Activity Report 2012

Section Partnerships and Cooperations

<p style="text-align:center;color:red;">**LFANT Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Projet Idex CPU

The LFANT team takes part in Work package 6 of the Idex project CPU (Numerical certification and reliability). The work package concerns "Codes, Cryptology and Arithmetic Algorithms" and involves researchers from the Institut de Mathématiques de Bordeaux (Codes and Lattices team, LFANT) and Laboratoire Bordelais de Recherche en Informatique (Combinatorics and Algorithmic team).

8.2. National Initiatives

8.2.1. ANR AlgoL: Algorithmics of L-functions

Participants: Bill Allombert, Karim Belabas, Henri Cohen, Jean-Marc Couveignes, Andreas Enge.

http://www.math.u-bordeaux1.fr/~belabas/algol/index.html

The ALGOL project comprises research teams in Bordeaux, Montpellier, Lyon, Toulouse and Besançon.

It studies the so-called L-functions in number theory from an algorithmic and experimental point of view. L-functions encode delicate arithmetic information, and crucial arithmetic conjectures revolve around them: Riemann Hypotheses, Birch and Swinnerton-Dyer conjecture, Stark conjectures, Bloch-Kato conjectures, etc.

Most of current number theory conjectures originate from (usually mechanised) computations, and have been thoroughly checked numerically. L-functions and their special values are no exception, but available tools and actual computations become increasingly scarce as one goes further away from Dirichlet L-functions. We develop theoretical algorithms and practical tools to study and experiment with (suitable classes of) complex or p-adic L-functions, their coefficients, special or general values, and zeroes. For instance, it is not known whether K-theoretic invariants conjecturally attached to special values are computable in any reasonable complexity model. On the other hand, special values are often readily computed and sometimes provide, albeit conjecturally, the only concrete handle on said invariants.

New theoretical results are translated into new or more efficient functions in the PARI/GP system.

The project lasted from 15/11/2007 to 15/02/2012, for 51 months it received an ANR funding of 200k€ for a global cost of 1M€.

8.2.2. ANR Peace – Parameter spaces for Efficient Arithmetic and Curve security Evaluation

Participants: Bill Allombert, Karim Belabas, Jean-Marc Couveignes, Andreas Enge, Nicolas Mascot, Enea Milio, Aurel Page, Damien Robert.

http://chic2.gforge.inria.fr/

The PEACE project is joint between the research teams of Institut de Recherche en Mathématiques de Rennes (IRMAR), LFANT and Institut Mathématiques de Luminy (IML).

The project aims to constitute a comprehensive and coherent approach towards a better understanding of theoretical and algorithmic aspects of the discrete logarithm problem on algebraic curves of small genus. On the theorical side, this includes an effective description of moduli spaces of curves, of abelian varieties, the maps that link these spaces and the objects they classify. The effective manipulation of moduli objects will allow us to develop a better understanding of the algorithmic difficulty of the discrete logarithm problem on curves, which may have dramatic consequences on the security and efficiency of already deployed cryptographic devices.

One of the anticipated outcomes of this proposal is a new set of general criteria for selecting and validating cryptographically secure curves (or families of curves) suitable for use in cryptography. Instead of publishing fixed curves, as is done in most standards, we aim at proposing generating rationales along with explicit theoretical and algorithmic criteria for their validation.

8.2.3. *ANR Simpatic – SIM and PAiring Theory for Information and Communications security*

Participant: Damien Robert.

The SIMPATIC project is an industrial research project, formed by academic research teams and industrial partners: Orange Labs, École Normale Supérieure, INVIA, Oberthur Technologies, ST-Ericsson France, Université de Bordeaux 1, Université de Caen Basse-Normandie, University of Paris 8.

The aim of the SIMPATIC project is to provide the most possible efficient and secure hardware/software implementation of a bilinear pairing in a SIM card. This implementation will then be used to improve and develop new cryptographic efficient algorithms and protocols in the context of mobile phones and SIM cards. The project will more precisely focus on e-ticketing and e-cash, on cloud storage and on the security of contactless and of remote payment systems.

As a member, Damien Robert will aim to bridge the gap between the theoretical results described in the pairing module and the practical realisation of pairing-based SIM cards in an industrial setting.

8.3. European Initiatives

8.3.1. *FP7 Projects*

8.3.1.1. ANTICS

Title: Algorithmic Number Theory in Cryptology

Type: IDEAS

Instrument: ERC Starting Grant

Duration: January 2012 - December 2016

Coordinator: Inria (France)

Abstract: Data security and privacy protection are major challenges in the digital world. Cryptology contributes to solutions, and one of the goals of ANTICS is to develop the next generation public key cryptosystem, based on algebraic curves and abelian varieties. Challenges to be tackled are the complexity of computations, certification of the computed results and parallelisation, addressed by introducing more informatics into algorithmic number theory.

8.3.2. *Collaborations in European Programs, except FP7*

Program: Erasmus Mundus

Project acronym: ALGANT

Project title: ALgebra, Geometry and Number Theory

Duration: 09/2004–

Coordinator: University Bordeaux 1

Other partners: University Leiden (Netherlands), University Milano (Italy), University Padova (Italy), University Paris-Sud (France), Chennai Mathematical Institute (India), Concordia University (Canada), Stellenbosch University (South Africa)

Abstract: Joint master and doctoral programme; the PhD theses of Athanasios Angelakis and Julio Brau are co-supervised by P. Stevenhagen (Leiden) and K. Belabas

8.4. Research Visitors

- Atelier PARI/GP (23–27/01)

- – Charles Boyd (Amherst)
- – Pierre Castel (Caen)
- – Jeroen Demeyer (Ghent)
- – Tony Ezome (Franceville)
- – Vincent Fleckinger (Besançon)
- – Jean-Pierre Flori (Télécom Paristech)
- – Eduardo Friedman (Santiago de Chile)
- – Loic Grenié (Bergamo)
- – Bernadette Perrin-Riou (Orsay)
- – Firmin Varescon (Besançon)
- Damien Stehlé, Lyon (06–09/03)
- Bernadette Perrin-Riou, Orsay (24–27/01, 09–23/03)
- Vasily Golyshev, Bonn and Moscow (12/03)
- Marco Streng, Warwick (27–30/03)
- Gaëtan Bisson, Sydney (10–13/04)
- David Lubicz, Rennes (10–13/04, 03–07/09, 17–21/12)
- Bruno Salvy, Inria Paris (14/06)
- Workshop MPFR/MPC (25–27/06)
  - – Benjamin Dadoun (Nancy)
  - – Mickaël Gastineau (Paris)
  - – Vincent Lefèvre (Lyon)
  - – Patrick Pélissier (Toulouse)
  - – Philippe Théveny (Lyon)
  - – Paul Zimmermann (Nancy)
- Bernhard Schmidt, Singapore (02/07)
- Fernando Mario, Berlin (09/10)
- Luca De Feo, Versailles (30/10)

8.4.1. *Visits to International Teams*

J.-M. Couveignes: Tsinghua University, Beijing, 02/04–08/05

A. Enge: Tsinghua University, Beijing, 20/04–02/06

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 PEPII

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).

<h1 style="color:red; text-align:center">BACCHUS Team</h1>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Title: PETALH: Preconditioning scientific applications on pETascALe Heterogeneuous 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 fur 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 Nederlands), ONERA (France), TSAGI (Russia), ENSAM (France), Imperial College (UK), Universities of Bergamo (Italy), Varsaw (Poland), Poznan (Poland), Linköping (Sweden), UniversitĆatholique 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 trubulent 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

Politechnico 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: Politechnico de Milano (Italy)

Andrea Filipni (From october 2012 until April 2013)

> Subject:

> Institution: Politechnico 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.

<p style="text-align:center">**CAGIRE Team**</p>

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 litterature, 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 od Science, Technology and Medecine, Loughborough University.

Abstract: The environmental benefits of low emissions lean burn technology in reducing NOx emissions up to 80only be effective when these are deployed to a large range of new aero-engine applications. While integrating methodologies for advanced engine architectures and thermodynamic cycles. It will support European engine manufacturers to pick up and keep pace with the US competitors, being already able to exploit their new low emission combustion technology to various engine applications with short turn-around times. Key element of the project will be the development and validation of design methods for low emissions combustors to reduce NOx and CO emissions by an optimization of the combustor aero-design process. Preliminary combustor design tools will be coupled with advanced parametrisation and automation tools. Improved heat transfer and NOx models will increase the accuracy of the numerical prediction. The 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 50work 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 NOx combustors' will validate the combustor design. The consortium consists of all major aero-engine manufactures 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.

CONCHA Project-Team (section vide)

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 culturaux 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, Derccion Genral de Investigacion Cinetifica 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 $n < p$.

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, equipement 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 Sicence Element ESRIN/AO/1-6668/11/I-AM, fund: E/0029-01-L. Partners: IWR (University of Heidelberg, Germany), GEOSTAT (Inria, France) , KIT (Karlsruher Institu fur 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, Interdiscplinary 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 Ingineria, Rosaria, Argentina.

<p style="text-align:center;color:red;">**MC2 Project-Team**</p>

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 electropermeabilization by nanopulses at the subcellular level. The goal is to develop new electrical devices and accurate models to understand the electropermeabilization 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 electropermeabilization models from the cell scale to the tissue scale. This project focuses on quite long pulses (from micro- to milli-pulses) compared with the ANR consortium INTCELL that has begun in december 2010. The main goal is to provide multi-scale modelling of "classical" eletroporation, in order to obtain numerical tools that can help from one side the biologists to understand the electropermeabilization process when "non standard" pulses are applied, and from the other side it eventually aims at providing tools for the physicians to optimize the pulse delivering when the electrochemotherapy is used.

8.2.6. 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-oncoly and mathematics, University of Alabama at Birmingham. We work on numerical modeling of brain tumor.
- Collaborations with Luca Zannetti, Politecnico di Torino; Simone Camarri, Universita 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.

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 KARPYCHEV (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.

<div align="center">

CARMEN Team

</div>

6. Partnerships and Cooperations

6.1. Regional Initiatives

- Project *Modélisation pour les données multimodales* (2012-2015) funded by the *Conseil Regional Aquitaine*. Coordinator J.-F. Aujol (Pr University Bordeaux 1). The PhD of G. ravon is funded within this project: 3D reconstruction by inverse problem in cardiac optical mapping.

6.2. National Initiatives

6.2.1. IHU Liryc

Our work is partially funded by the Liryc project.

- For 2012-2015: 1/2 PhD thesis associated to the project *Modélisation pour les données multimodales* (see section Regional Initiaves).

6.3. European Initiatives

6.3.1. Collaborations with Major European Organizations

Partner 1: CNR, IMATI (Italie) – G. Manzini.

Finite volume discretization on general, distorted meshes, for second order operators with anisotropy and discontinuities. Applications to the simulation of ECG.

Partner 2: Computational Biology Group, University of Oxford. Department of Computer Science (United Kingdom).

Our work with the computational biology group concerns the development of multi-scale models of the drugs and their effect on the electrical activity of the heart. The main goal is to assess the drug-induced effects on the electrocardiogram, using a computational model describing the physiology from ion channel to body surface potentials.

6.4. International Initiatives

6.4.1. Inria International Partners

- Collaboration with the Pr. Y. Bourgault (http://aix1.uottawa.ca/~ybourg/personal.html) from the department of Mathematics and statistics of the University of Ottawa (Canada).
    - *Subject:* models and numerical methods for cardiac electrophysiology.
    - *Support:* for the last years the collaboration was supported by the ANR project Momme (ANR-JCJC-07-0141), the *Region des Pays de la Loire* and the Natural Sciences and Engineering of Research council of Canada
- Equipe Problèmes Inverses et Contrôle (EPIC), University Tunis Al Manar. Laboratoire de Modélisation Mathématique et Numérique dans les Sciences de l'Ingénieur (LAMSIN), Tunisia.
- The EPIC team has an important experience in dealing with ill-posed inverse problems for static and evolution problems. The goal of this collaboration is to apply the methods developed in this team to inverse problems in electrocardiography.

6.5. International Research Visitors

6.5.1. Visits of International Scientists

- Y. Bourgault, Pr. Univeristy of Ottawa, Department of mathematics and statistics. 22/10/2012 to 26/10/2012.

  Comparison between the monodomain and bidomain models for cardiac electrophysiology.

- Moncef Mahjoub, Teaching assistant at University of Tunis Al Manar (ENIT-LAMSIN), Tunisia. 01/10/2012 to 06/10/2012.

  Inverse problems.

- Fadhel Jeday. Teaching assistant at University of Sousse, Tunisia. 03/12/2012 to 07/12/2012.

  Inverse problems.

6.5.1.1. Internships

Nicolas Claude (from July 2012 until September 2012)

  Subject: Real-time simulation of ECGs based on the finite element Sofa library developed at Inria Lille.

  Institution: ENSEIRB-MATMECA, Bordeaux (Master 1 student).

Jamila Lassoued (from August 2012 until November 2012)

  Subject: application of model reduction techniques to the inverse problems in cardiac electrophysiology.

  Institution: Ecole Nationale d'Ingénieurs de Tunis (Tunisia – Master 2 student)

Sinda Ben Khalfalla (from 04/12/2012 to 21/12/2012)

  Subject: Inverse problems for the quasistatic inverse problem in electrocardiology.

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

Mohammed Addouche (from 08/12/2012 to 05/01/2013)

  Subject: On using factorisation methods for the quasistatic inverse problems of electrocardiology.

  Institution: University of Tlemcen (Algeria – PhD student)

<p style="text-align:center;color:red;font-weight:bold;">MAGIQUE-3D Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

The PhD fellowship of Elodie Estecahandy is partially (50%) financed by the Conseil Régional d'Aquitaine.

The PhD fellowship of Vanessa Mattesi is partially (50%) financed by the Conseil Régional d'Aquitaine.

The Post-Doctoral fellowship of Juliette Chabassier is partially (50%) financed by the Conseil Général des Pyrénées Atlantiques.

The Post-Doctoral fellowship of Ángel Rodríguez Rozas is partially (50%) financed by the Conseil Régional d'Aquitaine.

8.2. National Initiatives

8.2.1. Depth Imaging Partnership

Magique-3D maintains active collaborations with Total. In the context of depth imaging and with the collaboration of Henri Calandra from Total, Magique-3D coordinates research activities dealing with the development of high-performance numerical methods for solving wave equations in complex media. This project involves French academic researchers in mathematics, computing and in geophysics, and is funded by Total. Currently, two project-teams are involved: Hiepacs and Nachos.

In the framework of DIP, three PhD students are working in Magique 3D and two new PhD students have been hired this year. One of them is shared with the project team Nachos (http://www-sop.inria.fr/nachos/). Moreover, one internship has been realized. Always in the framework of DIP, Magique-3D has a collaboration with Prof. Changsoo Shin who is an expert of Geophysics and works at the Department of Energy resources engineering (College of Engineering, Seoul National University). Jewoo Yoo, who is a first year PhD student advised by Prof.Changsoo Shin, has visited Magique-3D during four months, from November 2011 to February 2012.

The contract ends in 2012 and a second period will start in 2013. We aggreed with Total hat the new contract will be signed for five years and that Magique 3D will strenghten its collaboration with Professor J. Tromp at Princeton on the topic of full wave inversion.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. HPC-GA

Title: High Performance Computing for Geophysics Applications

Type: PEOPLE

Instrument: International Research Staff Exchange Scheme (IRSES)

Duration: January 2012 - December 2014

Coordinator: Inria (France)

Others partners: BCAM (Basque Center of Applied Mathematics), Spain; BRGM (Bureau de Recherches Géologiques et Minières), France; ISTerre (Institut des Sciences de la Terre, France; UFRGS (Federal University of Rio Grande do Sul), Institute of Informatics, Brazil; UNAM (National Autonomous University of Mexico) , Institute of Geophysics, Mexico;

See also: https://project.inria.fr/HPC-GA/en

Abstract: Simulating large-scale geophysics phenomenon represents, more than ever, a major concern for our society. Recent seismic activity worldwide has shown how crucial it is to enhance our understanding of the impact of earthquakes. Numerical modeling of seismic 3D waves obviously requires highly specific research efforts in geophysics and applied mathematics, leveraging a mix of various schemes such as spectral elements, high-order finite differences or finite elements.

But designing and porting geophysics applications on top of nowadays supercomputers also requires a strong expertise in parallel programming and the use of appropriate runtime systems able to efficiently deal with heterogeneous architectures featuring many-core nodes typically equipped with GPU accelerators. The HPC-GA project aims at evaluating the functionalities provided by current runtime systems in order to point out their limitations. It also aims at designing new methods and mechanisms for an efficient scheduling of processes/threads and a clever data distribution on such platforms.

The HPC-GA project is unique in gathering an international, pluridisciplinary consortium of leading European and South American researchers featuring complementary expertise to face the challenge of designing high performance geophysics simulations for parallel architectures: UFRGS, Inria, BCAM and UNAM. Results of this project will be validated using data collected from real sensor networks. Results will be widely disseminated through high-quality publications, workshops and summer-schools.

8.3.2. Collaborations in European Programs, except FP7

Joint project with BCAM (Basque Center of Applied Mathematics) funded by the Conseil Régional d'Aquitaine and the Basque Government in the framework of the Aquitaine-Euskadi Call. Total Amount: 14 000 euros.

Program: Fonds commun de coopération Aquitaine/Euskadi

Project acronym: AKELARRE

Project title: Méthodes numériques innovantes et logiciels performants pour la simulation de la propagation des ondes électromagnétiques en milieux complexes

Duration: février 2011 - février 2013

Coordinator: Hélène Barucq

Other partners: BCAM (Basque Center of Applied Mathematics), Spain

Abstract: This project brings together the complementary skills in the field of wave propagation of two research teams which are respectively located in Pau and Bilbao. The main objective of this collaboration is to develop innovative numerical methods and to implement powerful software for the simulation of electromagnetic waves in complex media. These waves play an important role in many industrial applications and the development of such software is of great interest for many industrial enterprises located in the region. Theoretical and practical issues are considered. In particular, we focus on the mathematical analysis of boundary conditions that play a crucial role for accurate numerical simulations of waves.

Joint project with the Matheon Research Center in Berlin funded by the European Union in the framework of the Procope 2012 Call. Total Amount: 4200 euros.

Program: PHC Procope 2012

Project acronym: Procope Inria - TU Berlin

Project title: Procope Inria - TU Berlin

Duration: January 2012 - December 2014

Coordinator: Sébastien Tordeux

Other partners: Matheon Research Center, TU Berlin, Germany

Abstract: This project aims in funding trips between Pau and Berlin. The young research group of Kersten Schmidt and Magique 3D are both specialist of the modeling and the simulation of the wave propagation phenomena. During this program we focus on the modeling of multiperforate plates which are present in the combustion chambers; on the derivation of absorbing boundary conditions for stratified media and on the development of precise numerical methods in the context of the Hardy problem.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. MAGIC

Title: Advance Modeling in Geophysics

Inria principal investigator: Hélène Barucq

International Partner:

Institution: California State University at Northridge (United States)

Laboratory: Department of Mathematics

Duration: 2006 - 2012

See also: http://uppa-inria.univ-pau.fr/m3d/Equipe-associee/index.html

The main objective of this collaboration is the design of an efficient solution methodology for solving Helmholtz problems in heterogeneous domains, a key step for solving the inversion in complex tectonics. The proposed research program is based upon the following four pillars:

1. The design, implementation, and the performance assessment of a new hybrid mixed type method (HMM) for solving Helmholtz problems. 2. The construction of local nonreflecting boundary conditions to equip HMM when solving exterior high-frequency Helmholtz problems. 3. The design of an efficient numerical procedure for full-aperture reconstruction of the acoustic far-field pattern (FFP) when measured in a limited aperture. 4. The characterization of the Fréchet derivative of the elasto-acoustic scattered field with respect to the shape of a given elastic scatterer.

8.4.2. Participation In International Programs

8.4.2.1. GEO3D

Joint project with the Novosibirsk state University in Russia funded by the Poncelet laboratory in the framework of the Inria Russia Call. Total Amount: 8000 euros for 2012.

Program: Inria-Russia

Title: Models and numerical simulations in Geosciences: wave propagation in complex media

Inria principal investigator: Sébastien Tordeux

International Partner (Institution - Laboratory - Researcher):

Novosibirsk State University (Russia (Russian Federation)) - Institute of Numerical Mathematics and Mathematical Geophysics - Yuri Laevsky

Duration: January 2012 to December 2014

See also: http://uppa-inria.univ-pau.fr/m3d/ConfFR/participants.html

GEO3D is a collaborative project between Magique 3D team-project (Inria Bordeaux Sud-Ouest) and the Institute of Numerical Mathematics and Mathematical Geophysics (Novosibirsk State University) in the context of geosciences. We are mainly interested to the derivation of numerical methods (discontinuous Galerkin approximation, space-time refinement), to the design of direct and inverse high performance solver, and to the modeling of complex media.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Jewoo Yoo, Ph.D Student at Seoul University spent five months MAGIQUE-3D from December 2011 to April 2012.

- Rabia Djellouli spent one week in MAGIQUE-3D in November 2012.

- Patrick Dular (Université de Liège) is visiting MAGIQUE-3D from December 2012 to February 2013.

<div align="center" style="color:red">**MAGNOME Project-Team**</div>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Aquitaine Region "SAGÉSS" comparative genomics for wine starters*
Participants: David James Sherman [correspondant], Elisabeth Bon, Pascal Durrens, Aurélie Goulielmakis, Nicolás Loira, Tiphaine Martin.

This project is a collaboration between the company SARCO, specialized in the selection of industrial yeasts with distinct technological abilities, with the ISVV and MAGNOME. The goal is to use genome analysis to identify molecular markers responsible for different physiological capabilities, as a tool for selecting yeasts and bacteria for wine fermentation through efficient hybridization and selection strategies. This collaboration has obtained the INNOVIN label.

8.2. National Initiatives

8.2.1. *ANR MYKIMUN*
Participants: Pascal Durrens [correspondant], Witold Dyrka, David James Sherman.

Signal Transduction Associated with Numerous Domains (STAND) proteins play a central role in vegetative incompatibility (VI) in fungi. STAND proteins act as molecular switches, changing from closed inactive conformation to open active conformation upon binding of the proper ligand. Mykimun, coordinated by Mathieu Paoletti of the IBGC (Bordeaux), studies the postulated involvement of STAND proteins in heterospecific non self recognition (innate immune response). MAGNOMEdevelops machine learning techniques for classifying and identifying STAND proteins in fungal genomes, as well as statistical analysis of their genomic neighborhoods.

8.2.2. *ANR DIVOENI, 2008-2012*
Participants: Elisabeth Bon [correspondant], Aurélie Goulielmakis.

LaBRI, through Elisabeth Bon, is a partner in DIVOENI, a four-year ANR project concerning intraspecies biodiversity of the oenological bacteria *Oenococcus oeni*. Coordinated by Prof. Aline Lonvaud (Univ. Bordeaux Segalen) from the Institute of Vine and Wine Sciences of Bordeaux – Aquitaine, this scientific programme was developed:

1. To evaluate the genetic diversity of a vast collection of strains, to set up phylogenetic groups, then to investigate relationships between the ecological niches (cider, wine, champagne) and the essential phenotypical traits. Hypotheses on the evolution in the species and on the genetic stability of strains will be drawn.
2. To propose methods based on molecular markers to make a better use of the diversity of the species.
3. To measure the impact of the repeated use of selected strains on the diversity in the ecosystem and to draw the conclusions for its preservation.

Elisabeth is in charge of the computational infrastructure dedicated to genomics and post-genomics data storage, handling and analysis. She coordinates collaboration with the CBiB-Centre de Bioinformatique de Bordeaux (Aurélien Barré).

8.3. European Initiatives

8.3.1. *FP7 Projects*

8.3.1.1. *Affinity Proteomics*
Participants: David James Sherman [correspondant], Natalia Golenetskaya.

A major objective of the "post-genome" era is to detect, quantify and characterise all relevant human proteins in tissues and fluids in health and disease. This effort requires a comprehensive, characterised and standardised collection of specific ligand binding reagents, including antibodies, the most widely used such reagents, as well as novel protein scaffolds and nucleic acid aptamers. Currently there is no pan-European platform to coordinate systematic development, resource management and quality control for these important reagents.

MAGNOME is an associate partner of the FP7 "Affinity Proteome" project coordinated by Prof. Mike Taussig of the Babraham Institute and Cambridge University. Within the consortium, we participate in defining community for data representation and exchange, and evaluate knowledge engineering tools for affinity proteomics data.

8.3.2. Collaborations with Major European Organizations

Prof. Mike Taussig: Babraham Institute & Cambridge University

Knowledge engineering for Affinity Proteomics

Henning Hermjakob: European Bioinformatics Institute

Standards and databases for molecular interactions

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. CARNAGE

Program: Inria-Russia

Title: CARNAGE: Combinatorics of Assembly and RNA in GEnomes

Inria principal investigator: Mireille Régnier

International Partner (Institution - Laboratory - Researcher):

State Research Institute of Genetics and Selection of Industrial Microorganisms (Russia (Russian Federation)) - Bioinformatics laboratory - Vsevolod Makeev

Duration: 2012–13

See also: http://en.inria.fr/domaines-epi/computational-sciences-for-biology-medicine-and-the-environment

CARNAGE addresses two main issues on genomic sequences, by combinatorial methods.

Fast development of high throughput technologies has generated a new challenge for computational biology. The recently appeared competing technologies each promise dramatic breakthroughs in both biology and medicine. At the same time the main bottlenecks in applications are the computational analysis of experimental data. The sheer amount of this data as well as the throughput of the experimental dataflow represent a serious challenge to hardware and especially software. We aim at bridging some gaps between the new "next generation" sequencing technologies, and the current state of the art in computational techniques for whole genome comparison. Our focus is on combinatorial analysis for NGS data assembly, interspecies chromosomal comparison, and definition of standard pipelines for routine large scale comparison.

This project also addresses combinatorics of RNA and the prediction of RNA structures, with their possible interactions.

8.4.2. Participation In International Programs

8.4.2.1. Génolevures and Dikaryome Consortia
Participants: David James Sherman [correspondant], Pascal Durrens, Florian Lajus, Tiphaine Martin, Anna Zhukova.

Since 2000 our team is a member of the Génolevures Consortium (GDR CNRS), a large-scale comparative genomics project that aims to address fundamental questions of molecular evolution through the sequencing and the comparison of 14 species of hemiascomycetous yeasts. The Consortium is comprised of 16 partners, in France, Belgium, Spain, the Netherlands (see http://genolevures.org/). Within the Consortium, our team is responsible for bioinformatics, for research in new methods of analysis. Pascal Durrens and Tiphaine Martin of the CNRS are responsible for the development of resources for exploiting comparative genomic data. Pascal Durrens is the editorial manager of the Génolevures on-line resource.

The Dikaryome Consortium is a scientific collaboration between several international partners and the National Center for Sequencing (CEA–Génoscope, Évry) on the sequencing, annotation, and comparative analysis of fungal genomes.

These perennial collaborations continue in two ways. First, a number of new projects are underway, concerning several new genomes currently being sequenced, and new questions about the mechanisms of gene formation. Second, through the development and improvement of the Génolevures On Line database, in whose maintenance our team has a longstanding committment and the improvement of tools like the YAGA software.

8.5. International Research Visitors

8.5.1. *Visits of International Scientists*

Rodrigo Assar Cuevas was invited for a month in Fall 2012 to work with David James Sherman on Quantized State Systems applied to BioRica hierarchical models.

8.5.2. *Visits to International Teams*

Anna Zhukova was invited to the Babraham Institute (Babraham, UK) for two week in December, 2012 to work on knowledge engineering for biological networks and visualization.

Pascal Durrens and David James Sherman are invited to the Vavilov Institute for General Genetics in Moscow in December, 2012 to work on regulon identification and analysis in hemisascomycete yeasts.

<p style="text-align:center; color:red;">**MNEMOSYNE Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ANR project KEOPS
Participants: Frédéric Alexandre, Thierry Viéville.

We are implicated in this «ANR Internal White Project» involving NEUROMATHCOMP and CORTEX Inria EPI in France with the U. of Valparaiso, U. Tecnica Frederico Santa-Maria, and U. Chile. The project addresses the integration of non-standard behaviors from retinal neural sensors, dynamically rich, sparse and robust observed in natural conditions, into neural coding models and their translation into real, highly non-linear, bio-engineering artificial solutions. An interdisciplinary platform for translation from neuroscience into bioengineering will seek convergence from experimental and analytical models, with a fine articulation between biologically inspired computation and nervous systems neural signal processing (coding / decoding) [9], [10].

7.2. International Initiatives

7.2.1. Inria Associate Teams

7.2.1.1. Cortina, associate team with Chile
Participants: Frédéric Alexandre, Thierry Viéville.

The goal of this associate team initiated within the Cortex team is to combine our complementary expertise, from experimental biology and mathematical models (U de Valparaiso and U Federico Santa-Maria) to computational neuroscience (CORTEX/MNEMOSYNE and NEUROMATHCOMP), in order to develop common tools for the analysis and formalization of neural coding and related sensory-motor loops. Recording and modeling spike trains from the retina neural network, an accessible part of the brain, is a difficult task that our partnership can address, what constitute an excellent and unique opportunity to work together sharing our experience and to focus in developing computational tools for methodological innovations.

CEPAGE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

+ **CRA Region** (participants: CEPAGE). This project, entitled "Services for large-scale distributed platforms", is an effort for the designing efficient algorithms for clustering and discovering resources in large scale distributed networks. This project provided the funding for the PhD thesis of Hubert Larcheveque.

+ **CRA Region** (participants: CEPAGE, RUNTIME (Bordeaux)). This project, entitled "Performance modeling for heterogeneous platforms", is an effort for the modeling of the behavior of applications on two different types of platforms: multicore architectures within the RUNTIME team, and large scale platforms within CEPAGE. This project provides the funding for the PhD thesis of Przemyslaw Uznanski.

7.2. National Initiatives

- **ANR ALADDIN** (Algorithm Design and Analysis for Implicitly and Incompletely Defined Interaction Networks; GANG and CEPAGE project-teams): the members of Cepage have been participating to the ANR project "blanc" (i.e. fundamental research) about the fundamental aspects of large interaction networks enabling massive distributed storage, efficient decentralized information retrieval, quick inter-user exchanges, and/or rapid information dissemination. The project is mostly oriented towards the design and analysis of algorithms for these (logical) networks, by taking into account proper ties inherent to the underlying infrastructures upon which they are built. The infrastructures and/or overlays considered in this project are selected from different contexts, including communication networks (from Internet to sensor networks), and societal networks (from the Web to P2P networks).

- **ANR USS-SIMGRID** (Ultra Scalable Simulations with SimGrid; participants: AlGorille (LORIA, Nancy), ASAP (Saclay), CEPAGE, Univ. of Hawai'i, GRAAL (LIP, ENS Lyon), MESCAL (Grenoble), MASCOTTE (Sophia Antipolis)). The members of CEPAGE were part of this project (2008-2011), whose goal was to extend the SimGrid simulation framework, originally developed for HPC, to provide a reasonable and quantifiable level of accuracy for the simulation of large scale application. This allowed to attend both the rising need for scalability of the HPC community and the need for simulation accuracy of the distributed computing community. SimGrid was extended to provide a family of models which offer different levels of accuracy at different simulation scales.

- **ANR SONGS** (Simulation of Next Generation Systems; participants: AlGorille (LORIA, Nancy), MESCAL (Grenoble), GRAAL (ENS Lyon), IN2P3 (Lyon), CEPAGE, HiePACS, RUNTIME (Bordeaux), LSIIT (Strasbourg), ASCOLA (Nantes), MASCOTTE, MODALIS (Sophia Antipolis)). This project started in 2012 as a follow-up of the USS-SIMGRID project. The aim is to further extend the domain of SimGrid, by designing a unified simulation framework for the four application domains: Grids, Peer-to-Peer systems, High Performance Computing, and Cloud systems. Achieving this goal mandates careful representation and modeling of the underlying concepts presented by each domain (memory, disks, energy, network and volatility) and of the interfaces specific to each domain. It also requires a transversal work on the simulation framework itself. CEPAGE is actively involved in this project, both for the peer-to-peer use cases and for the coordination of the modeling effort of the project.

- **ANR Displexity** (Calcul DIStribué: calculabilité et comPLEXITé; participants: CEPAGE, GANG and ASAP projects). The main goal of DISPLEXITY is to establish the scientific foundations of a theory of calculability and complexity for distributed computing. Displexity started in 2012.

- **ANR IDEA** ANR program "defis": project IDEA (2009-2012). The goal of this ANR is the study of identifying codes in evolving graphs. Ralf Klasing is the overall leader of the project.
- **ANR "Jeunes chercheurs" EGOS - Embedded Graphs and their Oriented Structures** (2012-2014) (see http://www.lirmm.fr/egos/)

  Participants: CEPAGE/LaBRI(Bordeaux) LIRMM(Montpellier), LIX(Palaiseau) The goal of this project is the study oriented structures on graphs of arbitrary genus.
- **AMADEUS** (CNRS funding on "BIG DATA": 2012-): Analysis of MAssive Data in Earth and Universe Sciences. This a multidisciplinary research project between computer science teams (LIRMM: University of Montpellier, LIF: University of Marseille) and CEPAGE), earth and climate science (CEREGE: Montpellier and IRD: Aix) and astronomy (LAM: University of Marseille). The aim of the project is to propose effective techniques for mining large data by essentially using distributed computing, visualization, summarization and approximation.

7.3. European Initiatives

7.3.1. EULER

Title: EULER (Experimental UpdateLess Evolutive Routing)

Type: COOPERATION (ICT)

Defi: Future Internet Experimental Facility and Experimentally-driven Research

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2010 - September 2013

Coordinator: ALCATEL-LUCENT (Belgium)

Others partners:
Alcatel-Lucent Bell, Antwerpen, Belgium
3 projects from Inria: CEPAGE, GANG and MASCOTTE, France
Interdisciplinary Institute for Broadband Technology (IBBT),Belgium
Laboratoire d'Informatique de Paris 6 (LIP6), Université Pierre Marie Curie (UPMC), France
Department of Mathematical Engineering (INMA) Université Catholique de Louvain, Belgium
RACTI, Research Academic Computer Technology Institute University of Patras, Greece
CAT, Catalan Consortium: Universitat Politecnica de Catalunya, Barcelona and University of Girona, Spain

See also: http://www-sop.inria.fr/mascotte/EULER/wiki/

Abstract: The title of this study is "Dynamic Compact Routing Scheme". The aim of this projet is to develop new routing schemes achieving better performances than current BGP protocols. The problems faced by the inter-domain routing protocol of the Internet are numerous:

The underlying network is dynamic: many observations of bad configurations show the instability of BGP;

BGP does not scale well: the convergence time toward a legal configuration is too long, the size of routing tables is proportional to the number of nodes of network (the network size is multiplied by 1.25 each year);

The impact of the policies is so important that the many packets can oscillated between two Autonomous Systems.

In this collaboration, we mainly focus on the scalability properties that a new routing protocol should guarantee. The main measures are the size of the local routing tables, and the time (or message complexity) to update or to generate such tables. The design of schemes achieving sub-linear space per routers, say in n where n is the number of AS routers, is the main challenge. The target networks are AS-network like with more than 100,000 nodes. This projet, in collaboration with the MASCOTE Inria-project in Nice Sophia-Antipolis, makes the use of simulation, developed at both sites.

7.3.2. Collaborations in European Programs, except FP7

Program: European COST

Project acronym: Complex HPC IC0805.

Project title: Open Network for High-Performance Computing on Complex Environments

Duration: 2010-2013

Coordinator: Inria

Other partners: 26 countries, see list at http://www.cost.eu/domains_actions/ict/Actions/IC0805?parties

Abstract: The main objective of this COST action is to coordinate European groups working on the use of heterogeneous and hierarchical systems for HPC as well as the development of collaborative activities among the involved research groups (http://complexhpc.org/index.php).

7.4. International Initiatives

7.4.1. Participation In International Programs

- **Royal Society Grant with the University of Liverpool.** International Joint Project, 2011-2013, entitled "SEarch, RENdezvous and Explore (SERENE)", on foundations of mobile agent computing, in collaboration with the Department of Computer Science, University of Liverpool. Funded by the Royal Society, U.K. Principal investigator on the UK side: Leszek Gasieniec. Ralf Klasing is the principal investigator on the French side.

  Participants: Nicolas Hanusse, David Ilcinkas, Ralf Klasing, Adrian Kosowski.

- **Spanish program CLOUDS**: Cloud Computing for Scalable, Reliable and Ubiquitous Services (http://lsd.ls.fi.upm.es/clouds). This is a large scale program which aims at advancing research in the area of Cloud Computing. CEPAGE is more particularly in contact with the LaDyr team of Univ. Rey Juan Carlos in Madrid, on the topic of resource allocation problems for Cloud providers.

  Participants: Olivier Beaumont, Lionel Eyraud-Dubois.

- **Collaboration with Canada.**

  Members of CEPAGE have a long-standing collaboration with researchers from the Chair of Distributed Computing at the University of Quebec in Outaouais and the Department of Computer Science at Carleton University. Sources of financing include: personal NSERC grants of Canadian professors (Prof. Andrzej Pelc, Prof. Jurek Czyzowicz, Prof. Evangelos Kranakis), funding from other Canadian grant agencies (a travel grant from Mitacs Inc.), and University of Bordeaux funding (a 3-month invited professorship for Prof. Jurek Czyzowicz).

  Participants: David Ilcinkas, Ralf Klasing, Adrian Kosowski.

- **Collaboration with Chile.**

  Adrian Kosowski is a foreign partner of the Chilean ministry grant (ANILLO CONICYT programme) entitled "Mathematical modeling for industrial and management science applications: a multidisciplinary approach". The Project Director is Eric Goles from Universidad Adolfo Ibañez, and collaborating researchers on the Chilean side include Karol Suchan and Ivan Rappaport. The collaboration has led to 2 joint papers.

  Participants: Adrian Kosowski.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

7.5.1.1. Visits to Cepage Members

- Ljubomir Perkovic, De Paul University Chicago, (September 2011 – June 2012)

- Prosenjit Bose, Carleton University Ottawa, (25/11/12 – 29/11/12)

- George Mertzios, Durham University, UK, (15/06/12 – 14/07/12)

- Leszek Gasieniec, University of Liverpool, UK, (08/06 – 22/06/12)

- Jurek Czyzowicz, Université du Québec, Canada, (08/06 – 22/06/12)

- Darek Dareniowski, Gdansk University of Technology, Poland, (08/06 – 28/06/2012)

- Miroslaw Korzeniowski, Technical University of Wroclaw, (March 2012 – September 2012)

7.5.1.2. Visits of Cepage Members

- Cyril Gavoille, MicroSoft Research, Mountainview, CA, two weeks in April 2012.

<p align="center" style="color:red">HIEPACS Project-Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. OPTIDIS: OPTImisation d'un code de dynamique des DISlocations

Participants: Olivier Coulaud, Aurélien Esnard, Luc Giraud, Jean Roman.

Grant: ANR-COSINUS
Dates: 2010 – 2014
Partners: CEA/DEN/DMN/SRMA (leader), SIMaP Grenoble INP and ICMPE / Paris-Est.
Overview: Plastic deformation is mainly accommodated by dislocations glide in the case of crystalline materials. The behaviour of a single dislocation segment is perfectly understood since 1960 and analytical formulations are available in the literature. However, to understand the behaviour of a large population of dislocations (inducing complex dislocations interactions) and its effect on plastic deformation, massive numerical computation is necessary. Since 1990, simulation codes have been developed by French researchers. Among these codes, the code TRIDIS developed by the SIMAP laboratory in Grenoble is the pioneer dynamic dislocation code. In 2007, the project called NUMODIS had been set up as team collaboration between the SIMAP and the SRMA CEA Saclay in order to develop a new dynamics dislocation code using modern computer architecture and advanced numerical methods. The objective was to overcome the numerical and physical limits of the previous code TRIDIS. The version NUMODIS 1.0 came out in December 2009, which confirms the feasibility of the project. The project OPTIDIS is initiated when the code NUMODIS is mature enough to consider parallel computation. The objective of the project in to develop and validate the algorithms in order to optimise the numerical and performance efficiencies of the NUMODIS code. We are aiming at developing a code able to tackle realistic material problems such as the interaction between dislocations and irradiation defects in a grain plastical deformation after irradiation. These kinds of studies where "local mechanisms" are correlated with macroscopic behaviour is a key issue for nuclear industry in order to understand material ageing under irradiation, and hence predict power plant secured service life. To carry out such studies, massive numerical optimisations of NUMODIS are required. They involve complex algorithms lying on advanced computational science methods. The project OPTIDIS will develop through joint collaborative studies involving researchers specialized in dynamics dislocations and in numerical methods. This project is divided in 8 tasks over 4 years. Two PhD thesis will be directly funded by the project. One will be dedicated to numerical development, validation of complex algorithms and comparison with the performance of existing dynamics dislocation codes. The objective of the second is to carry out large scale simulations to validate the performance of the numerical developments made in OPTIDIS. In both cases, these simulations will be compared with experimental data obtained by experimentalists.

8.1.1.2. RESCUE: RÉsilience des applications SCientifiqUEs

Participants: Emmanuel Agullo, Luc Giraud, Abdou Guermouche, Jean Roman, Mawussi Zounon.

Grant: ANR-Blanc (computer science theme)
Dates: 2010 – 2014
Partners: Inria EPI GRAAL (leader) and GRAND LARGE.
Overview: The advent of exascale machines will help solve new scientific challenges only if the resilience of large scientific applications deployed on these machines can be guaranteed. With 10,000,000 core processors, or more, the time interval between two consecutive failures is anticipated to be smaller than the typical duration of a checkpoint, i.e., the time needed to save all necessary application and system data. No actual progress can then be expected for a large-scale parallel application. Current fault-tolerant techniques and tools can no longer be used. The main objective of the RESCUE project is to develop new algorithmic techniques and software tools to solve the exascale resilience problem. Solving this problem implies a departure from current approaches, and calls for yet-to-be-discovered algorithms, protocols and software tools.

This proposed research follows three main research thrusts. The first thrust deals with novel checkpoint protocols. This thrust will include the classification of relevant fault categories and the development of a software package for fault injection into application execution at runtime. The main research activity will be the design and development of scalable and light-weight checkpoint and migration protocols, with on-the-fly storing of key data, distributed but coordinated decisions, etc. These protocols will be validated via a prototype implementation integrated with the public-domain MPICH project. The second thrust entails the development of novel execution models, i.e., accurate stochastic models to predict (and, in turn, optimize) the expected performance (execution time or throughput) of large-scale parallel scientific applications. In the third thrust, we will develop novel parallel algorithms for scientific numerical kernels. We will profile a representative set of key large-scale applications to assess their resilience characteristics (e.g., identify specific patterns to reduce checkpoint overhead). We will also analyze execution trade-offs based on the replication of crucial kernels and on decentralized ABFT (Algorithm-Based Fault Tolerant) techniques. Finally, we will develop new numerical methods and robust algorithms that still converge in the presence of multiple failures. These algorithms will be implemented as part of a software prototype, which will be evaluated when confronted with realistic faults generated via our fault injection techniques.

We firmly believe that only the combination of these three thrusts (new checkpoint protocols, new execution models, and new parallel algorithms) can solve the exascale resilience problem. We hope to contribute to the solution of this critical problem by providing the community with new protocols, models and algorithms, as well as with a set of freely available public-domain software prototypes.

8.1.1.3. BOOST: Building the future Of numerical methOdS for iTer

Participants: Emmanuel Agullo, Luc Giraud, Abdou Guermouche, Jean Roman, Xavier Vasseur.

Grant: ANR-Blanc (applied math theme)
Dates: 2010 – 2014
Partners: Institut de Mathématiques de Toulouse (coordinator); Laboratoire d'Analyse, Topologie, Probabilités in Marseilles; Institut de Recherche sur la Fusion Magnétique, CEAr/IRFM and Inria-HiePaCS
Overview: This project regards the study and the development of a new class of numerical methods to simulate natural or laboratory plasmas and in particular magnetic fusion processes. In this context, we aim in giving a contribution, from the mathematical, physical and algorithmic point of view, to the ITER project.

The core of this project consists in the development, the analysis, the implementation and the testing on real physical problems of the so-called Asymptotic-Preserving methods which allow simulations over a large range of scales with the same model and numerical method. These methods represent a breakthrough with respect to the state-of-the art. They will be developed specifically to handle the various challenges related to the simulation of the ITER plasma. In parallel with this class of methodologies, we intend to design appropriate coupling techniques between macroscopic and microscopic models for all the cases in which a net distinction between different regimes can be done. This will permit to describe different regimes in different regions of the machine with a strong gain in term of computational efficiency, without losing accuracy in the description of the problem. We will develop full 3-D solver for the asymptotic preserving fluid as well as kinetic model. The Asymptotic-Preserving (AP) numerical strategy allows us to perform numerical simulations with very large time and mesh steps and leads to impressive computational saving. These advantages will be combined with the utilization of the last generation preconditioned fast linear solvers to produce a software with very high performance for plasma simulation. For `HiePACS` this project provides in particular a testbed for our expertise in parallel solution of large linear systems.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. MYPLANET

Title: MYPLANET
Type: PEOPLE ()

Instrument: Initial Training Network (ITN)

Duration: October 2008 - September 2012

Coordinator: CERFACS (France)

Others partners: Allinea software, Alstom Power Switzerland, Czestochowa University of Technology, Genias Graphics, Rolls Royce PLC UK, Technical Univ. Munich, Turbomeca, University of Cambridge, University Carlos III Madrid and University of Cyprus.

See also: http://www.cerfacs.fr/myplanet/

Abstract: The present MYPLANET project responds to the first FP7-call "PEOPLE-INITIAL-TRAINING-ITN-2007-1" published by the European Commission. This collaborative initial training network represents a European initiative to train a new generation of engineers in the field of high performance computing applied to the numerical combustion simulation, energy conversion processes and related atmospheric pollution issues. Indeed, the project is based on the recognised lack on the European level of highly skilled engineers who are equally well-trained in both combustion technologies and high-performance computing (HPC) techniques. Thus the MYPLANET project will clearly contribute to the structuring of existing high-quality initial research training capacities in fluid mechanics and the HPC field through combining both public and private (industrial) sectors. The participation of industrial partners in the training of the researchers will directly expose these industries to high performance computing, which will have a very favourable impact on the quality and efficiency of their activities. Reciprocally, the research community will learn more about the mid and long term industrial challenges which will enable the research partners to initiate new activities in order to anticipate and address these industrial requirements.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra

Inria principal investigator: Olivier Coulaud

International Partners (Institution - Laboratory - Researcher):

> Stanford University (United States) - Institute for Computational and Mathematical Engineering - Eric Darve

> Lawrence Berkeley National Laboratory (United States) - Scientific Computing Group - Esmond Ng

Duration: 2012 - 2014

See also: http://people.bordeaux.inria.fr/coulaud/projets/FastLA_Website/index.html.

In this project, we propose to study fast and scalable hierarchical numerical kernels and their implementations on heterogeneous manycore platforms for two major computational kernels in intensive challenging applications. Namely, fast multipole methods (FMM) and sparse hybrid linear solvers, that appear in many intensive numerical simulations in computational sciences. Regarding the FMM we plan to study novel generic formulations based on H-matrices techniques, that will be eventually validated in the field of material physics: the dislocation dynamics. For the hybrid solvers, new parallel preconditioning approaches will be designed and the use of H-matrices techniques will be first investigated in the framework of fast and monitored approximations on central components. Finally, the innovative algorithmic design will be essentially focused on heterogeneous manycore platforms. The partners, Inria HiePACS, Lawrence Berkeley Nat. Lab and Stanford University, have strong, complementary and recognized experiences and backgrounds in these fields.

8.3.1.2. MORSE

Title: Matrices Over Runtime Systems at Exascale

Inria principal investigator: Emmanuel Agullo

International Partner:

> Institution: University of Tennessee Knoxville (United States)
>
> Laboratory: Innovative Computing Lab
>
> Researcher: George Bosilca

International Partner:

> Institution: University of Colorado Denver (United States)
>
> Laboratory: Department of Mathematics and Statistical Sciences
>
> Researcher: Julien Langou

Duration: 2011 - 2013

See also: http://www.inria.fr/en/teams/morse.

The goal of Matrices Over Runtime Systems at Exascale (MORSE) project is to design dense and sparse linear algebra methods that achieve the fastest possible time to an accurate solution on large-scale multicore systems with GPU accelerators, using all the processing power that future high end systems can make available. To develop software that will perform well on petascale and exascale systems with thousands of nodes and millions of cores, several daunting challenges have to be overcome, both by the numerical linear algebra and the runtime system communities. By designing a research framework for describing linear algebra algorithms at a high level of abstraction, the MORSE team will enable the strong collaboration between research groups in linear algebra and runtime systems needed to develop methods and libraries that fully benefit from the potential of future large-scale machines. Our project will take a pioneering step in the effort to bridge the immense software gap that has opened up in front of the High-Performance Computing (HPC) community.

8.3.2. Participation In International Programs

8.3.2.1. ECS : Enabling Climate Simulation at extreme scale

Participants: Emmanuel Agullo, Luc Giraud, Abdou Guermouche, Jean Roman, Mawussi Zounon.

Grant: G8
Dates: 2011 – 2014
Partners: Univ. Illinois at Urbanna Champaign, Inria, Univ. Tennessee at Knoxville, German Research School for Simulation Sciences, Univ. Victoria, Titech, Univ. Tsukuba, NCAR, Barcelona Supercomputing Center.
Overview: Exascale systems will allow unprecedented reduction of the uncertainties in climate change predictions via ultra-high resolution models, fewer simplifying assumptions, large climate ensembles and simulation at a scale needed to predict local effects. This is essential given the cost and consequences of inaction or wrong actions about climate change. To achieve this, we need careful co-design of future exascale systems and climate codes, to handle lower reliability, increased heterogeneity, and increased importance of locality. Our effort will initiate an international collaboration of climate and computer scientists that will identify the main roadblocks and analyze and test initial solutions for the execution of climate codes at extreme scale. This work will provide guidance to the future evolution of climate codes. We will pursue research projects to handle known roadblocks on resilience, scalability, and use of accelerators and organize international, interdisciplinary workshops to gather and disseminate information. The global nature of the climate challenge and the magnitude of the task strongly favor an international collaboration. The consortium gathers senior and early career researchers from USA, France, Germany, Spain, Japan and Canada and involves teams working on four major climate codes (CESM1, EC-EARTH, ECSM, NICAM).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

The following researchers have visited `HiePACS` in 2012

- George Bosilca, University of Tennessee at Knoxville visited from June 15 to December 31st.
- Yousef Saad, University of Minnesota from June 4 to June 15th.

8.4.1.1. Internships

Both Vincent Cohen and Homar Zenati share their internship time between Inria and UTK in the framework of the MORSE associate team. Pierre Ramet (BACCHUS team) contributed to the advisory of Homar Zenati's work.

PHOENIX Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Assistive Technologies for Elderly

The objective of this project is to provide an open platform of digital assistance dedicated to aging in place. This project is in collaboration with researchers in Cognitive Science (Bordeaux University) and the UDCCAS Gironde (Union Départementale des Centres Communaux d'Action Sociale) managing elderly care. This project will include a need analysis, the development of new assistive applications and their experimental validation.

This work is funded by CARSAT Aquitaine ("Caisse d'Assurance Retraite et de la Santé au Travail").

8.1.2. Cognitive Assistance for Supporting the Autonomy of Persons with Intellectual Disabilities

The objective of this project is to develop assistive technologies enabling people with intellectual disabilities to gain independence and to develop self-determined behaviors, such as making choices and taking decisions. This project is in collaboration with the "Handicap et Système Nerveux" reserach group (EA 4136, Bordeaux University), the TSA Chair of UQTR (Université du Québec à Trois-Rivières) in Psychology and the Association Trisomie 21 Gironde (Down's Syndrom). The TSA chair has recently designed and built a smart apartment that is used to conduct experimental evaluation of our assistive technologies in realistic conditions.

8.1.3. Certification of an open platform

The purpose of this project is to define concepts and tools for developing certifying open platforms. This certification process must ensure a set of critical properties (*e.g.,* safety, confidentiality, security) by certifying each tier application. These guarantees are essential to ensure that openness does not come at the expense of the user's well-being. To preserve the innovation model of open platforms, this certification process should also be as automatic as possible. Indeed, the success of open platforms is mainly due to the low development cost of a new application. The case study of this thesis will be the domain of home automation. The results of this thesis will be put into practice in the DiaSuiteBox open platform.

This project is funded by the Aquitaine region.

8.2. National Initiatives

8.2.1. Objects' World: design-driven development of large-scale smart spaces

The goal of this project is to develop an innovative communication technology, allowing the emergence of a new economic sector for large-scale smart spaces. Our objective is to propose concepts and tools for developing reliable applications orchestrating large-scale smart spaces of networked entities. The industrial partners of the Objects' World project will provide us with real-size case studies in various application domains (e.g., smart cities, tracking of vehicles, healthcare, energy management).

This work is funded by the OSEO national agency.

8.2.2. SERUS: Software Engineering for Resilient Ubiquitous Systems

The objectives of this project is to propose a design-driven development methodology for resilient systems that takes into account dependability concerns in the early stages, ensures the traceability of these requirements throughout the system life-cycle, even during runtime evolution. To provide a high level of support, this methodology will rely on a design paradigm dedicated to sense/compute/control applications. This design will be enriched with dependability requirements and used to provide support throughout the system life-cycle. This project is in collaboration with the TSF-LAAS research group (CNRS, Toulouse) and the ADAM research project-team (Inria Lille Nord Europe).

This work is funded by the Inria collaboration program (in French, "actions de recherches collaboratives").

8.2.3. School Inclusion for Children with Autism

The objective of this project is to provide children with assistive technologies dedicated to the school routines. This project is in collaboration with the "Handicap et Système Nerveux" research group (EA 4136, Bordeaux University), the PsyCLÉ research center (EA 3273, Provence Aix-Marseille University) and the "Parole et Langage" research laboratory (CNRS, Provence Aix-Marseille University).

This work is funded by the French Ministry of National Education.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7

Program: SUDOE territorial cooperation program (Interreg IV B)

Project acronym: Biomasud

Project title: Mechanisms for sustainability and enhancement of solid biomass market in the space of SUDOE

Duration: July 2011 - June 2013

Coordinator: AVEBIOM

Other partners: UCE (Consumers Union of Spain), CIEMAT (Public Research Agency for excellence in energy and environment, Spain), CBE (Centro da Biomassa para a Energia, Portugal), CVR (Centro para la Valorización de Residuos, Portugal) and UCFF (Union Française de la Coopération Forestière, France)

Abstract: The goal of the Biomasud european project is to show the viability of the biomass-based energy model. The project aims to propose a certification and traceability process throughout the value chain of biofuel. Our objective is to design and implement a prototype of traceability system that will extract automatically traceability information based on sensors such as RFID tags, simplifying the certification process. This work will leverage our DIASUITE development methodology and will be evaluated by the Biomasud partners.

8.4. International Initiatives

8.4.1. Inria International Partners

- University of McGill, Montréal, Canada
- University of Québec, Trois-Rivières, Canada

8.5. International Research Visitors

8.5.1. Visits of International Scientists

The Phoenix group has been visited by Tim Sheard for 3 months (January-March).

8.5.2. Visits to International Teams

Charles Consel is on sabbatical for the academic year of 2012-2013 at the University of Mc Gill in Montreal.

RUNTIME Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

REGION AQUITAINE   The Aquitaine Region Council is granting the PhD thesis of Andra Hugo about *Composability of parallel software over hybrid architectures*, from september 2011 to august 2014.

8.2. National Initiatives

8.2.1. ANR

ANR COOP   Multi-level Cooperative Resource Management (http://coop.gforge.inria.fr/).

ANR COSINUS 2009 Program, 12/2009 - 06/2013 (42 months)

Identification: ANR-09-COSI-001

Coordinator: Christian Pérez (Inria Rhône-Alpes)

Other partners: Inria Bordeaux, Inria Rennes, IRIT, EDF R&D.

Abstract: COOP aims at establishing generic cooperation mechanisms between resource management, runtime systems, and application programming frameworks to simplify programming models, and improve performance through adaptation to the resources.

ANR ProHMPT   Programming Heterogeneous Multiprocessing Technologies (http://runtime.bordeaux.inria.fr/prohmpt/).

ANR COSINUS 2008 Program, 01/2009 - 06/2012 (42 months)

Identification: ANR-08-COSI-013

Coordinator: Olivier Aumage (Inria Bordeaux)

Other partners: CEA INAC, CEA CESTA, CAPS entreprise, Bull, UVSQ PRiSM, Inria Grenoble.

Abstract: ProHMPT aims at focusing the joint research work of several teams about compilers, runtimes and libraries as well as scientific application programmers on designing methods and tools for programming heterogeneous platforms such as GPU and accelerators.

Nomination: The project ProHMPT has been nominated for the first round of selection for the best ANR projects recently completed.

ANR MediaGPU   Massive multimedia GPU-Based Processing (http://picoforge.int-evry.fr/projects/mediagpu/).

ANR CORD 2009 Program, 01/2010 - 12/2012 (36 months)

Identification: 2009-CORD-25-01

Coordinator: Pierre Pleven (Institut TELECOM)

Other partners: PLAY ALL, ATEME, HPC-Project, Inria Bordeaux

Abstract: The MediaGPU project will develop a software architecture and will review and adapt a number of classical multimedia algorithms, considering the latest advances offered by the new hardware architectures, such as Hybrid CPU+GPU and GPGPU. Initial key target applications are very large still images processing, high definition video encoding, video post-production, real-time geometry 3D synthesis.

ANR Songs   Simulation of next generation systems (http://infra-songs.gforge.inria.fr/).

ANR INFRA 2011, 01/2012 - 12/2015 (48 months)

Identification: ANR-11INFR01306

Coordinator: Martin Quinson (Inria Nancy)

Other partners: Inria Nancy, Inria Rhône-Alpes, IN2P3, LSIIT, Inria Rennes, I3S.

Abstract: The goal of the SONGS project is to extend the applicability of the SIMGRID simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

8.3. European Initiatives

8.3.1. FP7 Projects

PEPPHER FP7 Strep   "Performance Portability and Programmability for Heterogeneous Many-core Architectures"

Specific Targeted Research Project (STREP), October 2010 - December 2012

Coordinator: Universität Wien (Austria)

Others partners: Chalmers Tekniska Högskola AB (Sweden), Codeplay Software Limited (United Kingdom), Intel GmbH (Germany), Linköpings Universitet (Sweden), Movidia Ltd. (Ireland), Universität Karlsruhe (Germany)

Abstract: PEPPHER aims at providing a unified framework for programming architecturally diverse, heterogeneous many-core processors to ensure performance portability. PEPPHER will advance state-of-the-art in its five technical work areas:

1. Methods and tools for component based software
2. Portable compilation techniques
3. Data structures and adaptive, autotuned algorithms
4. Efficient, flexible run-time systems
5. Hardware support for autotuning, synchronization and scheduling

8.3.2. Collaborations in European Programs, except FP7

COST ComplexHPC   complexhpc.org

Program: COST

Project acronym: ComplexHPC

Project title: ComplexHPC

Duration: may 2009 – june 2013

Coordinator: Emmanuel Jeannot

Abstract: The goal of the Action is to establish a European research network focused on high performance heterogeneous computing in order to address the whole range of challenges posed by these new platforms including models, algorithms, programming tools and applications. This Action gathers more than 26 countries and 50 partners in Europe. The budget for the whole action and the four years is 380 000 euros.

8.4. International Initiatives

8.4.1. Inria Associate Teams

MORSE   Matrices Over Runtime Systems at Exascale

Inria Associate-Teams program: 2011-2013

Coordinator: Emmanuel Agullo (Hiepacs)

Parners: Inria (Runtime & Hiepacs), University of Tennessee Knoxville, University of Colorado Denver and KAUST.

Abstract: The Matrices Over Runtime Systems at Exascale (MORSE) associate team has vocation to design dense and sparse linear algebra methods that achieve the fastest possible time to an accurate solution on large-scale multicore systems with GPU accelerators, using all the processing power that future high end systems can make available. To develop software that will perform well on petascale and exascale systems with thousands of nodes and millions of cores, several daunting challenges have to be overcome both by the numerical linear algebra and the runtime system communities. With Inria Hiepacs, University of Tennessee, Knoxville and University of Colorado, Denver.

8.4.2. Participation In International Programs

ANR-JST FP3C Framework and Programming for Post Petascale Computing.

> ANR-JST 2010 Program, 03/2010 - 02/2013 (36 months)
>
> Identification: ANR-10-JST-002
>
> Coordinator: Serge Petiton (Inria Saclay)
>
> Other partners: CNRS IRIT, CEA DEN Saclay, Inria Bordeaux, CNRSPrism, Inria Rennes, University of Tsukuba, Tokyo Institute of Technology, University of Tokyo, Kyoto University.
>
> Abstract: Post-petascale systems and future exascale computers are expected to have an ultra large-scale and highly hierarchical architecture with nodes of many-core processors and accelerators. That implies that existing systems, language, programming paradigms and parallel algorithms would have, at best, to be adapted. The overall structure of the FP3C project represents a vertical stack from a high level language for end users to low level architecture considerations, in addition to more horizontal runtime system researches.

HPC-GA High Performance Computing for Geophysics Applications (http://project.inria.fr/HPC-GA/)

> European FP7 Programme, "Marie Curie" Action, PIRSES Scheme, 01/2012 - 12/2014 (36 months)
>
> Identification: PIRSES-GA-2011-295217
>
> Coordinator: Jean-François Méhaut (UJF)
>
> Other Partners: Inria Grenoble, Inria Bordeaux, Basque Center for Applied Mathematics (BCAM, Bilbao, Spain), Federal University of Rio Grande do Sul (UFRGS, Porto Alegre, Brazil), Universidad Nacional Autónoma de México (UNAM, Mexico, Mexico), Bureau de Recherche Géologique et Minière (BRGM, Orléans, France), Grand Équipement National de Calcul Intensif (GENCI, France).
>
> Abstract: The HPC-GA project is unique in gathering an international, pluridisciplinary consortium of leading European and South American researchers featuring complementary expertise to face the challenge of designing high performance geophysics simulations for parallel architectures: UFRGS, Inria, BCAM and UNAM. Results of this project will be validated using data collected from real sensor networks. Results will be widely disseminated through high-quality publications, workshops and summer-schools.

SEHLOC Scheduling evaluation in heterogeneous systems with hwloc

> STIC-AmSud 2012 Program, 01/2013 - 12/2013 (12 months, renewable)
>
> Coordinator: Brice Goglin
>
> Other Partners: Universidad Nacional de San Luis (Argentina), Universidad de la Repúpublica (Uruguay).

Abstract: This project focuses on the development of runtime systems that combine application characteristics with topology information to automatically offer scheduling hints that try to respect hardware and software affinities. Additionally we want to analyze the convergence of the obtained performance from our algorithms with the recently proposed Multi-BSP model which considers nested levels of computations that correspond to natural layers of nowadays hardware architectures.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Satoshi OHSHIMA visited us in September and October 2012, and accelerated the FEM application of the University of Tokyo execution by using STARPU.

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ADT CARRoMan

The ADT project CARRoMan started in november 2012 (recruitement of Antoine Hoarau). Autonomous human-centered robots, for instance robots that assist people with disabilities, must be able to physically manipulate their environment. There is therefore a strong interest within the FLOWERS team to apply the developmental approach to robotics in particular to the acquisition of sophisticated skills for manipulation and perception. ENSTA-ParisTech has recently acquired a Meka humanoid robot dedicated to human-robot interaction, and which is perfectly fitted to this research. The goal of this ADT is to install state-of-the-art software architecture and libraries for perception and control on the Meka robot, so that this robot can be jointly used by FLOWERS and ENSTA. In particular, we want to provide the robot with an initial set of manipulation skills. The engineer will develop a set of demos, which demonstrate the capabilities of the Meka, and provide a basis on which researchers can base their experiments.

8.1.2. CRA ARAUI

A Conseil Régional d'Aquitaine Project (ARAUI, 2011-) began, coordinated by Manuel Lopes entitled *Apprentissage Automatique en Robotique pour l'Adaptation aux Utilisateurs a Travers L'Interaction*. It will fund 50% of a 3 years PhD student and funding of 5500 euros for equipment.

The objective of ARAUI is the creation of robots that initiate autonomously the execution of frequent tasks after learning about the user's preferences through repeated interactions. Particularly these robots will act as personal companions or helpers and will be able to perform shared tasks with humans.

The long-term view of this project is that of a robot that comes out of the box with general purpose motor and sensory skills and then is adapted to each user's preferences and needs to achieve autonomous behavior. The major challenge is how to equip machines with such adaptability and learning capabilities. Until now machines are programmed by skilled engineers to perform a specific task and learning new tasks is not possible. Even in a restricted industrial setting the need for robots that can be more easily re-programmed to new tasks and environments has lead to research programs on flexible manufacturing that consider frequent changes in tasks and close (physical) interactions with human operators.

8.1.3. CRA ACROBATE

The Conseil Régional d'Aquitaine Project (ACROBATE, 2009-) continued, involving Thomas Cederborg and Pierre-Yves Oudeyer. The funding contributes with 50% funding for a 3 years PhD student. The objective of ACROBATE is to study mechanisms and models that can allow a robot to learn in a unified manner context-dependant motor skills and linguistic skills through interactions with humans.

8.1.4. ADT Acrodev

The ADT project (Acrodev, 2010-) continued, involving Paul Fudal, Haylee Fogg, Olivier Ly and Pierre-Yves Oudeyer. The Inria ADT funds two engineers for two years. The objective of Acrodev is on the one hand to build up re-usable software architectures for embedded control of Acroban-like robots, and on the other hand to explore novel morphologies in particular for the feet, hands and head of Acroban-like robots.

8.1.5. Collaboration with Labri/Unvi. Bordeaux I

We continued to collaborate with the Rhoban group at Labri/CNRS/Univ. Bordeaux I, and in particular Olivier Ly and Hugo Gimbert, about the design of bio-inspired compliant robotic morphologies, such as around the Acroban humanoid robot. The goal is to study both how properties of the body can facilitate motor control, and how to experiment and design such bodies with rapid prototyping methods.

8.1.6. Collaboration with Labri/Univ. Bordeaux I and Institut de Neurosciences Cognitives et Integratives d'Aquitaine

The collaboration with Olivier Ly, from Labri and Univ. Bordeaux I, as well as with Jean-René Cazalets, Christophe Halgand and Etienne Guillaud from Institut de Neurosciences Cognitives et Integratives d'Aquitaine, Bordeaux continued. The goal is to compare properties of the postural balance, and its relation to morphology and distributed control, in humans and in the humanoid Acroban (developed in collaboration with Labri), which vertebral column and postural control shares several fundamental features with the human vertebral column, and using the "Plateforme d'analyse de la motricité" available at the Institut de Neurosciences Cognitives et Integratives d'Aquitaine. This collaboration involves Matthieu Lapeyre and Pierre-Yves Oudeyer.

8.2. National Initiatives

8.2.1. ANR MACSi

An ANR Project (MACSi, ANR Blanc 0216 02), coordinated by ISIR/Univesity Paris VI (Olivier Sigaud), on developmental robotics (motor learning, visual learning, and exploration algorithms on the ICub robot) continued. The MACSi project is a developmental robotics project based on the iCub humanoid robot and the Urbi open source software platform. It is funded an as ANR Blanc project from 2010 to 2012. The project addresses four fundamental challenges, led by four partners:

- How can a robot learn efficient perceptual representations of its body and of external objects given initially only low-level perceptual capabilities? Challenge leader : Inria-ENSTA-ParisTech FLOWERS (Paris).
- How can a robot learn motor representations and use them to build basic affordant reaching and manipulation skills? Challenge leader : ISIR-UPMC-Paris 6 (Paris). ISIR hosts the iCub humanoid robot on which the achievements will be evaluated.
- What guidance heuristics should be used to explore vast sensorimotor spaces in unknown changing bodies and environments? Challenge leader : Inria-ENSTA-ParisTech FLOWERS (Bordeaux).
- How can mechanisms for building efficient representations/abstractions, mechanisms for learning manipulation skills, and guidance mechanisms be integrated in the same experimental robotic architecture and reused for different robots? Challenge leader : GOSTAI company (Paris).

Web site: http://macsi.isir.upmc.fr/

8.2.2. Quasimetric approach to probabilistic optimal control (LPPA)

- Jean-Luc Schwartz[1], Julien Diard[2], Pierre Bessire[3], Raphael Laurent[4], **1: GIPSA-Lab, Grenoble University, CNRS. 2: LPNC, Grenoble University, CNRS. 3: LPPA, Collège de France, CNRS. 4: GIPSA-Lab, Grenoble University.** Clément Moulin-Frier is continuing his collaborative work with people he worked with during his PhD thesis at GIPSA-Lab. See the section entitled "COSMO ("Communicating about Objects using Sensory-Motor Operations"): a Bayesian modeling framework for studying speech communication and the emergence of phonological systems" for more information.
- Jacques Droulez, Steve N'Guyen, **Laboratoire de Physiologie de Perception et de l'Action (LPPA), College de France, Paris**. Clément Moulin-Frier is continuing his collaborative work with people he worked with during his post-doc in 2011 at LPPA, College de France. See the section entitled "Probabilistic optimal control: a quasimetric approach" for more information.

8.2.3. Collaboration and technological transfer with Laboratoire de Physiologie de la Perception et de l'Action (LPPA)

A collaboration is in progress with Jacques Droulez and Steve Nguyen from Laboratoire de Physiologie de la Perception et de l'Action (LPPA), Paris. Poppy represents for them a humanoid platform very interesting because it is relatively flexible and versatile, with more similar proportions to that of humans, which facilitate comparison with the experimental results obtained in humans. The laboratory will evaluate this platform probabilistic methods of control of balance and locomotion.

In the short term the first experimental project with Poppy will test methods of management support, in the case of restoration of balance, in the case of walking to correct or prepare a change of direction. This project will be initiated in the framework of a long internship of master 2 that starts in January. In the future, we would also like to evaluate motor controllers compliant, and learning algorithms. This collaboration involves Matthieu Lapeyre and Pierre-Yves Oudeyer.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. EXPLORERS

Program: ERC Starting Grant

Project acronym: EXPLORERS

Project title: Exploring Epigenetic Robotics: Raising Intelligence in Machines

Duration: 12/2009-11/2014

Coordinator: Pierre-Yves Oudeyer

Abstract: In spite of considerable and impressive work in artificial intelligence, machine learning, and pattern recognition in the past 50 years, we have no machine capable of adapting to the physical and social environment with the flexibility, robustness and versatility of a 6-months old human child. Instead of trying to simulate directly the adult's intelligence, EXPLORERS proposes to focus on the developmental processes that give rise to intelligence in infants by re-implementing them in machines. Framed in the developmental/epigenetic robotics research agenda, and grounded in research in human developmental psychology, its main target is to build robotic machines capable of autonomously learning and re-using a variety of skills and know-how that were not specified at design time, and with initially limited knowledge of the body and of the environment in which it will operate. This implies several fundamental issues: How can a robot discover its body and its relationships with the physical and social environment? How can it learn new skills without the intervention of an engineer? What internal motivations shall guide its exploration of vast spaces of skills? Can it learn through natural social interactions with humans? How to represent the learnt skills and how can they be re-used? EXPLORERS attacks directly those questions by proposing a series of scientific and technological advances: 1) we will formalize and implement sophisticated systems of intrinsic motivation, responsible of organized spontaneous exploration in humans, for the regulation of the growth of complexity of learning situations; 2) intrinsic motivation systems will be used to drive the learning of forward/anticipative sensorimotor models in high-dimensional multimodal spaces, as well as the building of reusable behavioural macros; 3) intrinsically motivated exploration will be coupled with social guidance from non-engineer humans; 4) an information-theoretic framework will complement intrinsically motivated exploration to allow for the inference of body maps; 5) we will show how learnt basic sensorimotor skills can be re-used to learn the meaning of early concrete words, pushing forward human-robot mutual understanding. Furthermore, we will setup large scale experiments, in order to show how these advances can allow a high-dimensional multimodal robot to learn collections of skills continuously in a weeks-to-months time scale. This project not only addresses fundamental scientific questions, but also relates to important societal issues: personal home robots are bound to become part of everyday life in the 21st century, in particular as helpful social companions in an aging society. EXPLORERS' objectives converge to the challenges implied by this vision: robots will have to be able to adapt and learn new skills in the unknown homes of users who are not engineers. The ERC EXPLORERS is a central scientific driver of the FLOWERS team.

8.4. International Initiatives

8.4.1. Inria International Partners

- Luis Montesano, **University of Zaragoza, Spain**. Manuel Lopes collaborated with Luis Montesano on several topics. Recently on active learning approaches for grasping point learning [103] and clustering activities.

- Francisco Melo **Instituto Superior Técnico, Portugal**. Manuel Lopes collaborated with Francisco Melo on the development of active learning for inverse reinforcement learning. Recent developments consider the extension to more cues available to the learner and sampling complexity on the algorithm.

- José Santos-Victor, **Instituto Superior Técnico, Portugal**. Manuel Lopes collaborated with José Santos-Victor on the extension of affordances models to higher levels of representations, e.g. relational models.

- Maya Cakmak, Andrea Thomaz, **Georgia Tech, USA**. Manuel Lopes collaborated with Maya Cakmak on the development of optimal teaching algorithms for sequential decision problems (modeled as markov decision processes). The algorithm provides optimal demonstrations for systems that learn using inverse reinforcement learning. The joint work considers not only the algorithmic aspects but also a comparison with human behavior and the possibility of using insights from the algorithm to elicit better teaching behavior on humans [32].

- Marc Toussaint, Tobias Lang, **Free University of Berlin, Germany**. Manuel Lopes and Pierre-Yves Oudeyer are collaborating with FUB in the unification of exploration algorithms based on intrinsic motivation with methods for exploration in reinforcement learning such as R_{max}. We intend to develop a general framework for exploration in non-stationary domains [46]. Another project consider how to learn efficient representation for robotic hierarchical planning [44].

- Todd Hester and Peter Stone, **University of Texas, USA** (2012 -)
  Peter Stone is a leading expert on reinforcement learning applied to real robots (he won the RobotCup competition several times) and to multi-agent problems. We started this collaboration by introducing a new method to automatically select the best exploration strategy to use in a particular problem [42]. Future directions of the collaboration will include ad-hoc teams, exploration in continuous space and human-guided machine learning.

- Jacqueline Gottlieb and Adrien Baranes, **Columbia University, New-York, US**. Pierre-Yves Oudeyer and Manuel Lopes continued a collaboration with Jacqueline Gottlied, neuroscientist at Columbia University and specialist of visual attention and exploration in monkeys, and Adrien Baranes, postdoc in Gottlieb's lab and previously working in Flowers team. An experimental set-up with brain imaging and behavioural observations of monkeys, and made to evaluate new families of computational models of visual attention and exploration (some of which developped in the team around the concept of intrinsic motivation) is being elaborated.

- Louis ten Bosch, **Radboud University, The Netherlands**. Pierre-Yves Oudeyer and David Filliat continued to work with Louis ten Bosch on the modelling of multimodal language acquisition using techniques based on Non-Negative Matrix Factorization. We showed that these techniques can allow a robot to discover audio-video invariants starting from a continuous unlabelled and unsegmented flow of low-level auditory and visual stimuli. A journal article is in preparation.

- Britta Wrede, Katharina Rohlfing, Jochen Steil and Sebastian Wrede, **Bielefeld University, Germany**, Jun Tani **KAIST, South Korea**. Pierre-Yves Oudeyer collaborated with Wrede, Rohlfing, Steil, Wrede and Tani on the elaboration of a novel conceptual vision of teleoogical language and action development in robots. This led to the publication of a joint workshop article [64].

- Michael A. Arbib, **University of Southern California (Los Angeles, USA)**. Clément Moulin-Frier is continuing his collaborative work with Michael Arbib since his 6-month visit at USC in 2009. See the section entitled "Recognizing speech in a novel accent: the Motor Theory of Speech Perception reframed" for more information.

- Paul Vogt (**Tillburg University, The Netherlands**), Linda Smith (**Indiana University, Bloomington, US**), Aslo Ozyurek (**Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands**), Tony Belpaeme (**University of Plymouth, UK**). Pierre-Yves Oudeyer began collaboration with partners of the NWO SCMSC project to set up a research network on modeling of social cognition and symbolic communication.

- Michael Gienger from **Honda Research Institute Europe**. Alexander Gepperth collaborated with Principal Scientist Dr.Michael Gienger from Honda Research Institute Europe GmbH about robotic grasping: this activity will result in a jointly supervised internship ("stage de fine d'études") and a publication.

- Ursula Korner from **Honda Research Institute Europe**. Alexander Gepperth collaborated with Dr. Usula Körner of Honda Research Institute Europe GmbH, Offenbach (Germany), on the topic of biologically inspired learning architectures for visual categorization of behaviorally relevant entities. This work is intended to be summitted to the International Conference on Development and Learning, as well as the journal "Frontiers in Cognitive Systems".

- Michael Garcia Ortiz, **Laboratory for Cognitive Robotics (CoR-Lab) in Bielefeld, Germany**. Alexander Gepperth collaborated with Michael Garcia Ortiz, a PhD student from the Laboratory for Cognitive Robotics (CoR-Lab) in Bielefeld, Germany, on the exploitation of scene context for object detection in intelligent vehicles. This collaboration resulted in the submission of a journal publication to the journal "Neurocomputing".

- Martha White and Richard Sutton from the **University of Alberta, Canada**. Thomas Degris collaborated with Martha White and Richard Sutton on the paper "Off-Policy Actor–Critic" [38].

- Patrick Pilarski and Richard Sutton from the University of Alberta (Canada). Thomas Degris collaborated with Patrick Pilarski on the following papers: "Model-Free Reinforcement Learning with Continuous Action in Practice" [37], "Apprentissage par Renforcement sans Modèle et avec Action Continue" [65], "Dynamic Switching and Real-time Machine Learning for Improved Human Control of Assistive Biomedical Robots" [57], "Towards Prediction-Based Prosthetic Control" [58], and "Prediction and Anticipation for Adaptive Artificial Limbs" [27].

- Joseph Modayil from the **University of Alberta, Canada**. Thomas Degris collaborated with Joseph Modayil on the following paper: "Scaling-up Knowledge for a Cognizant Robot" [35].

- Ashique Rupam Mahmood from the **University of Alberta, Canada**. Thomas Degris collaborated with Ashique Rupam Mahmood on the following paper: "Tuning-Free Step-Size Adaptation" [50].

8.5. International Research Visitors

8.5.1. *Visits of International Scientists*

- Andrew Barto, Reinforcement learning and intrinsic motivation, University of Massachusetts Amherst, USA (oct 2012)

- Adam White, Reinforcement Learning and Artificial Intelligent group, Computing Science department of the University of Alberta, Canada (September 2012)

- Joseph Modayil, Reinforcement Learning and Artificial Intelligent group, Computing Science department of the University of Alberta, Canada (September 2012)

- Akihiko Yamaguchi, Robotics Lab of Prof. Ogasawara at NAIST in Japan (march 2012)

- Todd Hester, RL and Robotics Lab, Univ. Texas, US (may, june, july 2012)

- Louis ten Bosh, Speech processing, Univ. Radboud, The Netherlands (june 2012)

- Robert Saunders, Design Lab, Faculty of Architecture, University of Sydney, Australia (september 2012)

- Adrien Baranes, Columbia University, NY, USA (october 2012)

- Joshka Boedecker, Asada Lab, Osaka University, Japan (october 2012)

- Olivier Georgeon, Univ. Lyon, France (november 2012)

8.5.2. Internships

- Gennaro Raiola, MSc. Student from Università degli Studi di Napoli Federico II. Parameterized skills are able to map parameters of the task (for instance the 2D position of an object on a table) to the appropriate parameters of a policy for achieving this task. In this project, we use imitation learning to train a Dynamic Movement Primitive (DMP) with several observed trajectories. To achieve generalization, the basis functions in the DMP are expanded so that they span the space of the task relevant parameters. The resulting algorithm is applied to human reaching data, and to generalizing skills on the Nao robot.

- Laura Vogelaar, visiting student from GeorgiaTech and Carnegie Mellon University. Within a stochastic optimization context, we use clustering algorithms to determine features that are relevant to minimizing the cost of executing a skill. Our objective is to enable a robot to autonomously expand its libraries of skills, whilst simultaneously learning which skills can be successfully executed in which contexts.

8.5.3. Visits to International Teams

- Manuel Lopes (December 2012), Willow Garage, Palo Alto, USA: visit to Maya Cakmak to discuss tutoring systems and human-robot internaction.

- Manuel Lopes (December 2012), Bosch Research, Palo Alto, USA: visit to Dejan Pangercic to discuss active learning and human-robot interaction.

- Manuel Lopes (December 2012), Berkely University, USA: visit to Pieter Abbeel to discuss safe exploration methods and inverse reinforcement learning.

- Manuel Lopes (December 2012),

- Clément Moulin-Frier (November 2012), UC Merced, USA: visit to Anne Warlaumont's lab at UC Merced, to discuss about the role and the computational modeling of infraphonology in infant language development. The aim is to initiate a collaboration with Anne Warlaumont and D. Kimbrough Oller (University of Memphis, USA) to computationally study the possible role of intrinsic motivations in infraphonological exploration.

- Olivier Mangin (17/10/2012), Instituto Superior Técnico, Lisbone, Portugal

- Thomas Degris (June 2012), Reinforcement Learning and Artificial Intelligent group, Computing Science department of the University of Alberta, Canada (June 2012)

8.5.4. Participation to Summer/Winter School

- Jonathan Grizou participated to e'NTERFACE 2012, July, 2nd - July, 27th 2012, SUPELEC, Metz, France The 8th International Summer Workshop on Multimodal Interfaces took place on the SUPELEC campus of Metz, France. This one month summer school brought together more than 70 students and experts to work together and foster the development of tomorrow's multimodal research community. Jonathan Grizou enrolled in the Project P1 : "Speech, gaze and gesturing – multimodal conversational interaction with Nao robot", supervised by Graham Wilcock and Kristiina Jokinen (University of Helsinki). This summer school lead to a join publication by the members of the project P1 at the CogInfoCom 2012 conference [34].

- Jonathan Grizou and Fabien Bénureau participated to the IM-CLeVeR/FIAS Winter School on "Intrinsic Motivation: From Brains to Robots", December 3-8, 2012, Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany. The school brought together 25 students in the field of intrinsic motivation as well as leaders in the field (among which, Andrew Barto, Minoru Asada, Peter Redgrave, Giorgio Metta and others). Students' time was divided between keynotes in the morning and project work in the afternoon, supervised by the speakers and the school organizers. The school was an opportunity to meet and discuss with researchers and PhD students. It also allowed us to explain and disseminate our work; Pierre-Yves Oudeyer, notably, was an invited speaker. Jonathan

Grizou took part in the project "Intrinsic Motivation in Active Perception" while Fabien Benureau participated in "Playful Acquisition of Basic Behavioral skills Machine". The results of the school are highly positive, and some scientific collaborations may directly stem from this event in the future.

<p style="text-align:center">**MANAO Team**</p>

6. Partnerships and Cooperations

6.1. Regional Initiatives

6.1.1. CTP materials (2011-2015):

U. Zaragoza, U. Girona
Leader: P. Barla (*MANAO*)
This collaboration between regions on both French and Spanish sides of Pyrénées aims at studying material properties through their connections between physical and image space. Although the purpose of such a study is general in scope, we also target a particular application: the acquisition of material properties from a single image of an object of unknown shape, under unknown illumination.

6.2. National Initiatives

6.2.1. ANR

6.2.1.1. ALTA (2011-2015):

MAVERICK, REVES
Leader: N. Holzschuch (MAVERICK)
The project ALTA aims at analyzing the light transport equations and at using the resulting representations and algorithms for more efficient computation. We target lighting simulations, either offline, high-quality simulation or interactive simulations.

6.2.1.2. "Young Researcher" IMandM (2011-2015):

IRIT
Leader: L. Barthe (IRIT)
This project aims at the definition of simple and robust tools for the modeling of 3D objects. To this end, the proposed approach consists in combining the nice mathematical properties of implicit surfaces with classical meshes.

6.2.1.3. SeARCH (2009-2013):

PFT3D Archéovision (CNRS), CEAlex (USR CNRS 3134), ESTIA
Leader: P. Reuter
Cultural Heritage (CH) artifacts often come as a set of broken fragments leading to difficult 3D puzzles and sometime impossible to solve in a real world. The project's goal is to propose solutions from on-site acquisition, 3D surface reconstruction and semi-automatic virtual reassembly, taking into account the expertise of CH scientists.

6.2.2. Competitivity Clusters

6.2.2.1. LabEx CPU:

IMB (UPR 5251), LABRI (UMR 5800), Inria (CENTRE BORDEAUX SUD-OUEST), I2M (NEW UMR FROM 2011), IMS (UMR 5218), CEA/DAM
Some members of *MANAO* participate the local initiative CPU. As it includes many thematics, from fluid mechanics computation to structure safety but also management of timetable, safety of networks and protocols, management of energy consumption, etc., numerical technology can impact a whole industrial sector. In order to address problems in the domain of certification or qualification, we want to develop numerical sciences at such a level that it can be used as a certification tool.

6.3. European Initiatives

6.3.1. FP7 Projects

6.3.1.1. FP7 NoE - V-MusT.net (2011-2015):

partners available at http://www.v-must.net/participants

Leader: S. Pescarin (CNR - Italy)

V-MusT.net is a new European Network of Excellence dedicated to Virtual Museums. A Virtual Museum is a personalized, immersive, interactive experience that aims to enhance our understanding of the past in museums or on the Internet. The V-Must.net network enables heritage professionals around the world to connect, collaborate and advance the development and use of virtual museums.

6.3.1.2. FP7 ITN - PRISM "Perceptual Representations for Illumination, Shape and Materials" (2013-2016):

Giessen University, Université Paris-Descartes, Bilkent University, Université de Leuven, Delft University, Birmingham University, Philips and NextLimit

Leader: Roland Fleming (Giessen University)

The goal of this project is to better understand how the human visual system understands images in terms of meaningful components: How is shape perceived consistently in varying illumination conditions and for different materials? To which extent are humans able to guess the main illumination directions in a scene? What visual properties do we make use of to estimate the material an object is made of without touching it? Answering these questions will require inter-disciplinary research and collaborations.

<div align="center" style="color:red">**POTIOC Team**</div>

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Potioc has strong relationships with Cap Sciences http://www.cap-sciences.net/
- Potioc has started a collaboration with La CUB (Communauté Urbaine de Bordeaux). Joint Master thesis on "visualization of strategic data in 3D cities"

7.2. National Initiatives

ANR Project Instinct:

duration: 2009-2012

partners: MINT (Inria Lille), Immersion, Cap Sciences

website: http://anr-instinct.cap-sciences.net/

FUI SIMCA 2000:

duration: 2011-2013

partners: Oktal, ENAC (Ecole Nationale de l'Aviation Civile), Toulouse-Blagnac airport, Air France, CGx AERO in SYS

website: https://team.inria.fr/potioc/fr/collaborative-projects/simca/

PIA ville numérique "Villes transparentes":

duration: 2012-2014

partners: Pages Jaunes/Mappy, Vectuel/Virtuelcity

Inria ADT OpenViBE-NT:

duration: 2012-2014

partners: Inria teams Hybrid, Neurosys and Athena

website: http://openvibe.inria.fr

7.3. European Initiatives

LIRA Stress and Relaxation project:

Program: Inria - Philips - Fraunhofer partnership

Project acronym: LIRA

Project title: LIfe-style Research Association, Lifestyle Management: Stress and Relaxation

Coordinator: Frederic Alexandre

Other partners: Philips (Netherlands), Fraunhofer (Germany), Inria teams Hybrid and Mimetic

Abstract: The Stress and Relaxation project aims at offering services to a user, at home or at work, to help this user evaluate and control his level of stress

7.4. International Initiatives

7.4.1. International Partners

- Institute for Infocomm Research (I2R), Singapore - Wadsworth Center, Albany, USA and Kansas University, USA.
  Topic: Analysis of speech production and perception from ECoG signals
- BIG (Bristol Interaction Group), University of Bristol, UK.
  Topic: 3D User Interfaces and Musical Performance.

7.5. International Research Visitors

7.5.1. Visits to International Teams

- A. Cohé visited the BIG (Bristol Interaction and Graphics), in Bristol, UK, during 1 month
- F. Berthaut visited the Center for Computer Research on Music and Acoustics (CCRMA) of Stanford University, USA, during 2 months
- J. Laviole did a 3 month intership at Microsoft Research Redmond, USA