



RESEARCH CENTER

FIELD

**Applied Mathematics, Computation
and Simulation**

Activity Report 2012

Section Partnerships and Cooperations

Edition: 2013-04-24

COMPUTATIONAL MODELS AND SIMULATION

1. BACCHUS Team	5
2. CAD Team	9
3. CAGIRE Team	10
4. CALVI Project-Team	13
5. CASTOR Team	14
6. COFFEE Project-Team	16
7. CONCHA Project-Team (section vide)	17
8. DEFI Project-Team	18
9. GAMMA3 Project-Team	20
10. IPSO Project-Team	21
11. MC2 Project-Team	23
12. MICMAC Project-Team	25
13. NACHOS Project-Team	27
14. NANO-D Team	30
15. OPALE Project-Team	32
16. POEMS Project-Team	36
17. SCIPORT Team	38
18. SIMPAF Project-Team	40

MODELING, OPTIMIZATION, AND CONTROL OF DYNAMIC SYSTEMS

19. APICS Project-Team	42
20. BIPOP Project-Team	44
21. COMMANDS Project-Team	45
22. CORIDA Project-Team	48
23. DISCO Project-Team	49
24. GECO Team	51
25. MAXPLUS Project-Team	53
26. MCTAO Team	54
27. NECS Project-Team	56
28. NON-A Project-Team	59

OPTIMIZATION, LEARNING AND STATISTICAL METHODS

29. CLASSIC Project-Team	61
30. DOLPHIN Project-Team	62
31. GEOSTAT Project-Team	65
32. MISTIS Project-Team	67
33. MODAL Project-Team	69
34. REALOPT Project-Team	71
35. SELECT Project-Team	73
36. SEQUEL Project-Team	74
37. SIERRA Project-Team	82
38. TAO Project-Team	84

STOCHASTIC METHODS AND MODELS

39. ALEA Project-Team	90
40. ASPI Project-Team	91
41. CQFD Project-Team	92
42. I4S Team	95
43. MATHRISK Team	98
44. REGULARITY Project-Team	99
45. TOSCA Project-Team	100

BACCHUS Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Title: PETALH: Preconditioning scientific applications on pETascALe Heterogeneous machines

Type: ANR

Grant: Cosinus 2010

Duration: September 2011 - May 2013

Coordinator: GRIGORI Laura (Inria Saclay-Île de France)

Other partners: Inria Saclay-Île de France (leader of the project), Paris 6, IFP (Rueil-Malmaison), CEA Saclay.

See also: <http://petal.saclay.inria.fr/>

Abstract: In this collaborative effort, we propose to develop parallel preconditioning techniques for the emergent hierarchical models of clusters of multi-core processors, as used for example in future petascale machines. The preconditioning techniques are based on recent progress obtained in combining the well known incomplete LU (ILU) factorization with tangential filtering.

The track we are following in order to contribute to this goal is to investigate improved graph ordering techniques that would privilege the diagonal dominance of the matrices corresponding to the subdomains of the Schur complement. It amounts to integrating numerical values into the adjacency graph of the matrices, so that the importance of off-diagonal terms is taken into account when computing graph separators. The core of this work is planned to take place at the beginning of next year.

This project is a continuation of PETAL project that was funded by ANR Cosinus 2008 call.

8.1.2. 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.

8.1.2.1. CEMRACS 2012

Participants: Dragan Amenga-Mbengoué, Damien Genet, Emeric Martin [ONERA], Maxime Mogé [Cagire], Vincent Perrier [Cagire], Floren Renac [ONERA], Francois Rué, Mario Ricchiuto.

Jointly with the team Bacchus and with ONERA, we participated in project *Colargol*, which aimed at comparing implementations and performances of high order finite elements methods implemented in our library *Aerosol*, and in the high order discontinuous Galerkin library *AGHORA* developed at ONERA. For making fair comparisons with this library, we had to extend our library to three dimensions, and to finish the first parallel version of the code. Our first conclusions is the necessity of storing all geometrical terms of the finite elements methods (Jacobian, Jacobian matrices, etc...) for obtaining good performance. We are still running the comparison tests on the *Mésocentre de Calcul Intensif Aquitain*.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. IDIHOM

Title: Industrialisation of High-Order Methods

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2010 - September 2013

Coordinator: Deutsches Zentrum für Luft und Raumfahrt (Germany)

Others partners: DLR (Germany), Dassault Aviation (France), EADS-Cassidian (Germany), Cenaero (Belgium), Numeca (Belgium), ARA (UK), FOI (Sweden), Inria (France), NLR (the Netherlands), ONERA (France), TSAGI (Russia), ENSAM (France), Imperial College (UK), Universities of Bergamo (Italy), Warsaw (Poland), Poznan (Poland), Linköping (Sweden), Université Catholique de Louvain (Belgium).

See also: http://www.dlr.de/as/en/desktopdefault.aspx/tabid-7027/11654_read-27492/

Abstract: The proposed IDIHOM project is motivated by the increasing demand of the European aerospace industries to advance their CFD-aided design procedure and analysis by using accurate and fast numerical methods, so-called high-order methods. They will be assessed and improved in a top-down approach by utilising industrially relevant complex test cases, so-called application challenges in the general area of turbulent steady and unsteady aerodynamic flows, covering external and internal aerodynamics as well as aeroelastic and aeroacoustic applications. Thus, the major aim is to support the European aeronautics industry with proven-track method(s) delivering an increased predictive accuracy for complex flows and (by same accuracy) an alleviation of computational costs which will secure their global leadership. An enhancement of the complete "high-order methods suite" is envisaged, including the most relevant methods, Discontinuous Galerkin and Continuous Residual-Based methods, in combination with underlying technologies as high-order grid generation and adaptation, visualisation, and parallelisation. The IDIHOM project is a key-enabler for meeting the ACARE goals, as higher-order methods offer the potential of more accurate prediction and at the same time faster simulations. Inria is involved in the design of Continuous Residual-Based methods for the simulation of steady turbulent flows.

8.2.1.2. ADDECCO

Title: ADaptive schemes for DEterministic and stoChastiC Flow PrOblems (ADDECCO)

Type: IDEAS (AdG # 226316)

Instrument: ERC Advanced Grant (Advanced)

Duration: December 2008 - November 2013

Coordinator: Inria (France)

Others partners: none

See also: <http://www.math.u-bordeaux.fr/~rabgrall>

Abstract: The numerical simulation of complex compressible flow problem is still a challenge nowadays, even for the simplest physical model such as the Euler and Navier Stokes equations for perfect gases. Researchers in scientific computing need to understand how to obtain efficient, stable, very accurate schemes on complex 3D geometries that are easy to code and to maintain, with good scalability on massively parallel machines. Many people work on these topics, but our opinion is that new challenges have to be tackled in order to combine the outcomes of several branches of scientific computing to get simpler algorithms of better quality without sacrificing their efficiency properties. In this proposal, we will tackle several hard points to overcome for the success of this program. We first consider the problem of how to design methods that can handle easily mesh refinement, in particular near the boundary, the locations where the most interesting engineering quantities have to be evaluated. CAD tools enable to describe the geometry, then a mesh is generated which itself is used by a numerical scheme. Hence, any mesh refinement process is not directly connected with the CAD. This situation prevents the spread of mesh adaptation techniques in industry and we propose a method to overcome this even for steep problems. Second, we consider the problem of handling the extremely complex patterns that occur in a flow because of boundary layers: it is not always sufficient to only increase the number of degrees of freedom or the formal accuracy of the scheme. We propose to overcome this with class of very high order numerical schemes that can utilise solution dependant basis functions. Our third item is about handling unsteady uncertainties in the model, for example in the geometry or the boundary conditions. This need to be done efficiently: the amount of computation increases a priori linearly with the number of uncertain parameters. We propose a non-intrusive method that is able to deal with general probability density functions (pdf), and also able to handle pdfs that may evolve during the simulation via a stochastic optimisation algorithm, for example. This will be combined with the first two items of this proposal. Many random variables may be needed, the curse of dimensionality will be dealt thanks to multiresolution method combined with sparse grid methods. The aim of this proposal is to design, develop and evaluate solutions to each of these challenges. Currently, and up to our knowledge, none of these problems have been dealt with for compressible flows with steep patterns as in many moderns aerodynamics industrial problems. We propose a work program that will lead to significant breakthroughs for flow simulations with a clear impact on numerical schemes and industrial applications. Our solutions, though developed and evaluated on flow problems, have a wider potential and could be considered for any physical problem that are essentially hyperbolic.

8.3. International Initiatives

8.3.1. Inria Associate Teams

AQUARIUS associated team is a research project dealing 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.

8.3.2. Inria International Partners

Politecnico de Milano, Aerospace Department (Pr. A. Guardone)

We have a collaboration on ALE for compressible flows and ORC fluids.

von Karman Institute: T. Magin

We work together on Uncertainty Quantification problems for the identification of inflow condition of hypersonic nozzle flows.

8.3.3. Participation In International Programs

8.3.3.1. JLPC

In the context of the JLPC (Joint Laboratory for Petascale Computing), people involved in the development of graph partitioning algorithms in *Scotch* collaborate with several US partners (UIUC, Argonne) so as to improve partitioning run time and quality for large scale simulations. Sébastien Fourestier has been attending the Inria-UIUC meeting of last September and has delivered two talks, one regarding *Scotch* and the other regarding PaMPA.

8.3.3.2. 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.

8.3.3.3. Inria@SILICONVALLEY

People involved in the development of graph partitioning algorithms in *Scotch* have a loose collaboration with Sherry Li and her team at Berkeley, regarding sparse matrix reordering techniques.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Jan KLOSA (from Apr 2012 until Oct 2012)

Subject: Arbitrary Lagrangian Euler (ALE) for very high order schemes in compressible fluid dynamics

Institution: Technische Universität Braunschweig (Germany)

Paul Constantine (Post doc, January 2102)

Subject: Uncertainty quantification

Institution: Aquarius team, Stanford University (Germany)

Luca Arpaia (From Apr 2012 until Oct 2012)

Subject: Arbitrary Lagrangian Euler (ALE) for very high order schemes in compressible fluid dynamics

Institution: Politecnico de Milano (Italy)

Andrea Filipni (From october 2012 until April 2013)

Subject:

Institution: Politecnico de Milano (Italy)

8.4.2. Visits to International Teams

Visits of Pietro Marco Congedo and Gianluca Geraci during a month (June-July 2012) at the NASA Center for Turbulence Research, Stanford University.

CAD Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Inria Associate Teams

CAD is an Inria/Tsinghua University team related to LIAMA (China).

8.1.2. Participation In International Programs

We attend an international program of National Natural Science Foundation of China from 2010 to 2013.

Floating Point continuity clearly is a pioneer effort to solving a well-known unsolved problem. Up to now, almost all geometric modeling tool kits are based on traditional mathematics. They ignore the fact that computers can only represent a finite set of real numbers and simply use the formula $(a - \varepsilon < b)$ and $(b < a + \varepsilon)$ to compare whether two real numbers a and b are equal to each other or not. In the way, it becomes a very hard problem how to choose the proper value i.e., the precision is often out of control in geometric modeling tool kits although few documents report such the fact. This problem is very difficult. We also explore some formal methods and applied them to geometric algorithms. It seems to be an interesting research avenue. Finally, we also plan to study tolerances problem more carefully with CAD/CAM experts, because many of tolerances are not only directly related to the actual manufacturing process.

The central challenge with spline surfaces is to control their continuity when multiple patches join and to enable different types of sharpness. We are especially excited by a new result that addresses a central problem with spline modeling that has been open for five decades: the variation of continuity across a patch. This is needed, for example, when a crease forms in a smooth area. Because spline surfaces are modeled using a (mostly separable) tensorial product of polynomial bases, it is hard to have a different level of continuity on two opposite edges of a patch. We proposed a particularly elegant solution to this challenge by smoothly varying the parametric location of the spline knots. This allows the curve to transition from a configuration where knots overlap (sharp C^1 discontinuity) to a configuration where they are distinct (fully continuous surface). We think that this work will have a large impact on CAD-CAM. Moreover, we speculate that our new geometric representation could be good candidates for better solving numerical simulation (PDEs) problems.

CAGIRE Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Boundary conditions for DNS (6 months of post-doct funded by Conseil régional d'Aquitaine)

Although DNS is mostly used in simplified geometries, issues remain for properly imposing boundary conditions. Indeed, considering for example an inflow boundary condition (BC), a number of variables depending on the subsonic or supersonic nature of the flow must be suitably imposed. As far as the velocity is concerned, it is highly desirable to prescribe boundary conditions with statistics which will match as much as possible those encountered in practice while controlling the reflective nature of the boundary. This can be highly beneficial to drastically reduce the computational domain, thus reducing the computational time. It has to be checked though that the best identified methodology suitable for the continuous problem is still compatible with the methods of resolution adopted to solve the related discrete problem. The long-term objective is to develop, implement and test an efficient method to prescribe boundary conditions for the DNS simulation of a jet in cross-flow. The focus here will be made on the constraints brought about by the compressible and low Mach nature of the flow. Accordingly, the successful low Mach number compressible laminar flow simulation will be considered as the criterion of success of the post-doc. Project: The activity will begin by properly identifying the different sets of physical inlet/outlet physical boundary conditions that are relevant for the low Mach compressible nature of the flow to be simulated; In that framework, a specific analysis of the popular Navier-Stokes characteristic boundary condition (NSCBC) will be carried out in the context of a low Mach number viscous flow. Second, the compatibility of these NSCBC's with the finite element DG formulation retained in the Aerosol library will be investigated in depth in order to identify any potential incompatibility and the way to overcome it, if necessary. Then, the methodology for combining these BC's with the various flux schemes and methods of solution of Aerosol will be developed. The programming of the proposed methodology in Aerosol will be carried out in a parallel environment. Then, a set of unitary tests will be defined and progressively addressed. Last, the simulation of a laminar low-Mach jet in cross-flow configuration will be carried out. Yann Moguen has been recruited on November 2012 to take up that post-doct position. The Conseil régional d'Aquitaine 6-month funding is supplemented by funding from the European programme IMPACT-AE so that the total duration of the post-doct will be 12 months.

7.1.2. Low Mach number aspects for DG schemes (18 months of thesis funded by Conseil général des Pyrénées Atlantiques)

In the literature, the targeted direct numerical simulation (DNS) of a jet in a subsonic crossflow at low Mach number has been carried out by solving the zero Mach number Navier Stokes equations i.e. without acoustics. The reader is referred to the work by Muppidi and Mahesh (2007) or by Bagheri et al. (2009). Such an approach is acceptable since in a real combustion chamber, the Mach number is rarely above 0.3 and as long as thermo-acoustic instabilities are not to be dealt with. However, in the present project, it has been decided to adopt a compressible framework in order to be able to study in the future the interaction of a jet with a crossflow where a standing acoustic wave is present which corresponds to the configuration presently studied in the framework of the EU funded KIAI programme Workpackage 3.1). To the best of our knowledge, no DNS of an inclined turbulent JICF with a DG based compressible flow solver has been carried out so far. So a thesis work breakdown on that topic has been established as follows:

- Year 1: Understanding the industrial and contractual context. Asymptotic analysis for small Mach numbers of the continuous problem. Study of the various alternatives for discretization schemes at low Mach number. Establishing the link with schemes adapted for zero Mach number flows. Writing of the corresponding thesis chapter; Writing a communication for an international symposium. Participating in a summer school on numerical simulation.

- Year 2: Implementation of the schemes which exhibit a satisfactory asymptotic behavior at low mach number. Carrying out a DNS of an isothermal single jet in cross flow configuration with and without yaw angle in the framework of the IMPACT-AE programme. Analysis of the results, comparison with existing experimental data available in the team. Writing of the corresponding thesis chapter. Writing and submission of a journal paper.
- Year 3: Improvement of the schemes if necessary. Carrying out the DNS of a cold jet in a hot crossflow configuration with and without yaw angle in the framework of the IMPACT-AE programme. Analysis of the results. Writing of the corresponding thesis chapter. Thesis defense.

Thus a thesis proposal has been established and submitted to the Conseil Général des Pyrénées Atlantiques who agreed to fund 18 months of this thesis. The remaining 18 months will be funded through the European programme IMPACT-AE. The recruitment procedure was launched in June 2012 for a provisional starting date in January 2013.

7.2. National Initiatives

7.2.1. GIS Success

Participants: Vincent Perrier, Pascal Bruel.

We are presently participating in the CNRS GIS (Groupement d'Intérêt Scientifique) which is provisionally called "Super-calcul en Combustion et en Mécanique des Fluides dans les Géométries Complexes" and is led by CORIA. A license agreement has been signed with CORIA to permit the installation of the code Yales 2. This installation has been completed on the LMA cluster by the end of december 2012 and the first test will begin in january 2013 in the framework of our benchmarking activity.

7.2.2. CEMRACS 2012

Participants: Dragan Amenga-Mbengoué [Bacchus], Damien Genet [Bacchus], Emeric Martin [ONERA], Maxime Mogé, Vincent Perrier, Floren Renac [ONERA], Francois Rué [Bacchus], Mario Ricchiuto [Bacchus].

Jointly with the team Bacchus and with ONERA, we participated to the project *Colargol*, which aimed at comparing implementations and performances of high order finite elements methods implemented in our library Aerosol, and in the high order discontinuous Galerkin library AGHORA developed at ONERA. For making fair comparisons with this library, we had to extend our library to three dimensions, and to finish the first parallel version of the code. Our first conclusions is the necessity of stocking all geometrical terms of the finite elements methods (Jacobian, Jacobian matrices, etc...) for having good performances. We are still running the comparison tests on the Mésocentre de Calcul Intensif Aquitain.

7.3. European Initiatives

7.3.1. FP7 Projects

Participants: Vincent Perrier [responsible], Pascal Bruel [substitute].

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 of Science, Technology and Medicine, Loughborough University.

Abstract: The environmental benefits of low emissions lean burn technology in reducing NO_x emissions up to 80% only be effective when these are deployed to a large range of new aero-engine applications. While integrating methodologies for advanced engine architectures and thermodynamic cycles. It will support European engine manufacturers to pick up and keep pace with the US competitors, being already able to exploit their new low emission combustion technology to various engine applications with short turn-around times. Key element of the project will be the development and validation of design methods for low emissions combustors to reduce NO_x 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 NO_x models will increase the accuracy of the numerical prediction. The advanced representation of low emission combustors and the capability to investigate combustor scaling effects allow an efficient optimisation of future combustors targeting a cut of combustor development time by 50%. Work packages: WP1 'Development of smart design methodologies for clean combustion' as central WP to deliver the new methodology for combustor design, WP2 'Modelling and design of advanced combustor wall cooling concepts' for combustor liner design definition as key technology area, WP3 'Technology validation by detailed flame diagnostics' to substantiate fuel injector design rules implemented into the design methodology and WP4 'Methodology demonstration for efficient low NO_x combustors' will validate the combustor design. The consortium consists of all major aero-engine manufacturers in Europe, 7 universities and 3 research establishments with recognised experience in low emission combustion research and 10 SMEs. The contribution of our team is to create 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.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Dr. A. Naïmanova, Institute of Mathematics, Almaty, Kazakhstan came for a one-month stay in September 2012.

CALVI Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- Takashi Hattori, Simon Labrunie and Jean-Rodolphe Roche participate in the ANR project “CHROME” (Heating, Reflectometry and Waves for Magnetized Plasma), grouping researchers from Université Paris 6 (B. Després, M. Campos Pinto and others), the Inria project-team POEMS (E. Bécache, C. Hazard and P. Joly) and Université de Lorraine (S. Heuraux). Simon Labrunie is the head of the Lorraine team.

The CHROME project seeks to develop advanced mathematical and numerical tools for the simulation of electromagnetic waves in strongly magnetized plasmas (e.g., tokamak plasmas) in the context of reflectometry (a technique for probing the plasma by analysing the propagation of electromagnetic waves) and heating.

- GYPSI project (2010–2014), <https://sites.google.com/site/anrgypsi/>: coordinator Philippe Ghendrih (CEA Cadarache), other participants, University of Marseille, Universities of Strasbourg and Nancy (CALVI project-team). The aim is to understand the physics of turbulence in magnetically confined plasma using numerical simulation
- accepted ANR project “PEPPSI” in Programme Blanc SIMI 9 – Sciences de l’ingénierie (Edition 2012). Participants : Giovanni Manfredi (coordinator), Sever Hirstoaga.
- Stéphanie Salmon is a major member of ANR Project “VIVABRAIN” (Modèles Numériques, 2012) from 2013 to 2016.

8.1.2. Euratom-CEA projects

- Michel Mehrenberger is the coordinator of the project FR FCM (CNRS Federation on Magnetic Confinement Fusion), within Euratom-CEA association, Title: “Numerical Methods for GYSELA”, the goal is to help improving the numerical algorithms used by the GYSELA code developed at CEA Cadarache for the simulation of turbulence in magnetic fusion plasmas.
- Jean Roche is the coordinator of the FR FCM project with Euratom-CEA association, Title: “Full wave modeling of lower hybrid current drive in tokamaks”. The goal of this project is to develop a full wave method to describe the dynamics of lower hybrid current drive problem in tokamaks.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

E. Sonnendrücker: Max Planck Institut, Munich (Germany)

We will continue to collaborate with Eric Sonnendrücker on numerical and mathematical studies for plasma physics. We also collaborate on the SeLaLib project.

CASTOR Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

- ANR ECINADS
Castor is associated to the ANR ECINADS project started in end of 2009, devoted to the design of new solution algorithms for unsteady compressible flows, adapted to scalable parallelism and to reverse (adjoint) Automatic Differentiation. See in the activity report of Tropics.
- ANR ESPOIR
The ANR ESPOIR (Edge Simulation of the Physics Of Iter Relevant turbulent transport) associates the CASTOR team with the M2P2, LPIIM and LAMP laboratories in Marseille and IRFM in Cadarache to investigate edge plasma turbulence. The numerical simulation of the plasma wall interactions requires efficient codes and thus the development of advanced numerical methods and solvers. The aim of this project is to study different numerical strategies for edge plasma models in the real geometrical and magnetical configurations corresponding to the future Iter machine.
- ANEMOS : ANR-11-MONU-002
ANEMOS : Advanced Numeric for Elms : Models and Optimized Strategies associates JAD Laboratory/Inria (Nice, Manager), IRFM-CEA (Cadarache), "Maison de la Simulation (Saclay)" and Inria EPI Bacchus (Bordeaux) Elms are disruptive instabilities occurring in the edge region (SOL) of a tokamak plasma. The development of Elms poses a major challenge in magnetic fusion research with tokamaks, as these instabilities can damage plasma-facing components, particularly divertor plates. The mitigation or suppression of large Elms is a critical issue for successful operation of ITER. Goal for ANEMOS is to develop and improve numerical tools in order to simulate physical mechanisms of Elms and qualifies some strategies for their control. We then need to design efficient numerical strategies on the most advanced computers available to contribute to the science base underlying of proposed burning plasma tokamak experiments such as ITER.
- ANR IODISEE : IONospheric DIsturbances and Satellite-to-Earth communications. <http://iodissee.math.cnrs.fr/project/index.html>. In this ANR project, CASTOR will address the use of data-models coupling method to identify the input model parameters (especially, the initial data for the electronic density).

6.1.2. Inria initiatives

Large scale Initiative FUSION (2009–2012), http://www-math.u-strasbg.fr/ae_fusion: Modeling and numerical simulation of magnetic fusion plasmas in view of the ITER project.

6.1.3. Federation on Magnetic Confinement Fusion Projects

- FR FCM (Federation on Magnetic Confinement Fusion) project within Euratom-CEA association, "Reconstruction, simulation and control of plasma equilibrium"
- FR FCM (Federation on Magnetic Confinement Fusion) project within Euratom-CEA association, "Two-fluid numerical modelling of edge plasma in tokamak; Application to ITER".

6.2. International Initiatives

6.2.1. Euromediterranée 3+3 Medlagoon program

Participants: Hervé Guillard, Marco Bilanceri.

The goal of the Medlagoon project (<https://project.inria.fr/medlagoon/en>) is to contribute to the design of simulations tools aimed to the integrated mathematical modeling of Mediterranean lagoons ranging from hydrodynamics and sediment transport modeling to biological models for phyto and zoo-plankton. This program associates CASTOR with the Mohamedia Engineering school and the university of Oujda in Morocco, the University of Pisa (Italy), the Polytechnic school of Tunisia, the university of Paris 13, Ain Sham University in Egypt and the Department of Applied Mathematics, University of Crete in Greece.

6.3. International Research Visitors

6.3.1. Visits of International Scientists

6.3.1.1. University of Pilzen : Algebraic Multigrid Solvers

In the framework of a collaboration on algebraic multigrid solvers, Petr Vanek and Roman Kuzel of the University of Pilzen, Czech Republic have visited CASTOR in November.

6.3.1.2. Institute of Mathematical Modeling and university of Moscow : Acoustics

The long-term scientific collaboration with IMM on acoustics focussed this year on new reconstruction schemes for noise propagation with linear and nonlinear hyperbolic models. Ludwig W. Dorodnicyn has visited us in april 2012.

6.3.1.3. University of Oujda: Environmental flows

In the framework of the Medlagoon project, Imad El Mahi has visited us in November 2012

6.3.1.4. National Taiwan University : Granular and Multiphase flows

In the wake created by the Hubert Curien project (ORCHID 08-09), Keh-Ming Shyue (Department of Mathematics, National Taiwan University) has visited us in July 2012.

COFFEE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

The ANR-project Monumentalg, led by M. Ribot, is devoted to the modeling and simulation of biological damage on monuments and algae proliferation.

7.1.2. National and European networks

- GdR MoMas.
The research group MoMaS (Mathematical Modeling and Numerical Simulation for Nuclear Waste Management Problems) has activities centered around scientific computing, design of new numerical schemes and mathematical modelling (upscaling, homogenization, sensitivity studies, inverse problems,...). Its goal is to coordinate research in this area, as well as to promote the emergence of focused groups around specific projects In particular, in 2012, R. Masson has been involved in the organization of two MoMaS workshop "Multiphasic flows", Oct. 8-9 2012, with Danielle Hilhorst, University of Orsay.
- S. Junca is involved in the GdR-e "Wave Propagation in Complex Media for Quantitative and non Destructive Evaluation"; in particular he organized the Workshop "Nonlinearities in Acoustics" Nice, March 22-23/2012.
- GdR EGRIN is a newly created CNRS-network, devoted to gravitational flows and natural risks; Coffee is among the members of this network.
- R. Masson, with Pierre Samier (Total) has been organizer of ECMOR XIII European Conference on the Mathematics of Oil Recovery, 10-13 september 2012, Biarritz, France, a scientific event of the European Association of Geoscientists and Engineers.

CONCHA Project-Team (section vide)

DEFI Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Olivier Pantz is in charge of the Gaspard Monge Program for Optimization and operations research (PGMO) *Optimization of a Fast Sodium Reactor*

8.2. National Initiatives

8.2.1. ANR

- J.R. Li is the coordinator of the project Simulation du signal d'IRM diffusion dans des tissus biologiques (SIMUDMRI), funded 2010-2013 by the ANR Program COSINUS. Participants : Jing-Rebecca Li, Housseem Haddar, Dang Van Nguyen. Joint proposal between Inria-Saclay and CEA Neurospin. <http://www.cmap.polytechnique.fr/~jingrebeccali/grants/simudmri.html>
- 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>

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

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

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

Partner 2: University of Genova, Department of Math. (Italy)

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

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. ISIP

Title: Inverse Scattering and Identification Problems

Inria principal investigator: Housseem HADDAR

International Partner (Institution - Laboratory - Researcher):

University of Delaware (United States) - Mathematical Department - Fioralba Cakoni

Duration: 2008 - 2013

See also: <http://www.cmap.polytechnique.fr/~defi/ISIP/isip.html>

The associated team concentrates on the use of qualitative methods in electromagnetic inverse scattering theory with applications to the imaging of urban infrastructure, the nondestructive evaluation of coated materials and medical imaging. Most of the effort is focused in the solution of the inverse problems using time harmonic waves, in particular for frequencies in the resonance regime.

8.4.2. Inria International Partners

- Close collaboration with the former member of our EPI, A. Lechleiter, who is now professor at University of Bremen. Joint PhD advising of T. Rienmuller, partly funded by French-German university.

8.4.3. Participation In International Programs

- H. Haddar is member of the EPIC, an Inria team in the framework of LIRIMA.
- 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).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Mohamed MAHJOUB (from Feb 2012 until Aug 2012)

Subject: Level set method applied to structural optimization with contact

Institution: Ecole Polytechnique de Tunisie (Tunisia)

Jackie FAN YAN (from June 2012 until Aug 2012)

Subject: Direct and inverse simulation of hyper lenses

Institution: University of Delaware (Tunisia)

GAMMA3 Project-Team

5. Partnerships and Cooperations

5.1. Regional Initiatives

- Maîtrise des propriétés des fibres de chanvre (fibre / chènevotte), dans le cadre de valorisations en agro-composites base polymère, MAPROFI CONTRAT DE PROJETS ETAT-REGION 2007-2013, INRA, UTT, USTL, AFT plasturgie, ITC
- Valorisation par recyclage de composites bio-sourcés à base de fibres de chanvre au travers de leur comportement mécanique sous sollicitations statiques et dynamiques, Projet BioComposites Incitatif Amont DRRT 2012 de la région Champagne Ardenne

5.2. European Initiatives

5.2.1. FP7 Projects

- Projet Européen : FP7 Health-F5-2009-241818 : NANOANTENNA
Participants: Dominique Barchiesi [correspondant], Thomas Grosge, Sameh Kensentini
Développement d'un biocapteur in vitro, ultra sensible et sélectif destiné à la détection de protéines impliquées dans les premières phases du développement de maladies. Modélisation et optimisation numériques du dispositif (taille, forme, couplage électromagnétique-matériaux).

5.3. International Research Visitors

5.3.1. Internships

- ZHANG Jie, 3D advanced remeshing procedure for numerical simulation of forming processes
- SLIMANI Faouzi, Modélisation mécanique des aptitudes de formage à chaud des tôles et des tubes minces avec remaillage adaptatif en grandes déformations

5.3.2. Visits to International Teams

- Frederic Alauzet, Septembre 2011-Septembre 2012, Mississippi State University, CAVS lab.

IPSO Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR Programme blanc (BLAN) MEGAS: 2009-2012

Participants: François Castella, Philippe Chartier, Arnaud Debussche, Erwan Faou.

Geometric methods and sampling: application to molecular simulation. The project was financed for 3 years, coordinated by Tony Lelièvre and has gathered the following teams and persons:

- Team of Eric Cancès at CERMICS
- Team IPSO
- Mathias Rousset from Inria Lille
- Christophe Chipot, from the CNRS in Nancy.

P. Chartier was the coordinator for IPSO.

6.1.2. ANR Programme blanc GYPSI: 2010-2014

Participant: Nicolas Crouseilles.

Leader: Ph. Gendrih.

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

6.1.3. ANR Programme blanc E2T2: 2010-2014

Participant: Nicolas Crouseilles.

Leader: P. Beyer

6.1.4. ANR Programme blanc STOSYMAP

Participant: Arnaud Debussche.

Leader: A. Shirikyan, The full description is available at <http://shirikyan.u-cergy.fr/stosymap.html>

6.1.5. Inria Large scale initiative FUSION

Participant: Nicolas Crouseilles.

Leader: E. Sonnendrücker. The full description is available at http://www-math.u-strasbg.fr/ae_fusion

6.2. European Initiatives

6.2.1. FP7 Projects

6.2.1.1. <http://www.irisa.fr/ipso/perso/faou/geopardi.html> Geopardi

Title: Geometric Partial Differential Equations

Type: IDEAS ()

Instrument: ERC Starting Grant (Starting)

Duration: September 2011 - August 2016

Coordinator: Inria (France)

See also: <http://www.irisa.fr/ipso/perso/faou/geopardi.html>

Abstract: The goal is to develop new numerical methods for the approximation of evolution equations possessing strong geometric properties such as Hamiltonian systems or stochastic differential equations. Use intensive numerical simulations to discover and analyze new nonlinear phenomena.

6.3. International Initiatives

6.3.1. Participation In International Programs

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

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

Leaders: N. Mauser (Univ. Vienna) and F. Castella (IPSO).

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), Joerg Schmiedmayer (Vienna), Hans-Peter Stimming (Vienna).

Francois Castella (IPSO), Florian Mehats (IPSO), Francis Nier (Rennes), Raymond El Hajj (Rennes), Mohammed Lemou (IPSO), Claudia Negulsecu (Toulouse), Fanny Delebecque (Toulouse), Stephane Descombes (Nice), Philippe Chartier (IPSO), Christophe Besse (Lille),

The expected scientific and technological progress brought by the present project are as follows. "Quantum technology" as the application of quantum effects in macroscopic devices has an increasing importance, not only for far future goals like the "quantum computer", but already now or in the near future. The present project is mainly concerned with the mathematical and numerical analysis of these objects, in conjunction with experimental physicists. On the side of fermions quantum electronic structures like resonant tunnelling diodes show well studied "non classical effects" like a negative differential resistance that are exploited for novel devices. On the side of bosons the creation and manipulation of Bose Einstein Condensates (the first creation of BECs by Ketterle et al merited a Nobel prize) has become a standard technique that allows to study fundamental quantum concepts like matter-wave duality with increasingly large objects and advanced quantum effects like decoherence, thermalization, quantum chaos. In state-of-the-art experiments e.g. with ultracold atoms in optical lattices the bosonic or fermionic nature of quantum objects can change and it makes a lot of sense to treat the models in parallel in the development of mathematical methods. The experimental progress in these fields is spectacular, but the mathematical modelling and analysis as well as the numerical simulation are lagging behind. Low dimensional models are mostly introduced in a heuristic way and there is also a need for systematic derivations and comparison with the 3-d models. To close the gap is a main goal of this project that aims to deliver reliable tools and programme packages for the numerical simulation of different classes of quantum systems modelled by partial differential equation of NLS type. Virtually all participants have a strong track record of international collaboration, they grew up with the concept of the "European Research Area" where science knows no boundaries and scientists used to work in different countries, as it was the case in a pronounced way in mathematics and in quantum physics in the thirties of the last century. The Pre- and Post-Docs to be funded by this project will be trained in this spirit of mobility between scientific fields and between places.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

- Mechthild Thalhammer, University of Innsbruck, one week
- Yong Zhang, University of Vienna, three weeks

6.4.2. Visits to International Teams

- G. Vilmart: EPF Lausanne (Switzerland), invitation by Assyr Abdulle in the chair of numerical analysis and computational mathematics, several 1-2 weeks visits (totalizing 3 months).

MC2 Project-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 MANIPHYC

Participants: Charles-Henri Bruneau, Thierry Colin.

Simulations of complex fluids.

Collaboration with Rhodia-Lof and University of Lyon 1, 2008–2012.

8.2.2. ANR CARPEiNTER

Participants: Héloïse Beaugendre, Michel Bergmann, Charles-Henri Bruneau, Angelo Iollo [Leader Project], Lisl Weynans.

Cartesian grid, penalization method, complex flow. The P.I. is Angelo Iollo. See <http://www.math.u-bordeaux1.fr/CARPEiNTER/>

8.2.3. ANR CYCLOBULLE

Participants: Charles-Henri Bruneau, Yong Liang Xiang.

The formation and dynamics of long lived coherent structures in atmospheric flows can be mimicked by soap film experiments on an hemisphere heated at the equator. The aim of this work is to simulate such flows and to compare both to the experiments and to the known data of various tornados.

8.2.4. ANR INTCELL

Participants: Thierry Colin, Olivier Saut, Clair Poignard.

The members T.Colin, C.Poignard and O.Saut are involved in the consortium INTCELL directed by P.LEVEQUE (XLIM), and which begun in December 2010. This mutlidisciplinary project, composed of four partners (XLIM laboratory, Vectorology and Anticancer therapies team at the IGR, EDAM and MC2) aims at studying the electroporabilization by nanopulses at the subcellular level. The goal is to develop new electrical devices and accurate models to understand the electroporabilization of the cytoplasm constituents such as the nuclear envelop or the mitochondrial membrane, based on the experiments and on the simulations of molecular dynamics.

8.2.5. ANR MEMOVE

Participants: Mathieu Colin, 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) are involved in the consortium MEMOVE coordinanted by MC2 (coordinator C. Poignard), and which begins at the begining 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 electroporabilization 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 electroporabilization 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.

8.2.6. PEPS CaRaMel3d

- Program: PEPS Idex-CNRS
- Project acronym: CaRaMel3d
- Project title: Calibration et Recalage sur l'Imagerie Médicale
- Duration: 07/2012-07/2013
- Coordinator: Olivier Saut
- Other partners: Institut Bergonié, CHU Pellegrin (Bordeaux),
- Abstract: Les médecins de l'Institut Bergonié (centre régional de lutte contre le cancer) s'intéressent à l'évaluation de l'agressivité de métastases dans le poumon. Les modèles mathématiques spatiaux développés par des mathématiciens de l'IMB permettent de décrire la croissance d'une tumeur solide plus ou moins fidèlement. Pour adapter ces modèles à un patient, il faut développer des méthodes pour trouver des valeurs raisonnables de leurs paramètres. Ces modèles calibrés peuvent alors fournir une prédiction numérique de l'évolution des nodules. Une collaboration entre ces deux équipes a déjà permis de développer un modèle et une technique de calibration qui permet d'évaluer cette agressivité en utilisant des coupes 2D. Même si ces résultats sont encourageants, l'aspect 3D de la croissance n'est pas pris en compte. L'objectif de ce projet est de prendre en compte cette 3ème dimension en développant pour cela de nouveaux algorithmes de recalage et de calibration en vue d'une application pratique.

8.3. European Initiatives

8.3.1. FP7 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

8.4. International Initiatives

- Collaboration with Hassan Fathallah, Neuro-oncology and mathematics, University of Alabama at Birmingham. We work on numerical modeling of brain tumor.
- Collaborations with Luca Zannetti, Politecnico di Torino; Simone Camarri, Università di Pisa; Eyal Arian, Boeing Commercial Airplanes.
- 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.

MICMAC Project-Team

7. Partnerships and Cooperations

7.1. Regional activities

The project-team is shared between Inria and Ecole des Ponts ParisTech.

7.2. National Initiatives

The project-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 Micmac team. It is coordinated by E. Cancès.
- I. Dabo is members of the ANR PANELS (Photovoltaics from Ab-initio Novel Electronic-structure Simulations).The PANELS initiative gathers three groups (CNRS, Institut Neel, France; Université de Lyon, LPMCN, France; Ecole des Ponts, Université Paris-Est, CERMICS, France) expert in methodology developments around many-body perturbation theory and a novel orbital-dependent density functional formalism, in order to study the electronic, optical and transport properties of second/third generation photovoltaic devices.
- 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 (CMLS, Ecole polytechnique).
- F. Legoll participates to the ANR Megas.
- T. Lelièvre is in charge of the ANR project "MEGAS".
- T. Lelièvre is member of the ANR-project "BIGMC" (PI: Gersende Fort, Telecom ParisTech) and of the ANR-project "STAB" (PI: I. Gentil, Université de Lyon).
- F. Nier is a member of ANR-NOSEVOL led by F. Héreau (Nantes) T. Ramond (Orsay) and S. Vu-Ngoc (Rennes), started in jan. 2012 for 4 years.
- F. Nier is a member of ANR-LODIQUAS led by F. Castella (Rennes) and N. Mauser (Wien), started in april 2012 for 4 years.

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 CoDFT,
- the GdR Maths et entreprise,
- the GdR correl (correlated methods in electronic structure computations),
- the GDR-CNRS 3274 Dynamique Quantique 2009-2012,
- the GDR-CNRS 2434 Analyse des Equations aux Dérivées Partielles.

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

We have invited the following National researchers to visit our team:

- A. Lozinski (University of Toulouse and now at the University of Besançon): repeated visits during the year 2012.

7.3. International Initiatives

7.3.1. Visits of International Scientists

We have invited the following researchers to visit our team:

- U. Hetmaniuk (University of Washington in Seattle), March 5-16, 2012,
- B. Khoromskij and V. Khoromskaia, (Max-Planck-Institute for Mathematics in the Sciences Leipzig), December 17-20, 2012.
- G. Nguetseng (University of Yaoundé 1, Cameroon), March 19-30, 2012,

7.3.2. Bilateral international relations

E. Cancès is involved in a France-Berkeley project on the modelling of solvated molecules.

T. Lelièvre, G. Stoltz and F. Legoll participates 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 Nancy, Université de Lyon and Inria Rennes.

NACHOS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. Analysis of children exposure to electromagnetic waves (*KidPocket*)

Participants: Stéphane Lanteri, Joe Wiart [WHIST Laboratory, Orange Labs, Issy-les-Moulineaux].

The project-team is a partner of the KidPocket project (Analysis of RF children exposure linked to the use of new networks or usages) which is funded by ANR in the framework of the *Réseaux du Futur et Services* program and has started in October 2009 for a duration of 3 years.

See also the ewb page <http://whist.institut-telecom.fr/kidpocket>

8.1.2. Competitivity Clusters

8.1.2.1. Volumic, automatic, industrial and generic mesh generation (*MIEL3D-MESHER*)

Participants: Clément Durochat, Paul-Louis Georges [GAMMA project-team, Inria Paris - Rocquencourt], Stéphane Lanteri, Mark Lorient [Distene, Pôle Teratec, Bruyères-le-Chatel], Philippe Barabinot [LMS Samtech France].

MIEL3D-MESHER is a national project of the SYSTEM@TIC Paris-Région cluster which aims at the development of automatic hexahedral mesh generation tools and their application to the finite element analysis of some physical problems. One task of this project deals with the definition of a toolbox for the construction of non-conforming, hybrid hexahedral/tetrahedral meshes. In this context, the contribution of the team to this project aims at the development of a DGTD- $\mathbb{P}_p\mathbb{Q}_k$ method formulated on such hybrid meshes. Here, \mathbb{P}_p stands for the polynomial interpolation method on tetrahedral elements while \mathbb{Q}_k denotes the polynomial interpolation method on hexahedral elements.

8.1.3. Large-Scale Initiative

8.1.3.1. 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 [CALVI project-team, Inria Nancy - Grand-Est], Franck Cappello [GRAND-LARGE 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], 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 2012, the team is coordinating the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria large-scale initiative. 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 the C2S@Exa Inria large-scale initiative 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.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

Prof. Martin Gander: University of Geneva, Mathematics section (Switzerland)

Domain decomposition methods (optimized Schwarz algorithms) for the solution of the frequency domain Maxwell equations

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

Numerical modeling of the propagation of electromagnetic waves in biological tissues with biomedical applications

8.3. International Initiatives

8.3.1. Participation In International Programs

8.3.1.1. CNPq-Inria HOSCAR project

Participant: Stéphane Lanteri [Coordinator of the project].

Since July 2012, the team is coordinating the HOSCAR <http://www-sop.inria.fr/hoscar> Brazil-France collaborative project. The 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 Computação Científica), COPPE/UFRJ (Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), INF/UFRGS (Instituto de Informática, Universidade Federal do Rio Grande do Sul) and LIA/UFC (Laboratórios de Pesquisa em Ciência da Computação Departamento de Computação, Universidade Federal do Ceará). The French partners are research teams from several Inria research centers.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Prof. Martin Gander, University of Geneva, Switzerland, July 2-12

Prof. Jay Gopalakrishnan, Portland University, USA, July 2-6

Dr. Maciej Klemm, University of Bristol, UK, June 18-22

Dr. Sascha Schnepf, ETH Zurich, Switzerland, September 25-27

NANO-D Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

We have obtained a regional grant for a PhD student (ARC 2012). The PhD student will be co-advised by Jean-François Mehaut (LIG, Grenoble) and Benjamin Bouvier (IBCP, Lyon), and will develop algorithms for parallel adaptive molecular dynamics simulations.

7.2. National Initiatives

7.2.1. ANR

In 2012, NANO-D received funding from four ANR programs:

- **ANR 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 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).
- **ANR PIRIBio**: 25,000 Euros over four years (2010-2013). We are participating in this project coordinated by Michel Vivaudou at IBS, with Serge Crouzy at CEA/LCBM and Frank Fieschi at IBS.
- **ANR COSINUS**: 85,000 Euros over four years (2009-2012). This project, coordinated by NANO-D (S. Redon), gathers physicists, biologists and computer scientists from five research groups: Xavier Bouju and Christian Joachim at CEMES, Martin J. Field at IBS, Serge Crouzy at CEA/LCBM, Thierry Deutsch and Frederic Lancon at CEA/SP2M (total grant: 380,000 Euros).

7.2.2. 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.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. ADAPT

Title: Theory and algorithms for adaptive particle simulation

Type: IDEAS

Instrument: ERC Starting Grant

Duration: September 2012 - August 2017

Principal Investigator: Stephane Redon

Coordinator: Inria (France)

7.4. International Research Visitors

7.4.1. Internships

Georgy CHEREMOVSKIY (from Jul 2012 until Oct 2012)

Subject: Development of Orientation-Dependent Potential Function for Computational Drug Design

Institution: Moscow Institute for Physics and Technology (Russian Federation)

OPALE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. Project "OMD2", Optimisation Multi-Disciplinaire Distribuée (Distributed Multidisciplinary Optimization)

This project funded by ANR deals with the development of a software platform devoted to Multidisciplinary Design Optimization (MDO) in the context of distributed computing.

The notion of optimization platform based on distributed and parallel codes is undertaken with a distributed workflow management system running on a grid infrastructure using the GRID5000 middleware from Inria.

Renault is the coordinator of this project, which involves also EMSE, ENS Cachan, EC Nantes, Université de Technologie de Compiègne, CD-Adapco, Sirehna, Activeon, and Inria project TAO, OASIS and OPALE. This contract provides the grant supporting two PhD theses (A. Zerbinati and L. Trifan)

8.1.2. 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 Systemic 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).

8.1.3. Project "Bulbe"

This project is funded by the Ministry of Fishing and gathers OPALE Project-Team, K-Epsilon company (specialized in CFD for naval hydrodynamics) and PROFIL compagnie (naval architect). The objective is to design and optimize bow shapes for trawler ships, in order to reduce the fuel consumption during fishing campaigns. Our role is to construct an automated optimization loop to improve bow efficiency, on the basis of CFD tools provided by K-Epsilon company and naval architect recommendations.

8.1.4. Project "Memoria"

This project is funded by the National Foundation for Aeronautics and Space (FNRAE). The partners are the University of Toulouse Paul-Sabatier and the CERFACS. The objective is to study optimization methods under uncertainty in the context of aerodynamic problems.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. EXCITING

Title: Exact Geometry Simulation for Optimized Design of Vehicles and Vessels

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2008 - Mars 2012

Coordinator: Jozef Kepler universitet (Austria)

Others partners: SINTEF (SW), SIEMENS (GER), NTUA (GR), HRS (GR), TUM (GER), HYDRO (AUS), DNV (NOR)

See also: <http://exciting-project.eu/>

Abstract: The objective is to develop simulation and design methods and software based on the isogeometric concepts, that unify Computer-Aided Design (CAD) and Finite-Elements (FE) representation bases. Applications concern hull shape, turbine and car structure design.

8.2.1.2. GRAIN

Title: GReener Aeronautics International Networking

Type: CAPACITIES (TRANSPORTS)

Instrument: Coordination and Support Action (CSA)

Duration: October 2010 - December 2012

Coordinator: CENTRE INTERNACIONAL DE METODES NUMERICCS EN ENGINYERIA (Spain)

Others partners: AIRBUS (SP), ALENIA (I), EADS-IW (F), Rolls-Royce (UK), INGENIA (SP), NUMECA (B), U. SHEFFIELD (UK), U. BIRMINGHAM (UK), CIRA (I), VKI (B), AIRBORNE (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), ZJU (CN).

See also: <http://www.cimne.com/grain>

Abstract: The GReener Aeronautics International Networking (GRAIN) is a 24 month project co-funded by the 7th Framework Programme of the European Community (EC) and by the Chinese Ministry of Industry and Information Technology (MIIT). It is managed by the European Commission as a Coordination and Support Action. The main objectives of GRAIN are to identify and assess the future development of large scale simulation methods and tools needed for greener technologies reaching the Vision 2020 environmental goals. GRAIN will prepare the R&T development and exploitation with new large scale simulation tools used on distributed parallel environments to deeper understand and minimize the effects of aircraft/engine design on climate and noise impact. This objective can be met by supporting joint Europe-China networking actions for defining the necessary technologies to improve green aircraft performance.

8.2.1.3. MARS

Title: Manipulation of Reynolds Stress

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2010 - September 2013

Coordinator: CENTRE INTERNACIONAL DE METODES NUMERICCS EN ENGINYERIA (Spain)

Others partners: USFD (UK), AIRBUS (SP), FOI (SW), ALENIA (IT), DLR (GER), CNRS (FR), DASSAULT (FR), NUMECA (BEL), UNIMAN (UK), EADS (UK)

See also: <http://www.cimne.com/mars/>

Abstract: The objective is to study flow control devices for aeronautical applications. This project gathers twelve European partners and twelve Chinese partners for a common work that includes both experimental and numerical studies. Opale Project-Team is in charge of developing numerical algorithms to optimize flow control devices (vortex generators, synthetic jets).

8.2.1.4. TraM3

Title: TRaffic Management by Macroscopic Models

Type: IDEAS

Instrument: ERC Starting Grant (Starting)

Duration: October 2010 - September 2015

Coordinator: Inria (France)

See also: <http://www-sop.inria.fr/members/Paola.Goatin/tram3.html>

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.

8.2.2. Collaborations in European Programs, except FP7

Program: PHC Polonium

Project acronym: CROM3

Project title: Crowd Motion Modeling and Management

Duration: jan. 2011 - dec. 2012

Coordinator: P. Goatin (France), M.D. Rosini (Poland)

Other partners: ICM, Warsaw University (Poland)

Abstract: The aim of this collaboration is to provide new analytical and numerical tools for solving control and optimization problems arising in pedestrian traffic management. Our scope is to develop a rigorous analytical framework and fast and efficient numerical tools for solving optimization and control problems, such as buildings exits design. This will allow to elaborate reliable predictions and to optimize traffic fluxes. To achieve this goal, we will study in details the structure of the solutions of the partial differential equations modeling traffic dynamics, in order to construct ad hoc methods to tackle the analytical and numerical difficulties arising in this study.

8.2.3. Collaborations with Major European Organizations

Partner 1: organisme 1, labo 1 (pays 1)

Sujet 1 (max. 2 lignes)

Partner 2: organisme 2, labo 2 (pays 2)

Sujet 2 (max. 2 lignes)

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. ORESTE

Title: Optimal REroute Strategies for Traffic managEment

Inria principal investigator: PaolaGoatin

International Partner (Institution - Laboratory - Researcher):

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

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.

8.3.2. Participation In 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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Senior Researchers

Pr. Ellaia Rachid

Subject: Theory and algorithms for global and multiobjective optimization.

Institution: Ecole Mohammadia d'Ingénieurs (EMI) , Rabat (Morocco)

8.4.1.2. Internship

Bouthaina Yahyaoui, Asma Ghdami and Marwa Mokni

Subject: Multiobjective optimization of laminated composite Mindlin-Reissner plates

Institution: Institut Supérieur des Mathématiques Appliquées et d'Informatique, Kairouan, (Tunisia)

POEMS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- ANR project *AEROSON: Simulation numérique du rayonnement sonore dans des géométries complexes en présence d'écoulements réalistes*
Partners: EADS-IW, CERFACS, Laboratoire d'Acoustique de l'Université du Maine.
Start : 10/01/2009, End : 02/28/2013. Administrator : CNRS. Coordinator : Jean-François Mercier.
- ANR project *PROCOMEDIA: Propagation d'ondes en milieux complexes*
Partners: ESPCI, Laboratoire d'Acoustique 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, DMIA-ISAE.
Start : 12/01/2011, End : 11/30/2015. 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

8.1.2. Competitivity Clusters

- GDR Ultrasons: this GDR, which regroups more than regroup 15 academic and industrial research laboratories in Acoustics and Applied Mathematics working on nondestructive testing. It has been renewed this year with the participation of Great Britain.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. SIMPOSIUM

Title: Simulation Platform for Non Destructive Evaluation of Structures and Materials

Type: COOPERATION (ICT)

Defi: PPP FoF: Digital factories: Manufacturing design and product lifecycle manage

Instrument: Integrated Project (IP)

Duration: September 2011 - August 2014

Coordinator: CEA (Pierre Calmont) (France)

Others partners: SERCO LIMITED (UNITED KINGDOM), SIMULAYT LTD (UNITED KINGDOM), SKF SVERIGE AB (SWEDEN), UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II (ITALY), UNIVERSITA DEGLI STUDI DI CASSINO (ITALY), VOLKSWAGEN AG (GERMANY), ARCELORMITTAL MAIZIÈRES RESEARCH SA (FRANCE), EXTENDE (FRANCE), EUROPEAN AERONAUTIC DEFENCE AND SPACE COMPANY EADS FRANCE SAS (FRANCE), IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE (UNITED KINGDOM), SAARSCHMIEDE GMBH FREIFORMSCHMIEDE* (GERMANY), KATHOLIEKE UNIVERSITEIT LEUVEN (BELGIUM), FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V (GERMANY).

See also: http://cordis.europa.eu/projects/rcn/99653_en.html

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- *Sergei Nazarov*, Professor at the University of Saint-Petersbourg.

SCIPORT Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ECINADS

Sciport is coordinator of the ANR project ECINADS, with CASTOR team, university Montpellier 2, Institut de Mécanique des Fluides de Toulouse and the Lemma company in Sophia-Antipolis. ECINADS concentrates on scalable parallel solution algorithms for state and adjoint systems in CFD, and on the use of this adjoint for mesh adaptation applied to unsteady turbulent flows.

7.2. European Initiatives

7.2.1. FP7 Projects

Program: FP7-PEOPLE-2012-ITN

Project acronym: About Flow

Project title: Adjoint-based optimisation of industrial and unsteady flows

Duration: Nov 2012 - Oct 2016

Coordinator: J.-D. Mueller, Queen Mary University of London

Other partners: Engys (UK), ESI-Group (F), Inria (F), National Technical University of Athens (GR), Rolls Royce (D), RWTH Aachen University (D), Volkswagen AG (D), Warsaw University of Technology (PL).

Abstract: Adjoint-based methods have become the most interesting approach in CFD optimisation due to their low computational cost compared to other approaches. The development of adjoint solvers has seen significant research interest, and a number of EC projects have been funded on adjoint-based optimisation. In particular, partners of this proposal are members of the EC FP7 project FlowHead which develops complete adjoint-based design methods for steady-state flows in automotive design. Integration of the currently available shape and topology modification approaches with the gradient-based optimisation approach will be addressed, in particular development of interfaces to return the optimised shape into CAD for further design and analysis, an aspect that currently requires manual interpretation by an expert user. In industrial practice most industrial flows have small levels of instability, which leads to a lack of robustness and instability of the adjoint, such as trailing edge vortex shedding in turbo-machinery. Many industrial applications are also partly unsteady such as bluff body separation in cars or fully unsteady such as vertical-axis wind turbines. In unsteady adjoints 'checkpoints' of the flow solution at previous timesteps need to be recorded and algorithms for an effective balance between storage and recomputation need to be implemented. The recomputation involves significant memory and runtime overheads for which efficient methods are developed and implemented. The results of the project will be applied to realistic mid-size and large-scale industrial optimisation problems supplied by the industrial project partners ranging from turbo-machinery, to automotive to wind-turbines. Training will be provided by academic, industrial and SME partners in methods development, industrial application and software management. A large programme of complementary training in professional skills will be provided with support from all partners.

7.3. International Initiatives

7.3.1. Inria International Partners

The team's collaboration with the Mathematics and Computer Science (MCS) division of Argonne National Laboratory is recognised by Inria as an "Inria International Partnership". This partnership is named "SAR-DINE" for "Sophia-Antipolis ARgonne Differentiation INitiative".

7.3.2. Participation In International Programs

The team participates in the Joint Laboratory for Petascale Computing (Inria, University of Illinois at Urbana Champaign, Argonne National Laboratory). Laurent Hascoët gave talks at this year's meetings in Rennes and Argonne.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Trond Steihaug, professor at the University of Bergen, has spent a sabbatical period with the team, from september 2011 to may 2012. He worked on AD of Factorable and of Separable functions [15].

SIMPAF Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Collaborations within Inria

MICMAC (M. Rousset)
REO (A. Gloria)
COFFEE (E. Creusé and C. Calgaro)
POEMS (C. Besse and I. Lacroix-Violet)
CORIDA (C. Besse)
IPSO (C. Besse)

8.1.2. ANR

8.1.2.1. ANR MICROWAVE (2009-2012)

Participants: Christophe Besse, Ingrid Lacroix-Violet.

Ch. Besse and I. Lacroix-Violet are members of the new 4-years ANR "blanche" project MICROWAVE. Ch. Besse is the North node coordinator. The scientific subjects deal with artificial boundary conditions for dispersive equations, electromagnetism and high frequency regimes in acoustic simulations. This ANR project concerns the development of new numerical methods for wave propagation problems using tools from microlocal analysis. It focuses on microlocal analysis and numerical methods for acoustic and electromagnetic wave scattering and microlocal analysis and numerical methods for Schrödinger-type equations.

8.1.2.2. ANR IODISSEE (2009-2012)

Participants: Christophe Besse, Pauline Lafitte.

C. Besse has obtained a 4-years ANR grant, from the Cosinus proposal, for the project IODISSEE. P. Lafitte and C. Yang, also members of the EPI Simpaf, are involved in this project. The project IODISSEE also involves a team of mathematicians from Toulouse, a physicist team from Versailles and the Thales group. It deals with the elaboration of a physical model for helping the industrial partner for the new generation of Galileo satellites. For the last decade, satellite positioning devices became one of the most interesting means of navigation for the displacement of the goods and the people. The only current solution is based on the constellation of satellites Navstar GPS American system. Originally developed for military applications, its use was released under the Clinton administration. However, in order to guarantee its autonomy, Europe decided to launch a competitor program known as Galileo. Galileo system differs from the GPS thanks to its capability to provide real time integrity information to the user. In order to guarantee the stability of this system, it is fundamental to take into account the various problems which can affect the mission and to identify all the potential sources of system unavailability. One of the main source of data unavailability that has been identified is the phenomena of ionospheric scintillations. Indeed scintillation causes radio frequency signal amplitude fades and phase variations as satellite signals pass through the ionosphere. Such effects may induce loss of lock or cycle slips on ranging signals broadcast by Galileo satellites making them totally useless for accurate integrity information determination. Scintillations are clearly identified like a source of disturbances. They appear as the turbulent aspect of a larger disturbance of the ionospheric plasma density which have the shape of a plasma bubble. The difficulty of their modelling is due to the lacks of in situ measurements with regard to them. However, some measurements recently acquired during the mission of satellite DEMETER make possible on the one hand the validation of the models existing but also, using techniques of data-models coupling, to reinforce them. The object of this proposal is therefore to provide a physical model making it possible to anticipate the attenuation of the signals during their propagation within the disturbed Earth ionosphere.

8.1.2.3. ANR MEGAS (2009-2012)

Participant: Mathias Rousset.

M. Rousset is involved in the ANR MEGAS. The main scientific subject is numerical methods in Molecular Dynamics simulation.

8.1.2.4. ANR INTOCS (2009-2012)

Participant: Pauline Lafitte.

The main scientific subject of the project is the interaction of compressible waves, and more precisely the propagation of high frequency oscillations in hyperbolic boundary value problems. One of the physical motivations is the "Mach stems" formation in reacting gas flows. The head of the project is JF Coulombel (Univ. Nantes), former member of SIMPAF.

8.1.2.5. ANR AMAM (2011-2014)

Participant: Antoine Gloria.

A. Gloria is involved in the 4-year ANR project "young researcher" AMAM, led by V. Millot (Paris 7). The aim of the project is to develop mathematical tools for the analysis of multiscale problems in material sciences (PDEs and variational methods). The fields of interest are primarily micromagnetics, dislocations, fatigue in nonlinear elasticity, and homogenization.

8.1.2.6. ANR STAB (2013-2017)

Participant: Pauline Lafitte.

STAB (starting in 2013) : Most of the natural time-evolving systems that one encounters in Physics, Biology, Economics..., can be described by means of evolution equations, or systems of such equations. These equations may include randomness or not. During the last decade, a lot of progress has been made in the understanding of the stabilization of these dynamics, i.e. their convergence to equilibrium. In particular the picture of the qualitative description of the rate of convergence is now almost complete for symmetric models (reversible dynamics). However, the non-reversible setting is still insufficiently understood. One of the most fascinating features of this research area is the strong intricacy between the analysis of partial differential equations and stochastic methods, each approach enlightening the other one. The main goal of this project is to go further, developing tractable and efficient tools, in particular for numerical schemes and algorithms, based on the computation of explicit theoretical bounds. Hence, even if part of the project is devoted to the theoretical study of non-reversible or highly degenerate situations (we typically have to face kinetic or reaction-diffusion models for example), the heart of the project will include discretization schemes, approximating particle systems and concrete simulation situations (including boundary conditions). This concerns the stability of the discretization or numerical methods. The acronym STAB covers both aspects: stabilization and stability. Indeed, sensitivity to small perturbations (or to boundary conditions) is the first definition of large time stability for numerical schemes. The head of the project is I. Gentil (Univ. Lyon1).

8.1.3. Competitivity Clusters

8.1.3.1. LABEX Centre Européen pour les Mathématiques, la Physique et leurs Interactions – CEMPI (2012-2019)

The "Laboratoire d'Excellence" CEMPI was created by the French government within the framework of its "Projets d'Investissement d'Avenir" program, in February 2012. It is a joint venture of the Laboratoire Paul Painlevé (mathematics) and the Laboratoire Physique des Lasers, Atomes et Molécules (PhLAM). Several members of CEMPI participate actively in the CEMPI research and training project, notably through the focus area "The interaction of mathematics and physics". The corresponding research is described in Sections 3.2.4 and 3.5 .

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany (F. Otto)

Quantitative homogenization theory (see Section 3.2.1)

APICS Project-Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. Collaborations with Major European Organizations

APICS is part of the European Research Network on System Identification (ERNSI) since 1992.

Subject: System identification concerns the construction, estimation and validation of mathematical models of dynamical physical or engineering phenomena from experimental data.

8.2. International Initiatives

8.2.1. Inria International Partners

LMS grant, support of collaborative research with Leeds Univ., U.K., School of Mathematics (no. 41130, 2012).

PHC Utique CMCU, cooperation France-Tunisia (no. 10G 1503, led by Univ. Orléans, MAPMO).

NSF CMG collaborative research grant DMS/0934630, “Imaging magnetization distributions in geological samples”, with Vanderbilt University and the MIT (USA).

Cyprus NF grant “Orthogonal polynomials in the complex plane: distribution of zeros, strong asymptotics and shape reconstruction.”

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Smain Amari (RMC Ontario).
- Bernard Hanzon (Univ. Cork, External Collaborator).
- Tahar Mounni (Univ. Bizerte, Tunisia).
- Jonathan R. Partington (Univ. Leeds, U.K., External Collaborator).
- Vladimir Peller (Michigan state Univ. at East Lansing)
- Yves Rolain (Vrije Universiteit Brussels).
- Nikos Stylianopoulos (Univ. of Cyprus).

8.3.2. Internships

Shubham KUMAR (from May 2012 until Sep 2012)

Subject: Mathematical methods for multiplexers study

Institution: IIT Delhi (India)

Dmitry Ponomarev (from Jun 2012 until Aug 2012)

Subject: Constrained optimization with prescribed values on the disk

Pre-doctoral trainee

Rahul PRAKASH (from May 2012 until Sep 2012)

Subject: Mathematical methods for multiplexers study

Institution: IIT Delhi (India)

Xuan Zhang (from May 2012 until Sep 2012)

Subject: Groebner basis methods for multiplexers study

Institution: Polytech'Nice

Jie Zhou (from May 2012 until Aug 2012)

Subject: A Hardy-Hodge Decomposition on the 2D Sphere

Institution: Ecole des Mines de Nancy

8.4. External collaborators of the team

The following people are external collaborators of the team:

- Smain Amari [RMC (Royal Military College), Kingston, Canada, since October].
- Ben Hanzon [Univ. Cork, Ireland, since October].
- Mohamed Jaoua [French Univ. of Egypt].
- Jean-Paul Marmorat [Centre de mathématiques appliquées (CMA), École des Mines de Paris].
- Jonathan Partington [Univ. Leeds, UK].
- Edward Saff [Vanderbilt University, Nashville, USA].

BIPOP Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Participants: Guillaume James, Vincent Acary, Franck P erignon, Bernard Brogliato.

An IXXI project (institute for complex systems) has been accepted in November 2012. It concerns the study of nonsmooth mechanical systems with a particular focus on nonlinear waves, and nonlinear modes. Title: Ondes non lin aires dans les r eseaux granulaires et syst emes m ecaniques spatialement discrets.

8.1.1. ANR

- Project ChaSlim (01 October 2011–30 September 2015). Coordinated by Bernard Brogliato. Participants from BIPOP: V. Acary, O. Huber, B. Wang. Other partners: IRCCYN nantes and EPI NON-A from Inria Lille. Topic: reduction of chattering in sliding mode control (<http://chaslim.gforge.inria.fr/>)
- NSFC/ANR project Multiple Impact (01 january 2009 – 31 March 2012). Coordinated by B. Brogliato for the French side, and by C. Liu for the Chinese side. Participants from BIPOP: N.S. Nguyen.
- Project Saladyn (01 January 2009 –31 December 2012). Coordinated by V. Acary. Participants from BIPOP: F. P erignon, M. Br emond, B. Brogliato (<http://saladyn.gforge.inria.fr/>)
- Project Geolmi (January 2011– December 2014). Geometry and Algebra of LMI with Systems Control Applications. Participants from BIPOP: J. Malick (<http://homepages.laas.fr/henrion/geolmi/>)

8.1.2. Competitivity Clusters

- PSPC Project Romeo 2 (01 December 2012–01 December 2016). Topic: Development of a humanoid robot assistant and companion for everyday life. Participants from Bipop: P.-B. Wieber and D. Dimitrov.

8.2. International Initiatives

8.2.1. Participation In International Programs

- PHC Procope collaboration with DLR in Munich (Jan. 2012–Dec. 2013). Topic: Real-Time Optimization based Control of Bipedal Humanoid Robots. Participants from Inria: P.-B. Wieber, A. Herdt, J. Lafaye, D. Dimitrov.

COMMANDS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. DGA

Participants: Olivier Bokanowski, Anna Désilles, Hasnaa Zidani.

Our team has a financial support from the DGA, within the programme "études Laboratoires". The research programme concerns the Hamilton-Jacobi approach for optimal control problems with state constraints. Our main interest in this class of control problems comes from the fact that the field has an important potential role in future technological developments to take account of environmental, physical or economical constraints.

A part of our findings in this topic have been used to develop a software for collision avoidance of a Uav.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. SADCO

Title: Sensitivity Analysis for Deterministic Controller Design

Instrument: Initial Training Network (ITN)

Duration: January 2011 - December 2014

Coordinator: Inria (France)

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

See also: <http://itn-sadco.inria.fr>

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.

8.2.2. Collaborations with Major European Organizations

Univ. Rome 1 - La Sapienza: Department of Mathematics

Collaboration with Antonio Siconolfi on "Hamilton-Jacobi equations in multi-domains".

Univ. Rome 2: Department of Mathematics

Numerical schemes for Hamilton-Jacobi coupled systems, controller design for hybrid systems.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. OCONET

Title: Optimization and control in network economics

Inria principal investigator: J.F. Bonnans

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - Center for Mathematical Modeling - Alejandro Jofre

Duration: 2012 - 2014

Web page: 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.

8.3.2. Inria International Partners

Univ. Buenos Aires: Department of Mathematics

Collaboration with Constanza de la Vega on the optimal control of systems with delay.

Moscow State Univ.: Department of Mathematics

Collaboration with Andrei Dmitruk on optimal control with singular arcs.

ENIT, Tunis: Department of Mathematics

Collaboration with Mohamed Mnif on the numerical methods for swing options.

Louisiane State University, USA

Collaboration with Peter Wolenski on stratified controlled systems.

8.3.3. Participation In International Programs

The team is involved in the "Energy Optimization" group of the Inria research center in Chile (CIRIC). Several visits to Chile were conducted in relation with this project.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Claudia Sagastizabal from IMPA in Rio (2 weeks, November 2012)
- Fabio Ancona, from Univ. of Padova (1 week, October 2012)
- Roberto Ferretti, from Univ. of Rome II (2 weeks, October 2012)
- Antonio Siconolfi, from Univ. of Rome I (2 weeks, June 2012)
- Lars Grüne, from Univ. of Bayreuth (1 week, June 2012)
- Adam Oberman, from Univ. of Vancouver (2 weeks, May 2012)
- Peter Wolenski, from Univ. of Louisiane (3 days, March 2012)
- Mohamed Mnif, from ENIT (2 weeks, February 2012)

8.4.1.1. Internships

Imene BEN LATIFA (from Feb 2012 until May 2012)

Subject: Numerical computation of swing options

Institution: Ecole Nationale d'Ingénieurs de Tunis (Tunisia)

Lucas Corrales (from May 2012 until Jul 2012)

Subject: Optimal control for some drug models

Institution: National University of the Center of the Buenos Aires Province (Argentina)

8.4.2. Visits to International Teams

- Olivier Bokanowski visited the Mathematics Department at Brown Univ., for 1 week.
- Hasnaa Zidani visited the Mathematics Department at Univ. of Rome 1- La sapienza, for 1 week.
- Olivier Bokanowski visited the Mathematical institute (Oxford), for 1 week.

CORIDA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

Alexandre Munnier, Jean-François Scheid (co-leader), Takéo Takahashi and Marius Tucsnak are members of the project CPER AOC-MISN "Autopropulsion dans un Fluide à bas Reynolds" (AFR). Collaborative project with the CRAN laboratory (Centre de Recherche en Automatique de Nancy).

8.1.1. ANR

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

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.

DISCO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- + DIGITEO Project (DIM LSC) ALMA
 Project title: Mathematical Analysis of Acute Myeloid Leukemia
 Decembre 2010 - December 2013
 Coordinator: Catherine Bonnet
 Other partners: Inria Paris-Rocquencourt, France, L2S, France, INSERM, Cordeliers Research Center, France.
 Abstract: this project studies a model of leukaemia based on previous works by M. Adimy and F. Crauste (Lyon), with theoretical model design adjustments and analysis in J. L. Avila Alonso's Ph D thesis and experimental parameter identification initiated by F. Merhi, postdoc of Bang (Dec. 2010-Nov. 2011), working at St. Antoine Hospital (Paris) on biological experiments on leukaemic cells.

- + DIGITEO Project (DIM Cancéropôle) ALMA2
 Project title: Mathematical Analysis of Acute Myeloid Leukemia - 2
 October 2011 - March 2013
 Coordinator: Jean Clairambault (Inria Paris-Rocquencourt)
 Other partners: Inria Saclay-Île-de-France, France, L2S, France, INSERM, Cordeliers Research Center, France.
 Abstract: This project has taken over the experimental identification part in St. Antoine Hospital, together with further model design with the postdoc of A. Ballesta (BANG). With this postdoc project have also been developed the theoretical and experimental - in leukaemic cell cultures - study of combined therapies by classical cytotoxics (anthracyclins, aracytin) and recently available targeted therapies (anti-Flt-3).

- + DIGITEO Project (DIM LSC) MOISYR
 Project title: Monotonie, observateurs par intervalles, et systèmes à retard
 Decembre 2011 - Decembre 2014
 Coordinator: Frédéric Mazenc
 Other partners: organisme, labo (pays) L2S, France, Mines-ParisTech, France.
 Abstract: MOISYR is concerned with the creation of 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 setp, we shall extend our result to discrete time systems and to a specific class of continuous/discrete systems called Networked Control Systems.

8.2. National Initiatives

8.2.1. Competitivity Clusters

C. Bonnet and S. Olaru are members of the Multimodal Transportation section of the IRT SystemX

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Partner 1: Patras University, Greece

Constrained control systems (analysis and design)

Partner 2: Leeds University, United Kingdom

Analysis of delay systems

Partner 3: Bilkent University, Turkey

Modelling of cell dynamics

Partner 4: RWTH Aachen University, Germany

Mathematical systems theory, control theory, symbolic computation.

Alban

8.4. International Initiatives

8.4.1. Inria International Partners

- UNICAMP, Sao Paulo, Brazil
- Kyushu Institute of Technology, Iizuka, Fukuoka, Japan
- Louisiana State University, Baton Rouge, USA
- University of California, San Diego, CA, USA

8.4.2. Participation In International Programs

A. Quadrat has developed a strong collaboration with the members of the Lehrstuhl B für Mathematik and particularly with Daniel Robertz and Mohamed Barakat. He is a member of a PHC Procope developed in collaboration with the University of Limoges (XLIM) and the Lehrstuhl B für Mathematik, RWTH Aachen University (2011-2012) which aims at developing computer algebra aspects to mathematical systems theory and control theory.

A. Quadrat is developing a new collaboration with the team of Ülle Kotta, Control Systems Department, Tallinn University, Estonia, on symbolic computation and control theory. A PHC Parrot has just been accepted (2013-2015).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Mohamed Barakat (University of Kaiserslautern), Daniel Robertz (University of Aachen), and Thomas Cluzeau (University of Limoges) visited A. Quadrat within a PHC Procope.

George Bitsoris (University Patras, Greece), 1 Octobre - 30 Novembre 2012.

Hiroshi Ito, Kyushu Institute of Technology, Japan, 26 September - 8 October 2012.

Hitay Ozbay, Bilkent University, Turkey, 19 November - 23 November 2012.

GECO Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- **Digitéo project CONGEO.** CONGEO (2009–2013) is financed by Digitéo in the framework of the DIM *Logiciels et systèmes complexes*. It focuses on the neurophysiology applications. U. Boscain, Y. Chitour (leader), F. Jean and P. Mason are part of the project.

7.2. National Initiatives

- **ANR project GCM.** The project ANR GCM (*programme blanc*, 2009–13) involves the great majority of GECO's members (permanent and external). It focuses on various theoretical aspects of geometric control and on quantum control. It is coordinated by J.-P. Gauthier.
- **ANR ArHyCo.** The project ANR ArHyCo (*programme ARPEGE*, 2009–12) is about switched systems. It is coordinated by J. Daafouz. The first theme of the ANR, on stability of switched systems, is lead by M. Sigalotti.

7.3. European Initiatives

7.3.1. 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.

7.4. International Initiatives

7.4.1. Inria International Partners

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

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

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

7.4.2. Participation In 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/>

7.5. International Research Visitors

7.5.1. Visits of International Scientists

Gianluca Panati visited GECO from 18/6 to 18/7 (thanks to an invitation by École Polytechnique). He worked on the control of spin-boson systems in collaboration with U. Boscain, P. Mason and M. Sigalotti.

7.5.1.1. Internships

Guilherme MAZANTI (from Jul 2012 until Nov 2012)

Subject: Persistent excitation with bounded variation & arbitrary rate of stabilization

Institution: University of São Paulo (Brazil)

MAXPLUS Project-Team

8. Partnerships and Cooperations

8.1. Actions nationales/National Initiatives

8.1.1. ANR

- Projet ANR Arpège ASOPT (Analyse statique et Optimisation), responsable B. Jeannet. Partenaires: équipe-projet Popart (Inria Grenoble), équipe MeASI, EADS, et Maxplus. Ce projet a été labellisé par le pôle de compétitivité System@tic. Ce projet a financé notamment le postdoc de S. Sergeev dans l'équipe.
- Participation au projet ANR CPP (Confidence, Proof and Probabilities), responsable J. Goubault Larecq. Partenaires: LSV, CEA List, Inria Saclay (Comète [responsable], Parsifal, Maxplus), Supelec L2S, Supelec SSE.
- Participation de Cormac Walsh au projet ANR FINSLER (Géométrie de Finsler et applications), démarrage 1 Dec 2012.

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.

8.2. Actions internationales/International Initiatives

8.2.1. Participation In 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-Darmstadt).
- La thèse de Zheng Qu est co-encadrée par Shanjian Tang de l'université Fudan (Shanghai), dans l'équipe duquel la doctorante effectue une partie de son travail de recherche.
- Les membres de l'équipe sont partenaires du Grant RFBR–CNRF 11-01-93106 "Tropical Mathematics and Mathematical Physics", porté par l'équipe de Grigori Litvinov (Moscou independent University), qui a financé le séjour de M. Akian et C. Walsh au Workshop "Tropical and idempotent Mathematics", Moscou, 26-31 août 2012.

8.3. Accueils de chercheurs étrangers/International Research Visitors

8.3.1. Chercheurs étrangers/Visits of International Scientists

- Srinivas Sridharan (University of California San Diego), 1 semaine en mai.
- Ngoc Tran (Berkeley University), 3 jours en Juin.
- Visites d'un ou deux jours de Paul Van Dooren, Roberto Tempo, Konstantin Avrachenkov (autour de la thèse d'Olivier Fercoq, avec séminaire).
- Visites d'un jour de Maurizio Falcone, Xavier vasseur, Yvan Notay (autour de la thèse de Sylvie Detournay).
- Ricardo Katz (Conicet, Rosario, Argentine), 1 mois en octobre-novembre, financé par DIGITEO.
- Alexander Guterman (Université d'état de Moscou), 5 jours en décembre.

8.3.1.1. Stagiaires/Internships

- Soren Ravn, stage de M2 du 15 mars au 9 mai.

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

- P. Benchimol, visite à TU Darmstadt, 19 au 24 mars 2012.
- Z. Qu: séjour à l'Université Fudan, août - sep 2012.

MCTAO Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

The “région *Provence Alpes Côte d’Azur*” partially supports Helen Heninger’s PhD. The other part come from Thales Alenia space, see section 6.1 .

7.2. National Initiatives

7.2.1. *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 in leave from Université de Bourgogne; Jean-Baptiste Caillaud collaborates actively with us; there is also an active common seminar <http://nolot.perso.math.cnrs.fr/JourneesContrôleTransport2.html> .

7.2.2. *GCM (ANR project)*

This is a four year project ending in 2013, on Geometric Control Methods, Sub-Riemannian Geometry and Applications. It is organized in four “poles” and gathers people from Université du Sud Toulon-Var, Université de Bourgogne (Dijon), École Polytechnique (Paris), Nancy-Université, Université Joseph Fourier (Grenoble 1), Université Paris Sud, ParisTech ENSTA and Université Nice Sophia-Antipolis. Bernard Bonnard and Ludovic Rifford (leader of one pole) are members of this project. More details on the site; <http://www-fourier.ujf-grenoble.fr/~charlot/GCM.html>.

7.2.3. *MOA (GDR)*

Bernard Bonnard and Ludovic Rifford participate in this CNRS network on Mathematics of Optimization and Applications. <http://gdrmoa.univ-perp.fr/>.

7.3. European Initiatives

Collaborations with Major European Organizations

Technische Universität München, Department of Chemistry (Germany).

The applications of optimal control to MNR (see sections 4.2 and 5.1.2) are conducted with the group of Prof. Steffen Glaser in Munich.

7.4. International Initiatives

Inria International Partners

University of Hawaii, Department of Mathematics (U. S. A.)

There is a lon term collaboration on optimal control and control of quantum systems, see mostly section 5.1.1 . Besides, Gautier Picot, a former Phd student from Dijon has a temporary position at the Math Department and collaborates with M. Chyba and G. Patterson (second Phd student from M. Chyba) in relation with the Laboratoire d’Astronomie de Paris, to apply the Hampath code to make rendez-vous with quasi-asteroids entering in the solar system near the L1-Lagrange point, in the continuation of the work developed by G. Picot and B. Daoud. This collaboration is very active and has to be emphasized.

University of Toronto, Department of Mathematics (Canada)

Optimal Transport. Alice Erlinger’s PhD is co-supervised by Ludovic Rifford and John Mc Cann from University of Toronto. See section 5.4 .

7.5. International Research Visitors

7.5.1. Visits of International Scientists

Alessio Figalli, from University of Texas at Austin, visited twice, for a total of slightly more than a month.

7.5.2. Visits to International Teams

There is a strong collaboration with the control group in the University of Hawaii around M. Chyba. B. Bonnard visited the group twice in 2012-2013 (a total of 3 months). The purpose of the collaboration is to study the aspects of the contrast problem in Nuclear Magnetic Resonance, see section [5.1.1](#) .

NECS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The 12-months post-doctoral stay of Alireza Esna Ashari has been funded by Inria-Schneider Endowed Chair on Foundations of Component-based Design for Embedded Systems. A. Esna Ashari has been working on distributed estimation and fault detection using wireless sensor networks, under the supervision of F. Garin and A. Kibangou.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. ANR VOLHAND

VOLHAND (**VOL**ant pour personne âgée et/ou **HAND**icapée) is a project funded by the ANR (National Research agency). This project, started in October 2009, is a result of collaboration between C. Canudas de Wit and Franck Quaine/Violaine Cahouët (from the biomechanical team of GIPSA-Lab). The project aims at developing a new generation of Electrical power-assisted steering specifically designed for disabled and aged people. Our contribution is to work out new assisted laws that accommodate to the specific mechanical characteristics of this particular driver population. The consortium is composed by: LAMIH, CHRU, Fondation Hopale, GIPSA-Lab, INRETS and JTEKT. More information can be found on-line: <http://www.univ-valenciennes.fr/volhand/>.

8.2.2. PREDIT

8.2.2.1. MoCoPo

The MOCOPo project (Measuring and mOdelling traffic CONgestion and POLLution) is funded by the French Ministry in charge of Transport (MEDDTL), through the PREDIT (Research and Innovation in Land Transport Program). The project began in January 2011 and will end up in December 2013. Various research institutes and universities, some teams of the MEDDTL and pollution measurements associations are involved in the project: LICIT (Transport and Traffic Engineering Laboratory, joint unit of IFSTTAR and ENTPE), LTE (Transports and Environment Laboratory, IFSTTAR), LEPSIS (Laboratory for Road Operations, Perception, Simulators and Simulations, IFSTTAR), IM (Infrastructures and Mobility Department, IFSTTAR), MACS (Monitoring, Assessment, Computational Sciences, IFSTTAR), Inria-NECS, Atmo Rhône Alpes, DIR-CE (Center-East Direction of Roads), LRPC Angers (Regional Laboratory of Angers), CERTU (Center for Cities and Urban Transportation), and CEREAs (Center of Teaching and Research in Atmospheric Environment, laboratory Ecole des Ponts ParisTech / EDF Research and Development). NeCS is particularly involved in tasks devoted to travel time estimation and prediction. For this purpose one post-doc (Fabio Morbidi) has been recently hired. More information can be found on-line: <http://mocopo.ifsttar.fr/>.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. FeedNetBack

Title: FeedNetBack

Type: COOPERATION (ICT)

Defi: Networked embedded and control systems

Instrument: Specific Targeted Research Project (STREP)

Duration: September 2008 - January 2012

Coordinator: Inria (France)

Others partners: ETH Zurich (CH), Universidad de Sevilla (ES), KTH Stockholm (SE), Università di Padova (IT), Ifremer (FR), Videotec (IT), OMG (GB), Vitamib (FR).

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

Abstract: The main objective of the FeedNetBack project is to generate a rigorous co-design framework that integrates architectural constraints and performance trade-offs from control, communication, computation, complexity and energy management. The goal is to master complexity, temporal and spatial uncertainties such as delays and bandwidth in communications and node availability. This approach enabled the development of more efficient, robust and affordable networked control systems that scale and adapt with changing application demands. The project extend the current scientific state-of-the-art in networked control and develop a set of software tools to support the co-design framework.

8.3.1.2. Hycon2

Title: Highly Complex and Networked Control Systems

Type: COOPERATION (ICT)

Defi: Engineering of Networked Monitoring and Control Systems

Instrument: Network of Excellence (NoE)

Duration: September 2010 - August 2014

Coordinator: CNRS (France)

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

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

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.

8.4. International Initiatives

8.4.1. Inria International Partners

- H. Fourati has started a new collaboration with the Kazakhstan National Technical University (KazNTU). He currently co-advises with Pr. Olga Shiryayeva in KazNTU, Zarina Samigulina PhD student in KazNTU. He also submitted an European project "LA STRADA" with two teams and an SME: Istituto per le Applicazioni del Calcolo "M. Picone" (Università di Roma), the Mathematical Modeling and Scientific Computing Research Group (University of Mannheim) and Karrus (SME).
- F. Garin has collaborations with University of Padova, Italy (S. Zampieri), University of Newcastle, Australia (D. Quevedo), with Lund University, Sweden (G. Como and E. Lovisari), and with KTH Stockholm, Sweden (D. Varagnolo)

8.4.2. Participation In International Programs

8.4.2.1. TeMP

TeMP (Tensor-based Information modelling and Processing) is a project funded in the framework of the French-Brazilian bilateral collaboration program (FUNCAP-Inria). It started from August 2011 for a duration of two years and is coordinated for the French part by A. Kibangou. This project aims to study, analyze, propose and evaluate new models and techniques for digital communication systems using tensors and multilinear algebra tools, through in-depth theoretical analysis of mathematical models, optimization algorithms, and computational simulations. Indeed, new models should be developed for generalizing existing tensor models in order to allow the modeling of a wider class of communication systems for more realistic propagation channels including the cooperation among multiple nodes of a communication network (users or sensors). Due to dynamic change of parameters, tensor-based filtering algorithms need to be developed for information retrieval systems in cooperative communication. These algorithms should be distributed for avoiding network vulnerability and for a better management of computation and storage resources.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Maria Guinaldo Losada, PhD Student, UNED, Madrid, Spain, 2 months visit (Oct. and Nov. 2012).
- André L.F. de Almeida, Associate Professor, UFC, Brazil, visit within the framework of the TeMP project (January 2012).
- Joao Cesar M. Mota, Professor, UFC, Brazil, visit within the framework of the TeMP project (January 2012).
- Zarina Samigulina, PhD student, Kazakhstan National Technical University (KazNTU), two weeks visit (November 2012).

8.5.2. Visits to International Teams

- H. Fourati spent two weeks in Kazakhstan National Technical University (KazNTU), Dec. 2012.
- F. Garin spent three weeks in Lund University during the LCCC focus period on Information and Control in Networks, Oct. 2012.
- A. Kibangou spent three weeks in UFC, Brazil, in two stays (May and Oct. 2012).
- C. Canudas de Wit visited universities of Berkeley (USA), Lund (Sweden), Madrid, Sevilla, and Valencia (Spain).

NON-A Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

- We are 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" and "Control in Electrical Engineering".
- Model-free control: collaborations with Professor Brigitte D'Andréa-Novel at Mines ParisTech and Professor Emmanuel Delaleau at ENIB (Brest).
- Atomic Force Microscope (AFM): application of new algebraic methods in tapping mode for AFM, collaboration with the National Laboratory of Metrology (LNE) located at Trappes.

7.2. European Initiatives

- Collaboration with Sarah Spurgeon of University of Kent on Sliding mode control;
- Collaboration with Emmanuel Brousseau of Cardiff University for the project: "on nano mechanical machining of 3D nano structures by AFM".

7.3. International Initiatives

- Collaboration with Professors Tulay Adali (University of Baltimore, USA) and Daniel Alpay (University of Ben Gurion, Israel) on signal processing.
- Collaboration with Professors Emilia Fridman (Tel Aviv University) and Joao Manoel Gomes da Silva (UFRGS, Porto Alegre, Brasil) on time-delay systems.
- Collaborations with Professor Guiseppe Fedele from University of Calabria, Italy, on "Model-free control".
- Programme Hubert Curien GALILEE for scientific exchange between LAGIS and University of Cagliari, Italy;
- Programme Hubert Curien VOLUBILIS (Maroc, Integrated Action MA/09/211) between LAGIS (Université Lille1), Non-A/Inria and Laboratory of Electronic, Information and Biotechnology of Department of Science at University Moulay Ismail of Meknès;
- Programme Hubert Curien COGITO for scientific exchange between University of Reims Champagne Ardenne, Non-A and University of Zagreb.
- Collaboration and scientific exchanges with Saint-Petersburg National Research University ITMO, Russia, on interval estimation of linear-parameter-varying systems and on spark ignition engine control.
- Collaboration and scientific exchanges with Universidad Nacional Autónoma de México (UNAM) (Prof. L. Fridman) and Autonomous University of Nuevo Leon (Prof. M. Basin), Mexico, on estimation of linear-parameter-varying systems and sliding-mode control.

7.4. International Research Visitors

7.4.1. Visits of international scientists

- Emilia Fridman, Professor of Tel Aviv University, Israel, June 2012, supported by École Centrale de Lille;

- Marc Bodson, Professor of University of Utah, USA, June 2012, supported by École Centrale de Lille;
- Michael Basin, Professor of Autonomous University of Nuevo Leon, Mexico, June 2012, supported by a bilateral CNRS project.
- Hebertt Sira Ramírez, Professor of CINVESTAV IPN, Mexico, November 2012, supported by École Centrale de Lille.

7.4.2. Internships

- Stanislav Chebotarev, PhD student of National Research University ITMO, Russia, June 2012, "Interval estimation of LPV systems", supported by ITMO;
- Hector Rios, PhD student of UNAM, Mexico, September–November 2012, "Discrete state estimation for switched LPV systems", supported by UNAM.

CLASSIC Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

- ANR project in the conception and simulation track: EXPLO/RA (involves Emilien Joly, Pierre Gaillard, Sébastien Gerchinovitz, Gilles Stoltz; see <http://sites.google.com/site/anexplora/>);
- ANR project in the blank program: Parcimonie (involves Sébastien Gerchinovitz, Vincent Rivoirard, Gilles Stoltz; see <http://www.proba.jussieu.fr/ANR/Parcimonie/>);
- ANR project in the blank program: Calibration (involves Vincent Rivoirard, who is the coordinator; see <https://sites.google.com/site/anrcalibration/home>);

7.2. European Initiatives

Thanks to the PASCAL European network of Excellence (<http://www.pascal-network.org/>), we have strong links with Gábor Lugosi, Universitat Pompeu Fabra, Spain and Nicolò Cesa-Bianchi, Università degli Studi di Milano.

7.3. International Initiatives

We have some internal collaborations, with

- Karine Bertin, University of Valparaiso, Chile;
- Luc Devroye, McGill University, Canada;
- Shie Mannor, Technion, Israel.

In particular, Pierre Gaillard spent 5 months working with Shie Mannor from January to May 2012.

DOLPHIN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- + PPF Bioinformatics: This program within the University of Lille 1 deals with solving bioinformatics and computational biology problems using combinatorial optimization techniques, 2010-2013.
- + PPF High Performance Computing, This program deals with parallel optimization, 2010-2013.
- + CIA (Campus Intelligence Ambiante) project from CPER (Contrat Plan Etat Région): Transversal research action: “High performance computing”, 2010-2013.

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 Black-box 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).

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.2. Collaborations in European Programs, except FP7

Program: COST

Project acronym: IC0804

Project title: Energy efficiency in large scale distributed systems

Duration: Jan 2009 - May 2013

Coordinator: J. M. Pierson

Other partners: More than 20 European countries.

Abstract: The COST Action IC0804 proposes realistic energy-efficient alternate solutions to share IT distributed resources. As large scale distributed systems gather and share more and more computing nodes and Storage resources, their energy consumption is exponentially increasing. While much effort is nowadays put into hardware specific solutions to lower energy consumptions, the need for a complementary approach is necessary at the distributed system level, i.e. middleware, network and applications. The Action characterizes the energy consumption and energy efficiencies of distributed applications.

8.3.3. Collaborations with Major European Organizations

University of Luxembourg: CSC, ILIAS (Luxembourg), “Design of parallel and hybrid metaheuristics to solve complex optimization problems”

University of Malaga: ETSI Informatica (Spain), “Parallel metaheuristics for dynamic optimization”

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. STEM

Title: deciSion Tools for Energy Management (STEM)

Inria principal investigator: L. Brotcorne

International Partners (Institution - Laboratory - Researcher):

Université de Montréal (Canada) - Département d'informatique et recherche opérationnelle
- Francois Gilbert

Polytechnic School of Montreal (Canada) - Département de mathématique et génie industriel - Michel Gendreau

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 between costs (production, security) and revenues when determining the daily hydro-electricity generation and storage within an environment where demand is stochastic.

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

8.4.2. Inria International Partners

- University of Sydney, Australia
- University of Montreal and Ecole Polytechnique of Montreal, Canada
- University of Dortmund, Germany
- ETH Zurich, Switzerland
- SINTEF, Norway

8.4.3. Participation In International Programs

- Inria STIC-Tunisie, 2011-2013.
- Inria STIC-Algérie, 2011-2013.
- CNRS PICS Luxembourg, 2011-2014.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

The project had visitors during the year 2010:

- Prof. Michel Gendreau, University of Montreal
- Prof. Pascal Bouvry, University of Luxembourg
- Dr. Gleb Belov, Univ. Essen, Germany
- Dr. Manuel Lopez-Ibanez, IRIDIA, Université Libre de Bruxelles, Belgium,
- Dr. Boris Naujoks, Cologne University of Applied Sciences, Gummersbach, Germany
- Prof. Gunter Rudolph, TU Dortmund University, Germany

8.5.2. Visits to International Teams

- D. Brockhoff, June 2012, TU Dortmund University, Germany
- D. Brockhoff, March 2012, ETH Zurich, Switzerland
- E-G. Talbi, Dec 2012, Univ. Luxembourg, Luxembourg
- A. Liefoghe, jan 2012, University of Malaga, Spain

GEOSTAT Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- OPTAD project. Title: *Méthodes multiéchelles pour l'optique adaptative et les données d'astronomie*", with Conseil Régional Région Aquitaine. Duration: 2010-2013.
- Convention CRA 20111602015 on speech processing, with Conseil Régional Région Aquitaine (2011-2014) (funding, equipment and Speech databases).
- DIAFIL project, cofunded by Conseil Régional Région Aquitaine and IHU LYRIC. Title: *Méthodes non-linéaires pour le diagnostic et la prévention de la fibrillation ventriculaire*.

7.2. National Initiatives

- HIRESUBCOLOR, OSTST-CNES-NASA program. Partners: DYNBIO (LEGOS UMR CNRS 5565), LOCEAN, ICM-CSIC. Title: *Multiscale methods for the evaluation of high resolution ocean surface velocities and subsurface dynamics from ocean color, SST and altimetry*. We obtained a 1 year prolongation in 2012 from CNES. Coordinator: H. Yahia. Abstract: nonlinear signal processing methods for high resolution mapping of ocean dynamics. Duration: 2008-2012.
- FIBAUR ARC: *Fibrillation auriculaire: approches nouvelles pour l'analyse des signaux complexes du rythme cardiaque*. Inria ARC, duration: 2011-2012. Partners: GEOSTAT, INSERM EA3668, SIGMA team (ESPCI).

7.3. International Initiatives

- CRSNG Canadian program. Title: *Profilage à partir des données hétérogènes du Web pour la cybercriminalité*. Partners: Concordia University, University of Sherbrooke, E-Profile Compagny, S. d. Quebec, GEOSTAT (Inria). Coordinator: Concordia University. Duration: 2011-2014. Abstract: use of various complex signals for cybersecurity.

7.4. European Initiatives

- OCEANFLUX project, ESA (European Space Agency), Program: Support to Science Element ESRN/AO/1-6668/11/I-AM, fund: E/0029-01-L. Partners: IWR (University of Heidelberg, Germany), GEOSTAT (Inria, France) , KIT (Karlsruher Institut für Technologie, Germany), LEGOS (CNRS DR14, France), IRD (France), University Paul Sabatier (France). Duration: 2011-2013. Abstract: Mapping at high spatial resolution of GHGs exchange flux between ocean and atmosphere using model outputs and nonlinear techniques in signal processing. Coordinator: C. Garbe, Interdisciplinary Center for Scientific Computing (IWR), University of Heidelberg.
- PHC Volubilis. Title: *Study of upwelling in the Moroccan coast by satellite imaging*. Partners: GEOSTAT, Rabat University, CRTS. French coordinator: K. Daoudi. Abstract: multiscale methods for the characterization of coastal upwelling from remote sensing data. Duration: 2010-2012.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

Max Little (MIT Media Lab Human Dynamics Group, Visiting Senior Research Associate, Oxford Complex Systems) has made one month visit at GEOSTAT. He made a presentation to Inria BSO: *A global functional minimization approach to nonlinear signal processing* on Thursday, April 5th.

7.5.1.1. Internships

Hicham Badri (from Mar 2012 until Aug 2012)

Subject: Computer graphics effects from the framework of reconstructible systems

Institution: Université Mohamed V Agdal - Faculté des Sciences de Rabat (Morocco)

Nicolas Vinuesa (from October 1st 2012 until April 31 2013)

Subject: Biologically realistic coding efficiency in auditory cortex vs wavelet analysis

Institution: Universidad Nacional de Rosario, Facultad de Ciencias Exactas, Agrimensura Y Ingeniería, Rosaria, Argentina.

MISTIS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

MISTIS participates in the weekly statistical seminar of Grenoble. F. Forbes is one of the organizers 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.

7.2. National Initiatives

7.2.1. Competitvity Clusters

MISTIS is a partner in a three-year (2010-12) MINALOGIC project (I-VP for Intuitive Vision Programming) supported by the French Government. The project is led by VI Technology (<http://www.vitechnology.com>), a world leader in Automated Optical Inspection (AOI) of a broad range of electronic components. The other partners involved are the CMM (Centre de Morphologie Mathematiques) in Fontainebleau, and Pige Electronique in Bourg-Les-Valence. The overall goal is to exploit statistical and image processing techniques more intensively to improve defect detection capability and programming time based on existing AOI principles so as to eventually reach a reliable defect detection with virtually zero programming skills and efforts.

7.2.2. ARC Inria

Florence Forbes is coordinating the 2-year Inria ARC project AINSI (<http://thalie.ujf-grenoble.fr/ainsi>). AINSI stands for "Modeles statistiques pour l'Assimilation d'Informations de Neuroimagerie fonctionnelle et de perfuSion cerebrale". The goal is to propose an innovative statistically well-based solution to the joint determination of neural activity and brain vascularization by combining BOLD constrast images obtained in functional MRI and quantitative parametric images (Arterial Spin Labelling: ASL). The partners involved are Visages team from Inria in Rennes and Parietal in Saclay, the INSERM Unit U594 (Grenoble Institute of Neuroscience) and the LNAO laboratory from CEA NeuroSpin.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. HUMAVIPS

Title: Humanoids with audiovisual skills in populated spaces

Type: COOPERATION (ICT)

Defi: Cognitive Systems and Robotics

Instrument: Specific Targeted Research Project (STREP)

Duration: February 2010 - January 2013

Coordinator: Inria (France)

Others partners: CTU Prague (Czech Republic), University of Bielefeld (Germany), IDIAP (Switzerland), Aldebaran Robotics (France)

See also: <http://humavips.inrialpes.fr>

Abstract: Humanoids expected to collaborate with people should be able to interact with them in the most natural way. This involves significant perceptual, communication, and motor processes, operating in a coordinated fashion. Consider a social gathering scenario where a humanoid is expected to possess certain social skills. It should be able to explore a populated space, to localize people and to determine their status, to decide to join one or two persons, to synthesize appropriate behavior, and to engage in dialog with them. Humans appear to solve these tasks routinely by integrating the often complementary information provided by multi sensory data processing, from low-level 3D object positioning to high-level gesture recognition and dialog handling. Understanding the world from unrestricted s

7.4. International Research Visitors

7.4.1. Internships

MINWOO JAKE LEE (from Jun 2012 until Aug 2012)

Subject: Clustering or classification of high dimensional data in the presence of outliers

Institution: Colorado State University (United States)

El Hadji DEME (from Mar 2012 until May 2012)

Subject: Bias reduction in extreme-value statistics

Institution: Université Gaston Berger (Senegal)

Seydou-Nourou Sylla (from October 2012 to December 2012)

Subject: Classification for medical data

Institution: Université Gaston Berger (Senegal)

MODAL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Institut de Biologie de Lille, Génomique et Maladies Métaboliques lab*

Participants: Christophe Biernacki, Julien Jacques, Loic Yengo.

8.1.2. *Industrial Studies Center, Arcelor-Mittal*

Participants: Clément Thery, Christophe Biernacki.

8.1.3. *Gene Diffusion*

Participants: Julien Jacques, Julie Hamon.

8.1.4. *Institut Pasteur Lille and Institut de Biologie de Lille*

Participant: Guillemette Marot.

- Team "Etudes Transcriptomiques et Génomiques Appliquées"n (D. Hot).
- Team "Peste et Yersinia pestis", (F. Sebbane).
- team "Unité d'approches fonctionnelle et structurale des cancers", O. Pluquet.

8.1.5. *Université de Lille 2*

Participant: Guillemette Marot.

Plate-forme de génomique fonctionnelle et Structurale, (M. Figeac)

8.1.6. *CHRU Lille*

Participant: Guillemette Marot.

Centre de Biologie Pathologie, Laboratoire d'Hématologie, (C. Preudhomme)

8.1.7. *ASEL and CRESGE*

Participant: Cristian Preda.

ASEL (Association Septentrionale pour l'Etude de Lymphomes) and CRESGE (Centre de Recherches Economiques Sociologiques et de Gestion) from Lille

8.2. National Initiatives

8.2.1. *StatLearn'12*

Christophe Biernacki, Alain Ceélisse, Serge Iovleff and Julien Jacques co-organized with Charles Bouveyron (University Paris 1, SAMM) a workshop on "Challenging problems in Statistical Learning", StatLearn'12, in April 2012 in Lille (<http://www.inria.fr/en/centre/lille/calendar/workshop-statlearn-12>). There were about 80 applicants, 12 one-hour invited talk organized in four sessions: Statistical learning and vizualization, Statistical learning in high dimension, Statistical learning and structured data, New and future problems in statistical learning.

8.2.2. *StatOmique*

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

8.3. European Initiatives

8.3.1. University of Granada, Department of Statistics and Operational Research

Participant: Cristian Preda.

Collaboration with Professor Ana Aguilera : teaching at Master and Doctoral level, joint research, ERASMUS mobility and conference organization.

8.4. International Research Visitors

8.4.1. Nanyang Technology University of Singapore

Participant: Cristian Preda.

Collaboration with Professor Lian Heng on functional regression models : joint research.

Cristian Preda was invited at NTU from December 3th to December 15th 2012.

REALOPT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Region Aquitaine is supporting a post-doc in our team. Jinil Han has been recruited to contribute to our team effort to develop efficient decomposition based approaches to real-life combinatorial optimization problems. Jinil's research aims at enhancing performance of such approach and prepare the way to high performance computing through parallelization. Jinil's mission extends to problem solving that serves both as a motivation and an proof-of-concept. Jinil has contributed to warm-starting the methods and to convergence acceleration through stabilization techniques [23].

8.2. National Initiatives

8.2.1. CNRS

Pierre Pesneau has got a grant from the OR research group from CNRS to finance mission between Bordeaux and Paris within the context of a collaboration with University Paris 6 (P. Fouilhoux) and University Paris 13 (S. Borne, R. Grappe, M. Lacroix). This collaboration aims to study polyhedral properties and algorithmic aspects to the problem of connected graph partitioning.

8.3. International Initiatives

8.3.1. ANR Gratel

André Raspaud launched in 2005 a fruitful cooperation with the Department of Applied Mathematics of the Sun Yat-Sen University of Kaohsiung, Taiwan. This gave rise to an international ANR project funded for three years (January 2010 - December 2013), that is managed by Arnaud Pêcher and André Raspaud. The scientific priority theme is "Telecommunications", a well-known key application area of graph theory. The aim is to tackle especially wireless communications problems, with the help of graph colorings and polyhedral graph theory. Currently, Sagnik Sen (PhD student of E. Sopena, A. Pêcher, A. Raspaud) benefits from a scholarship on this ANR.

8.3.2. Inria Associate Teams

8.3.2.1. SAMBA

Title: Combinatorial optimization problems

Inria principal investigator: François Vanderbeck

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidade Catolica do Rio de Janeiro (Brazil) - ATD-Lab - Marcus Poggi

Duration: 2011 - 2013

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

The so-called Dantzig-Wolfe decomposition approach has not yet made its way into general purpose solvers for Mixed Integer Programming (MIP). Despite its proved efficiency, the use of the method is currently restricted to specific applications and requires ad-hoc algorithms developed by experts. Our project is to develop general purpose algorithms to make this method generic. We shall focus in particular on (i) preprocessing procedures, (ii) warm-starting, (iii) stabilization (to improve convergence), (iv) strategies for combining cut and column generation, and (v) primal heuristics. The project builds on the accumulated experience of both the Brazilian and the French teams that have done pioneering work in tackling complex applications and deriving generic solution strategies

using this decomposition approach. The new algorithms are implemented and tested in the software platform BaPCod. Hence, the collaborative research on methodological developments should lead to, as a bi-product, a Version 2 of BaPCod as a state-of-the-art Branch-and-Price-and-Cut Solver. This prototype should (i) serve as proof-of-concept code for the research planned in this project and beyond, (ii) enable us to achieve new benchmark results on key problems, (iii) provide incentive for the use of the method by non experts, (iv) leverage technology transfer to industry.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Short term Visitors

- Artur Pessoa, LOGIS, the Universidade Federal Fluminense (UFF), Brazil.
- Oriol Serra, Universitat Politècnica de Catalunya, Spain
- Eduardo Uchoa, LOGIS, the Universidade Federal Fluminense, Brazil.

8.4.1.2. Internships

Diego PECIN, from Pontificade Universitat Catholica (PUC-Rio) from Feb 2012 until Mar 2012

Subject: Comparative study of column generation stabilization techniques

Institution: Federal University of Rio de Janeiro (Brazil)

Alexey KARPYPHEV (from Sep 2012 until Dec 2012)

Subject: Multi-commodity transportation problem with application to the freight service design

Institution: Moscow Institute of Physics and Technology (Russia)

8.4.2. Visits to International Teams

Pierre Pesneau was invited one week (Mars 5th-9th, 2012) by Luis Gouveia (Universidade de Lisboa) to work on time-dependent formulations for the capacitated vehicle routing problem.

Ruslan Sadykov and Francois Vanderbeck have both spend a two-week visit in our associated team at PUC-Rio and UFF in Brazil in March 2012.

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

SELECT is animating a working group on model selection and statistical analysis of genomics data with the Biometrics group of Institut Agronomique Nationale Paris-Grignon (INAPG).

Pascal Massart is co-organizing a working group at ENS (Ulm) on Statistical Learning. This year the group focused interest on regularization methods in regression. Most of SELECT members are involved in this working group.

SELECT is animating a working group on Classification, Statistics and fMRI imaging with Neurospin.

SELECT is animating a working group on Unsupervised Classification with the CMAP (École Polytechnique)

8.2. European Initiatives

Gilles Celeux and Pascal Massart are members of the PASCAL (Pattern Analysis, Statistical Learning and Computational Learning) network.

8.3. International Initiatives

Gilles Celeux is one of the co-organizers of the Working Group on Model-Based Clustering. This year this workshop took place in Guelph (Canada).

SEQUEL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Connectome, and large graph mining

Participant: Philippe Preux.

- *Title:* Connectome and epilepsy
- *Type:* No funding yet (self-funded project)
- *Coordinator:* Louise Tyvaert, Department of clinical neurophysiology, CHRU Lille, Université de Lille 2, France
- *Others partners:* Mostrare, Inria Lille
- *Duration:* Began in spring 2012
- *Abstract:* The long term goal of this collaboration is to investigate the use of machine learning tools to analyse connectomes, and possibly related EEG signals, to determine, for a given patient, the region of the brain from which originate epilepsy strokes. As a first step, we concentrate on connectome, that is a graph representation of the connectivity in the brain. We study the properties of these graphs from a formal point of view, and try to match these properties with brain activity, and brain disorders.
- *Activity Report:* being a multi-disciplinary project, the first thing was to understanding each others. Connectomes having been acquired at the hospital via MRI and image processing, the resulting graphs have been processed using a spatially regularized spectral clustering approach; we were able to recover well-known brain areas automatically. Indeed, one of the first issues to clarify is the relevance of the graph representation of these MRI data (connectomes), an issue unclear in the medicine community. These first results have been submitted for publication at the IEEE 2013 symposium on Bio-Imaging (ISBI'2013).

8.2. National Initiatives

8.2.1. DGA/Thales

Participants: Emmanuel Duflos, Philippe Vanheeghe, Emmanuel Delande.

- *Title:* Multi-sensor PHD filtering with application to sensor management (<http://www.theses.fr/2012ECLI0001>)
- *Type:* PhD grant
- *Coordinator:* LAGIS - Inria Lille - Nord Europe (SequeL)
- *Others partners:* DGA and Thales Communications
- *Web site:* <http://www.theses.fr/2012ECLI0001>
- *Duration:* *EDIT THIS:* 3 years
- *Abstract:* The defense of this PhD thesis was held in January 2012.
- *Activity Report:*

8.2.2. ANR-Lampada

Participants: Mohammad Ghavamzadeh, Hachem Kadri, Jérémie Mary, Olivier Nicol, Philippe Preux, Daniil Ryabko, Christophe Salperwyck.

- *Title:* Learning Algorithms, Models and sPArse representations for structured DATA
- *Type:* National Research Agency (ANR-09-EMER-007)
- *Coordinator:* Inria Lille - Nord Europe (Mostrare)
- *Others partners:* Laboratoire d'Informatique Fondamentale de Marseille, Laboratoire Hubert Curien ; Saint Etienne, Laboratoire d'Informatique de Paris 6.
- *Web site:* <http://lampada.gforge.inria.fr/>
- *Duration:* ends mid-2014
- *Abstract:* Lampada is a fundamental research project on machine learning and structured data. It focuses on scaling learning algorithms to handle large sets of complex data. The main challenges are 1) high dimension learning problems, 2) large sets of data and 3) dynamics of data. Complex data we consider are evolving and composed of parts in some relations. Representations of these data embed both structure and content information and are typically large sequences, trees and graphs. The main application domains are web2, social networks and biological data.

The project proposes to study formal representations of such data together with incremental or sequential machine learning methods and similarity learning methods.

The representation research topic includes condensed data representation, sampling, prototype selection and representation of streams of data. Machine learning methods include edit distance learning, reinforcement learning and incremental methods, density estimation of structured data and learning on streams.

- *Activity Report:* Philippe Preux has collaborated with Ludovic Denoyer and Gabriel Dulac-Arnold from LIP'6 to investigate further the idea of datum-wise representation, introduced in 2011, and originally published at ECML/PKDD'2011. This eventually led to a deep presentation in the *Machine Learning Journal*.

They also studied the reinforcement learning problem in the case of a large but not infinite number of actions (hundreds, or thousands discrete actions). They introduced the use of Error-correcting output codes to deal with this setting, proposed, and studied two RL algorithms that take advantage of an ECOC-based representation of actions. The idea was published at ECML/PKDD'2012 and other conferences (EWRL workshop held as part of the ICML conference, and French ones).

Hachem Kadri and Philippe Preux have continued their work on machine learning for functional data. They introduced an algorithm for multiple operators learning. Along with Mohammad Ghavamzadeh, they only introduced an operator-based approach for structured output.

Daniil Ryabko and colleagues have obtained new results on nonparametric clustering of time-series data. In particular, a fully online clustering algorithm has been developed; we have also shown how to use binary classification methods for clustering time series.

8.2.3. ANR EXPLO-RA

Participants: Alexandra Carpentier, Mohammad Ghavamzadeh, Jean-François Hren, Alessandro Lazaric, Rémi Munos, Daniil Ryabko.

- *Title:* EXPLORation - EXPLOitation for efficient Resource Allocation with Applications to optimization, control, learning, and games
- *Type:* National Research Agency
- *Coordinator:* Inria Lille - Nord Europe (SequeL, Rémi Munos)

- Others partners: Inria Saclay - Ile de France (TAO), HEC Paris (GREGHEC), Ecole Nationale des Ponts et Chaussées (CERTIS), Université Paris 5 (CRIP5), Université Paris Dauphine (LAMSADE).
- Duration: 2008-2012.
- See also: <https://sites.google.com/site/anexplora/>
- Activity Report: We developed bandit algorithm for planning in Markov Decision Processes based on the optimism in the face of uncertainty principle.

8.2.4. ANR CO-ADAPT

Participants: Alexandra Carpentier, Rémi Munos.

- *Title:* Brain computer co-adaptation for better interfaces
- *Type:* National Research Agency
- *Coordinator:* Maureen Clerc
- *Other Partners:* Inria Odyssee project (Maureen Clerc), the INSERM U821 team (Olivier Bertrand), the Laboratory of Neurobiology of Cognition (CNRS) (Boris Burle) and the laboratory of Analysis, topology and probabilities (CNRS and University of Provence) (Bruno Torresani).
- *Web site:* <https://twiki-sop.inria.fr/twiki/bin/view/Projets/Athena/CoAdapt/WebHome>
- *Duration:* 2009-2013
- *Abstract:* The aim of CoAdapt is to propose new directions for BCI design, by modeling explicitly the co-adaptation taking place between the user and the system. The goal of CoAdapt is to study the co-adaptation between a user and a BCI system in the course of training and operation. The quality of the interface will be judged according to several criteria (reliability, learning curve, error correction, bit rate). BCI will be considered under a joint perspective: the user's and the system's. From the user's brain activity, features must be extracted, and translated into commands to drive the BCI system. From the point of view of the system, it is important to devise adaptive learning strategies, because the brain activity is not stable in time. How to adapt the features in the course of BCI operation is a difficult and important topic of research. We will investigate Reinforcement Learning (RL) techniques to address the above questions.
- *Activity Report:* See <https://twiki-sop.inria.fr/twiki/bin/view/Projets/Athena/CoAdapt/WebHome>

8.2.5. ANR AMATIS

Participant: Pierre Chainais.

- *Title:* Multifractal Analysis and Applications to Signal and Image Processing
- *Type:* National Research Agency
- *Coordinator:* Univ. Paris-Est-Créteil (S. Jaffard)
- *Duration:* 2011-2015
- *Other Partners:* Univ. Paris-Est Créteil, Univ. Sciences et Technologies de Lille and Inria (Lille, ENST (Telecom ParisTech), Univ. Blaise Pascal (Clermont-Ferrand), and Univ. Bretagne Sud (Vannes), Statistical Signal Processing group at the Physics Department at the Ecole Normale Supérieure de Lyon, one researcher from the Math. Department of Institut National des Sciences Appliquées de Lyon and two researchers from the Laboratoire d'Analyse, Topologie et Probabilités (LAPT) of Aix-Marseille University.
- *Abstract:* Multifractal analysis refers to two concepts of different natures : On the theoretical side, it corresponds to pointwise singularity characterization and fractional dimension determination ; on the applied side, it is associated with scale invariance characterization, involving a family of parameters, the scaling function, used in classification or model selection. Following the seminal ideas of Parisi and Frisch in the mid-80s, these two components are usually related by a Legendre transform, stemming from a heuristic argument relying on large deviation and statistical thermodynamics prin-

principles : The multifractal formalism. This led to new theoretical approaches for the study of singularities of functions and measures, as well as efficient tools for classification and models selection, that allowed to settle longstanding issues (e.g., concerning the modeling of fully developed turbulence). Though this formalism had been shown to hold for large classes of functions of widely different origins, the generality of its level of validity remains an open issue. Despite its popularity in applications, the interactions between theoretical developments and applications are unsatisfactory. Its use in image processing for instance is still in its infancy. This is partly due to discrepancy between the theoretical contributions mostly grounded in functional analysis and geometric measure theory, and applications naturally implying a stochastic or statistical framework. The AMATIS project aims at addressing these issues, by proposing a consistent and documented framework combining different theoretical approaches and bridging the gap towards applications. To that end, it will both address a number of challenging theoretical issues and devote significant efforts to elaborating a WEB platform with softwares and documentation. It will combine the efforts of mathematicians with those of physicists and experts in signal and image processing. Dissemination among and interactions between scientific fields are also intended via the organization of summer schools and workshop.

- *Activity Report*: a collaboration with P. Bas (CR CNRS, LAGIS) has started on the steganalysis of textured images. While steganography aims at hiding a message within some support, e.g. a numerical image, steganalysis aims at detecting the presence or not of any hidden message in the support. Steganalysis involves two main tasks: first identify relevant features which may be sensitive to the presence of a hidden message, then use supervised classification to build a detector. While the steganalysis of usual images has been well studied, the case of textured images, for which multifractal models may be relevant, is much more difficult. Indeed, textured images have a rich and disordered content which favors hiding information in an unperceptible manner. A student internship of 6 months at Master level has finished in November. The purpose was to explore the potential of new multiscale wavelet based discriminant features for steganalysis.

8.2.6. National Partners

- Inria Nancy - Grand Est, Team MAIA, France.
 - Bruno Scherrer *Collaborator*
We have had collaboration on the topics of *approximate dynamic programming and statistical learning* and *high-dimensional reinforcement learning* this year. On the first topic, we have published a conference paper [47] and a technical report [62], and on the second one we have published a conference paper [36] together.
- Supélec, IMS Research Group, Metz, France.
 - Matthieu Geist *Collaborator*
We have had collaboration on the topics of *approximate dynamic programming and statistical learning* and *high-dimensional reinforcement learning* this year. On the first topic, we have published a conference paper [47] and a technical report [62], and on the second one we have published a conference paper [36] together.
- LIP'6, UPMC, Paris, France.
 - Ludovic Denoyer *Collaborator*
We have a collaboration on the topic of *reinforcement learning, sparse representation*. We have worked on the datum-wise representation of data, as well as the handling of large but non infinite sets of actions. See section 8.2.2 for further details.

8.3. European Initiatives

8.3.1. FP7 Projects

PASCAL-2

Participants: the whole SEQUEL team is involved.

- *Title:* Pattern Analysis, Statistical Modeling, and Computational Learning
- *Type:* Cooperation (ICT), Network of Excellence (NoE)
- *Coordinator:* Univ. Southampton
- *Others partners:* Many european organizations, universities, and research centers.
- *Web site:* <http://www.pascal-network.org/>
- *Duration:* March 2008 - February 2013

PASCAL-2 Pump Priming Programme

Participants: Mohammad Ghavamzadeh, Rémi Munos.

- *Title:* Sparse Reinforcement Learning in High Dimensions
- *Type:* PASCAL-2 Pump Priming Programme
- *Partners:* Inria Lille - Nord Europe, Shie Mannor (Technion, Israel)
- *Web site:* <http://sites.google.com/site/sparsersl/home>
- *Duration:* November 2009 - September 2012
- *Abstract:* With the explosive growth and ever increasing complexity of data, developing theory and algorithms for learning with high-dimensional data has become an important challenge in statistical machine learning. Although significant advances have been made in recent years, most of the research efforts have been focused on supervised learning problems. We propose to design, analyze, and implement reinforcement learning algorithms for high-dimensional domains. We will investigate the possibility of using the recent results in l_1 -regularization and compressive sensing in reinforcement learning.
- *Activity report:* The project ended early this year. The list of publications obtained within the project is listed at <https://sites.google.com/site/sparsersl/publications>.

ComPLACS

Participants: Mohammad Ghavamzadeh, Nathan Korda, Prashanth Lakshmanrao Anantha Padmanabha, Alessandro Lazaric, Rémi Munos, Philippe Preux, Daniil Ryabko, Michal Valko.

- *Title:* Composing Learning for Artificial Cognitive Systems
- *Type:* Cooperation (ICT), Specific Targeted Research Project (STREP)
- *Coordinator:* University College of London
- *Other partners:* University College London, United Kingdom (John Shawe-Taylor, Stephen Hailes, David Silver, Yee Whye Teh), University of Bristol, United Kingdom (Nello Cristianini), Royal Holloway, United Kingdom (Chris Watkins), Radboud Universiteit Nijmegen, The Netherlands (Bert Kappen), Technische Universitat Berlin, Germany (Manfred Opper), Montanuniversitat Leoben, Austria (Peter Auer), Max-Planck Institute of Biological Cybernetics, Germany (Jan Peters).
- *Web site:* <http://www.complacs.org/>
- *Duration:* March 2011 - February 2015
- *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.

- *Activity report:* We worked on WorkPackage 2 (multi-armed bandits and extensions) and we designed hierarchical bandit-based planning algorithms for MDPs and POMDPs.

8.4. International Initiatives

8.4.1. Inria Associate Teams

SEURL

- *Title:* Decision-making under Uncertainty with Applications to Reinforcement Learning, Control, and Games
- *Inria principal investigator:* Rémi Munos
- *International Partner:*
 - *Institution:* University of Alberta (Canada)
 - *Laboratory:* Department of Computer Science
 - *Principal investigator:* Csaba Szepesvári
- *Duration:* January 2010 - January 2013
- *Website:* <http://sites.google.com/site/associateteamualberta/home>
- *Abstract:* This associate team aims at bridging researchers from the SequeL team-project at Inria Lille with the Department of Computing Science of the University of Alberta in Canada. Our common interest lies in machine learning, especially reinforcement learning, bandit algorithms and statistical learning with applications to control and computer games. The department of Computing Science at the University of Alberta is internationally renown as a leading research institute on these topics. The research work spans from theory to applications. Grounded on an already existing scientific collaboration, this associate team will make it easier to collaborate further between the two institutes, and thus strengthen this relationship. We foresee that the associate team will boost our collaboration, create new opportunities for financial support, and open-up a long-term fruitful collaboration between the two institutes. The collaboration will be through organizing workshops and exchanging researchers, postdoctoral fellows, and Ph.D. students between the two institutes.
- *Activity report:* This year we had two Ph.D. students from the university of Alberta, Yasin Abbasi and Bernardo Avila Pires, who visited SequeL for six and four weeks, respectively. We send our Ph.D. student Amir Sani to a workshop organized by the university of Alberta and McGill university in Barbados in April. Mohammad Ghavamzadeh had a one week visit to the university of Alberta to work with Csaba Szepesvári and Bernardo Avila Pires.
- *Joint Publications:* We have one conference paper submitted [53] and one in preparation [61] this year.

8.4.2. Inria International Partners

- University of Alberta, Edmonton, Alberta, Canada.
 - Prof. Csaba Szepesvári *Collaborator*
 - Bernardo Avila Pires *Collaborator*
 With Csaba Szepesvári we managed the associate team with the university of Alberta. We have had several visits to SequeL and UAlberta this year. We also have a conference paper [61] on *risk bounds in cost-sensitive multiclass classification* in preparation with Csaba Szepesvári and Bernardo Avila Pires.

- McGill University, Montreal, Quebec, Canada.
 - Prof. Joelle Pineau *Collaborator*
 - Prof. Doina Precup *Collaborator*
 - Amir massoud Farahmand *Collaborator*
 Mohammad Ghavamzadeh and Rémi Munos wrote a proposal with Joelle Pineau, Doina Precup, and Amir Farahmand to start an associate team with the McGill university. Mohammad Ghavamzadeh also have a conference paper submitted [53] on *classification-based approximate policy iteration* with Amir Farahmand and Doina Precup.
- Technion - Israel Institute of Technology, Haifa, Israel.
 - Prof. Shie Mannor *Collaborator*
 Mohammad Ghavamzadeh continued his collaboration with Shie Mannor. This year, we co-authored a book chapter on *Bayesian reinforcement learning* [57].
- University of Waterloo, Waterloo, Ontario, Canada.
 - Prof. Pascal Poupart *Collaborator*
 Mohammad Ghavamzadeh continued his collaboration with Pascal Poupart. This year, we co-authored a book chapter on *Bayesian reinforcement learning* [57].
- University of Waterloo, Waterloo, Ontario, Canada.
 - Prof. Carl Haas *Collaborator*
- University of Waterloo, Waterloo, Ontario, Canada.
 - Prof. Giovanni Cascante *Collaborator*
- Politecnico di Milano, Italy.
 - Prof. Marcello Restelli *Collaborator*
 - Prof. Nicola Gatti *Collaborator*
 We continued our collaboration on transfer in reinforcement learning and we developed a novel collaboration focused on the interplay between bandit theory and mechanism design, notably in the sponsored search auction application domain [35].
- Technicolor Research, Palo Alto.
 - Branislav Kveton *Collaborator*
 We have an ongoing collaboration related to the sequential graph-based learning. This involves both theory and the application to industry, such as sequential face recognition. Currently we investigate the problem of face detection from a single labeled face and the streams of unlabeled data.

8.5. International Research Visitors

- Ronald Ortner, from University of Leoben, Austria.
Period: spent his sabbatical Jan-Oct 2012 with us. Some papers as a result of this collaboration are [43], [44]; some more are under submission.
- Gusztav Morvai, senior research at Budapest University of Technology and Economics.
Period: Oct 18-24, 2012
- Tor Lattimore, Ph.D. student at Australian National University.
Period: Nov. 2-9, 2012
- Bernardo Avila Pires
Period: May 2012 (one month)
He worked with Mohammad Ghavamzadeh on *risk bounds in cost-sensitive multiclass classification*. The outcome of this collaboration has been a conference paper in preparation [61] so far.

- Joelle Pineau
Period: September 2012 (one week)
Prof. Pineau visited SequeL for one week as a part of her sabbatical. During her stay, in addition to have discussions with SequeL team members and giving two talks on her research, she wrote a proposal with Mohammad Ghavamzadeh and Rémi Munos to start an associate team between SequeL and McGill university.
- Pr. Giovanni Cascante, University of Waterloo, Waterloo, Ontario, Canada.
Period: June 2012
He worked with Philippe Vanheeghe and Emmanuel Duflos on parameters estimation in acoustic probing in civil engineering. The outcome of this collaboration has been a project master (from November 2012) and a proposition of research project under evaluation the University of Waterloo so far.

8.5.1. Internships

- Louis Dacquet, student at Ecole Centrale Lille.
Period: April-June 2012.
He worked with Pierre Chainais on *blind image deconvolution*.
- Alexandre Kazmierowski, student at Ecole Telecom ParisTech.
Period: June-July 2012.
He worked with Pierre Chainais and Antoine Gloria (SIMPAF project) on textured models for heterogeneous media and homogeneization theory in PDEs.
- Phuong Nguyen, Ph.D. student at Australian National University.
Period: 15 February - 30 April 2012
He worked with Daniil Ryabko on state representation for reinforcement learning. As a result, one paper is submitted and one is being prepared.
- Florian Gas, Student at the Ecole Centrale de Lille, France.
Period: May 2012 - July 2012.
He worked with Emmanuel Duflos on foundations of Sequential Monte Carlo Methods in high dimension

SIERRA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. Calibration

Participant: Sylvain Arlot.

S. Arlot, Membre du projet ANR Calibration

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/>

8.1.1.2. Detect

Participants: Sylvain Arlot, Francis Bach, Rémi Lajugie.

Title: New statistical approaches to computer vision and bioinformatics

Coordinator: Ecole Normale Supérieure (Paris)

Leader of the project: Sylvain Arlot

Other members: J. Sivic (Willow project-team, ENS), A. Celisse (University Lille 1), T. Mary-Huard (AgroParisTech), E. Roquain and F. Villers (University Paris 6).

Instrument: ANR, Young researchers Program

Duration: Sep 2009 - Aug 2012

Total funding: 70000 Euros

See also: <http://www.di.ens.fr/~arlot/ANR-DETECT.htm>

Abstract: The Detect project aims at providing new statistical approaches for detection problems in computer vision (in particular, detecting and recognizing human actions in videos) and bioinformatics (e.g., simultaneously segmenting CGH profiles). These problems are mainly of two different statistical nature: multiple change-point detection (i.e., partitioning a sequence of observations into homogeneous contiguous segments) and multiple tests (i.e., controlling a priori the number of false positives among a large number of tests run simultaneously).

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. SIERRA

Participants: Francis Bach [correspondant], Simon Lacoste-Julien, Augustin Lefèvre, Nicolas Le Roux, Mark Schmidt.

Title: SIERRA – Sparse structured methods for machine learning

Type: IDEAS

Instrument: ERC Starting Grant (Starting)

Duration: December 2009 - November 2014

Coordinator: Inria (France)

See also: <http://www.di.ens.fr/~fbach/sierra>

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: the tenet of this proposal is that to achieve the expected breakthroughs, this two-stage paradigm should be replaced by an integrated process where the

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. STATWEB

Participants: Francis Bach [correspondant], Ronny Luss.

Title: Fast Statistical Analysis of Web Data via Sparse Learning

Inria principal investigator: Francis Bach

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - EECS and IEOR Departments - Laurent El Ghaoui

Duration: 2011 - 2013

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.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Michael Jordan (U.C. Berkeley, <http://www.cs.berkeley.edu/~jordan>), is spending one year in our team, starting September 2012, financed by the Fondation de Sciences Mathématiques de Paris and Inria.

TAO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- **JASMIN**– 2010-2012 (205 kEur). *DRIRE programme FEDER*.
Participants: CADLM, Intercim, TAO (Michèle Sebag) .
- **CSDL**– 2009-2012 (290 kEur). *FUI System@tic (Région Ile de France grant). Complex System Design Lab*
Participants: Anne Auger, Nikolaus Hansen, Ilya Loshchilov, Raymond Ros, Verena Heidrich-Meisner, Marc Schoenauer.
- **TIMCO**– 2012-2015 (432 kEur). *FUI-System@tic (Région Ile de France grant)*.
Participants: Cécile Germain, Marc Schoenauer, Lovro Iljasic.

8.2. National Initiatives

- **OMD2** – 2009-2012 (131 kEur). *Optimisation Multi-Disciplinaire Distribuée, ANR programme COSINUS* Coordinator Maryan Sidorkiewicz, RENAULT Technocentre;
Participants: Anne Auger, Yohei Akimoto, Nikolaus Hansen, Marc Schoenauer, Olivier Teytaud.
- **SyDiNMaLaS** – 2009-2012 (158 kEur). *Integrating Symbolic Discovery with Numerical Machine Learning for Autonomous Swarm Control, ANR programme BLANC* Coordinator Michèle Sebag, CNRS;
Participants: David Meunier, Marc Schoenauer, Michèle Sebag.
- **TRAVESTI** – 2009-2012 (206 kEur). *Estimation du volume de Trafic par Interface Spatio-temporelle, ANR programme SYSCOMM 2008* Coordinator Cyril Furtlehner, Inria;
Participants: Anne Auger, Cyril Furtlehner, Victorin Martin, Maxim Samsonov.
- **ASAP** – 2009-2013 (178 kEur). *Apprentissage Statistique par une Architecture Profonde, ANR programme DEFIS 2009* Coordinator Alain Rakotomamonjy, LITIS, Université de Rouen, France;
Participants: Sylvain Chevallier, Hélène Paugam-Moisy, Sébastien Rebecchi, Michèle Sebag.
- **IOMCA** 2010-2013 (264 kEur). *Including Ontologies in Monte-Carlo Tree Search and Applications, ANR international project coordinated by O. Teytaud (Tao, Inria)*.
Participants: Adrien Couëtoux, O. Teytaud.
- **EXPLORA** 2010-2012 (289 kEur, to be shared with Inria Lille). *EXPLoitation pour l'Allocation efficace de Ressources. Applications l'optimisation. ANR Project coordinated by R. Munos (Inria Lille)*.
Participants: David Auger, Olivier Teytaud.
- **DESCARWIN** 2010-2013 (201 kEur). *Coordinateur P. Savéant, Thalès*.
Participants: Mostepha-Redouane Khouadjia, Marc Schoenauer.
- **SIMINOLE** 2010-2014 (1180k, 250k 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, Djalel Benbouzid, Nikolaus Hansen, Michèle Sebag, Cécile Germain
- **NUMBBO** 2012-2016 (290k for TAO). *Analysis, Improvement and Evaluation of Numerical Black-box Optimizers, ANR project, Coordinator Anne Auger, Inria. Other partners: Dolphin, Inria Lille, Ecole des Mines de Saint-Etienne, TUD Dortmund*
Participants: Anne Auger, Nikolaus Hansen, Marc Schoenauer, Ouassim Ait ElHara

- **LOGIMA** 2012-2016 (136k 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

8.2.1. Other

- **GCO** - 2011-2012) *Green Computing Observatory* PEPS-INS2I. Coordinator Cécile Germain. Participants: Cécile Germain, Julien Nauroy, Michèle Sebag.
- **GO** (2011-2013) *Observatoire de la Grille* Action de Développement technologique Inria. Coordinator Cécile Germain. Participants: Dawei Feng, Cécile Germain, Julien Nauroy, Michèle Sebag. Also funded by the France Grilles national initiative.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. SYMBRION

Title: Symbiotic Evolutionary Robots Organisms

Type: COOPERATION (ICT)

Defi: Embedded systems design

Instrument: Integrated Project (IP)

Duration: February 2008 - January 2013

Coordinator: Universität Stuttgart (Germany)

Others partners: Almende, Netherlands; Universität Graz, Austria; Universität Karlsruhe, Germany; Vlaams Interuniversitair Instituut Voor biotechnologie VZW, Blegium; University of the West of England, Bristol, United Kingdom; Eberhard Karls Universität Tübingen, Germany; University of York, United Kingdom; Université libre de Bruxelles, Belgium; Inria, France.

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

8.3.1.2. MASH

Title: Massive Sets of Heuristics For Machine Learning

Type: COOPERATION (ICT)

Defi: Cognitive Systems and Robotics

Instrument: Specific Targeted Research Project (STREP)

Duration: January 2010 - December 2012

Coordinator: IDIAP Research Institute (Switzerland)

Others partners: Centre National de la Recherche Scientifique, France; Weierstrass-Institut für Angewandte Analysis Und Stochastik, Part of Forschungsverbund Berlin E.V, Germany; Inria, France; Ceske Vysoke Uceni Technicke V Praze, Czech Republic.

See also: <http://mash-project.eu/>

Abstract: The Mash project is about massive crowd-sourcing. It is based on several artificial applications. We however used the codes also for our favorite applications, because the original Mash applications have nearly no user, which make it hard to have massive crowd-sourcing; for our applications, we have a moderate number of users, but at least they are motivated. Our contributions are twofolds:

- Building solvers on top of existing expert solvers; this is quite related to our Metis platform (Section 5.1) and our work on Minesweeper and on the mixing of direct policy search and Monte-Carlo Tree Search;

- Adapting solvers for cases in which we can not “undo” on the problem, i.e. if we apply a decision, we can not come back to the previous time step; this makes planning much harder and slower. This is developed in [63].

8.3.1.3. *CitInES*

Title: City and Industry Energy Strategy

Type: COOPERATION (ICT)

Defi: Design of a decision support tool for sustainable, reliable and cost-effective e

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2011 - March 2014

Coordinator: Artelys (France)

Others partners: Artelys (<http://www.artelys.com>), Inescp (<http://www2.inescporto.pt/>, Portugal), Ait (<http://www.ait.ac.at/>, Austria), Armines (Ecole des Mines, Paris <http://www.ensmp.fr>), Tupras (<http://www.tupras.com.tr>, Turkey), Ervet (<http://www.ervet.it/>, Italy), Schneider (<http://www.schneider-electric.com>), Cesena (Italy), Bologna (Italy)

See also: <http://www.citines.com>

Abstract: According to OECD, 67% of world energy is used by cities and 70% of CO2 emissions come from cities. Therefore, optimizing urban energy investments is a key challenge for reducing polluting emissions and financial exposition to fuel price uncertainties. However, the definition of a sustainable, reliable and cost-effective energy strategy requires to simulate the whole energy chain (consumption, transport, distribution, storage, production) with different types of energy (electricity, gas, heat, wind, waste, etc.) and to assess the environmental and financial impacts of various long-term scenarios (fuel prices, consumption scenarios, etc.).

Local authorities facing this issue have today only partial answers to these questions (simulation of a given type of energy, of a part of the energy chain only or without any long-term risk assessment) and lack a global analysis.

The goal of the CitInES project is to design and develop decision-support software to help local authorities / industries to :

- Assess and compare energy strategies through detailed energy chain simulations
- Optimize local energy strategy to cost-effectively integrate green energy and reduce CO2 emissions
- Define robust energy schemes to face fuel price uncertainties.

The CitInES project is financed by the European Commission, under 7th Framework Programme. It gathers:

- 4 high-level research centers (INESCP for electric system modelling, AIT for building and energy infrastructure planning, ARMINES for long-term energy strategies and Inria for optimization algorithms)
- 1 SME specialized in decision-support software in the energy field (Artelys, leader of the consortium)
- 2 well-known industrial groups (Schneider Electric for its expertise in electric systems; TUPRAS, Turkish refineries as end-user) and 1 national company (ERVET for its expertise in energy processes)
- 2 large cities (Cesena and Bologna as end-users).

8.3.1.4. *EGI-Inspire*

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

Type: Research Infrastructures (CP-CSA)

Defi: European Grid Infrastructure Ecosystem

Instrument: Integrated Project (IP)

Duration: May 2010 - April 2014

Coordinator: EGI.eu (Netherlands)

Others partners: 50 institutions, coordinator for France: CNRS.

See also: <http://www.egi.eu>

Abstract: The EGI-InSPIRE project supports the transition from a project-based system to a sustainable pan-European e-Infrastructure, by supporting 'grids' of high-performance computing (HPC) and high-throughput computing (HTC) resources. EGI-InSPIRE supports the establishment of a sustainable model for a European Grid Infrastructure (EGI) that integrates resources contributed by national and domain-specific resource providers. Key to this process is a new organisation, EGI.eu, coordinator on behalf of the European resource provider community of the EGI-InSPIRE project. The EGI is a federation of independent national and domain specific resource providers, who support specific research communities and international collaborators both within Europe and worldwide.

8.3.2. Collaborations in European Programs, except FP7

Program: COST

Project acronym: Action IC0804

Project title: Energy Efficiency in Large Scale Distributed Systems

Duration: January 2009 - May 2013

Coordinator: IRIT

Other partners: see <http://www.cost804.org>

Abstract: The main objective of the Action is to foster original research initiatives addressing energy awareness/saving and to increase the overall impact of European research in the field of energy efficiency in distributed systems.

8.3.3. Collaborations with Major European Organizations

Partner 1: organisme 1, labo 1 (pays 1)

Sujet 1 (max. 2 lignes)

Partner 2: organisme 2, labo 2 (pays 2)

Sujet 2 (max. 2 lignes)

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 Electricity Generation

Inria principal investigator: Olivier Teytaud

International Partner (Institution - Laboratory - Researcher):

National University of Tainan (Taiwan) - Ontology Application and Software Engineering
- Chang-Shing Lee

Duration: 2012 - 2014

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

The objectives of the project are three-folds:

- Objective 1: Designing consistent iterative realistic algorithms for partially observable 1-player or 2-player games. We mean:
 - consistent algorithms, in the sense that they are mathematically, provably, optimal asymptotically in the computation time.
 - iterative algorithms in the sense that when you give more time to the algorithm, it should be better; and with little time, it should do its best for replying something acceptable. This is also termed an anytime algorithm. Most algorithm which survive decades are iterative.
 - realistic algorithms; we mean that one can easily design a consistent iterative algorithm that will never work in practice in a real-world setting; so, additionally, we want an algorithm which looks reasonable and we refer to the second objective for the assessment of this property

We consider our work on MineSweeper[31] and combining Mcts and Dps [38] as realizations of this principle; we also apply this principle for real applications in the related [Citines project](#).

- Objective 2: Impressive visible applications, e.g. applications in games or puzzles, because such games are very clear assessment tools. Possibilities include Minesweeper (on which we believe that much progress is still possible), Chinese Dark Chess, Kriegspiel, Phantom-Go, card games. Such nice results are critical for advertising and assessing our research. Since the beginning of the project, we had results on MineSweeper, Urban Rivals.
- Objective 3: Big industrial applications. Having both mathematics and visible realizations in games and industrial applications might be considered as too much; yet, we have chosen to request the maximum possible funding and to include many people in the travelling; also, the persons in the project are all people working in related subjects, with various terminologies, and we already have concrete applications in mind, just far enough from our past activities for being new (we want to tackle in a principled manner partial observability which was somehow ignored in many past works) and close enough for strongly reducing the “warm up” time. In the fully observable case, we worked successfully for these three objectives and want to do the same in the partially observable case. More precisely, when working on real applications in the field of energy generation, we have seen that many problems are simplified so that they boil down to fully observable problems, but that this is a bad application; and our solvers must include some tricks for the partial observability. This is the main motivation for this project; 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. We believe that requirements above (objective 1) and visible realizations will facilitate the migration to real-world application; also we point out that previous research projects involving us facilitated contacts with industry, in particular in the field of energy generation, which is a key point for this third objective. A roadmap for objective 3 is as follows:
 - Check on simple versions of energy production problems whether the fully observable approximation is ok. We guess that in many cases it is not ok, and we want to clearly state to which extent (by how many percents) we loose in terms of loss function.
 - Experiment our algorithms on real industrial problems. We will work both on Taiwan-centered and on Europe-Centered electricity generation problems in order to widen the scope of the analysis and so that both partners can be helpful in terms of applications in their own countries.

We have made papers related to energy management, including papers in very applied conferences. We are in the process of creating a company in Taiwan, hopefully during the

2nd semester of 2013. One student (Adrien Couëtoux) has spent 6 months there, another student has spent 5 months; Adrien just starts a second 6 months stay there.

8.4.2. Inria International Partners

8.4.2.1. Microsoft Research Cambridge

Within the *Microsoft-Inria Joint Lab*, the collaboration with Youssef Hamadi (Microsoft Research Cambridge), through the *Adapt* project, has been pursued, in spite of the departure of the 2 PhD students Alvaro Fialho and Alejandro Arbelaez. Nadjib Lazaar and Manuel Loth have been hired as post-doc, and a new collaboration with Christian Shulte (KTH Stockholm) based on the use of Bandit algorithm within GECODE has recently given its first results [52] (see Section 3.2).

8.4.3. Participation In International Programs

- The UCT-SIGhas started a collaboration with Inria Chile around energy management; for the moment this is only preliminary discussions (a few face-to-face meetings in Paris, a visioconference with Inria Chile).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Christian Shulte (Software and Computer Systems, School of Information and Communication Technology, KTH - Royal Institute of Technology in Stockholm, Sweden), Jan. 24-27, to initiate the generic implementation of Bandit algorithms in Gecode (see Section 3.2).
- Visits from a Taiwanese delegation, see [the Franco-Taiwanese week](#). This included visits to Univ. Paris-Sud, to other universities (Paris-Nord, Limoges), to companies working around energy.
- One month visit from Cheng-Wei Chou, Taiwanese ph.D. student from National Dong-Hwa University.
- Francis Maes, Post-doc, Leuven University, Leuven, Nov. 20 to Dec. 21.
- One week visit from Muneki Yasuda associate professor in the department of Information science, Tohoku University.

Xiangliang ZHANG (25-31 October 2012)

Continued collaboration on large scale clustering.

Institution: KAUST-King Abdullah University of Science and Technology (Saudi Arabia)

8.5.1.1. Internships

Christopher DELGADO (from Apr 2012 until Sep 2012)

Subject: Designing lean classifiers for detectors and triggers

Institution: Massachusetts Institute of Technology (United States)

Gaurav MAHESHWARI (from Apr 2012 until Sep 2012)

Subject: Sampling-based statistical analysis in large-scale physics experiments

Institution: IIT HYDERABAD (India)

Mauro DI MASSO (from Mar 2012 until Sep 2012)

Subject: Evolutionary Adaptation and the Emergence of Speciation in a Population of Autonomous Robots

Institution: National University of Rosario (Argentina)

8.5.2. Visits to International Teams

- Olivier Teytaud has made a one-year visit (August 2011 to July 2012) in National University of Tainan, Taiwan, and to many other universities.

ALEA Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The project PSI (Psychology and sounds interactions), headed by P. Legrand received a grant by the region Aquitaine for a PhD thesis on “Dimension reduction in supervised learning. Application to the study of brain activity”.

8.2. National Initiatives

8.2.1. ANR Propagation (2010-2012)

To combat dramatic event such as happened in Bombay last year (coming from the sea, a terrorist commando killed more than 200 peoples in Bombay city), authorities are decided to deploy efficient sea surveillance system to protect coastal zone including sensitive infrastructures often in vicinity of important cities.

Regulation on frequencies allocation and on coastal constructions is strong constraint to be taken into account to install technical capabilities to permanently survey vulnerable littoral zones. For example, new active sensor shall be frequencies compatible within numerous existing ones in inhabited region. In this context to perform coastal surveillance, attractive solution is to deploy passive sensors networks because:

- Not necessarily compatible within existing active sensors network.
- Provide large possibilities to install the passive sensors, because, it is not needed to be on the shoreline, but can be deployed inside the territory. Such as facility offers more potential sites and then, to optimise the deployment for optimal coverage of the sensitive zone.
- Is totally undetectable by external technical means in hand of structured criminal organisations.

For these objectives, the PROPAGATION project study, develop and experiment a demonstrator to carry out maritime traffic picture from a set of passive sensors: passive radar, AIS and optronic cameras deployed over a coastal site. This is a joint ANR project with DCNS, Thalés and Exavision.

8.2.2. Project PEPH

This is an interdisciplinary exploratory research project, between Institut de Mathématiques de Bordeaux and Laboratory Ecologie & Evolution, UMR 7625 CNRS-UMPC-ENS (responsible: B. Cazelles). The objective of this project on the dynamics of epidemic diseases characterized by multiple strains of pathogens, is to use the competencies of the ALEA team to get efficient Bayesian optimization techniques. An [opening workshop](#) on stochastic models and bayesian inference in epidemiology has been organized in Bordeaux in November 2011.

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Partner 1: Oxford University, Department of Statistics (UK)
 Interacting particle systems
 Bayesian Nonparametrics
 Partner 2: Imperial College (UK)
 Interacting Particle Systems

8.4. International Research Visitors

8.4.1. Visits of International Scientists

The following researchers visited the Team ALEA during 2012: A. Doucet (Univ. Oxford), C. Holmes (Oxford), N. Whiteley (Univ. Bristol), R. Xu (Univ. of Tech. Sydney), G. Peters (University College London), Pavel V. Shevchenko (CSIRO).

ASPI Project-Team

6. Partnerships and Cooperations

6.1. National initiatives

6.1.1. Ensemble methods for prediction and data assimilation (PREVASSEMBLE) — ANR Conception et Simulation

Participants: François Le Gland, Valérie Monbet.

See 5.14 .

Inria contract ALLOC 3767 — January 2009 to December 2012.

This ANR project is coordinated by École Normale Supérieure, Paris. The other partner is Météo-France. This is a collaboration with Étienne Mémin and Anne Cuzol (Inria Rennes Bretagne Atlantique, project-team FLUMINANCE).

The contribution of ASPI to this project is to continue the comparison of sequential data assimilation methods initiated in [73], [62], such as the ensemble Kalman filter (EnKF) and the weighted ensemble Kalman filter (WEnKF), with particle filters. This comparison has been made on the basis of asymptotic variances, as the ensemble or sample size goes to infinity, and also on the impact of dimension on small sample behavior.

The consortium has organized the international conference on *Ensemble Methods in Geophysical Sciences*, held in Toulouse in November 2012.

CQFD Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

In collaboration with UMR SAVE of INRA de Bordeaux, Anne Gégout-Petit and Marie Chavent supervise a PhD until september 2012 founded by a regional grant on the subject "Détermination des facteurs environnementaux et culturels liés à l'esca de la vigne par une approche de modélisation spatio temporelle".

Marie Chavent participates to a project financed by the Région Aquitaine for three years (2010-2013), named *PSI : Etude des interactions états psychophysiologiques et musique* including the PHD-grant of Laurent Vezard. The subject of this PHD, co-directed by M. Chavent, F. Faita and P. Legrand from Project-Team ALEA, is *Dimension reduction in the context of supervised learning. Applications to the electrical brain activity study.*

7.2. National Initiatives

7.2.1. ANR FAUTOCOES

The goal of the project "FAUTOCOES" (number ANR-09-SEGI-004) of the ARPEGE program of the French National Agency of Research (ANR) can be described as follows. Today, complex technological processes must maintain an acceptable behavior in the event of random structural perturbations, such as failures or component degradation. Aerospace engineering provides numerous examples of such situations: an aircraft has to pursue its mission even if some gyroscopes are out of order, a space shuttle has to succeed in its re-entry trip with a failed on-board computer. Failed or degraded operating modes are parts of an embedded system history and should therefore be accounted for during the control synthesis.

These few basic examples show that complex systems like embedded systems are inherently vulnerable to failure of components and their reliability has to be improved through fault-tolerant control. Embedded systems require mathematical representations which are in essence dynamic, multi-model and stochastic. This increasing complexity poses a genuine scientific challenge:

- to model explicitly and realistically the dynamical interactions existing between the physical state variables defining the system: pressure, temperature, flow rate, intensity, etc, and the functional and dysfunctional behavior of its components;
- to estimate the performance of the system through the evaluation of reliability indexes such as availability, quality, and safety;
- to optimize the control to prevent system failures, as well as to maintain the system function when a failure has occurred.

Our aim is to meet the previously mentioned challenge by using the framework of piecewise deterministic Markov processes (PDMP's in short) with an emphasis on probabilistic and deterministic numerical methods. More precisely, our objectives are

- to use the framework of piecewise deterministic Markov processes to model complex physical systems and phenomena;
- to compute expectations of functionals of the process in order to evaluate the performance of the system;
- to develop theoretical and numerical control tools for PDMP's to optimize the performance and/or to maintain system function when a failure has occurred.

More details are available at <http://fautocoes.bordeaux.inria.fr/>.

7.2.2. 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 will work on tasks 1 and 3.

7.3. International Initiatives

7.3.1. Collaborations with Major European Organizations

Numerical methods for Markov decision processes 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 (LP) 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).

This project is supported by the *Gobierno de Espana, Direccion General de Investigacion Cientifica y Tecnica* (reference number: MTM2012-31393) for three years (25 000 euros) to support the scientific collaboration between Tomas Prieto-Rumeau and François Dufour.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Tomas Prieto-Rumeau (Department of Statistics and Operations Research, UNED, Madrid, Spain) visited the team during one month in 2012. 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 Markov Decision Processes. He visited the team during two weeks in 2012.

Alexey Piunovskiy (University of Liverpool) visited the team during one month in 2012. The main subject of the collaboration is the linear programming approach for Markov Decision Processes.

7.4.2. Visits to International Teams

François Dufour has visited A. Piunovskiy at Liverpool University for a week in March.

Jérôme Sracco was invited to MCR Biostatistics Units at Cambridge University for one week in november 2012. He gave a seminar untitled "Dimension reduction based on sliced inverse regression (SIR): a look at the special case when $n < p$.

I4S Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *Pôle de Compétitivité ASTECH MODIPRO*

Participants: Laurent Mevel, Meriem Zghal.

Contract Inria 4162

I4S is implied in a national project for aircraft SHM starting Fall 2009. This project will improve on monitoring procedures developed in previous projects to provide some algorithms for use in Dassault Aviation aircraft monitoring procedures. I4S works together with Qinghua Zhang of Inria Rocquencourt, project team SISYPHE, on this topic. The project ended in October 2012.

8.1.2. *Collaboration with IFSTTAR*

Participant: Laurent Mevel.

I4S is related to the project FUI SIPRIS (Systèmes d'Instrumentation pour la prévention des risques), lead by Advitam. Work has just started with IFSTTAR.

8.1.3. *Collaboration with ALEA, EPI Team at Inria Bordeaux Center*

Participants: Laurent Mevel, Meriem Zghal.

I4S has a 2 year collaboration with EPI ALEA on using particular filtering in vibration analysis. The output has been submitted for publication.

8.1.4. *Collaboration with ISAE*

Participants: Laurent Mevel, Ahmed Jhinaoui.

Ahmed Jhinaoui is finishing his thesis on helicopter instability. This thesis is codirected by professor Morlier from ISAE, France. This thesis is funded by FP7-NMP Large Scale Integrated Project IRIS. See also [25].

8.2. European Initiatives

8.2.1. *FP7 Projects*

8.2.1.1. *FP7 ISMS*

Type: PEOPLE

Instrument: Industry-Academia Partnerships and Pathway (IAPP)

Duration: September 2010 - August 2013

Coordinator: SVS (Structural Vibrations Solutions) (Denmark)

Others partners: University of British Columbia, Canada

In 2009, a proposal has been submitted with SVS, University of British Columbia and I4S to develop a framework for handling structural health monitoring methods. This proposal implies some long stay of the concerned people, Laurent Mevel and Michael Döhler for I4S abroad. Palle Andersen and one of its engineer from SVS are assumed to stay 9 months at Inria, for tighten integration of COSMAD and ARTEMIS software. The proposal has been rated 88/100 and ranked A in the final selection procedure. The project has been signed on August 1st 2010 and has been running from September 1st. Michael Döhler has been spending 5 months in 2010-2011 in Danemark. Laurent Mevel spent 2 months in 2012 in Danemark. The mid term project has been well reviewed by the EC.

8.2.1.2. FP7-NMP CP-IP 213968-2 IRIS

Type: Cooperation

Instrument: Collaborative project -Large Scale Integrating project

Duration: October 2008 - March 2012

Coordinator: VCE, Austria (Denmark)

Others partners: 40 partners

IIRIS (*Integrated European Industrial Risk Reduction System*), which holds its kick off meeting in October 2008. This project has been elaborated within the framework of the SAMCO association. I4S is involved in the online monitoring sub-project.

I4S is involved in the core consortium of this FP7-NMP Large Scale Integrated Project.

Inria is involved in Group 3 about Structural Health Monitoring. I4S works with Sheffield University and BAM (Germany) for development of tools for structural damage detection for bridges and wind farms. Laurent Mevel is also member of the core IRIS Vision group, and is responsible of the scientific coherency of the project.

The project ended in Spring 2012.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. SIMS, Canada

Participants: Michael Döhler, Laurent Mevel.

A new project called SIMS is currently ongoing on vibration analysis and monitoring in Canada. This project is funded by Ministry of Transport, British Columbia, Canada. It implies deep collaboration with University of British Columbia, Canada.

SVS and I4S are investigating how to link the modal analysis software ARTeMIS of SVS and COSMAD. Through an annual agreement, I4S gets a license of ARTeMIS in exchange to offer support for integrating our damage detection software into SVS software and offerings. A contract has been signed, where I4S provides algorithms and expertise for integration within a damage detection structural health monitoring system and SVIBS does the implementation. This technology transfer has been funded by the ministry of transportation of British Columbia, Canada. The work is supervised by UBC, CA. The end product will be a web based structural health monitoring system for in operation bridges.

8.3.1.2. Collaboration on damage localization and monitoring with Boston University

This work is related to the thesis of Luciano Marin. The objective is the draft of an associated Inria team. Currently exchange of postdocs and joint PhD supervision have been done.

8.3.2. Participation In International Programs

8.3.2.1. Northeastern University

Participants: Laurent Mevel, Luciano Marin.

Program: International joint supervision of PhD agreement

Title: Design of fast statistical algorithms for monitoring of damage and uncertainties in civil and aeronautic structures

Inria principal investigator: Laurent MEVEL

Northeastern University (United States)

Duration: May 2011 - Apr 2014

This collaboration involves a new PhD student, Luciano Marin, and is involving Professor Bernal from University of Boston, USA.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Michael Döhler of Northeastern University has visited twice in June and September 2012 for a total of 4 weeks.

MATHRISK Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

ANR ANR-08-BLAN, Program: Big'MC (Issues in large scale Monte Carlo). (2009-2012).

Partners ENST, ENPC, University Paris-Dauphine.

7.1.2. Competitvity Clusters

Pôle Finance Innovation.

Project "Credinext" on credit risk derivatives (2009-2012).

Partners: Thomson Reuters, Lunalogic, Pricing Partners, Ecole Polytechnique, Inria, ENPC, Université Paris-Est Marne la Vallée.

(Several PhD and Postdoc grants)

7.2. European Initiatives

Eurostars Program "Transparency in Financial Markets" (OSEO grant) (Postdoc grants).

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Emmanuella Rosazza Gianin, Bococca Milano University , January 2012

Peter Forsyth, Waterloo university Canada, July 2012

7.3.2. Internships

- Roxana Dumitrescu, Master 2 , University Paris-Dauphine
- Jiang Pu , Ecole Polytechnique, 3rd year

REGULARITY Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

Erick Herbin is member of the CNRS Research Groups:

- GDR Mascot Num, devoted to stochastic analysis methods for codes and numerical treatment;
- GDR Math-Entreprise, devoted to mathematical modeling of industrial issues.

8.2. International Initiatives

8.2.1. Inria International Partners

- Regularity collaborates with Bar Ilan university on theoretical developments around set-indexed fractional Brownian motion and set-indexed Lévy processes (invitations of Erick Herbin in Israël during five months in 2006, 2007, 2008, 2009 and 2011 and invitation of Prof. Ely Merzbach at Ecole Centrale Paris in 2008, 2009, 2010 and 2011). The PhD thesis of Alexandre Richard is co-supervised by Erick Herbin and Ely Merzbach.

Erick Herbin was invited to the Mathematics Colloquium (Bar Ilan University, Israel) in July, 2012. Talk: "Haudorff dimension of the graph of Gaussian processes".

- Regularity collaborates with Michigan State University (Prof. Yimin Xiao) on the study of fine regularity of multiparameter fractional Brownian motion (invitation of Erick Herbin at East Lansing in 2010).
- 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.
- Regularity collaborates with Milan University (Prof. Davide La Torre) on the study of certain economic growth models. A joint project has just been selected in the frame of the Galilée program.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Professors Ely Merzbach from Bar Ilan University and Franklin Mendivil from Acadia University have visited the team this year.

8.3.1.1. Internships

Ankush GOYAL (from May 2012 until Jul 2012)

Subject: Stochastic calculus with multistable Lévy motion and applications in finance

Institution: IIT Delhi (India)

TOSCA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- N. Champagnat and D. Villemonais are members of the ANR MANEGE (Modèles Aléatoires eN Écologie, Génétique et Évolution, started in 2009) 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. In addition, the three working groups that operate in each of the three poles of the MANEGE project (Paris, Palaiseau, Marseille) gather all local probabilistic interests in the issues of this project. http://www.cmap.polytechnique.fr/~anr-manege/index_en.html
- N. Champagnat is member of the ANR MODECOL (Using mathematical MODELing to improve ECOlogical services of prairial ecosystems, which ended in August 2012), whose goal is to develop computational ecological modeling of terrestrial plants communities via the simulation of a prairie in relation with environmental data. This project focuses on developing an original toolbox that takes advantage of complementary mathematical disciplines (partial differential equations, individual-based stochastic modelling...) to assess ecological problems. Simulations will be extensively processed using distributed computing and webcomputing. Our target application concerns the setup of herbal strips around intensive cereal fields for purifying water from extra nitrate and pesticides, imposed by the European Common Agricultural Policy. <http://ecobio.univ-rennes1.fr/modecol/gb/description.php>
- S. Herrmann, J. Inglis, D. Talay and E. Tanré are member of the ANR MANDy (Mathematical Analysis of Neuronal Dynamics, started in 2009 under the direction of M. Thieullen, Univ. Paris 6). This project, which gathers mathematicians and neuroscientists, aims at developing mathematically rigorous approaches to neuroscience considering single neurons as well as interconnected neuronal populations. Our target is to conduct the mathematical analysis of existing models where there is still much work to be done and to enrich the modelling by proposing new models. See <http://www.proba.jussieu.fr/pageperso/thieullen/MANDy/accueil.html> for a more complete description of this project.
- A. Lejay is member of the ANR SIMUDMRI (Simulation of diffusion MRI signals in biological tissues) which started in November 2010 (directed by Jing-Rebecca Li, Inria Rocquencourt). <http://www.cmap.polytechnique.fr/~jingrebeccali/grants/simudmri.html>
- 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, Jacques Morice.

Carbon value and carbon tax in the context of renewable energies deployment Since January 2009, M. Bossy was member of a collaboration funded by the French Environment and Energy Management Agency (ADEME), involving the Center for Applied Mathematics (CMA) at Mines ParisTech, and COPRIN and TOSCA teams at Inria Sophia Antipolis. It focuses on a short term carbon value derived from the so-called financial *carbon market*, the European Union Emission Trading Scheme (EU ETS), which is a framework for GHG emissions reduction in European industry.

The objective of this project is to study the compatibility and complementarity of a carbon tax and a target for renewable energy deployment. As a first step, we are developing a method for assessing the EU ETS value. We consider the constraints related to emission allowances distributed through national plans of allocation (NAP) and the mechanisms of taxes that are taking place. The work will focus on electricity producers, key players in the market in its first phase (NAP-I, 2005-2007). The impact of the *Renewable Energies* park of the electricity producers on their own carbon value will be particularly studied.

We have selected the financial concept of indifference price as a relevant methodology to assess the European Union Emission Trading Scheme (EU ETS) value. In this setting, modelling strategies of production and emission of market quotas rely on stochastic optimal control problems and associated Hamilton-Jacobi-Bellman equations.

This year, we worked on game theoretic approach for the carbon market price, in the framework of a cap&trade program. Based on the Nash equilibrium concept, we derive an equilibrium price equation for the allowances. The analysis of this equation and its wellposedness strongly depend on the design of the penalty function.

The final report [30] synthesizes of the results of all the work of this 2009-2012 ADEME Convention

8.1.3. Promotion of Mathematics in the industry

D. Talay is the Vice-President of the Fondation d'Entreprise Natixis which aims to contribute to develop research in quantitative finance. He also serves as a member of the Scientific Committee of the Foundation.

D. Talay is a member of the Scientific Committee of the AMIES National Agency aimed to promote interactions between Mathematics and Industry.

8.2. European Initiatives

8.2.1. FP7 Projects

- A. Lejay participates to the *Multifractality* (action Marie Curie International Research Staff Exchange Scheme FP7-PEOPLE-IRSES-2008) with Nancy, Kiev, Israël and Cardiff (2009–2012).

8.3. International Initiatives

8.3.1. Inria Associate Team: ANESTOC

Title: Stochastic modelling of renewable energies

Inria principal investigator: Denis Talay

International Partner (Institution - Laboratory - Researcher):

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

Duration: 2011 - 2013

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

This associate team complements a CIRIC research program in Chile. We refer to the TOSCA-ANESTOC project on stochastic modelling of renewable energies, especially wind farms, and oceanic resources. Our associate team ("équipe associée Inria") will conduct its joint research at two different levels. Firstly, the mathematical work on its own which we have called the "Mathematical Kernel" (MK), motivated by a number of fundamental problems raised by the specific applications in which we are interested. The second level of research concerns two main axes of Applications: (A1) Applications to Engineering (Renewable energies) and (A2) Applications to Neuroscience. The Mathematical Kernel includes a number of fields in the domains of Stochastic Analysis, Statistics and Numerical Analysis. In particular, it is worth mentioning the following: 1. Probabilistic resolution of Boussinesq non-linear partial differential equations; 2. Stochastic approach to Pope's equations on wind dynamics; 3. Open system dynamics as a bridge between Molecular Dynamics and Stochastic

Differential Equations; 4. Inference on Stochastic Processes; 5. Algorithms and simulation. The Applications include the stochastic modelling of renewable energy through ocean resources and wind farms (CIRIC-subproject). This subject will be developed with engineers of the Catholic University of Chile. In addition, applications to ion-channel dynamics through cell membranes will be considered jointly with biophysicists of the CINV (Neuroscience Centre of Valparaíso).

8.3.2. Inria International Partners

- TOSCA participates to the NCCR FINRISK (Financial Risk) forum launched by the Swiss National Science Foundation and managed by the University of Zürich.

8.3.3. Participation In International Programs

- D. Talay was the international coordinator of the MathAmsud program 08MATH05 - Stochastic Analysis and Mathematical Physics Research Network which started in 2009, also involved M. Bossy, A. Lejay and E. Tanré, and ended this year.
- M. Bossy, A. Lejay, D. Talay and E. Tanré are members of the CIRIC project *Stochastic Analysis of Renewable Energies: Ocean Energy and Wind Farms; dynamics and numerics* with Chile.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- L. Beznea (Simion Stoilow of the Institute of Mathematics of the Romanian Academy) has been visiting TOSCA Nancy for five weeks in April, November and December.
- Patricio Orio (Univ. of Valparaíso) visited TOSCA Sophia-Antipolis one week in October.
- The TOSCA *seminar* organized by J. Charrier and J. Inglis in Sophia Antipolis has received the following speakers: Rolando Rebolledo (Universidad de Chile), François Dufour (Université Bordeaux), Nicole El Karoui (Ecole Polytechnique, Palaiseau), Huyên Pham (Université Paris Diderot), Pierre Patie (Université Libre de Bruxelles), Pierre-Louis Lions (Collège de France), Nicolas Perrin (Inria Sophia Antipolis – Méditerranée), Philip Protter (Columbia University, USA), Mathieu Rosenbaum (CREST), Nicolas Bouleau (ENPC), Jean Jacod (Université Pierre et Marie Curie, Paris), Jonathan Mattingly (Duke University, USA), Patricio Orio (Universidad de Valparaíso, Chile), Carl Graham (Ecole Polytechnique, Palaiseau).

8.4.2. Internships

Souhail BOUKHEROUAA (from Mar 2012 until Aug 2012)

Subject: Evaluation of Value-at-Risk and applications to portfolio management

Institution: Université de Lorraine and Alphability

Yi LU (from May 2012 until July 2012)

Subject: Asymptotic expansions methods for options prices.

Institution: École Polytechnique

Rajarshi SARKHAR (from March 2012 until August 2012)

Subject: The First Passage Time Problem

Institution: University of Nice - Master Erasmus Mundus Mathmodes

Khaled SALHI (from Feb 2012 until Jun 2012)

Subject: Uncertainties and stochastic volatility models

Institution: Ecole Polytechnique de Tunisie (Tunisia)

8.4.3. Visits to International Teams

- M. Deaconu was invited one week by Fabio Nobile at the *Ecole Polytechnique Fédérale de Lausanne* in July.
- A. Lejay spend a month at the Bernoulli Center at Ecole Polytechnique Fédérale de Lausanne during the SPDE Semester.
- E. Tanré has visited University of Valparaíso and Pontifical University in Chile in January and March.