivier Saut.

- Program: Plan Cancer: Physique, Mathématiques et Sciences de l'ingénieur appliqués au Cancer
- Project acronym: MIMOSA
- Project title: Mathematical modeling for exploration of the impact of mechanical constraints on tumor growth
- Duration: 2014-2017
- Coordinator: T. Colin

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. FFAST

Title: FUTURE FAST AEROELASTIC SIMULATION TECHNOLOGIES

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Duration: January 2010 - December 2012

Coordinator: University of Bristol (Saint Pierre And Miquelon)

Others partners: University of Bristol, irias, TU Delft, Politecnico di Milano, Numeca, EADS, DLR, Airbus, University of Cap Town, csir, Optimad

See also: http://www.bris.ac.uk/aerodynamics-research/ffast/

Abstract: The FFAST project aims to develop, implement and assess simulation technologies to accelerate future aircraft design. These technologies will demonstrate a step change in the efficiency and accuracy of the dynamic aeroelastic "loads process" using unique critical load identification methods and reduced order modelling. The outcome from the project will contribute to the industrial need to reduce the number of dynamic loads cases analysed, whilst increasing the accuracy and reducing the cost/time for each unsteady aeroelastic analysis performed compared to the current approach. Unsteady loads calculations play an important part across much of the design and development of an aircraft, and have an impact upon the concept and detailed structural design, aerodynamic characteristics, weight

8.3.2. Collaborations in European Programs, except FP7 & H2020

Program: European associated laboratory

Project acronym: EBAM

Project title: Pulsed electric fields applications in biology and medicine

Duration: January 2011 - December 2014

Coordinator: C. Poignard

Other partners: Institut Gustave Roussy (CNRS, Paris), Laboratory of Pharmacology and Structural Biology (CNRS and University of Toulouse, Toulouse), Laboratory XLIM (Limoges), Faculty of Health Sciences (Primorska), Laboratory of Structure and Reactivity of the Complex Molecular Systems (CNRS and University of Lorraine), University of Ljubljana (Ljubljana), Institute of Oncology (Ljubljana)

Abstract: The main aim of the LEA EBAM is to use an interdisciplinary approach, integrating biology, chemistry, physics, biophysics, mathematics, computational modelling and engineering, through the expertise of its members in order to

- Enhance our understanding on the mechanisms of classical electropermeabilization and of the new nanopermeabilization (electropermeabilization using nanosecond electric pulses), as well as on the mechanisms of transmembrane transport of molecules into electroporated cells and tissues on a microscopic and macroscopic scale.
- Contribute to a better and safer implementation of the electropermeabilization-based applications, and to the development of new applications.
- Develop new devices and new equipment for the nanopermeabilisation at cell and tissue levels.
- Develop new approaches like treatment planning in existing applications, such as antitumor electrochemotherapy and in vivo gene transfer for therapeutic purposes.
- Disseminate the knowledge and the applications in the scientific community and in the society, through publications, a one-week course (already implemented) co-directed by the LEA directors, internal and external training, and through other means that the LEA will develop and/or will apply for (to the EC programs for example).

8.4. International Initiatives

- Collaboration with Hassan Fathallah, Neuro-oncoly and mathematics, University of Alabama at Birmingham. We work on numerical modeling of brain tumor.
- PHC Sakura on cancer modeling with University of Osaka. (12Keur for 2 years) Collaboration with the University of Osaka on the modeling of the cell migration in cancer.
- Collaboration with IAC, CNR (R. Natalini) and E. Signori on tissue electroporation and DNA transfection.
- Collaboration with John Ebos, Roswell Park Cancer Institute, Buffalo, NY, USA. Quantification of metastatic potential and differential effect of anti-angiogenenic therapies on primary tumor and metastasis, in a preclinical setting.
- Collaboration with the Center of Cancer and Systems Biology at Tufts University, Boston, MA, USA. We work together on quantitative modeling of tumor-tumor interactions and their implications on global metastatic dynamics.
- Collaborations with Luca Zannetti, Politecnico di Torino; Simone Camarri, Universita di Pisa; Eyal Arian, Boeing Commercial Airplanes.
- Collaboration with Sinisa Krajnovic, Chalmers University, on the high fidelity simulation and control of ground vehicle flows.
- Collaboration with Spencer Sherwin and Denis Doorly (Imperial College London) on the novel flow diagnostics approaches.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- J. Zubelli (IMPA, Rio de Janeiro, Brazil) from June 30th to July 4th
- V. Pérez-Garcia and A. Martinez (Universidad de Castilla-La Mancha, Ciudad Real, Spain) from November 12th to November 14th
- M. Ohta (Tokyo University of Sciences, Japan) from December 4th to 12th
- L. Wegner (Karlsruhe institute of Technology, Germany) from December 15th to 19th

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.

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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. QUANTHOM

Type: FP7

Instrument: ERC Starting Grant

Duration: February 2014 - January 2019

Coordinator: Antoine Gloria

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

Inria contact: Antoine Gloria

Abstract: Quantitative methods in stochastic homogenization

8.2.2. Collaborations with Major European Organizations

Max Planck Institute for Mathematics in the Sciences (Germany).

Development of a quantitative theory of stochastic homogenization.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

The activity around quantitative stochastic homogenization was developed in collaboration with F. Otto, director of the Max Planck Institute for Mathematics in the Sciences, Leipzig (Germany).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Daniel Marahrens (MPIMS, Leipzig): one week in March (A. Gloria), annealed estimates on Green's functions.
- Felix Otto (MPIMS, Leipzig): one week in April (A. Gloria), quantitative stochastic homogenization.
- Gilbert Reinisch (physicist at University of Reykjavik): from May 12th 2014 to May 28th 2014 (G. Dujardin and M. Gazeau), numerical simulations of several differential systems modelling the evolution of quantum dots. This visit was cofounded by Inria and the LabEx CEMPI. This work is a follow up of the paper [18].
- Marco Cicalese (Univ. Munich): one week in May (A. Gloria), derivation of nonlinear elasticity from polymer-physics.
- Jean-Christophe Mourrat (ENS Lyon): 10 days in May (A. Gloria), quantitative stochastic homogenization.
- Stefan Neukamm (Weierstrass Institute, Berlin, now at Univ. Dresden): 10 days in May (A. Gloria), quantitative stochastic homogenization.
- Ansgar Jüngel (Univ. Vienna): one week in July (C. Chainais and I. Lacroix-Violet), discrete functional inequalities for asymptotic preserving schemes.

MOKAPLAN Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Jean-David 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. Four extended seminars have been organized/co-organized by Mokaplan. Check https://project.inria.fr/isotace/news.
Christophe Duquesne (Aurigetech) is a software and mobility consultant hired on the ANR budget. He helps the consortium to develop its industrial partnerships.

7.2. International Initiatives

7.2.1. Inria Associate Teams

7.2.1.1. MOKALIEN

Title: Numerical Optimal Transportation in (Mathematical) Economics

International Partner (Institution - Laboratory - Researcher):

McGill University (CANADA)

Duration: 2014 - 2016

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

The overall scientific goals is to develop numerical methods for large scale optimal transport and models based on optimal transport tools
see https://team.inria.fr/mokaplan/files/2014/09/MOKALIEN_Proposal_2013.pdf, section 2.

A few additional applications were suggested at our annual workshop in october
https://team.inria.fr/mokaplan/first-meeting-in-montreal-at-u-mcgill-october-20-24-2014/

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Adam Oberman (U. Mc Gill) visited Mokaplan in June.

7.3.2. Visits to International Teams

7.3.2.1. Sabbatical programme

Guillaume Carlier in on sabbatical for the academic year (délégation CNRS at the UMI-CNRS 3069 PIMS at UVIC, Victoria, British Columbia, Canada). He is taking advantage of this full-research year to work on optimal transport methods for kinetic models for granular media (with M. Agueh and Reinhard Illner), Wasserstein barycenters and to continue to develop joint projects on numerical optimal transport with J.D. Benamou's MOKAPLAN team.

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 [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA 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], 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 projet 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

Type: FP7

Defi: Special action

Instrument: Integrated Project

Objectif: Exascale computing platforms, software and applications

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.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Declared Inria International Partners

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

7.3.2. Participation In other International Programs

7.3.2.1. 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 Grad<uate 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.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Liang Li, UESTC, China, July 15-August 8

Jay Gopalakrishnan, Portland University, USA, December 8-11

Maciej Klemm, University of Bristol, UK, July 29-August 2

NANO-D Project-Team

6. Partnerships and Cooperations

6.1. 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.

6.2. National Initiatives

6.2.1. ANR

In 2014, NANO-D had funding from two ANR programs:

- **ANR Jeunes Chercheurs Jeunes Chercheuses (JCJC)**: 340,000 Euros over three years (2011-2014). This grant has been provided to S. Redon by the French Research Agency for being a finalist in the ERC Starting Grant 2009 call, and is for two PhD students and an engineer.
- **ANR Modeles Numeriques (MN)**: 180,000 Euros over four years (2011-2015). This project, coordinated by NANO-D (S. Grudinin), gathers biologists and computer scientists from three research groups: Dave Ritchie at LORIA, Valentin Gordeliy at IBS (total grant: 360,000 Euros).

6.2.2. PEPS

Sergei Grudinin participates in the Cryo-CA PEPS project. Cryo-CA (Computational algorithms for biomolecular structure determination by cryo-electron microscopy) is a 2-years project, supported by the Projets Exploratoires Pluridisciplinaires (PEPS) program in the panel Bio-Maths-Info provided by CNRS (French National Centre for Scientific Research). The project started on the 01/09/2012. Its main goal is to develop computational algorithms for cryo-electron microscopy (cryo-EM).

The partners of the Cryo-CA project are: Inria Nancy / Team Orpailleur (David Ritchie); Inria Grenoble / Team NANO-D (Sergei Grudinin); and INSERM IGBMC/ Team Integrated structural Biology (Annick Dejaegere, Patrick Schultz, and Benjamin Schwarz).

The main scientific aim of this cross-disciplinary project is to develop computational algorithms to help experimentalists and molecular modelers to solve more rapidly and accurately the structures of macromolecular complexes using cryo-electron microscopy (cryo- EM) and integrative structural biomolecular modeling techniques. More specifically, this PEPS initiative aims to address two important challenges in single particle cryo-EM, namely particle picking and multi-dimensional structure fitting. In the longer term, a further driving aim of this project is to develop strong collaborations amongst the participating teams to position ourselves for a larger project proposal to ANR or ERC.

6.3. European Initiatives

6.3.1. FP7 & H2020 Projects

6.3.1.1. ADAPT

Type: IDEAS

Defi: NC

Instrument: ERC Starting Grant

Objectif: Theory and algorithms for adaptive particle simulation

Duration: September 2012 - August 2017

Coordinator: Stephane Redon

Inria contact: Stephane Redon

6.4. International Initiatives

6.4.1. Inria International Partners

6.4.1.1. Informal International Partners

- We have a collaboration with Boston University on the development of docking algorithms (Dima Kozakov).
- We have a collaboration with ETH Zurich on the development of interactive algorithms for quantum chemistry (Markus Reiher).

6.5. International Research Visitors

6.5.1. Visits of International Scientists

Prof. Dima Kozakov visited the group in 2014. Dima Kozakoz is a Research Assistant Professor at Boston University (http://www.bu.edu/bmerc/people/affiliated-faculty/). Proteomics revolution provided blue-print of molecular interactions in the cell, however, full mechanistic understanding of how molecules interact comes only from three-dimensional structures. As was shown by Protein Structure Initiative (PSI), it is much more difficult to obtain structures of the protein complexes using high resolution experimental approaches, such as an X-ray or NMR, rather than structures of its individual components. Our groups (at Boston University and Inria / LJK Grenoble) have developed highly efficient protein docking approaches, which were successful in the CAPRI protein docking competition, and thus our next goal is to apply these to genome scale studies. We hope that structural modeling can not only provide potential complex structures, but also clean up uncertainty of the data obtained from high-trhoughtput approaches.

OPALE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Project "SOKA"

OPALE team is coordinator of the project SOKA, funded by INSEP. The objective is the optimization of the shape 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).

7.1.2. Project "OASIS"

The OASIS project, Optimization of Addendum Surfaces In Stamping, is an R&D consortium (CS, Arcelor-Mittal, ErDF, Inria, UTC, EURODECISION, ESILV, NECS, DeltaCAD, SCILAB-DIGITEO) of the Pole Systemtic Paris-Region dedicated to develop an optimal design framework (methods-software platforms-applications) for stamping processes. The EPI OPALE/Inria is the leader within the consortium for the Optimization work-package (one of six WP), the role of which is to develop efficient tools well adapted to Pareto front identification of the multicriteria-dependent stamping processes.

The OASIS project yields 2.4 Meuro total financial support (one Ph.D thesis, two post-doctoral positions and 12 months internship for OPALE).

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. GRAIN 2

Type: Cooperation

Defi: Transport (incl. Aeronautics)

Instrument: Coordination and Support Action (CSA)

Objectif: NC

Duration: October 2013 - June 2016

Coordinator: Centre Internacional de Metodes Numerics en Enginyeria, Barcelone (Spain)

Partner: Airbus (Sp), Alenia (I), EADS-IW (F), Rolls-Royce (UK), Ingenia (Sp.), Numeca (B), U. Sheffield (UK), U. Birmingham (UK), CIRA (I), VKI (B), Airbone (NL), Leitat (Sp), Cerfacs (F), U. Cranfield (UK), CAE (CN), GTE (CN), ARI (CN), FAI (CN), ASRI (CN), SAERI (CN), BIAM (CN), ACTRI (CN), BUAA (CN), NPU (CN), PKU (CN), NUAA (CN), ZIU (CN)

Inria contact: Toan Nguyen

Abstract: The main objective of GRAIN2 is to focus its greening activities following the Flight Path 2050 Vision for Aircraft en route to the very ambitious challenge "Protecting the environment and the energy supply" in three major following lines: i) greening the air vehicle, ii) greening the Air transport System and iii) Reducing the carbon foot print of aviation via sustainable alternative fuels. GRAIN2 will identify innovative R & D methods, tools and HPC environments (supercomputers and GPGPUs) in the different KGTs according to the needs of major aeronautical industries to deeper understand the mechanism of engine exhaust emissions, to improve fuel efficiency and environmental performance, to lower noise for landing gear and high lift surfaces, to introduce new materials with multiple functions, to help significantly the development of biofuels for greenhouse gas emission reduction, etc.

http://www.cimne.com/grain2/

7.2.1.2. 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

7.2.1.3. VELaSSCo

Type: FP7 (Strep)

Defi: ICT, Technologies for Digital Content and Languages

Instrument: Specific Targeted Research Project

Objectif: Scalable data analytics

Duration: January 2014-December 2016

Coordinator: Centre Internacional de Metodes Numerics en Enginyeria (Spain)

Partners: JOTNE (No.), SINTEF (No.), Fraunhofer IGD (D), ATOS (SP), Univ. Edinburgh (UK)

Inria contact: Toan Nguyen

Abstract: VELaSSCo aims at developing a new concept of integrated end-user visual analysis methods with advanced management and post-processing algorithms for engineering modelling applications, scalable for real-time petabyte level simulations [59]. The interface will enable real-time interrogation of simulation data, generating key information for analysis. Main concerns have to do with handling of large amounts of data of a very specific kind intrinsically linked to geometrical properties; how to store, access, simplify and manipulate billion of records to extract the relevant information; how to represent information in a feasible and flexible way; and how to visualise and interactively inspect the huge quantity of information they produce taking into account end-user's needs. VELaSSCo achieves this by putting together experts with relevant background in Big Data handling, advanced visualisation, engineering simulations, and a User Panel including research centres, SMEs and companies form key European industrial sectors such as aerospace, household products, chemical, pharmaceutical and civil engineering.

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. ORESTE

Title: Optimal REroute Strategies for Traffic managEment

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (ÉTATS-UNIS)

Duration: 2012 - 2014

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

ORESTE is an associated team between OPALE project-team at Inria and the Mobile Millennium / Integrated Corridor Management (ICM) team at UC Berkeley focused on traffic management. With this project, we aim at processing GPS traffic data with up-to-date mathematical techniques to optimize traffic flows in corridors. More precisely, we seek for optimal reroute strategies to reduce freeway congestion employing the unused capacity of the secondary network. The project uses macroscopic traffic flow models and a discrete approach to solve the corresponding optimal control problems. The overall goal is to provide constructive results that can be implemented in practice. Both teams have actively contributed to recent advances in the subject, and we think their collaboration is now mature enough to take advantage of the associate team framework. The Inria team and its theoretical knowledge complement the Berkeley team, with its engineering knowledge anchored in practice.

7.3.2. Participation In other International Programs

- Inria@SILICONVALLEY :

  ORESTE Associated Team with UC Berkeley takes part to the program.

- LIRIMA Team ANO 2010-2014:

  The agreement governing the creation of the International Laboratory for Research in Computer Science and Applied Mathematics (LIRIMA) was signed on 24th November 2009 in Yaoundé. LIRIMA enables cooperation between Inria research teams and teams in Africa (Sub-Saharan Africa and the Maghreb) to be reinforced. It is the continuation of the major operation undertaken by the SARIMA program (2004-08 Priority Solidarity Fund created by the French Ministry of Foreign & European Affairs).

  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), multiobjective optimization in structural mechanics, and vehicle traffic and crowd motion. Refer to the website http://www.lirima.uninet.cm/index.php/en/ for more details on the LIRIMA Africa themes and teams.

- 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. Senior Researchers

Pr. Rinaldo M. Colombo

Subject: Conservation laws with non-local flux function.

Institution: Brescia University , Brescia (Italy)

Pr. Simone Göttlich

Subject: Optimization of traffic flows on networks.

Institution: Mannheim University , Mannheim (Germany)

Pr. Moez Kallel

Subject: Data completion for heat-elasticity systems

Institution: ENIT, Tunis al Manar University (Tunisia)

7.4.1.2. Internships

- E. Bertino from Ecole Centrale de Nantes (uncertainty quantification in traffic flow models).
- C. Fiorini from Politecnico di Milano (multiple gradient descent algorithm applied to unsteady optimization).
- S. Scialanga from Roma La Sapienza University (traffic flow models with non-local velocity)

POEMS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives - ANR

- ANR project *PROCOMEDIA: Propagation d'ondes en milieux complexes*
  Partners: ESPCI, Laboratoire d'Acoutique de l'Université du Maine, Departamento de Fisica de la Universidad de Chile.
  Start : 04/01/2011, End : 03/30/2014. Administrator : CNRS. Coordinator for POEMS : Jean-François Mercier.
- 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: Université Pierre et Marie Curie (Paris 6), Université de Lorraine
  Start : 10/01/2012, End : 10/01/2015 Administrator : Inria Coordinator for POEMS: Eliane Bécache
- ANR project *SODDA: Diagnostic de défauts non francs dans les réseaux de câbles*
  Partners: CEA LIST, ESYCOM, LGEP (Supelec)
  Start : 10/01/2012, End : 10/01/2015 Administrator : Inria Coordinator for Poems: Patrick Joly
- 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

8.2. European Initiatives - FP7 & H2020 Projects

8.2.1. SIMPOSIUM

Type: FP7

Defi: ICT for the Enterprise and Manufacturing

Instrument: Integrated Project

Objectif: PPP FoF: Digital factories: Manufactoring design and product lifecycle management

Duration: September 2011 - August 2014

Coordinator: Steve MAHAUT, CEA/LIST

Inria contact: P. Joly, E. Lunéville

Abstract: Gathering together industrial companies, research centres and universities, the purpose of the SIMPOSIUM project is the integration in a unique platform of interoperable Non Destructive Evaluation simulation tools, to make possible virtual testing of parts at the early stages of manufacturing and design. The role of POEMS team is to develop a new finite element library (XLiFE++) with specific tools dedicated to propagation in waveguides. The library is now available and simulations of propagation in composite (anistropic elastic medium) waveguide have been done and compared to simulations provided by CIVA platform.

8.2.2. 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

Wilkins Aquino (Duke University)

George Biros (University of Texas, Austin)

Fioralba Cakoni (University of Delaware)

Eric Chung (Chinese University of Hong Kong)

Dan Givoli (Technion - Israel Institute of Technology)

Nabil Gmati (Ecole Nationale d'Ingénieurs de Tunis)

Bojan Guzina (University of Minnesota)

Manfred Kaltenbacher (Technische Universitat Wien)

Sergei Nazarov (Saint-Petersburg University)

Jeronimo Rodriguez (University of Santiago de Compostela)

Kersten Schmidt (Technische Universitat Berlin)

Chrysoula Tsogka (University of Crete)

Ricardo Weder (Universidad Nacional Autonoma, Mexico)

Wensheng Zhang (Institute of Computational Mathematics, Beijing)

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.

8.3.3. Visits of International Scientists

Ricardo Weder, Institute of Applied Mathematics and Systems, Universidad Nacional Autonoma, Mexico (June 2014).

Wensheng Zhang, Institute of Computational Mathematics, Beijing (September 2014).

Eric Chung, Department of Mathematics, Chinese University of Hong Kong (November 2014).

Shravan Veerapaneni, Department of Mathematics, University of Michigan (December 2014).

8.3.4. Visits to International Teams

Gary Cohen visited Prof. Wensheng Zhang at LSEC, Institute of Computational Mathematics, Chinese Academy of Sciences (CAS) in Beijing January 5-13.

Gary Cohen visited Dr. Eric Chung at Department of Mathematics in The Chinese University of Hong Kong (CUHK). They continued their collaboration on staggered discontinuous Galerkin methods and started a collaboration on mortar elements for hybrid meshes for the Maxwell's system.

APICS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Contract Provence Alpes Côte d'Azur (PACA) Region - Inria, BDO

Contract (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

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), respectively specialized in filters, antennas and amplifiers design. The core idea of the project is to work on the co-integration of various microwave devices in the context of GPS satellite systems in particular it provides us with an opportunity to work on matching problems (see Section 6.3.1).

8.2.2. ANR MagLune

The ANR project MagLune (Magnétisme de la Lune) has been approved by 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 will participate 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

8.4.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

Inria principal investigator: Laurent Baratchart

International Partner (Institution - Laboratory - Researcher):

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

Duration: 2013 - 2015
See details at : 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 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 . 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"

Cyprus NF grant was obtained by N. Stylianopoulos (Univ. Cyprus) to conduct joint research with L. Baratchart, E.B. Saff (Vanderbilt Univ.) and V. Totik (Univ. Szeged, Hungary). The title of the grant is: "Orthogonal polynomials in the complex plane: distribution of zeros, strong asymptotics and shape reconstruction".

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Doug Hardin (Vanderbilt Univ., Nashville, USA, Aug 2014)
- Benjamin Lanfer (BESA, Munich, Germany, Oct 2014)
- Eduardo A. Lima (MIT, Cambridge, USA, Mar 2014)
- Moncef Mahjoub (ENIT LAMSIN, Tunis, Tunisia, Jun 2014)
- Michael Northington (Vanderbilt Univ., Nashville, USA, Aug 2014)
- Yves Rolain (Vrije Universiteit Brussel, Belgium, June 2014)
- Maxim Yattselev (Indiana University–Purdue University, Indianapolis, USA, May 2014)

8.5.1.1. Internships

- Olga Permiakova, Master 2 Computational Biology - UNSA (5 months), Inverse source problem for electromagnetic fields, with physical applications.

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), University of Urana-Champaign at Indianapolis (Indianapolis, USA), 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 CSF program (with University of Cyprus).

BIPOP Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Florence Bertails-Descoubes was awarded in November 2014 an ERC starting grant to work on the parameter identification of slender structures subject to contact and friction. The grand will start in 2015 and will serve to fund 3 PhD students, 2 post-docs and 1 engineer on a total project duration of 5 years.

8.3. International Initiatives

8.3.1. Inria International Labs

Vincent Acary is on sabbatical at Santiago from September 2014 to August 2016.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Ryo Kikuuwe (Associate professor, Khushu University, Japan) from 01 September 2014 to 28 February 2015.
- Nathan Krislock (Associate professor, North Illinios University, USA) from 01 June to 10 July.

8.4.2. Visits to International Teams

8.4.2.1. Sabbatical programme

Acary Vincent

Institution: CMM Chili (Date : Sep 2014 - Aug 2016)

Institution: Inria Chile (Date: Sep 2014 - Aug 2015)

COMMANDS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- F. Bonnans is coordinator of the ICODE project “Strategic crowds: analysis and simulation”, with U. Limoges, Paris-Sud.
- F. Bonnans participates to two PGMO project: “Hydro-electric scheduling under uncertainty”, with U. Auckland, “Perturbation analysis for deterministic and stochastic optimal control problems”, with U. Limoges and TSE (Toulouse),
- P. Martinon participates to the OPTIBIO project, supported by FMJH-PGMO, devoted to “New challenges in the optimal control of bioprocesses”, with U. Angers, Lille 1 / Limoges

8.2. National Initiatives

8.2.1. DGA

Participants: Olivier Bokanowski, Anna Désilles, Hasnaa Zidani.

This project is a collaboration in the framework of a 3-year (2012-2015) research program funded by DGA. The title of the project is “Problèmes de commande optimale pour des systèmes non-linéaires en présence d’incertitudes et sous contraintes de probabilité de succès”.

8.2.2. ANR HJNet

Participants: Olivier Bokanowski, Zhiping Rao, Hasnaa Zidani.

The team is part of the collaborative project HJNet funded by the French National Research Agency (ANR-12-BS01-0008-01). It started in January 2013 and will end in December 2013. Website: http://hjnet.math.cnrs.fr

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. SADCO

Type: FP7

Defi: NC

Instrument: Initial Training Network

Objectif: NC

Duration: January 2011 - December 2014

Coordinator: Inria

Partner: Univ. of Louvain, Univ. Bayreuth, Univ. Porto, Univ. Rome - La Sapienza, ICL, Astrium-Eads, Astos solutions, Volkswagen, Univ. Padova, Univ. Pierre et Marie Curie.

Inria contact: Hasnaa Zidani

Abstract: Optimisation-based control systems concern the determination of control strategies for complex, dynamic systems, to optimise some measures of best performance. It has the potential for application to a wide range of fields, including aerospace, chemical processing, power systems control, transportation systems and resource economics. It is of special relevance today, because optimization provides a natural framework for determining control strategies, which are energy efficient and respect environmental constraints. The multi-partner initial training network SADCO aims at: Training young researchers and future scientific leaders in the field of control theory with emphasis on two major themes sensitivity of optimal strategies to changes in the optimal control problem specification, and deterministic controller design; Advancing the theory and developing new numerical methods; Conveying fundamental scientific contributions within European industrial sectors.

See: http://itn-sadco.inria.fr

8.4. International Initiatives

8.4.1. Inria International Labs

We are involved in the CIRIC team "Optimization and control of energy", jointly with U. de Chile at Santiago. This collaboration involved several visits of the team in Santiago: F. Bonnans (1 week), B. Heymann (2 months) and P. Martinon (2 weeks).

8.4.2. Inria Associate Teams

8.4.2.1. OCONET

Title: Optimization and control in network economics

International Partner:

Universidad de Chile (CHILI)

Duration: 2012 - 2014.

See also: http://www.cmm.uchile.cl/EA_OCONET/

Limited resources in telecommunication, energy, gas and water supply networks, lead to multi-agent interactions that can be seen as games or economic equilibrium involving stochastic optimization and optimal control problems. Interaction occurs within a network, where decisions on what to produce, consume, trade or plan, are subject to constraints imposed by node and link capacities, risk, and uncertainty, e.g. the capacity of generators and transmission lines; capacity of pipeline in gas supply; switches and antennas in telecommunication. At the same time, nonlinear phenomena arise from price formation as a consequence of demand-supply equilibria or multi-unit auction processes in the case of energy and telecommunication. We will focus first in this project in electricity markets in which there are producers/consumers PCs, and an agent called ISO (Independent system operator) in charge of the management of the network. One major application we have in mind is the one of smart (electrical) grids, in view of the increased use of renewable energies, that is, a massive entry of wind, geothermal, solar in particular.

8.4.3. Inria International Partners

8.4.3.1. Informal International Partners

Collaboration with the CIFASIS lab of U. Rosario, Argentina (3 months visit of J. Gianatti).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Andew Philpott, U. Auckland (NZ), 6 weeks. Research on stochastic optimization with F. Bonnans and F. Wahid.

8.5.1.1. Internships

- Justina Gianatti, Cifasis, U. Rosario (Argentina), 3 months. Research on stochastic control with F. Bonnans.

CORIDA Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Most of the members of our team are involved in at least one ANR program.

Marius Tucnsak is local coordinator of ANR blanc project Hamecmopsys. This ANR project will be active up to 2015.

Antoine Henrot is head of the ANR blanc project OPTIFORM since September 2012. This project is devoted to the Geometric Analysis of Optimal Shapes. It gathers scientist from Grenoble, Chambéry, Lyon, Rennes and Paris Dauphine. This ANR project will be active up to August 2016.

Xavier Antoine is coordinator for partner 2 of ANR blanc project BECASIM since September 2013. This ANR project will be active up to 2017.

7.1.2. GDR

Thomas Chambrion has been animator of the EDP group of GDR MAC since October 2014.

7.2. International Research Visitors

7.2.1. Visits of International Scientists

Prof Gengsheng Wang, University of Wuhan, China, visited our team for 3 months.

Prof George Weiss, University of Tel Aviv, Israel, visited our team for 1 month.

7.2.2. Visits to International Teams

Julie Valein has been invited for 3 months (October-December) in the Department of Applied Physics and Applied Mathematics (APAM) at Univeristy of Columbia, New-York, USA.

DISCO Project-Team

8. Partnerships and Cooperations

8.1. 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).

- DIGITEO Project (DIM LSC) MOISYR

  Project title: Monotonie, observaterus par intervalles et systèmes à retard.

  Dedember 2011- December 2014

  Coordinator: Frédéric Mazenc

  Other partners: L2S, France, Mines-ParisTech, France

  Abstract: MOISYR is concerned with the problem of extending the theory of monotone systems to the main families of continuous time systems with delay along with the application of this theory to the design of observers and interval observers. In particular, nonlinear systems with pointwise and distributed delays and stabilizable systems with delay in the input shall be considered. In a second step, we extend our result to discrete time systems and to a specific class of continuous/discrete systems calles Networked Control Systems.

8.2. National Initiatives

8.2.1. 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.

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).

Frédéric Mazenc is member of the Conseil du Laboratoire of Laboratoire des Signaux et Systèmes (L2S).

Frédéric Mazenc is member of the commission scientifique du CRI Saclay- Ile-de-France.

8.3. European Initiatives

8.3.1. 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.

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Program: **PHC Pessoa (Portugal)**

Project acronym: 28750QA

Project title: Robust Distributed Model Predictive Control of Medium- and Large- Scale Systems

Duration: 2013-2014

Coordinator: Cristina Stoica (French leader), Fernando Lobo Perreira (Portuguese leader)

Other partners: Sorin Olaru

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Program:**PHC Brancusi (Romania)**

Project acronym: 28705PF

Project title: Adaptive and predictive control of bioprocesses (modelling, identification and control of interconnected bioprocesses)

Duration: 2013-2014

Coordinator: Sihem Tebbani (French leader), Dan Selisteanu (Romanain leader)

Other partners: Sorin Olaru

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Program:**PHC Parrot**

Project acronym: CASCAC

Project title: Computer Algebra, Symbolic Computation, and Automatic Control

Duration: 2013 - 2014

Coordinator: Alban Quadrat (French leader), Maris Tõnso (Estonian leader)

Other partners: Institute of Cybernetics, University of Tallinn

Abstract: The CASCAC project is at the interfaces of control theory, computer algebra and software engineering. The goals of the project are: 1. Develop new theoretical results on nonlinear control systems defined by functional equations (e.g., ordinary differential equations, partial differential equations, differential time-delay equations, partial difference equations). 2. Implement them on dedicated softwares developed in the computer algebra system Mathematica. In particular, Mathematica versions of the OREMODULES and OREMORPHISMS packages will be developed. 3. Develop an interface between the C library BLAD (http://www.lifl.fr/~boulier/pmwiki/pmwiki.php?n=Main.BLAD) − dedicated to differential algebra techniques − and Mathematica. This interface will allow one to have access to differential elimination techniques in Mathematica and to use them in decision methods for nonlinear control theory. 4. Co-supervise the Master thesis of Kristina Halturina with Prof. Ülle Kotta on constructive aspects of differential flatness and its applications to control theory (e.g., tracking, motion planning).

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Program:**PHC GALILEE 2014**

Project acronym: SeTASDelSys - 30188PK

Project title: Set theoretic analysis of switched and time delay systems with application to fault tolerant control systems

Duration: January 2014 - December 2014

Coordinator: Sorin Olaru (France), Stefano Miani (Italy)

Other partners: Dipartimento di Ingegneria Elettrica, Gestionale e Meccanica, Universita' degli Studi di Udine, Italy

Abstract: The present Galileo project intends to initiate a collaborative research relationship based on the common interest of the French and Italian teams in the set-theoretic analysis of switched and delay time dynamics. On a broad perspective, the results on these topics can be extended to different aspects of the control design (as fault tolerance, constraints handling or robustness with respect to communication uncertainties). The scientific objective is to address two main open problems : i) the construction of (positive) invariant sets for switched dynamical systems; ii) the definition of the appropriate concepts of set invariance for delay time systems and their algorithmic construction.

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Program: **PHC Rila (Bulgaria)**

Project acronym: 29401YJ

Project title: Robust Distributed Model Predictive Control of Medium- and Large- Scale Systems

Duration: 2013-2014

Coordinator: Sorin Olaru (French leader), Alexandra Grancharova (Bulgarian leader)

Other partners: Bulgarian Academy of Science

Abstract: The project intends to address the control design of large scale dynamical systems with an emphasis on distributed predictive control strategies. There are two points of view with respect to the control synthesis in this framework: a. avoid the use of a global prediction model in the receding horizon optimal control of the subsystems and privilege the use of a coordination level in the decision process; b. consider the distributed synthesis for a network of discrete-time constrained linear systems without central coordinator. In the present project we intend to contribute to both of these directions by: a. Prediction of the interactions in between subsystems in a decomposition-coordination scheme. This can be done by imposing a reduced set of constraints for the MPC problems at the lower levels. b. With respect to the MPC design in the absence of coordination one of the issues will be the definition of appropriate terminal sets, ensuring invariance properties or at least recursive feasibility for the global functioning. We will investigate the construction of terminal set for a stabilizing centralized MPC decomposable in the form of a cross product of sets in each subsystem state space. An interesting idea on this direction was presented recently by the participants in this project.

8.3.2. Collaborations with Major European Organizations

Partner 1: University of L'Aquila, Department of Electrical and Information Engineering (Italy)

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

Partner 2: RWTH Aachen University, Germany

Mathematical systems theory, control theory, symbolic computation

Partner 3: Bilkent University, Turkey

Control of linear and nonlinear systems with delays, medical applications

Partner 4: Tel Aviv University, Israel

Stability analysis of nonlinear Partial Differential Equations

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- E. Acchab, University of El Jadida, Marocco, 01-15/11.
- M. Barakat, University of Kaiserslautern, Germany, 31/04-01/05.
- Y. Belikov, University of Tallinn, Estonia, 26-30/05.
- E. Fridman, University of Tel-Aviv, Israël, 22/09-22/10.
- U. Kotta, University of Tallinn, Estonia, 26-30/05.
- P. Laakkonen, University of Tampere, Finland, 09-17/06.
- G. Regensburger, RICAM, Linz, Austria, 06/03.
- D. Robertz, University of Plymouth, United Kingdom, 02-05/06.
- M. Tõnso, University of Tallinn, Estonia, 26-30/05, 17-21/11.
- Y. Yamamoto, University of Kyoto, Japan, 15-30/04.

National scientists who gave a talk at the seminar *Théorie Algébrique des Systèmes* (http://pages.saclay.inria.fr/alban.quadrat/Seminar.html): F. Boulier (University of Lille I, 27/05), Y. Bouzidi (Inria Nancy, VEGAS, 30/06), T. Cluzeau (University of Limoges, 19-20/11), J.-A. Weil (University of Limoges, 20/01, 03/02).

8.4.1.1. Internships

- Master thesis: W. Djema, *Etude de la stabilité d'un modèle de leucémie aiguë myëloblastique*, Ecole Nationale Polytechnique d'Alger (Algeria), 17/06/2014, C. Bonnet et F. Mazenc.
- Master thesis: K. Halturina, *Constructive study of differential flatness and its applications in control theory*, University of Tallinn (Estonia), grant of the French governement (3 months), 15/05/2014, Alban Quadrat.
- Master thesis: N. Ribard, *Etude constructive des théorèmes de Warfield sur l'équivalence des systèmes fonctionnels linéaires*, University of Versailles (France), 15/09/2014, Alban Quadrat.

8.4.2. Visits to International Teams

Alban Quadrat visited the department of mathematics of the University of SUNY Cortland, New York (USA), 09/2014.

8.5. International Initiatives

8.5.1. Inria International Partners

8.5.1.1. Informal International Partners

- UNICAMP, Sao Paulo, Brazil.

- Kyushu Institute of Technology, Iizuka, Fukuoka and University of Kyoto, Kyoto, Japan.

- Louisiana State University, Baton Rouge, USA.

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.
- **Digitéo project 2012-061D SSyCoDyC.** SSyCoDyC (2013–2014) is financed by Digitéo in the framework of the DIM *Hybrid Systems and Sensing Systems*. It focuses on the application of techniques of hybrid systems to the analysis of retarded equations with time-varying delays. SSyCoDyC has financed the post-doc fellowship of Ihab Haidar and was coordinated by Paolo Mason and Mario Sigalotti.
- 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. iCODE's aims are fostering research, spin-offs creation, training and diffusion of Control and Decision in Paris-Saclay. To those aims, iCODE has received a budget of 980Keuros, supported by *investissements d'avenir*. The scientific topics addressed by iCODE are organized in four research initiatives:
  - Control & Neuroscience
  - Large-scale systems & Smart grids
  - Behavioral Economics
  - White research initiative.

  iCODE is coordinated by Yacine Chitour (L2S-Univ. Paris Sud), associated member and collaborator of GECO. Mario Sigalotti is member of the Steering Committee.

7.2. European Initiatives

7.2.1. FP7 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.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. 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.

7.3.2. 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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. FONDEOL2

Participants: Dominique Siegert, Ivan Guéguen.

Type: Region

Objectif: wind turbines SHM

Duration: June 2011 to June 2014

Coordinator: STX France

Partners: IFSTTAR, Central School of Nantes and EGIS

Inria contact: Ivan Guéguen

Abstract: The project involves innovation supports and foundations for offshore wind around 5 lots representing the issues of the project:

- Lot 1: The design methodology
- Lot 2: Design, calculation, execution and control of offshore foundations
- Lot 3: Structural supports remote monitoring of wind
- Lot 4: Eco-design of supports and foundations for wind jacket and gravity
- Lot 5: Integration of noise reduction during pile installation in foundation design jacket

We are interested in the problem of Lot 3, structural monitoring of wind turbine supports. This lot covers an area of research in full expansion, commonly known as Structural Health Monitoring (SHM).

8.1.2. 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.

8.2. National Initiatives

8.2.1. 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 ...).

8.2.2. 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.

8.2.3. SIPRIS

Participants: Laurent Mevel, Dominique Siegert, Ivan Guéguen, Vincent Le Cam, Mathieu Le Pen, Michael Doehler.

contract 6841.

Type: FUI

Objectif: Systèmes d'Instrumentation pour la prévention des risques

Duration: June 2013 to June 2014

Coordinator: ADVITAM

Inria contact: L. Mevel

Abstract: The project concerns the behavior of a prestressed concrete beam, a series of vibration and displacement measurement was carried out in line with internal stresses due to the cables. This followed an experimental modal analysis and study of the variations of modal parameters on the beam. As part of the project, the laboratory signaling gantry of IFSTTAR Nantes was instrumented to perform an experimental system for automatic damage detection based on monitoring the natural modes of vibration. The gantry was also modeled by the finite element method to predict the variations of the first natural frequencies of vibration for a damage event catalog. The gantry is a metallic structure of 8x12 m, formed by the assembly of profiled aluminum alloy welded. This portico was installed there thirty years on the site. Each pillar is fixed in a massive concrete anchor with threaded rods 10, which are critical for the stability of the gantry. CAD geometric model made with Solidworks that was used for the mesh structure with shell elements. The FE mesh consists of 59231 triangular elements at 6 knots, the model has a total of 143,831 nodes. The thicknesses of the shells of the parts constituting the structure are between 3 and 25 mm. The mechanical properties of the aluminum alloy are reported in the table below. The boundary conditions applied to the model consisted of blocking the degrees of freedom of movement and rotation on the edges of holes arranged to pass the threaded rods. The mesh is refined in the vicinity of the holes. The results give an excellent correlation between simulation and experiment on the relative value for the third mode. The correlation is smaller for the first and the second mode. An update of the numerical model can refine the correlation between simulation and experiment, especially the absolute value of frequencies. As shown in the simulation and experimentation, modes with greater frequency of changes generally important in their relative value.

Tests were performed on laboratory test slabs SII Nantes

Very good progresses has also been validated compared to the problems encountered on PEGASE 1 due to memory limitations (few memory, no MMU, reduced Linux...). A global method is currently tested: transcoding SSI algorithms from Matlab sources to C codes using the Matlab-coder toolbox. Thus code execution is compared to the results got from Matlab from a common benchmark of data files

8.2.4. Collaboration with ISAE

Participants: Laurent Mevel, Ahmed Jhinaoui.

Ahmed Jhinaoui has finished his thesis on helicopter instability. This thesis was co-directed by professor Morlier from ISAE, France. This thesis is funded by FP7-NMP Large Scale Integrated Project IRIS.

8.2.5. 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.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ISMS

Participants: Michael Doehler, Laurent Mevel.

Type: FP7

Defi: Internet-Based Structural Monitoring System

Instrument: Industry-Academia Partnerships and Pathway

Objectif: Develop damage detection framework for SHM

Duration: September 2010 - August 2014

Coordinator: Palle Andersen

Partner: Structural Vibration Solutions (Denmark), University of British Columbia (Canada)

Inria contact: Laurent Mevel

Abstract:

ISMS aimed to address the significant commercial opportunity and rapidly emerging technological potential of improved Damage Detection or Structural Health Monitoring (SHM) technologies for large-scale civil infrastructure by challenging significant and non-trivial, inter-disciplinary and intersectoral barriers currently preventing industrial application and take-up of these technologies. The principal strategic objective of ISMS was joint design and development of a fully automated internet-based damage detection procedure robust to environmental changes with application to fully instrumented large-scale civil infrastructures, primarily bridges [50].

8.3.2. Collaborations in European Programs, except FP7 & H2020

8.3.2.1. European Research Network on System Identification (ERNSI)

Participants: Qinghua Zhang, Michael Doehler, Laurent Mevel.

The I4S project-team is involved in the activities of the European Research Network on System Identification (ERNSI) federating major European research teams on system identification, currently teams from 8 countries. 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.

8.3.2.2. 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. 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).

8.3.2.3. 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.

8.3.2.4. EBONSI

Participant: Qinghua Zhang.

Type: ANR-NSFC

Objectif: Extended Block-Oriented Nonlinear System Identification

Duration: from April 2011 to March 2014.

Coordinator: Qinghua Zhang

Partner: CRAN, Laboratory of Industrial Process Monitoring and Optimization of Peking University.

Inria contact: Qinghua Zhang

Abstract: The main idea of block-oriented nonlinear system identification is to model a complex system with interconnected simple blocks. Such models can cover a large number of industrial applications, and are yet simple enough for theoretic studies. The objectives of the EBONSI project are to extend classical block-oriented nonlinear models to new model structures motivated by industrial applications, and to relax some traditional restrictions on experimental conditions. This is an international project jointly funded by the French Agence Nationale de la Recherche (ANR) and the Chinese National Natural Science Foundation (NSFC) .

Maxplus Project-Team

8. Partnerships and Cooperations

8.1. Actions nationales/National Initiatives

8.1.1. 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).

8.1.2. Programme Gaspard Monge pour l'Optimisation

- Projet intitulé "Méthodes tropicales pour l'optimisation", responsable X. Allamigeon, faisant intervenir M. Akian, P. Benchimol, S. Gaubert, R. Katz, et Z. Qu.
- 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).

8.1.3. 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.

8.2. Actions internationales/International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

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

- 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.

8.2.2. Participation In other International Programs

- La thèse de Pascal Benchimol est financée par une bourse Monge/DGA prévoyant des visites régulières du doctorant dans l'équipe de Michael Joswig (TU Berlin).

8.3. Accueils de chercheurs étrangers/International Research Visitors

8.3.1. Chercheurs étrangers/Visits of International Scientists

- Ricardo Katz (Conicet, Rosario, Argentine), 2 mois entre Septembre et Novembre, financé par Digitéo et PGMO.
- Alexander Guterman (Université d'état de Moscou), 3 jours en Mars, 5 jours en Septembre.
- Visites d'un jour de Francisco Santos, Thorsten Theobald et Michael Joswig (autour de la thèse de Pascal Benchimol).
- Visite de Thomas Hansen, une semaine, Octobre 2014.

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

8.3.2.1. Research stays abroad

- A. Marchesini, visite à l'Université de Manchester, 22-25 avril 2014 et participation a NEP14.
- X. Allamigeon, visite à TU Berlin, 28–30 Avril 2014.
- S. Gaubert, visite à TU Berlin, 28–30 Avril 2014.
- S. Gaubert, visite au CIFASIS, Rosario, Argentina, 8-15 Juin 2014.

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. IMB - Université de Bourgogne, Dijon

The team is officially a common team with University of Nice, but also has very strong links with Université de Bourgogne and IMB (Institute of Mathematics in Burgundy). Bernard Bonnard is currently on leave from Université de Bourgogne; Jean-Baptiste Caillau collaborates actively with us; there is also an active common seminar http://math.unice.fr/~rifford/publis/Journee_McTAO/J_McTAO.html . A formal convention between Inria and Université de Bourgogne has been signed in 2014. It makes the IMB control team a part of McTAO as of January, 2015.

8.2.2. Explosys (franco-german ANR project)

Bernard Bonnard is a memebr of this project, accepted in October, 2014. The coordinators are Dominique Sugny (Dijon) and Stefen Glaser (Munich). The budget is approximately 500 K€.

8.2.3. 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. International Initiatives

There is a strong collaboration with the control group in the University of Hawaii around M. Chyba. The purpose of the collaboration is to study the aspects of the contrast problem in Nuclear Magnetic Resonance.

NECS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. 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).

8.1.2. 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 will construct 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 will bring some responses on how to advance the current pedestrian navigation solutions for the critical domains, using robust software. The specific contribution of LOCATE-ME will be 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).

8.1.3. Other collaborations

Inertial and magnetic data integration for human movements analysis

The goal of this consortium, which is in its second year, is to work on how to deal with inertial data in different or complementary fields. Orange Grenoble lab works on the analysis of inertial data and sells some smart-phones equipped with inertial unit. The goal of Orange is to develop from these data some analysis bricks. The bricks are identified by: a) Monitoring of activity by identifying postures and deduce the activity by a correlation table, b) Prevention of falls by an analysis of walking monitoring, c) Monitoring of indoor and outdoor trajectory, d) Position of the sensor, and e) Identification of the dynamic parts of the signal. Orange offers to provide laboratories participating in the consortium: a) The database created through a 2012 IGS experiment where 7 peoples wore smart-phones for 3 months and the report of the experiment, b) The ability to store the data recorded by the consortium on a server in the capacity limit of the predefined server, c) The loan of smart-phones, and d) A schedule of specifications of a service activity monitoring of remote person. A consortium agreement has been signed by eight laboratories: INSA-INL, UJF-AGIM, UJF-GIPSA, CNRS-LAAS, CNRS-IRIT, Ecole des mines de Douai, ISFTTAR, UTT et Orange Labs.

8.2. European Initiatives

8.2.1. Hycon2

Type: COOPERATION

Objective: Engineering of Networked Monitoring and Control Systems

Instrument: Network of Excellence

Objective: Engineering of Networked Monitoring and Control systems

Duration: September 2010 - August 2014

Coordinator: CNRS (France)

Partners: Inria (France), ETH Zurich (Switzerland), TU Berlin (Germany), TU Delft (Netherlands) and many others

Inria contact: C. Canudas de Wit

Abstract: Hycon 2 aims at stimulating and establishing a long-term integration in the strategic field of control of complex, large-scale, and networked dynamical systems. It focuses in particular on the domains of ground and aerospace transportation, electrical power networks, process industries, and biological and medical systems.

See also: http://www.hycon2.eu

8.2.2. 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 will develop 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 will lead the intelligent traffic-management use and show case.

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

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. COMFORT

Title: COntrol and FOrecasting in Transportation networks

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (ÉTATS-UNIS)

Duration: 2014 - 2016

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

COMFORT is an Associate Team between Inria project-team NeCS and the Berkeley University project PATH. The joint team is in its 1st year of activity. 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 will address issues related to model validation before developing new traffic forecasting and distributed control algorithms. In particular the crucial issue of robustness will be considered through a complementary approach based on both stochastic and deterministic methods. 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. Three main objectives will be addressed in this collaboration: a) Model validation and robust modeling for traffic estimation, control and forecasting; b) New methods for traffic forecasting; c) New methods for distributed traffic control and estimation.

8.3.2. Inria International Partners

H. Fourati has a collaboration with the Kazakhstan National Technical University (KazNTU). He co-advised (with Pr. Olga Shiryayeva in KazNTU) Zarina Samigulina, a PhD student in KazNTU, which defended her PhD Thesis in May 2014.

8.3.3. Participation In other International Programs

F. Garin, A. Kibangou, P. Grandinetti, and C. Canudas de Wit participated in the workshop Berkeley-Inria-Stanford (BIS'2014, Paris) wich is the joint research program inria@Silicon Valley.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Massinissa Boudraham, Master student, University of Bordeaux, from March to September 2014, co-advised by H. Fourati and P. Geneves, master thesis: *Systèmes de navigation pédestre : Analyse et étude comparative*.

8.4.2. Visits to International Teams

8.4.2.1. Sabbatical programme

- C. Canudas de Wit spent one week at the UC Berkeley. He has several meetings with Prof. Horowitz and Dr. Gomes to set up the ground for the collaboration with the student Giovanni De Nunzio on the problem of bandwidth optimization of green waves under eco-driving constraints. He has also two working meetings with Prof. Varaiya on issues of back-pressure control for light intersections, and discussion on modeling limitations of the CTM. He participated also in two seminars organized by the Transportation Institute at UC Berkeley. He also met with Prof. Murat Arcak and his student Sam Coogan and have some discussions on issues of monotonicity in traffic models.
- A. Kibangou spent one week in the Advanced Sensor Networks Group of the department of Electrical and Electronical Engineering of the University of Pretoria (South Africa), one of the top university in Africa.

8.4.2.2. Explorer programme

Giovanni De Nunzio

Date: 24/09/2014 – 14/12/2014

Institution: University of California Berkeley (USA) Visit of Giovanni De Nunzio (Ph.D. student at NeCS team) at PATH, UC Berkeley. Collaboration with Dr. Gabriel Gomes and Prof. Roberto Horowitz. Participation to weekly meeting both for Freeway Traffic research group (held by Prof. Howitz) and Arterial Traffic research group (held by Prof. Varaiya). Two presentations were given at the Arterial meeting: one about the preliminary results with Dr. Gomes, one about the research activities carried out at NeCS team. Participation to the bi-weekly Intelligent Transportation Systems seminars at UC Berkeley.

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 in 2015), "Campus international sur la securite et intermodalite de transport", project "CONTRAERO" with LML and IEMN, 2011–2015
- ADT Inria SLIM "Development of ROS software library for multi-robots cooperation", 2013–2014 Project Agrégation, Conseil Général du Val d'Oise, (http://www.scilab.org/fr/community/scilabtec/2013/Projet-Agregation-la-simulation-numerique-dans-les-essais)

8.2. National Initiatives

- 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 ROCC-SYS (Robust Control of Cyber-Physical Systems), coordinator Dr. L. Hetel: 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

- HYCON2 (http://www.hycon2.eu/) The FP7 NoE HYCON2, started in September 2010, is a four-year project coordinated by the CNRS (Françoise Lamnabhi-Lagarrigue). It aims at stimulating and establishing a long-term integration in the strategic field of control of complex, large-scale, and networked dynamical systems. It focuses in particular on the domains of ground and aerospace transportation, electrical power networks, process industries, and biological and medical systems. Our PhD students are regularly supported for their participation to the EECI training.

8.3.2. Collaborations in European Programs, except FP7 & H2020

- SYSIASS (http://www.sysiass.eu/) Here is the major issue on which the project SYSIASS seeks to answer by developing new technologies and putting them in the service of patients and health professionals from our regions. Indeed preserve the autonomy of the elderly and disabled people is a major issue in today's society. In Europe, with the progressive ageing of the population policy to support the elderly is increasingly based on the assumption that care must be provided efficiently to the patient where he is based. In addition, special attention is devoted to people with disabilities for their better integration into society. Advances in technology proposed by SYSIASS (SYStème Intelligent et Autonome d'aide aux Soins de Santé / Autonomous and Intelligent Healthcare System) will be realized in practice through an intelligent wheelchair that can provide better mobility to

the patient and to allow health care professionals to easily transport patients to desired locations within a clinic or home environment. Moreover such a system must be able to communicate with the outside world, to adapt to specific patient needs and any special disability that he may have, and to facilitate access to medical data for health professionals. Our PhD students are regularly supported for participation in the accociated EECI traning.

- ICityForAll: EU Ambiant Assisted Living Program (http://www.icityforall.eu/) The project is leaded by CEA and it includes University of Paris Descartes-UPD, CENTICH, Active Audio (SME, France), Tech. Univ of Munich - TUM (Germany), EPFL (Suisse), ENEA (Italy), Centro Ricerche FIAT-CRF (Italy). The goal of I'City for All (Age sensitive ICT systems for Intelligible City for All) is to enhance speech and audio alarms intelligibility in order to improve the sense of well-being of seniors through better social interactions, better security and then improved mobility. Mamadou Mboup is involved as a subcontractor of UPD.

8.4. International Initiatives

8.4.1. Inria Associate Teams

- 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

- Professor Emilia Fridman, Tel Aviv University, Israel
- Sliding Mode Control Lab., UNAM, Mexico
- Department Control Automatico, CINVESTAV-IPN, Mexico
- UPIBI, 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?article217)
- CNRS-CONACYT project, UNAM, Mexico, "Estimation of state for hybrid systems using sliding mode techniques", 2014

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Prof. Emilia Fridman, Tel Aviv State University, Israel, from Jun 2014 until Jul 2014
  Subject:*Homogeneity application for time-delay systems : finite-time stability*
- Dr. Francisco Bejarano Rodriguez, National Polytechnic Institute, Mexico, until Jul 2014
  Subject:*Observability and observer for linear time-delay systems with unknown inputs*
- Prof. Leonid Fridman, UNAM, Mexico, until Jul 2014
  Subject:*State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes*

8.5.1.1. Internships

- Mimia Benhadri, Skikda University Algeria, Jun 2014
  Subject:*Time Delay Systems*

- Andrea Aparicio Martinez, UNAM, Mexico, from Jun 2014 until Jul 2014
  Subject:*State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes*
- Ivan De Jesus Salgado Ramos, National Polytechnic Institute, Mexico, from Jul 2014
  Subject:*PID control design based on the different differentiation techniques*
- Tonametl Sanchez Ramirez,UNAM, Mexico, until Jul 2014
  Subject:*State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes*
- Carlos Vazquez Aguilera, UMEA, Sweden, from Nov 2014
  Subject:*Application of discontinuous Lyapunov functions for dead-zone compensation*
- Konstantin Zimenko, ITMO, Russia, from Nov 2014
  Subject:*Transfer functions for homogeneous finite-time stable systems*
- Zohra Kader from March 2014 to September 2014
  Subject: *Left inversion of nonlinear time delay system*.

8.5.2. Visits to International Teams

8.5.2.1. Explorer programme

- Gang Zheng, Nanjing University of Science and Technology (China), in December 2014, supported Sino-French International Joint Laboratory of Automation and Signals (University Lille 1)
- Andrey Polyakov, UPIBI, National Polytechnic Institute, Mexico, in October 2014, supported by UPIBI-IPN

QUANTIC Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. Towards QUANTIC project-team / PSL structuring project TOCOSUQI*

In the framework of the creation of the QUANTIC project-team, we have continued our going collaboration with the non-Inria members of this future project-team (not yet official members of QUANTIC). Indeed, we have a close collaboration with the experimental physicists Benjamin Huard and Françlis Mallet at ENS and applied mathematician Pierre Rouchon at Mines Paristech. These collaborations include all the subjects introduced in the above research program. In the framework of these collaborations, we have also benefited from a 2-year PSL* funding from september 2013 to August 2015. The funding was, in particular, used for the 6 months visit of Ananda Roy, PhD student at Yale university. 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.

6.1.2. ANR project EPOQ2

This young researchers ANR project, entitled "Estimation problems for quantum and quantum-like systems" and led by Mazyar Mirrahimi, was run between October 2009 and June 2014. This project had contributed to the development of a system theory approach in quantum engineering, with applications, in particular, within the field of quantum information processing. After important and fruitful collaborations with the physicists at Laboratoire Kastler-Brossel, ENS, our activities turned towards the feedback control of quantum systems taking into account the destructive character of quantum measurements. This later on led to new collaborations with the Physicists at Yale university which will be detailed in the sequel. EPOQ2 was highlighted in the 2013 annual report of Agence Nationale de la Recherche.

6.1.3. 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 Daniel Esteve and Fabien Portier (Quantronics group, CEA Saclay), François Mallet and Benjamin Huard (Laboratoire Pierre Aigrain, ENS), Nicolas Roch and Olivier Buisson (Institut Neel, Grenoble) and Mazyar Mirrahimi (Inria). 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.

6.2. European Initiatives

6.2.1. 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": besides concluding their work on "symmetrization and quantum consensus", mainly initiated before A.S. joined Inria, a novel line of work in the direction of quantum thermalization and quantum random walks has been explored. Further joint work for the future is planned about among others generalized Markovian feedback and weak reservoir engineering.

Partner 2: Ghent University.

A. Sarlette is establishing a collaboration with applied mathematicians interested in quantum control at UGent (Dirk Aeyels and Lode Wylleman) 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", 2013-2015. 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.

6.3. International Initiatives

6.3.1. Inria International Partners

6.3.1.1. Declared Inria International Partners

The 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 [2] and preparation of non-classical field states through single photon Kerr effect [3] to the design of new experiments on single qubit cooling [1] and stabilization of maximally entangled states of superconducting qubits [8] by reservoir engineering techniques. Through these collaborations, Mazyar Mirrahimi and his former PhD student, Zaki Leghtas, currently a postdoc with Michel H. Devoret’s group, have introduced a new direction for hardware-efficient universal quantum computation [4], [5]. These theoretical proposals have already led to groundbreaking experiments [10], [9].

6.4. International Research Visitors

6.4.1. Visits of International Scientists

Ananda Roy, Yale university, Department of Applied Physics, PhD student from the groups of A. Douglas Stone and Michel H. Devoret, has visited us for sixth month from February through July 2014.

6.4.2. Visits to International Teams

6.4.2.1. 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.

CLASSIC Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

ANR project in the blank program: Calibration (2012–2015; involves Vincent Rivoirard, who is the coordinator; see https://sites.google.com/site/anrcalibration/home)

DOLPHIN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- 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).

8.2. National Initiatives

8.2.1. 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) (2011-2014).
- 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)

8.3. European Initiatives

8.3.1. 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

8.3.2. Collaborations with Major European Organizations

University of Luxembourg: organisme 1, labo 1 (Luxembourg)

Energy aware scheduling in Cloud computing systems

University of Tunis: LARODEC (Tunisia)

Multi-objective optimization under uncertainty using possibility theory

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. STEM

Title: deciSion Tools for Energy Management (STEM)

International Partner (Institution - Laboratory - Researcher):

Université de Montréal (CANADA)

Duration: 2012-2014

See also: http://dolphin.lille.inria.fr/Dolphin/STEM

The economic rise of developing countries, together with the need to meet ever more stringent pollution reduction targets, will increase the stress on the global energy system. Within this framework, the goal of the current project is to develop decision tools for energy management in a context of market deregulation. We will focus on two issues, namely demand management and production planning.

The first problem is concerned with the efficient management of consumption. More precisely, the short or long term behaviour of customers can be influenced through signals sent by a utility (or several utilities) to the end-users. These signals can take the form of an "optimal" pricing scheme, or yet of devices (timers, automatic switches, etc.) designed to induce an "optimal" behaviour from the users.

The second issue is concerned with efficient management of sustainable energy production . Indeed the development of renewable energy introduces new parameters in the supply/demand global equilibrium process. The issue is to achieve the right trade-off according to costs when determining the daily generation, usage and storage of renewable energy within an environment where grid prices and renewable energy level productions are stochastic.

The first problem is modeled as a bilevel program, the second one as a integer mutli-objective stochastic program. Efficient and effective solution methods are developed and implemented to solve these problems.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

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

8.4.2.2. Informal International Partners

- University of Coimbra, Portugal.

- VUB, Brussels, Belgium.
- IRIDIA, Université Libre de Bruxelles.
- Cologne University of Applied Sciences, Germany.
- Leiden University, Netherlands.
- UMONS University and Tractebel company, Belgium.
- EMI - Univ. Rabat, Morocco.

8.4.3. 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).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Prof. Hernan Aguirre, Shinshu University, Nagano, Japan
- Prof. Bernard Gendron, University of Montreal, Canada
- 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 March 2015]
- Prof. Bernard Gendron, University of Montreal, Canada

8.5.1.1. Internships

- Martin Drozdik [PhD student, Shinshu University, Nagano, Japan, from Nov 2013 to Sept 2014]
- Miyako Sagawa [Master student, Shinshu University, Nagano, Japan, from Oct 2014 to Nov 2014]

8.5.2. Visits to International Teams

8.5.2.1. Explorer programme

Liefooghe Arnaud

Date: June 2014 - Jul 2014

Institution: Shinshu (Japan)

8.5.2.2. Research stays abroad

- A. Liefooghe, Oct 2014, IRIDIA, Univ. Libre de Bruxelles, Belgium
- D. Brockhoff, Research visit (invited) in China in October 2014 including East China Normal University, Shanghai, China (group of Aimin Zhou), Jiaotong University, Xi'An, China (group of Hui Li), and Xidian University, Xi'An, China (group of Maoguo Gong)
- L. Brotcorne, Sept 2014, Polytechnic School of Montreal
- L. Brotcorne, Oct 2014, Huhne Logisitc University, Hamburg
- E-G. Talbi, Mar 2014, Univ. Murcia, Spain
- E-G. Talbi, Juin 2014, EMI, Univ. Agdal Rabat, Morocco

GEOSTAT Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Project VAD-MMF with Conseil Régional Aquitaine: *Voice Activity Detection using the Multiscale Microcanonical Formalism*, 2012-2015.
- Project CAVERNOM with Conseil Régional Aquitaine: *Cardiac Arrhythmia Complexity and Variability by means of Robust Nonlinear Methods*, 2015.

7.2. 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.
- IHU LIRYC and CRA DIAFIL project [2012-2014]. Post-doctoral fellow: B. Xu. Project leaders H. Yahia and O. Bernus.
- REGION AQUITAINE PROJECT "OPTAD". Participants : H. Yahia, S. Kumar Maji. Project leader: H. Yahia.

GEOSTAT is a member of the GDRs ISIS and PHENIX.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, except FP7 & H2020

Program: ESA (European Spatial Agency) Support to Science Element.

Project acronym: OceanFlux.

Project title: High resolution mapping of GHGs exchange fluxes.

Duration: 09/2011 - 09/2014.

Coordinator: C. Garbe.

Other partners: : IWR (University of Heidelberg), LEGOS (CNRS DR-14), GEOSTAT (Inria), KIT (Karlsruher Institut fur Technologie, Frankfurt), IRD, Université Paul Sabatier.

Abstract: The EBUS (Eastern Boundary Upwelling Systems) and OMZs (Oxygen Minimum Zone) contribute very significantly to the gas exchange between the ocean and the atmosphere, notably with respect to the greenhouse gases (hereafter GHG). Invasion or outgasing fluxes of radiatively-active gases at the air-sea interface result in coupled or decoupled sink and source configurations. From in-situ ocean measurements, the uncertainty of the net global ocean-atmosphere CO2 fluxes is between 20 and 30%, and could be much higher in the EBUS-OMZ. Off Peru, very few in-situ data are available presently, which justifies alternative approaches for assessing the fluxes. GHG vertical column densities (VCD) can be extracted from satellite spectrometers. The accuracy of these VCDs need to be very high in order to make extraction of sources feasible. To achieve this accuracy is extremely challenging, particularly above water bodies, as water strongly absorbs infra-red (IR) radiation. To increase the amount of reflected light, specular reflections (sun glint) can be used on some instruments such as GOSAT. Also, denoising techniques from image processing may be used for improving the signal-to-noise ratio (SNR). GHG air-sea fluxes determination can be inferred from inverse modeling applied to VCDs, using state of the art modeling, at low spatial resolution. For accurately linking sources of GHGs to EBUS and OMZs, the resolution of the source regions

needs to be increased. This task develops on new non-linear and multiscale processing methods for complex signals to infer a higher spatial resolution mapping of the fluxes and the associated sinks and sources between the atmosphere and the ocean. Such an inference takes into account the cascading properties of physical variables across the scales in complex signals. The use of coupled satellite data (e.g. SST and/or Ocean colour) that carry turbulence information associated to ocean dynamics is taken into account at unprecedented detail level to incorporate turbulence effects in the evaluation of the air-sea fluxes. We will present a framework as described above for determining sources and sinks of GHG from satellite remote sensing. The approach includes resolutions enhancements from nonlinear and multiscale processing methods. The applicability is validated against ground truth observations and numerical model studies.

7.4. International Initiatives

7.4.1. Inria Associate Teams

7.4.1.1. OPTIC

Title: Optimal inference in Complex and Turbulent data

International Partner (Institution - Laboratory - Researcher):

IITR (INDE)

Duration: 2014 - 2017.

See also: https://optic.bordeaux.inria.fr/. The associated team is supported by Inria and IFCAM.

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.

7.4.2. Participation In other International Programs

- IFCAM (India), in cooperation with OPTIC associated team (7.4.1): Indo-French Centre for Applied Mathematics (IFCAM) project [2014-2017]. Title: Optimal inference in complex and turbulent data. 3-year contract, IFCAM funding, started 2014. Partners: GEOSTAT and IIT ROORKEE (INDIA).

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Professor Dharmendra Singh, IIT Roorkee, in the framework of the OPTIC associated team, visited GEOSTAT in June 2014.

7.5.1.1. Internships

- Ashwini Jaya Kular. Master 2 intern from Apr to Oct 2014.
- Jiri Mekyska, PhD student at Brno university (Czech republic), spent the month of June at GEOSTAT. His internship was funded by the Joseph Fourier grant.

7.5.2. Visits to International Teams

H. Yahia (2 weeks) and N. Brodu (2 weeks) visited IIT Roorkee in 2014, to work in the framework of the OPTIC associated team.

MISTIS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- **PERSYVACT project.** MISTIS is involved in a 2-year exploratory project, funded (20 keuros for the whole project) by the PERSYVAL labex (https://persyval-lab.org/en), with other teams from local laboratories, LJK, GIPSA-Lab and TIMC. The goal of this research project is to build tools for analyzing hierarchically structured models for high dimensional complex data. In parallel, MISTIS received **15 keuros** from the labex for the PhD of A. Chiancone co-advised with J. Chanussot from GIPSA-Lab.
- **Grenoble Pole Cognition (2013-14).** We received in 2012, 2013 and 2014 **2.5 keuros** from the Grenoble Pole Cogntion, http://www.grenoblecognition.fr/, for collaborative projects involving the GIN and NeuroSpin. This funding was used this year for the internship of Alexis Arnaud on MRI analysis for small animals.
- MISTIS is involved in three regional initiatives: PEPS (funded by CNRS and the PRES of Grenoble), AGIR (funded by Université Grenoble 1 and Grenoble-INP) and the MOTU project (funded by UPMF). The first two projects focus on the modelling of the extreme risk and its application in social science. The partners include the LTHE (Laboratoire d'étude des Transferts en Hydrologie et Environnement) and the 3S-R lab (Sols, Solides, Structures - Risques). The third project focuses on the use of statistical techniques for transportation data analysis and involves the GAEL laboratory (Grenoble Applied Economics Laboratory).
- 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.
- S. Girard is at the head of the probability and statistics department of the LJK since september 2012.

8.2. International Initiatives

8.2.1. 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, the National University of Ireland in Galway, and more recent partners like IDIAP involved in the HUMAVIPS project, Université Gaston Berger in Senegal and University of Melbourne in Australia. We will 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 and eventually explore the possibility for a H2020 project in the *Personalizing Health and Care* axis.

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

- Fabrizio Durante, Free University of Bozen-Bolzano, Italy.
- Emma Holian and John Hinde from National University of Ireland, Galway, Ireland.
- K. Qin and D. Wraith from RMIT in Melbourne, Australia and Queensland University of Technology in Brisbane, Australia.
- E. Deme and S. Sylla from Saint Louis university and IRD in Saint Louis, 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.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Seydou Nourou Sylla (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for four months.
- Darren Wraith (Queensland University of Technology in Brisbane, Australia) has been hosted by the MISTIS team for 2 weeks.

8.3.1.1. Internships

Alexis Arnaud (Master, from Feb 2014 until June 2013)

Subject: Mixtures of generalized Student multivariate distributions: application to tumor characterisation from multiparametric MRI.

Institution: University Montpellier 2

Anne Charlier (2nd year)

Subject: Estimation of gaz concentrations in a gaz mixture from spectrophotometric measures.

Institution: PHELMA, Grenoble-INP

Lisa Qian-ru (Master)

Subject: Inverse regression to identify and quantify polluants from UV spectroscopy measures.

Institution: Univ. PMF, Hemera, Meylan

Seydou-Nourou Sylla (PhD, from September 2014 to December 2014)

Subject: Classification for medical data

Institution: Université Gaston Berger (Sénégal)

MODAL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Collaborations within SIRIC

Participants: Guillemette Marot, Alain Celisse.

SIRIC (Site of integrated research in Cancerology) ONCOLille has been created during "Plan Cancer 2". More information about it can be found at http://www.canceropole-nordouest.org/qui-sommes-nous/le-cancer-en-region/le-siric-oncolille.html. Collaborations established through common articles or funding proposals writings with members of MODAL concern the following teams:

Univ. Lille 2, Functional and structural genomics, M. Figeac

CHRU Lille, Hematology laboratory, C. Preudhomme

CNRS, UMR8161, IBL (Institute of Biology of Lille), O. Pluquet

Inserm UMR837 - Team 5, I. Van Seuningen

8.1.2. Other collaborations

Institut Pasteur Lille, Transcriptomics and Applied Genomics, D. Hot (**Participant:** G. Marot)

Inserm U1011, J. Eeckhoute (**Participants:** G. Marot, A. Celisse)

Registre Regional des Cancers de Lille et sa Region, Dr. Karine Ligier (**Participant:** C. Preda)

8.2. National Initiatives

8.2.1. 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.

8.2.2. Working groups

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

Guillemette Marot belongs to the StatOmique working group http://vim-iip.jouy.inra.fr:8080/statomique/

8.3. International Initiatives

8.3.1. Inria Associate Teams

Associate Team acronym: SIMERGE (Statistics Inference for the Management of Extreme Risks and Global Epidemiology)

Principal investigator (Inria): Stéphane Girard Mistis, Inria Grenoble Rhône-Alpes, France.

Principal investigator (Main team): Abdou Kâ Diongue LERSTAD, Université Gaston Berger, Sénégal.

Other participants: Laboratory EQUIPPE (Economie QUantitative Intégration Politiques Publiques Econométrie), Univ. Lille 1, 2 and 3, MODAL, IRD (Institut de Recherche pour le Développement), Unité de Recherche sur les Maladies Infectieuses et Tropicales Emergentes (URMITE), Dakar, Sénégal.

REALOPT Project-Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Inria Associate Teams

8.1.1.1. SAMBA

Title: Combinatorial optimization problems

International Partner (Institution - Laboratory - Researcher):

Pontifícia Universidade Católica do Rio de Janeiro, Brazil

Universidade Federal Fluminense (UFF), Brazil

Universidad Adolfo Ibañez, Chile

Duration: 2014 - 2017

See also: https://wiki.bordeaux.inria.fr/realopt/pmwiki.php/Project/Samba

The renewed project builds on our previous SAMBA output with new emphasis on 4 axis:

1. **Algorithmic Performance Enhancements:** In the line of the considerable algorithmic speed-up that we obtained recently in SAMBA by developping stabilization techniques, warm-starting techniques (with memorized basis to initialize the node of the enumeration tree), and strong branching techniques (that limit the size of the enumeration tree), we aim to develop intensive preprocessing techniques building on contraint propagation. Further contibutions shall consist in integrating dynamic aggregation-disagregation techniques.
2. **Extending the Dantzig-Wolfe reformulation paradigm**. The current SAMBA project has lead to finalizing a technique called “column generation for extended formulations” which can be understood as a generalization of Dantzig-Wolfe reformulation: To favour early convergence, the Dantzig-Wolfe reformulation is lifted into an extended variable space where the recombination of solutions arises. Further extension is built in the proposal of Goycoolea et al.
3. **Combining Dantzig-Wolfe decomposition with Benders’:** In a stochastic environement, a numerically realistic approach in to build solutions that resists to worst case perturbations drawn within a contrained uncertainty set. In such context, bilevel optimization naturally arises: the second level models the worst case reaction of the system, along with our recourse, considering as fixed, the decisions of the first level of optimization. The model constraints are therefore decomposed into first level and second level, suited for Benders approach. When the first stage is a multiple resource planning applications, a strong model leading to good continuous approximation can be obtained by reformulating the problem in terms of variables that encode a work allocation for an individual resource (this is known as the Dantzig-Wolfe decomposition approach).
4. **Build-up our BAPCOD software platform for new benchmarks and industrial transfer:** the aim is to translate our research output into efficient code, to develop high level interface that free the end users from the expert knowledge normally required for complex decomposition based solution.

8.2. International Research Visitors

8.2.1. Visits of International Scientists

- B. Stevens, Carleton University (Canada), has visited the University of Bordeaux for one year.
- Shunji Tanaka, Associate professor at Kyoto University, has visited the University of Bordeaux for one week in September 2014.
- Marcos Goycoolea visited us in Bordeaux on the first week of September 2014.

8.2.2. Visits to International Teams

8.2.2.1. Research stays abroad

- Ruslan Sadykov visited Alexander Lazarev of Institute of Control Sciences of Russian Academy of Sciences, Moscow, Russia, for one week in february 2014.
- Arnaud Pêcher has visited the University of Rosario, Rosario, Argentina, for two weeks in December 2014.
- Pierre Pesneau visited Luis Gouveia of the University of Lisbon, Portugal, for one week in July 2014.

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Pascal Massart is co-organizing a working group at ENS (Ulm) on Statistical Learning.

Christine Keribin is animating the bimensual rendez-vous SFdS "methods and Software".

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

8.2. National Initiatives

8.2.1. ANR

SELECT is participating to the ANR 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 Dublin (Ireland).

Yves Rozenholc has been invited at the Department of Statistics of the University of Haifa for three weeks, at the Department of Mathematics of Eindhoven University for one week and at the Institut of statistic, biostatistic and actuarial sciences of the catholic University of Louvain.

SEQUEL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Pierre Chainais and Hong-Phuong Dang are part of the ARCIR project *REPAR*, PARcimonious REpresentations, which is funded by the Region Nord-Pas de Calais for 2 years. This project is focused on sparsity based methods for signal and image processing. It has permitted to hire 1 postdoc for 1 year (2014-2015) who works on the use of sparse representation for video-tracking. The targetted application is in biological microscopy to track cellular vesiculas (collab. Laurent Héliot, Aymeric Leray, Univ. Lille 1).

8.2. National Initiatives

8.2.1. ANR BNPSI

Participants: Pierre Chainais, Hong-Phuong Dang, Clément Elvira, Emmanuel Duflos, Philippe Vanheeghe.

- *Title*: Bayesian Non Parametric approaches for Signal and Image Processing
- *Type*: National Research Agency no ANR-13-BS-03-0006-01
- *Coordinator*: Ecole Centrale Lille, LAGIS (P. Chainais)
- *Duration*: 2014-2018
- *Other Partners*: Inria Bordeaux, team ALEA, Université de Bordeaux, IMS, Institut de Recherche en Indormatique de Toulouse (IRIT), CEA-LIST Saclay.
- *Abstract*: 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.
- *Activity Report*: This ANR Project was accepted in 2013. It has started in february 2014 on a new area of research for signal and image processing and is supervised by Pierre Chainais. Three meetings have taken place in Lille (in February), Toulouse (in June) and Bordeaux (in November). One special session on Bayesian non parametric approaches has been submitted and accepted to the international conference EUSIPCO 2015. We have also been selected by the Franch National Signal & Image Processing Society (GRETSI) to organize the Peyresq 2016 Signal processing summer school. Two PhD students have been recruited in october 2014 thanks to this project: Clément Elvira works in Lille is co-supervised by P. Chainais and N. Dobigeon (Toulouse), Jessica Sodjo works in Bordeaux and is co-supervised by A. Giremus (IMS), N. Dobigeon (Toulouse) and F. Caron (Oxford). Moreover, Hong-Phuong Dang (PhD, 2nd year) has obtained new results on BNP for dictionary learning. The Indian Buffet Process permits to propose a method to learn a dictionary of which size automatically adapts to data. Several publications are in preparation. François Caron who is co-leading this project with Pierre Chainais has moved to Oxford University as an Assistant Professor so that we will benefit from strong connections with the Statistics Departmnt in Oxford University.

8.2.2. 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*: ExTra-Learn started officially in October and one paper has been published at NIPS'14 and in the workshop on "Transfer and Multi-task Learning" at NIPS'14.

8.2.3. National Partners

- Laboratoire Paul Painlevé Université des Sciences et Technologies de Lille, France
  - Mylène Maïda *Collaborator*

    Ph. Preux has collaborated with M. Maïda and co-advised a student of the École Centrale de Lille. The motivation of this collaboration is the study of random matrices and the potential use of this theory in machine learning.
- CMLA - ENS Cachan.
  - Julien Audiffren *Collaborator*
    M. Valko, A. Lazaric, and M. Ghavamzadeh work with Julien on Semi-Supervised Apprenticeship Learning. We work on a maximum entropy algorithm that outperforms the approach without unlabeled data.
- Laboratoire Lagrange, Université de Nice, France.

  - Cédric Richard *Collaborator*
    We have had collaboration on the topic of *dictionary learning over a sensor network*.
- Laboratoire de Mécanique de Lille, Université de Lille 1, France.
  - Jean-Philippe Laval *Collaborator*
    We co-supervise a starting PhD student (Linh Van Nguyen) on the topic of *high resolution field reconstruction from low resolution measurements in turbulent flows*.
- Institut Carnot de Bourgogne, CNRS UMR 6303, Université de Bourgogne, Dijon, France.
  - Aymeric Leray *Collaborator*
    P. Chainais and A. Leray have written an article on the topic of *quantitative guarantees of a super resolution method via concentration inequalities*. A paper has been published in ICASSP 2014 proceedings and a journal article is submitted to IEEE Transactions on Image Processing.
- LAGIS (CRIStAL), Ecole Centrale Lille - Université de Lille 1, France.
  - Patrick Bas *Collaborator*
    P. Chainais and P. Bas have a collaboration on the topic of *adaptive quantization to optimize classification from histrograms of features with an application to the steganalysis of textured images*.
- University of Oxford (Great-Britain)
  - Dr. François Caron *Collaborators*
  - P. Chainais is co-leading the ANR BNPSI in collaboration with François Caron. Note that Rémi Bardenet will arrive in Lille as a CNRS researcher in feb. 2015 after a post-doc at Oxford University.
- LTCI, Institut Télécom-ParisTech, France.
  - Charanpal Dhanjal*Collaborator*
    We have a collaboration on the topic of *Matrix Factorization update* with application to sequential recommendation and sequential clustering. This collaboration has leaded to two publications this year: one in Neurocomputing journal [2], one at SDM'14 conference [14].

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. CompLACS

Type: FP7

Defi: Cognitive Systems, Interaction, Robotics

Instrument: Specific Targeted Research Project

Objectif: Cognitive Systems and Robotics

Duration: March 2011 - February 2015

Coordinator: John Shaw-Taylor

Partner: University College London, University of Bristol, Royal Holloway, University of London, Radboud Universiteit Nijmegen, Technische Universitat Berlin, Montanuniversitat Leoben, Institut National de Recherche en Informatique et en Automatique, Technische Universität Darmstadt

Inria contact: Rémi MUNOS

Abstract: One of the aspirations of machine learning is to develop intelligent systems that can address a wide variety of control problems of many different types. However, although the community has developed successful technologies for many individual problems, these technologies have not previously been integrated into a unified framework. As a result, the technology used to specify, solve and analyse one control problem typically cannot be reused on a different problem. The community has fragmented into a diverse set of specialists with particular solutions to particular problems. The purpose of this project is to develop a unified toolkit for intelligent control in many different problem areas. This toolkit will incorporate many of the most successful approaches to a variety of important control problems within a single framework, including bandit problems, Markov Decision Processes (MDPs), Partially Observable MDPs (POMDPs), continuous stochastic control, and multi-agent systems. In addition, the toolkit will provide methods for the automatic construction of representations and capabilities, which can then be applied to any of these problem types. Finally, the toolkit will provide a generic interface to specifying problems and analysing performance, by mapping intuitive, human-understandable goals into machine-understandable objectives, and by mapping algorithm performance and regret back into human-understandable terms.

8.4. International Initiatives

8.4.1. Inria International Partners

- Inria International partnership with Leoben, Austria; starting October 2014; duration: 4 years.
  - Ronald Ortner and Peter Auer: Montanuniversität Leoben (Austria).
  - Reinforcement learning (RL) deals with the problem of interacting with an unknown stochastic environment that occasionally provides rewards, with the goal of maximizing the cumulative reward. The problem is well-understood when the unknown environment is a finite-state Markov process. This collaboration is centered around reducing the general RL problem to this case.

    In particular, the following problems are considered: representation learning, learning in continuous-state environments, bandit problems with dependent arms, and pure exploration in bandit problems. On each of these problems we have successfully collaborated in the past, and plan to sustain this collaboration possibly extending its scopes.

8.4.1.1. Informal International Partners

- Technion - Israel Institute of Technology, Haifa, Israel.
  - Odalric-Ambrym Maillard *Collaborator*
    Daniil Ryabko has worked with Odalric Maillard on representation learning for reinforcement learning problems. It led to a paper in AISTATS [46].
- School of Computer Science, Carnegie Mellon University, USA.
  - Prof. Emma Brunskill *Collaborator*
  - Mohammad Gheshlaghi Azar, (now at Northwestern University in Chicago) *Collaborator*
    A. Lazaric continued his collaboration on transfer in multi-arm bandit and reinforcement learning which led to one publication at ICML'14. We have submitted an associate team project with E. Brunskill on the topic of multi-arm bandit applied to education.
- Technicolor Research, Palo Alto.
  - Branislav Kveton *Collaborator*
    Michal Valko and Rémi Munos worked with Branislav on Spectral Bandits aimed at recommendation for the entertainment content recommendation. Michal continued the ongoing research on online semi-supervised learning and this year delivered the algorithm for a challenging single picture per person setting. Victor Gabillon has spent 6 month at Technicolor as an intern to work on the sequential learning with submodularity, which resulted in 1 accepted paper at NIPS, 1 in ICML, and 1 in AAAI.

- University of Cambridge (UK)
  - Alexandra Carpentier *Collaborator*
  - Michal Valko collaborates with A. Carpentier on extreme event detection (such as network intrusion) with limited allocation capabilities.
- Politecnico di Milano (Italy)
  - Prof. Marcello Restelli and Prof. Nicola Gatti *Collaborators*
  - A. Lazaric continued his collaboration on transfer in reinforcement learning which leads to a publication in NIPS'14. Furthermore, we have submitted a journal version of an application of multi-arm bandit in sponsored search auctions which is currently under review.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Daniele Calandriello, student at Politecnico di Milano, Italy

  Period: April 2013 to May 2014.

  He was working with A. Lazaric on multi-task reinforcement learning.
- Jessica Chemali, Master, Carnegie Mellon University, May-August 2014

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

Ryabko Daniil

Date: Jan 2014 - Jan 2015

Institution: Centro de Modelamiento Matematico (Chile)

8.5.2.2. Research stays abroad

Munos Rémi

Date: Jul 2013 - June 2014

Institution: Microsoft Research New England (USA)

Munos Rémi

Date: October 2014 - now

Institution: Google Deepmind (UK)

Ghavamzadeh Mohammad

Date: September 2013 - now

Institution: Adobe Research (USA)

SIERRA Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. 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/

7.1.2. CNRS: Gargantua

Participants: Sylvain Arlot, Francis Bach, Simon Lacoste-Julien, Alexandre d'Aspremont.

Titre: Big data; apprentissage automatique et optimisation mathématique pour les données gigantesques

Coordinator: Laboratoire Jean Kuntzmann (UMR 5224)

Leader: Zaid Harchaoui

Other members: 13 members: S. Arlot, F. Bach, S. Lacoste-Julien, A. d'Aspremont and researchers from Laboratoire Jean Kuntzmann, Laboratoire d'Informatique de Grenoble (Universite Joseph Fourier) and Laboratoire Paul Painleve (Universite Lille 1).

Instrument: défi MASTODONS du CNRS

Duration: May 2013-Dec 2014

Total funding: 60 000 euros for the two years

Webpage: http://lear.inrialpes.fr/people/harchaoui/projects/gargantua/index.html

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. SIERRA

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Duration: December 2009 - November 2014

Coordinator: F. Bach

Abstract: Machine learning is now a core part of many research domains, where the abundance of data has forced researchers to rely on automated processing of information. The main current paradigm of application of machine learning techniques consists in two sequential stages: in the representation phase, practitioners first build a large set of features and potential responses for model building or prediction. Then, in the learning phase, off-the-shelf algorithms are used to solve the appropriate data processing tasks. While this has led to significant advances in many domains, the potential of machine learning techniques is far from being reached.

7.2.1.2. SIPA

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

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.

7.2.1.3. SpaRTaN

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

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. STATWEB

Title: Fast Statistical Analysis of Web Data via Sparse Learning

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (ÉTATS-UNIS)

Duration: 2011 - 2014

See also: http://www.di.ens.fr/~fbach/statweb.html

The goal of the proposed research is to provide web-based tools for the analysis and visualization of large corpora of text documents, with a focus on databases of news articles. We intend to use advanced algorithms, drawing from recent progresses in machine learning and statistics, to allow a user to quickly produce a short summary and associated timeline showing how a certain topic is described in news media. We are also interested in unsupervised learning techniques that allow a user to understand the difference between several different news sources, topics or documents.

7.3.2. Inria International Partners

7.3.2.1. International Partners

IFCAM: Collaboration with Indian Institute of Science, Bangalore (Chiranjib Battacharya). 10000 Euros for visits from/to India.

7.4. International Research Visitors

7.4.1. Internships

Visit from Raman Sankaran Indian Institute of Science, Bangalore, May-Juky 2014.

TAO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- **TIMCO (Technology for In Memory Computing applications)** FUI Project – 2012-2015 (432 kEuros)
  Coordinator: Bull SA
  Participants: Cécile GERMAIN(WP Algorithm adaptation: the paradigm shif coordinator)
- **ROM - Réduction de modèles et optmisisation multiphysiques** – 2014 (73 kEuros).
  Coordinator: IRT System X
  Participants: Marc Schoneuaer, François Gonard (PhD)
- **ISN** – 2013-2016 (105 kEuros).
  Related to Thomas Schmitt's PhD - A Collaborative Filtering Approach to Matching Job Openings and Job Seekers
  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

8.2. National Initiatives

- **SIMINOLE** – 2010-2014 (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: Balázs Kégl, Nikolaus Hansen, Emmanuel Benazera, Michèle Sebag, 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
- **LOGIMA** – 2012-2016 (136kEuros for TAO). Logics, structural representations, mathematical morphology and uncertainty for semantic interpretation of images and videos, ANR project, Coordinator Céline Hudelot, MAS-ECP. Other partners: TAO , LTCI-Telecom ParisTech
  Local coordinator: Jamal Atif
- **ACTEUR** – 2014-2018 (236kEuros). Cognitive agent development for urban simulations, ANR project, Coordinator P. Taillandier (IDEES, Univ Rouen).

  Participants: Philippe Caillou

8.2.1. 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

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. CitInES

Type: FP7

Defi: ICT for a low carbon economy

Instrument: Specific Targeted Research Project

Objectif: ICT systems for energy efficiency

Duration: October 2011 - March 2014

Coordinator: Artelys

Partners: Artelys (SME, France), Inria (Tao), AIT (Austria), Tupras (4 refineries, Turkey), Cesena (City, Italy), Ervet (Italy), Inesc-Porto (Portugal), Armines (France), Bologna (City, Italy)

Inria contact: Olivier Teytaud

Abstract: Design of a decision support tool for sustainable, reliable and cost-effective energy strategies in cities and industrial complexes

8.3.1.2. EGI-Inspire

Type: FP7

Defi: e-Infrastructure

Instrument: CP-CSA

Objectif: Integrated Sustainable Pan-European Infrastructure for Researchers in Europe

Duration: May 2010 - April 2014

Coordinator: EGI.eu foundation

Partner: Université Paris XI (France)

Inria contact: Cécile Germain-Renaud

Abstract: To support European science and innovation, a longer lasting operational model is now needed - both for coordinating the infrastructure itself and for delivering integrated services that cross national borders.The EGI-InSPIRE project will support the transition from a project-based system to a sustainable pan-European e-Infrastructure.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. INDEMA

Title: Intelligent Decision Making Mechanisms with Hidden Information, and Application to El ectricity Generation

International Partner (Institution - Laboratory - Researcher):

NUTN (TAIWAN)

Duration: 2012 - 2014

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

The objective of the project is three-fold:

- Objective 1: Designing consistent iterative realistic algorithms for partially observable 1-player or 2-player games.
  • Consistent algorithms (provably, asymptotically optimal in the computation time).
  • Iterative a.k.a. anytime algorithms, improving its results as the computational time allowed increases and requiring little time to yield a decent answer. Most algorithms which survive decades are iterative.
  • Realistic algorithms, i.e. suited to real-world settings.
- Objective 2: Impressive visible applications, e.g. applications in games or puzzles, such as Minesweeper (on which we believe that much progress is still possible), Chinese Dark Chess, Kriegspiel, Phantom-Go, or card games. Games and puzzles offer nice frameworks to assess and make our research highly visible.
- Objective 3: Big industrial applications. Having both mathematics and visible realizations in games and industrial applications might be considered as too ambitious. Yet, our strategy is to tackle e.g. the field of energy generation because: i) it is close from our past activities (thus reducing the warm-up time), yet with a new challenge, partial observability; ii) in real applications, many problems are simplified so that they boil down to fully observable problems, (e.g. through including tricks in the solvers); iii) our former achievements facilitate our contact with industry. Formally, we assume that mathematical analysis can be done on this (objective 1); that it will provide big results in games (objective 2) where many main programs are based on non-consistent algorithms; that these results will translate to real-world application.
  Our roadmap is:
  • Check on simple versions of energy production problems whether the fully observable approximation holds true. We guess that in many cases it does not; the next point is to assess the loss of performance incurred;
  • Experiment our algorithms on real industrial problems, considering both Taiwan-centered and Europe-Centered electricity generation problems in order to widen the scope of the analysis, enforcing the applicability of the approach.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

- Shinshu University (Professor Akimoto, Professor Tanaka, Professor Aguire). Partnership officialized via MOU signature between Inria and Shinshu University. Joint project funded by the Japanese governement.
- Dortmund University through the funded ANR project NumBBO.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Holger Hoos, Professor, Dept of Computer Science, University of British Columbia, from Oct. 1. to Dec. 31., funded by Microsoft-Inria Joint Lab.
- Daria La Rocca, PhD student at University Roma 3, Italy, from Oct. 2013 until Oct. 2014
- Luigi Malago, Post-Doc at University Shinshu, Japan, since Sept. 2014 (see Section 8.4.2.1).

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Olivier Teytaud, National University of Tainan and Dong Hwa University in Hualien, Taiwan (6 months).
- Jialin Liu, National University of Tainan and Dong Hwa University in Hualien, Taiwan (6 months).

- Marie-Liesse Cauwet, National University of Tainan and Dong Hwa University in Hualien, Taiwan (3 months).
- Constance Deperrois, National University of Tainan and Dong Hwa University in Hualien, Taiwan (1 month).
- Baptiste Roziere, National University of Tainan and Dong Hwa University in Hualien, Taiwan (2 months).
- Sandra Cecilia Astete Morales, National University of Tainan and Dong Hwa University in Hualien, Taiwan (1 month).
- Vincent Berthier, National University of Tainan and Dong Hwa University in Hualien, Taiwan (4 months).
- David L. Saint-Pierre, National University of Tainan and Dong Hwa University in Hualien, Taiwan (4 months).

ASPI Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. PDMP Inférence, Évolution, Contrôle et Ergodicité (PIECE) — ANR Jeunes Chercheuses et Jeunes Chercheurs

Participant: Florent Malrieu.

January 2013 to December 2016.

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, modelling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

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

Participant: Patrick Héas.

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.

7.2. International Initiatives

7.2.1. Inria International Partners

Arnaud Guyader collaborates with the group of Nicolas Hengartner at Los Alamos National Laboratories, on the development of fast algorithms to simulate rare events, and on iterative bias reduction techniques in nonparametric estimation. This collaboration has a long record of bilateral visits.

CQFD Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Chaire Inria-AIRBUS-Conseil régional d'Aquitaine

The chaire is funding the PhD thesis of Christophe Nivot on the optimization of the assembly line of a launcher. It comprises several steps from the production of the subassemblies to the final launch. The aim of the thesis is finding the best rates of delivery of the subassemblies, the best choice of architecture (regarding stock capacities) and the best times when to stop and restart the workshops to be able to carry out twelve launches a year according to a predetermined schedule at minimal cost.

8.1.2. 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 performs 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.

8.2. National Initiatives

8.2.1. ANR ADAPTEAU

The ANR project ADAPTEAU has been obtained for the period 2012-2016 and will start in january 2012.

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.

8.2.2. 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.

8.2.3. 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.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

IRSES FP7 MARIE CURIE ACOBSEC: http://cordis.europa.eu/project/rcn/109603_en.html
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) 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.

8.3.2. Collaborations in European Programs, except FP7 & H2020

Numerical methods for Markov decision processes (2013-2015). 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).

8.4. International Initiatives

8.4.1. Participation In other International Programs

Control of Dynamic Systems Subject to Stochastic Jumps USP-COFECUB grant (2013-2014). This collaboration is also supported by the **Associate Team Inria: CDSS (2014-2016)**. The main goals of this joint cooperation is to study the control of dynamic systems subject to stochastic jumps. Three topics are considered. 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 problem 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 at Inria and O. Costa in USP 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 allows a first cooperation between B. de Saporta and E. Costa. The third research subject is focused on quantum control by using Lyapunov-like stochastic methods and P. Rouchon and P. Pereira da Silva conduct it.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Tomas Prieto-Rumeau (Department of Statistics and Operations Research, UNED, Madrid, Spain) visited the team during two weeks in 2014. 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 2014 supported by the USP-COFECUB grant and the Associate Team Inria: CDSS.

Alexey Piunovskiy (University of Liverpool) visited the team during six weeks in 2014. 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.

Giuliano Casale (Imperial College), invited from December 10th to December 12nd 2014 to continue his collaboration with Jonatha Anselmi.

Leonardo Trujillo (ITT Tijuana, Mexico) visited the team for one month in october 2014 to continue his collaboration with Pierrick Legrand.

8.5.2. Visits to International Teams

Francois Dufour visited Alexey Piunovskiy (University of Liverpool) to continue his work about the linear programming approach for Markov Decision Processes.

Pierrick Legrand visited Leonardo Trujillo (ITT Tijuana, Mexico) in nov 2014.

MATHRISK Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

B. Jourdain is involved in the ANR Stab (2013/2016). Partners: Lyon1 and Paris-Dauphine.

8.1.2. Competitivity Clusters

Pôle Finance Innovation.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. 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).
- Mannheim University (Alexander Schied, Chair of Mathematics in Business and Economics, Department of Mathematics)
- Roma Tor Vergata University (Lucia Caramellino)
- Ritsumeikan University (A. Kohatsu-Higa).

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Arturo Kohatsu-Higa, Ritsumeikan University, 3 months

- Lucia Caramellino, Tor Vergata University, Roma, 2 weeks

- Oleg Kudryavtsev, Rostov University , 2 months

- Xiao Wei, Beijing university, 2 months

8.3.2. Visits to International Teams

8.3.2.1. Research stays abroad

- V. Bally, Ritsumeikan University, Japan, one month
- A. Sulem:

  - "Adjunct Professorship", Center of Mathematics for Applications (CMA), University of Oslo, Norway, 1st Semester 2014.

  - Participation to the "Stochastics in Environmental and Financial Economics" program, Centre of Advanced Studies of the Norwegian Academy of Sciences and Letters, Oslo, Last term 2014.

REGULARITY Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Regularity has strong collaborations with Nantes University (Anne Philippe) [40] and Rennes University (Ronan Le Guével) [42].

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

- Regularity collaborates with St Andrews University (Prof. Kenneth Falconer) on the study of multistable processes.
- Regularity collaborates with Acadia University (Prof. Franklin Mendivil) on the study of fractal strings, certain fractals sets, and the study of the regularization dimension.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Pr. Franklin Mendivil, from Acadia University was invited for one month in the team.

TOSCA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- N. Champagnat, J. Claisse and D. Villemonais were members of the ANR MANEGE (Modèles Aléatoires eN Écologie, Génétique et Évolution, ending in April 2014) whose aim is to provide methodological and conceptual advances in the study of stochastic processes modeling ecology, population genetics and evolution of life. This work is sustained by regular exchanges with biologists from several teams in France. http://www.cmap.polytechnique.fr/~anr-manege/index_en.html
- N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, started in October 2014), aiming at understanding, in the greatest generality, the phenomena of propagation in non-local reaction-diffusion equations. These equations can present integral forms of diffusion operators, or speed that depend on integrals of the solution, memory effects, or long-range interactions in source terms. http://www.agence-nationale-recherche.fr/projet-anr/?tx_lwmsuivibilan_pi2[CODE]=ANR-14-CE25-0013
- A. Lejay is member of the ANR H2MNO4 (ANR Cosinus, 2012–2015) on Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology which started in November 2012 (directed by Joceyline Erhel, IRISA, Rennes).

8.1.2. Contract with ADEME

Participants: Mireille Bossy, Sélim Karia.

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 have almost completed the SDM version with complex terrain description. We also improved the turbulence modelling to better take into account the shear effect near the ground.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

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

8.3. International Initiatives

8.3.1. Inria International Labs

The CIRIC Team on *Stochastic Analysis of Renewable Energies: Ocean Energy and Wind Farms; dynamics and numerics* (2012-2014) is managed by TOSCA and ANESTOC (Univ Catolica, Santiago). It is composed of three main projects.

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 improvement on wind mills modeling in the SDM software (see [28]). This modeling is based on our Lagrangian version of the actuator disc actuator line methods to take the mills into account. We evaluated and compared the case of non rotating and rotating actuator disc, and started to work on the validation of the approach by comparison with measurements.

8.3.2. Inria Associate Teams

8.3.2.1. ANESTOC-TOSCA

Title: Stochastic modelling of biology and renewable energies

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (CHILI)

Duration: 2013 - 2016

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. In particular, a part of the Associated Team is strongly related to the CIRIC project "Stochastic Analysis of Renewable Energy". 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 by developing and improving the Winpos software based on the downscaling methods, and waves energy potential of a site using video and developping stochastic models for the Wave Energy Converter called Oscillating Water Column.

The other part of this Associated Team is related to neurosciences, more specifically by considering applications to ion-channel dynamics through cell membranes (jointly with biophysicists of the CINV, Neuroscience Centre of Valparaíso).

8.3.3. Participation In other International Programs

8.3.3.1. Math Amsud project SIN

Participant: Etienne Tanré.

It is likely that the stochastic components play an important role in the functions of the neurons and of the networks they form. We describe and study the effect of the noise at different scales of neural activity, such that the level of the ionic channels and the level of neural networks, which are responsible for conveying and processing the information coded in sequences of spikes. The most popular models of this class are leaky integrate and fire (LIF) neural networks. We study the synchronization of neurons in those networks.

The Math Amsud project SIN (Stochastic, Inference, Neuroscience) started in 2013. We worked specifically in 2014 on stochastic modelling in neuroscience.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- M. Baar (Bonn University) has been visiting TOSCA Nancy for one week in September.
- L. Beznea (Simion Stoilow Institute of Mathematics of the Romanian Academy) has been visiting TOSCA Nancy one week in March and three weeks in July.
- The TOSCA *seminar* organized by J. Inglis in Sophia Antipolis has received the following speakers: Maxime Bonelli (TOSCA), Hector Olivero-Quinteros (Universidad de Chile), Jean-François Jabir (CIMFAV, Fac. de Ingenieria, Universidad de Valparaiso), Tony Lelièvre (École des Ponts ParisTech), Christophe Profeta (Université d'Evry-Val d'Essone), Xiaolu Tan (Ceremade, Univ. Dauphine), Pierre Patie (ORIE, Cornell University), Alexandre Richard (Inria, Regularity), Paola Cinnella (CMI, Université Aix Marseille), Caroline Bauzet (CMI, Université Aix Marseille), Laurent Mertz (Laboratoire J.A. Dieudonné, Univ. Nice – Sophia Antipolis), Charles-Edouard Bréhier (Cermics, École des Ponts).

8.4.1.1. Internships

BEDOUI Akram

Subject: Gestion du risque de portefeuille par la méthode des copules

Date: Feb 2014 - June 2014

Institution: EPT (Tunisie)

DEJAX Florian

Subject: Carbon and electricity markets

Date: from Jun 2014 until Aug 2014

Univ. Paris (France)

FOGUEN TCHUENDOM Rinel

Subject: Bayesian Inference via Markov Chain Monte Carlo methods: A financial case study

Date: March 2014 - August 2014

Institution: Université de Nice – Sophia Antipolis (France)

LALANNE Victor

Subject: Carbon and electricity markets

Date: from Jun 2014 until Aug 2014

Univ. Nice (France)

PAPIC-PONCE Alexis

Subject: Divergence of Euler numerical scheme for SDE with non Lipschitz coefficients

Date: March 2014

Institution: PUC (Chile)

PICCOLOMINI Tatiana

Subject: Probabilistic interpretation of non-linear PDEs with branching diffusion processes

Date: from March 2013 until July 2014

Institution: Universidad de Buenos Aires (Argentina)