RESEARCH CENTER
Bordeaux - Sud-Ouest

FIELD

Activity Report 2014

Section Partnerships and Cooperations

Edition: 2015-06-01

LFANT Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANRPeace – Parameter spaces for Efficient Arithmetic and Curve security Evaluation

Participants: Bill Allombert, Karim Belabas, Jean-Marc Couveignes, Andreas Enge, Hamish Ivey-Law, 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 at constituting 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 theoretical side, this includes an effective description of moduli spaces of curves and 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.

The ANR organised the conference “Effective moduli spaces and applications to cryptography” in June 2014 as a part of the Centre Henri Lebesgue’s Thematic Semester 2014 “Around moduli spaces”.

6.1.2. ANRSimpatic – SIM and PAiring Theory for Information and Communications security

Participants: Guilhem Castagnos, 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, Université de Paris 8.

The aim of the SIMPATIC project is to provide the most 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 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.

D. Robert is a participant in the Task 2 whose role is to give state of the art algorithms for pairing computations, adapted to the specific hardware requirements of the Simpatic Project.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

6.2.1.1. ANTICS

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

Duration: January 2012 - December 2016

Coordinator: Inria (France)

Inria contact: Andreas Enge

Abstract: Data security and privacy protection are major challenges in the digital world. Cryptology contributes to solutions, and one of the goals of ANTICS (Algorithmic Number Theory in Cryptology) 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.

6.3. International Initiatives

6.3.1. Inria International Labs

The *MACISA* project-team (Mathematics Applied to Cryptology and Information Security in Africa) is one of the new teams of LIRIMA. Researchers from Inria and the universities of Bamenda, Bordeaux, Dakar, Franceville, Maroua, Ngaoundéré, Rennes, Yaoundé cooperate in this team.

The project is concerned with public key cryptology and more specifically the role played by algebraic maps in this context. The team focus on two themes:

- Theme 1 : Rings, primality, factoring and discrete logarithms;
- Theme 2 : Elliptic and hyperelliptic curve cryptography.

The project is managed by a team of five permanent researchers: G. Nkiet, J.-M. Couveignes, T. Ezome, D. Robert and A. Enge. Since Sep. 2014 the coordinator is T. Ezome and the vice-coordinator is D. Robert. The managing team organises the cooperation, schedules meetings, prepares reports, controls expenses, reports to the LIRIMA managing team and administrative staff.

A non-exhaustive list of activities organised or sponsored by Macisa includes

- The Summer school in M'Bour in Senegal with the International Center for Pure and Applied Mathematics (ICPAM/CIMPA), June 2014;
- The Annual Cameroonian workshop on Cryptography, Algebra and Geometry (CRAG), July 2014;
- The visit of Thierry Mefenza (Cameroun), to École Normale Supérieure de Paris for a PhD Thesis with Damien Vergnault, November 2013 and September–November 2014;
- The visit of Hortense Boudjou (Maroua) to work with Abdoul Aziz Ciss (École Polytechnique de Thièse, Sénégal), May – July 2014;
- The visit of Abdoul Aziz Ciss (Dakar) and Tony Ezome (Franceville) to Bordeaux, September 2014.
- Kodjo Kpognon Egadédé defended his PhD thesis in december 2014 under the supervision of Julien Sebag.

The team was evaluated in September 2014 as part of the general LIRIMA evaluation seminar.

6.3.2. Inria International Partners

6.3.2.1. Informal International Partners

The team is used to collaborate with Leiden University through the ALGANT program for PhD joint supervision.

Eduardo Friedman (U. of Chile), long term collaborator of K. Belabas and H. Cohen is a regular visitor in Bordeaux (about 1 month every year).

6.4. International Research Visitors

6.4.1. Visits of International Scientists

- Hartmut Monien, Universität Bonn, Germany. 01/2014;
- Eduardo Friedman, Universidad de Chile, 02/2014;
- Amalia Pizarro-Madariaga, Universidad de Valparaiso, Chile, 04/2014;
- Tony Ezome Mintsa, University of Franceville, Gabon, 04/2014 and 09/2014;
- Alina Dudeanu, École polytechnique fédérale de Lausanne, Switzerland, 05/2014;
- Kamal Khuri-Makdisi, American University of Beirut, Lebanon, 07/2014;
- Abdoul-Aziz Ciss, University of Dakar, 09/2014;
- Dimitar Jetchev, École polytechnique fédérale de Lausanne, Switzerland, 10/2014;

6.4.1.1. Internships

- Ilaria Chillotti (with D. Robert), Université Joseph Fourier, 02/2014–07/2014]
- Gregor Seiler (with A. Enge), Technische Universität Berlin, Germany, 10/2013–03/2014

BACCHUS Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

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

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

Coordinator: M. Ricchiuto

Other partners: UMR EPOC (P. Bonneton)

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

6.2. National Initiatives

6.2.1. Inria Project Lab

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

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

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

6.2.1.2. FUI Rodin

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

Type: FUI

Duration: July 2012 - July 2015

Coordinator: ALBERTELLI Marc (Renault)

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

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

6.2.1.2.1. ANR MAIDESC

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

Type: ANR

Duration: 48 months

Starting date : 1st Oct 2013

Coordinator: Dervieux Alain (Inria Sophia)

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

6.2.1.2.2. ANR UFO

Title: Uncertainty quantification For compressible fluid dynamics and Optimisation.

Type: ANR

Duration: 36 months

Starting date : 1st June 2011

Coordinator: Remi Abgrall (Inria Bordeaux Sud-Ouest)

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

6.2.1.2.3. PIA TANDEM

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

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

Duration: 48 months

Starting date : 1st Jan 2014

Coordinator: H. Hebert (CEA)

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

6.2.1.3. PEPS

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

Type : PEPS IDEX-CNRS

Duration : 12 months

Starting : Date May 2013

Coordinator : M. Colin

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

Full models→Asymptotic models→Numerical scheme.

6.2.1.4. APP Bordeaux 1

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

Type : Project Bordeaux 1

Duration : 36 months

Starting : September 2014

Coordinator : M. Colin

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

6.3. European Initiatives

6.3.1. FP7 & H2020 Projects

6.3.1.1. STORM

Type: COOPERATION

Defi: NC

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: October 2013 - September 2016

Coordinator: SNECMA (France)

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

Inria contact: Heloise Beaugendre

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

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

6.4. International Initiatives

6.4.1. Inria Associate Teams

6.4.1.1. AQUARIUS2

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

International Partner (Institution - Laboratory - Researcher):

Stanford University (ÉTATS-UNIS)

Duration: 2011 - 2016

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

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

6.4.1.2. AMoSS

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

International Partner (Institution - Laboratory - Researcher):

Inria Sophia-Antipolis and University of Nice (France)

Inria Bordeaux and University of Bordeaux (France)

University of Marseille (France)

National Cheng Kung University, Tainan, Taiwan

National Taiwan University and Academia Sinica,Taipei, Taiwan

Duration: 2014 - 2016

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

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

6.4.2. Inria International Partners

6.4.2.1. Informal International Partners

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

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

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

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

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

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

6.4.3. Participation In other International Programs

6.4.3.1. Inria-CNPq

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

6.5. International Research Visitors

6.5.1. Visits of International Scientists

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

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

6.5.1.1. Research stays abroad

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

CAGIRE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Predicting pressure losses in aeronautical fuel injectors

This is a 3-year programme, funded by Conseil Régional d'Aquitaine (call 2014) and two small-size companies, MMP (Gurmençon, France) and GDTECH (Bordes, France). A one-year post-doc will be recruited beginning of 2015. The objective is to investigate the possibility of using advanced RANS or hybrid RANS-LES approaches to better predict the pressure losses in injector.

8.2. National Initiatives

8.2.1. GIS Success

We are members of the CNRS GIS Success (Groupement d'Intérêt Scientifique) organised around the two major codes employed by the Safran group, namely AVBP and Yales 2.No specific activity has been devoted around those codes during 2014.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

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

Program: Propulsion

Project acronym: IMPACT-AE

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

Duration: 01/11/2011 - 31/10/2015

Coordinator: Roll Royce Deutschland

Other partners:

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

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

8.4. International Initiatives

8.4.1. Informal International Partners

- Collaboration [RM] with the M. Hadziabdic (International university of Sarajevo, Bosnia and Herzegovina) on the turbulence and heat transfer modelling of jets impinging on a heated, rotating disk.
- Collaboration [RM] with the A.T. Nguyen (University of Vietnam-Ho Chi Minh City) on the development of a new hybrid RANS/LES method based on temporal filtering.
- Collaboration [RM] with E. Juntasaro (King Mongkut's University of Technology North Bangkok, Thailand) on the modelling of transition to turbulence.
- Collaboration [RM] with S. Lardeau (CD-Adapco, London, UK) on the development of an industrial version of the EB-RSM model and its implementation in the commercial CFD software STAR-CCM+.
- Collaboration [PB, VP, YM] with E. Dick (University of Ghent, Belgium) on the development of schemes for the simulation of unsteady low Mach number flows.
- Collaboration [PB] with A. Allouhi, A. Jamil, Y. Mourad (Ecole Supérieure de Technologie of Fès, Marocco) on energy issues related to transition and phase change materials.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

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

8.5.2. Visits to International Teams

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

CQFD Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

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

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

8.1.2. Inter-LabEx project between CPU and TRAIL

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

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

8.2. National Initiatives

8.2.1. ANR ADAPTEAU

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

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

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

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

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

The CQFD team work on tasks 1 and 3.

8.2.2. ANR Piece

ANR Piece (2013-2016) of the program *Jeunes chercheuses et jeunes chercheurs* of the French National Agency of Research (ANR), lead by F. Malrieu (Univ. Tours). The Piecewise Deterministic Markov Processes (PDMP) are non-diffusive stochastic processes which naturally appear in many areas of applications as communication networks, neuron activities, biological populations or reliability of complex systems. Their mathematical study has been intensively carried out in the past two decades but many challenging problems remain completely open. This project aims at federating a group of experts with different backgrounds (probability, statistics, analysis, partial derivative equations, modeling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

8.2.3. ANR BNPSI "Bayesian Non Parametric methods for Signal and Image Processing"

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

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

IRSES FP7 MARIE CURIE ACOBSEC: http://cordis.europa.eu/project/rcn/109603_en.html
Over the last decade, Human-Computer Interaction (HCI) has grown and matured as a field. Gone are the days when only a mouse and keyboard could be used to interact with a computer. The most ambitious of such interfaces are Brain-Computer Interaction (BCI) systems. BCI's goal is to allow a person to interact with an artificial system using brain activity. A common approach towards BCI is to analyze, categorize and interpret Electroencephalography (EEG) signals in such a way that they alter the state of a computer. ACoBSEC's objective is to study the development of computer systems for the automatic analysis and classification of mental states of vigilance; i.e., a person's state of alertness. Such a task is relevant to diverse domains, where a person is required to be in a particular state. This problem is not a trivial one. In fact, EEG signals are known to be noisy, irregular and tend to vary from person to person, making the development of general techniques a very difficult scientific endeavor. Our aim is to develop new search and optimization strategies, based on evolutionary computation (EC) and genetic programming (GP) for the automatic induction of efficient and accurate classifiers. EC and GP are search techniques that can reach good solutions in multi-modal, non-differentiable and discontinuous spaces; and such is the case for the problem addressed here. This project combines the expertise of research partners from five converging fields: Classification, Neurosciences, Signal Processing, Evolutionary Computation and Parallel Computing in Europe (France Inria, Portugal INESC-ID,

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

8.3.2. Collaborations in European Programs, except FP7 & H2020

Numerical methods for Markov decision processes (2013-2015). This project is funded by the Gobierno de Espana, Direcion General de Investigacion Cientifica y Tecnica (reference number: MTM2012-31393) for three years to support the scientific collaboration between Tomas Prieto-Rumeau, Jonatha Anselmi and François Dufour. This research project is concerned with numerical methods for Markov decision processes (MDPs). Namely, we are interested in approximating numerically the optimal value function and the optimal controls for different classes of constrained and unconstrained MDPs. Our methods are based on combining the linear programming formulation of an MDP with a discretization procedure referred to as quantization of a probability distribution, underlying the random transitions of the dynamic system. We are concerned with optimality criteria such as the total expected cost criterion (for finite horizon problems) and, on the other hand, the total expected discounted cost and the average cost optimality criteria (for infinite horizon problems).

8.4. International Initiatives

8.4.1. Participation In other International Programs

Control of Dynamic Systems Subject to Stochastic Jumps USP-COFECUB grant (2013-2014). This collaboration is also supported by the **Associate Team Inria: CDSS (2014-2016)**. The main goals of this joint cooperation is to study the control of dynamic systems subject to stochastic jumps. Three topics are considered. In the first topic we study the control problem of piecewise-deterministic Markov processes (PDMP's) considering constraints. In this case the main goal is to obtain a theoretical formulation for the equivalence between the original optimal control problem of PDMP's with constrains and an infinite dimensional static linear optimization problem over a space of occupation measures of the controlled process. F. Dufour at Inria and O. Costa in USP carry out this topic. In the second topic we focus on numerical methods for solving control and filtering problems related to Markov jump linear systems (MJLS). This project allows a first cooperation between B. de Saporta and E. Costa. The third research subject is focused on quantum control by using Lyapunov-like stochastic methods and P. Rouchon and P. Pereira da Silva conduct it.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Tomas Prieto-Rumeau (Department of Statistics and Operations Research, UNED, Madrid, Spain) visited the team during two weeks in 2014. The main subject of the collaboration is the approximation of Markov Decision Processes.

Oswaldo Costa (Escola Politécnica da Universidade de São Paulo, Brazil) collaborate with the team on the theoretical aspects of continuous control of piecewise-deterministic Markov processes. He visited the team during two weeks in 2014 supported by the USP-COFECUB grant and the Associate Team Inria: CDSS.

Alexey Piunovskiy (University of Liverpool) visited the team during six weeks in 2014. The main subject of the collaboration is the linear programming approach for Markov Decision Processes. This research was supported by the Clusters d'excellence CPU.

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

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

8.5.2. Visits to International Teams

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

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

GEOSTAT Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

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

7.2. National Initiatives

- ICARODE [2013-2016]. Participants : Hussein Yahia, Oriol Pont, Véronique Garçon, Joel Sudre, Antonio Turiel, Christine Provost [LOCEAN]. 4-year contract, CNES-NASA funding, started 2013. Title: *ICARODE: Integration and cascading for high resolution ocean dynamics*. Project leader: H. Yahia.
- IHU LIRYC and CRA DIAFIL project [2012-2014]. Post-doctoral fellow: B. Xu. Project leaders H. Yahia and O. Bernus.
- REGION AQUITAINE PROJECT "OPTAD". Participants : H. Yahia, S. Kumar Maji. Project leader: H. Yahia.

GEOSTAT is a member of the GDRs ISIS and PHENIX.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, except FP7 & H2020

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

Project acronym: OceanFlux.

Project title: High resolution mapping of GHGs exchange fluxes.

Duration: 09/2011 - 09/2014.

Coordinator: C. Garbe.

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

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

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

7.4. International Initiatives

7.4.1. Inria Associate Teams

7.4.1.1. OPTIC

Title: Optimal inference in Complex and Turbulent data

International Partner (Institution - Laboratory - Researcher):

IITR (INDE)

Duration: 2014 - 2017.

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

The OptIC associated team targets the extension and development of a strong collaboration between Inria GEOSTAT team and INDIAN INSTITUTE OF TECHNOLOGY ROORKEE Dept of Electronics and Computer Engineering (Prof. D. Singh's group) on non-linear Signal Processing for Universe Sciences, with a strong emphasis on data fusion in Earth Observation and monitoring. Non-linear Physics puts strong evidence of the fundamental role played by multiscale hierarchies in complex and turbulent data: in these data, the information content is statistically localized in geometrical arrangements in the signal's domain, while such geometrical organization is not attainable by classical methods in linear signal processing. This is one of the major drawbacks in the classical analysis of complex and turbulent signals. The goal of this associated team is to show that inference of physical variables along the scales of complex and turbulent signals can be performed through optimal multiresolution analysis performed on non-linear features and data extracted from the signals, resulting in novel and powerful approaches for data fusion between different acquisitions (in temporal/spatial/spectral resolutions). This program needs both strong expertise in the physical processes beyond the acquisitions and the application of non-linear physics ideas on the behavior of the acquired physical phenomena. The proposal will focus on specific applications in Earth Observation and monitoring for which the Indian partner has developed a very strong expertise, notably in its knowledge and use of the physical processes in remote sensing acquisitions. This partnership is an extremely interesting and high potential collaboration between two teams which focus separately either on the acquisition of the physical processes or their analysis by Complex Systems and non-linear physics methodologies. The recent results obtained in super-resolution by GEOSTAT promises strong applications to a much wider range of Universe Sciences problems, notably with a strong emphasis on data fusion between the physical variables acquired on related but different acquisitions. OptiC builds on a collaboration between Inria and IIT ROORKEE teams, added with partners in Universe Sciences and earth observation (ONERA, CNRS) already involved in research actions with GEOSTAT.

7.4.2. Participation In other International Programs

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

7.5. International Research Visitors

7.5.1. Visits of International Scientists

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

7.5.1.1. Internships

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

7.5.2. Visits to International Teams

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

MC2 Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

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

8.2. National Initiatives

8.2.1. ANR MEMOVE

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

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

8.2.2. French-German cooperative consortium SmartOnline

Participants: Angelo Iollo, Iraj Mortazavi.

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

8.2.3. Plan Cancer METASTASIS

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

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

8.2.4. Plan Cancer MIMOSA

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

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

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. FFAST

Title: FUTURE FAST AEROELASTIC SIMULATION TECHNOLOGIES

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Duration: January 2010 - December 2012

Coordinator: University of Bristol (Saint Pierre And Miquelon)

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

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

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

8.3.2. Collaborations in European Programs, except FP7 & H2020

Program: European associated laboratory

Project acronym: EBAM

Project title: Pulsed electric fields applications in biology and medicine

Duration: January 2011 - December 2014

Coordinator: C. Poignard

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

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

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

8.4. International Initiatives

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

8.5. International Research Visitors

8.5.1. Visits of International Scientists

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

REALOPT Project-Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Inria Associate Teams

8.1.1.1. SAMBA

Title: Combinatorial optimization problems

International Partner (Institution - Laboratory - Researcher):

Pontifícia Universidade Católica do Rio de Janeiro, Brazil

Universidade Federal Fluminense (UFF), Brazil

Universidad Adolfo Ibañez, Chile

Duration: 2014 - 2017

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

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

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

8.2. International Research Visitors

8.2.1. Visits of International Scientists

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

8.2.2. Visits to International Teams

8.2.2.1. Research stays abroad

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

CARMEN Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Modélisation of the multinodal date (years 2012–2015) funded by the Conseil Regional Aquitaine. Coordinator J.-F. Aujol (Pr University Bordeaux). The PhD of G. ravon is funded within this project: 3D reconstruction by inverse problem in cardiac optical mapping.

7.2. National Initiatives

7.2.1. IHU LIRYC

Our work is partially funded by the LIRYC project (ANR 10-IAHU 04).

- For 2014: the salary of M. Potse, member of Carmen, is payed by the LIRYC..
- For 2012-2015: 1/2 PhD thesis associated to the project *Modélisation pour les données multimodales* (see section Regional Initiaves).

7.2.2. ANR HR-CEM

In 2014, we are supported for the project "High Resolution Cardiac Electrophysiology Models: HR-CEM" within the call for project « Modèles Numériques » of the ANR.

The scientific start of the project was on November, 4th, 2013.

It is an international project that involves three partners, Inria (coordinator), IHU LIRYC, and UMI-CRM at Montréal (Canada). The project has some external collaborators in Univ. Bordeaux and Univ. Pau.

Based on these collaborations and new developments in structural and functional imaging of the heart available at LIRYC, we plan to reconsider the concepts behind the models in order to improve the accuracy and efficiency of simulations. Cardiac simulation software and high-resolution numerical models will be derived from experimental data from animal models. Validation will be performed by comparing of simulation output with experimentally recorded functional data. The validated numerical models will be made available to the community of researchers that take advantage of in-silico cardiac simulation and, hopefully, become references. In particular we shall provide the first exhaustive model of an animal heart including the four chambers coupled through the special conduction network, with highly detailed microstructure of both the atria and the ventricles. Such a model embedded in high-performance computational software will provide stronger medical foundations for in-silico experimentation, and elucidate mechanisms of cardiac arrhythmias.

7.2.3. AMIES – Medic Activ

We were granted by the Agency AMIES a financial support to complete the one obtained from the Région Aquitaine for the Medic Activ project (see above). The objective of this support is to developp reduced order models of cardiac electrophysiology that might enter the MedicActiv framework. The difficulty is to define qualitatively realistic but fast numerical simulations of the ECG and cardiac function, for educational purpose.

7.2.4. ANR Labcom CardioXcomp

We are participant in the ANR Labcom project between Inria and the society Notocord (www.notocord.com). At Inria, the proejct is leaded by JF. Gerbeau from the Reo team and we participate to the study and developpment of cardiac electrophysiology models suited to the context of the proejct.

7.2.5. REO

The CARMEN team is a partner with the REO team at Inria Paris Rocquencourt and NOTOCORD companie in the CardioXcomp project.

7.2.6. MedicActiv

The CARMEN team cooperate in interaction with the MedicActiV project.

7.3. International Initiatives

7.3.1. Inria International Labs

- LIRIMA: Equipe Problèmes Inverses et Contrôle (EPIC), University Tunis Al Manar et 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.

  This collaboration is mainly supported by the international laboratory LIRIMA.
- Cooperation with Laboratoire de Modélisation Mathématique et Numérique dans les Sciences de l'Ingénieur (LAMSIN in Tunisia.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

In the framework of the EPIC project in the LIRIMA lab, N. Zemzemi has invited:

- Mohamed Jebalia assistant professor from LAMSIN Tunisia
- Moncef Mahjoub assistant professor from LAMSIN Tunisia
- Jamila Lassoued. Phd student from LAMSIN Tunisia
- Najib Fikal PHD student from University MohamedV, Moroco
- El Mahid El Guarmah assitant professor from University of Marrakech. Moroco.

7.4.2. Internships – Visiting PhD Students

- Carlos Chavez Borgesn, from may 2014 to Sep 2014,*Inverse Problem of Electrocardiography: estimating the location of cardiac isquemia in a 3D geometry*
- Ali Gharaviri, from Apr 2014 to May 2014
- Wajih Mbarki, until Aug 2014, *Analysis of an interaction problem in biomathematics: purkinje/myocardium coupling in the heart*
- Jamila Lassoued, until Aug 2014, *Construction of reduced order methods for optimization problems in cardiac electrophysiology*

MAGIQUE-3D Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

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

The Post-Doctoral fellowship of Ángel Rodríguez Rozas is partially (50%) funded 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, Magique-3D coordinates research activities dealing with the development of high-performance numerical methods for solving wave equations in complex media. This project involves 2 other Inria Team-Projects (Hiepacs and Nachos) which have complementary skills in mathematics, computing and in geophysics. DIP is fully funded by Total by the way of an outline agreement wit Inria .

Since its beginning (2009), eight PhD students have been funded and Magique 3D has hired six of them, one being shared with the project team Nachos (http://www-sop.inria.fr/nachos/). Moreover, several internships have been realized. In 2014 the second phase of DIP has begun. Lionel Boillot has been hired as engineer to work on the DIP platform.

8.2.2. Micro-local analysis of wave equations

The numerical solution of wave equations most often requires to truncate the propagation domain to define a computational domain limited by an artificial boundary. Magique-3D is very involved in the construction and mathematical validation of boundary conditions which are set on the artificial boundary. Different techniques can be used for the design of such conditions and Magique-3D maintains a collaboration with Prof. Olivier Lafitte from the University of Paris 13 on the mathematical analysis of the Dirichlet-to-Neumann (DtN) operator for acoustic waves. This issue is addressed by applying micro-local analysis which enables us to consider the full DtN operator in the whole space of frequencies.

8.2.3. Partnership with the department DMAE of ONERA

title: Modeling of multiperforated plates

Coordinator: Sébastien Tordeux

Other partners: Department DMAE of ONERA

Abstract: In the aeronautic industry, there is a need of numerical models for the design of turboreactors of new generation. Magique-3D is cooperating with the department DMAE of ONERA to develop acoustic models of multiperforated plates which is an important component of the turboreactors.

This project is interdisciplinary, since it involves the experimental expertise of Estelle Piot (acoustician engineer of ONERA working on acoustic bench), the competences in mathematical modeling of Magique 3D. In parallel to the obtention of new theoretical results we are jointly developing a new numerical library based on the discontinuous Galerkin approximation which aims in interpreting experimental data.

This cooperation is formalized thanks to the common supervision of the PhD of Vincent Popie funded by ONERA and DGA and is a follow-up of the ANR APAM (2008-2011).

8.3. European Initiatives

8.3.1. FP7 & H2020 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, multidisciplinary 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.

Two members of MAGIQUE-3D (Julien Diaz and Victor Péron) participated to the last Workshop of HPC-GA in Grenoble on October 2014.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. MAGIC

Program: Inria International Partner

Title: Advance Modelling in Geophysics

Inria principal investigator: Hélène Barucq

International Partner (Institution - Laboratory - Researcher):

California State University at Northridge (United States) - Department of Mathematics - Rabia Djellouli

The Associated Team MAGIC was created in January 2006 and renewed in January 2009. At the end of the program in December 2011, the two partners, MAGIQUE-3D and the California State University at Northridge (CSUN) decided to continue their collaboration and obtained the "Inria International Partner" label in 2013.

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

The ultimate objective of this research collaboration is to develop efficient solution methodologies for solving inverse problems arising in various applications such as geophysical exploration, underwater acoustics, and electromagnetics. To this end, the research program will be based upon the following three pillars that are the key ingredients for successfully solving inverse obstacle problems: 1) The design of efficient methods for solving high-frequency wave problems. 2) The sensitivity analysis of the scattered field to the shape and parameters of heterogeneities/scatterers. 3) The construction of higher-order Absorbing Boundary Conditions.

In this framework, Rabia Djellouli visited Magique 3D in December 2014

8.4.2. Participation In other International Programs

8.4.2.1. HOSCAR

Program: Inria-CNPq

Title: High performance cOmputing and SCientific dAta management dRiven by highly demanding applications

Inria principal investigator: Stéphane Lanteri (Nachos, Inria Sophia Antipolis-Méditerranée

International Partners:

LNCC (Laboratório Nacional de Computaçäo Científica), Brazil;

COPPE/UFRJ (Instituto Alberto Luiz Coimbra de Pós-Graduaçäo e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), Brazil;

INF/UFRGS (Instituto de Informática, Universidade Federal do Rio Grande do Sul);

LIA/UFC (Laboratórios de Pesquisa em Ciência da Computaçäo Departamento de Computaçäo, Universidade Federal do Ceará).

Inria Teams :

NACHOS, Inria Sophia Antipolis - Méditerranée;

ZENITH, Inria Sophia Antipolis - Méditerranée;

MOAIS, Inria Grenoble - Rhone-Alpes;

HIEPACS, Inria Bordeaux - Sud-Ouest;

MOAIS, Inria Bordeaux - Sud-Ouest;

MAGIQUE 3D, Inria Bordeaux - Sud-Ouest;

Duration: 2012-2015

See also: http://www-sop.inria.fr/hoscar/

HOSCAR is a CNPq - Inria collaborative project between Brazilian and French researchers, in the field of computational sciences, also sponsored by the French Embassy in Brazil. It is coordinated by the team-project Nachos

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models, (ii) scientific data management,

and (iii) high-performance software systems. Several Brazilian institutions are participating to the project among which: LNCC (Laboratório Nacional de Computação Científica), COPPE/UFRJ (Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), INF/UFRGS (Instituto de Informática, Universidade Federal do Rio Grande do Sul) and LIA/UFC (Laboratórios de Pesquisa em Ciência da Computação Departamento de Computação, Universidade Federal do Ceará). The French partners are research teams from several Inria research centers.

8.4.2.2. GEO3D

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 - Sébastien Tordeux

Duration: January 2012 - 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) and the Institute of Petroleum Geology and Geophysics, in the context of geosciences.

We are mainly interested in the derivation of numerical methods (discontinuous Galerkin approximation, space-time refinement), the design of direct and inverse high performance solver, and the modeling of complex media.

More precisely, we are actually interested in

1. the computation of truncated Singular Value decomposition of very large matrix to analyze the inverse problem;
2. the coupling of a discontinuous Galerkin method with a finite differences method for the direct problem;
3. a spectral time stepping method for the direct problem;
4. an algorithm to determine an impedance coefficient using indirect measurement.

An international workshop on “Computational Geophysics” gathering around 50 participants has been organized in Novosibirsk in the framework of GEO3D in September 2014

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Serguey Solovyev spent two months in MAGIQUE-3D in march 2014 and in December 2014.
- Mounir Tlemcani spent one month in MAGIQUE-3D in May 2014.
- Laurent Gizon
- Rabia Djellouli spent two weeks in MAGIQUE-3D in December 2014.

MAGNOME Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

MAGNOME works with the ISVV and local industry to develop analyses and tools for rationalizing wine starter strain selection using genomics.

8.2. National Initiatives

8.2.1. ANR MYKIMUN.

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).

In MYKIMUN we extend the notion of fungal immune receptors and immune reaction beyond the *P. anserina* NWD gene family. We develop *in silico* machine learning tools to identify new potential PRRs based on the expected characteristics of such genes, in *P. anserina* and beyond in additional sequenced fungal genomes. This should contribute to extend concept of a fungal immune system to the whole fungal branch of the eukaryote phylogenetic tree.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

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 International Partners

8.4.1.1. Informal International Partners

MAGNOME collaborates with Rodrigo Assar Cuevas at the University of Chile, Santiago, Chile and Joaquín Fernandez at the University of Rosario, Rosario, Argentina on hierarchical hybrid modeling using quantized state systems.

MAGNOME collaborates with Nicolás Loira at the University of Chile on methods for inferring genome-scale metabolic models.

MNEMOSYNE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

As our team just settled in Bordeaux, it was an important priority for our early years of activity to initiate local collaborations, at the regional level.

7.1.1. Project of the Aquitaine Regional Council: Decision making, from motor primitives to action

The aim of this project (partly funding the PhD of Meropi Topalidou) is to investigate decision making at intermediate level in order to establish the link between motor primitives and higher level actions. The question is to understand how continuous complex motor sequences can be dynamically represented as actions such that they can be manipulated to resolve conflict when several actions are possible. This PhD work will require an extensive review of the literature and more specifically literature that promote a global view on decision making. The DANA modeling framework will be used for the design of distributed, numerical and adaptive models using rate based neuron models. The model will ideally be embodied into a simulator or a robotic platform in order to solve a simple taks such as for example, foraging or grasping, with a continuous component at the motor level.

7.1.2. Project of the Department Sciences and Technologies of the University of Bordeaux: Pinokio

In collaboration with school of engineers ENSEIRB and the support of the Department Sciences and Technologies of the University of Bordeaux, we've built a prototype of a motorized lamp equipped with a camera and leds. It can move autonomously and track faces with dedicated algorithms. The goal of this project is to have a dedicated robotic platform to study motor interaction and to investigate decision making in order to establish the link between motor primitives and higher level actions.

7.1.3. Project PEPS of the Idex: Dopamine control of a novel basal ganglia cell-type

The neurotransmitter dopamine (DA) plays a key role in basal ganglia (BG) circuits. However, despite the fundamental importance of DA in those circuits, the electrophysiological effects of dopamine on target neurons are largely unknown. Furthermore, contrary to classical models that only view the globus pallidus (GP) as a relay station of the indirect pathway, our neuroscientist colleagues at IMN have discovered a novel GP cell-type called the Arkypallidal (Arky-GP) neurons that only project to striatum in a very dense way. Arky-GP cells represent a novel BG pathway that might contribute massively to the GABAergic inhibition in striatum. In this project, we would like to explore for the first time whether DA has a direct action on Arky-GP neurons through D2 DA receptors. To do so, this project is based on multidisciplinary approaches that bring together 3 teams of IMN with different but complementary expertise (anatomical, in vivo electrophysiology, optogenetic manipulation, and computational modeling).

7.1.4. Collaboration with the Neurocentre Magendie on parameter optimization: Neurobees

The development of computational models of neurons and networks typically involves tuning of the numerical parameters to fit experimental results. This fitting is necessary to obtain consistent neural activity and therefore consistent action potential genesis and timing which play a key role in neural information encoding. However his task requires the exploration of multidimensional parameter spaces which are rarely accessible to analytical approaches. Moreover, if the parameter tuning can sometimes be manually completed it is more convenient to use automated optimization algorithms at least for two reasons: (i) to apply an homogeneous processing to all the calculation and parameter space exploration which alleviates operator influence and (ii) to avoid a tedious and uncertain result from human operators when the dimensionality increases. In computational

neuroscience, the optimization algorithms are often applied to cell scale models to mimic the electrical activity of their biological counterpart. Most of the time, it is necessary for the neuroscientist to quantify biophysical parameters such as dynamic conductances, ionic concentrations or even neuronal structure to understand the neuron dynamic properties. In this field, there is an important need for innovative optimization tools. We have recently developed with neuroscientists of the Bordeaux Magendie Neurocentre, a new multi-agent algorithm in line with ABC (Artificial Bee Colony) paradigm. This algorithm whose principle is based on honeybees food foraging has been successfully applied to several neural modeling optimization problems. We have applied it to several benchmarks and it has shown significantly higher performances in computing optimal parameter values in comparison with the previous optimization tools. A method paper summarizing all these results will be submitted at the begining of 2015.

7.1.5. Collaboration with IMS on GSM signal effects: JNNS (Julia Neural networks Simulator)

In collaboration with IMS (Laboratory of Material and System Integration, in Bordeaux) we have developed a electrophysiological setup aiming at the investigation of the effects of GSM (Global System for Mobile communications) signal on neural living tissue [15]. Our biological model consists in a cortical cell culture growing on a multi-electrode array. A first series of observations have been published showing a significant effect of these wavelengths on primary neural cell cultures spontaneous electrical activity. We are now looking for the action mechanism and site which could explain the observed effects. Along with these experimental investigations, modeling studies are considered. A spiking neuron network model is developed, taking into account biological features of the cell culture and exhibiting similar excitatory/inhibitory connectivity ratios as well as spontaneous bursting activity and a model of the recording setup (extracellular electrodes). To optimize the model development and notably the simulation speed, we have implemented the model using the Julia language. This tool is also be developed following the NeuroML initiative standards.

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. ANR project KEOPS

Participants: Frédéric Alexandre, Thierry Viéville.

We were responsible for this "ANR Internal White Project" involving Mnemosyne and Neuromathcomp Inria Project-Teams in France with the U. of Valparaiso, U. Tecnica Frederico Santa-Maria, and U. Chile, that ended in december 2014. The project was addressing the integration of non-standard behaviors of retinal neural sensors, observed in natural conditions, into neural coding models and their translation into real, highly non-linear, bio-engineering artificial solutions. Results concerning the thalamus and the retina evoked in § 6.3 have been obtained in this project. Furthermore, new collaboration tracks have been conducted, taking benefit of interdisciplinarity of this international collaboration, e.g. at the methodological level (*cf.* the ECOS project in § 7.3).

7.3. International Initiatives

7.3.1. Project BGaL with India

In the 3-years project "Basal Ganglia at Large (BGaL)", funded by the CNRS and the CEFIPRA, we collaborate with the computer science department of IIIT Hyderabad and the biomedical department of IIT Madras, for the design of models of basal ganglia, of their relation with other brain structures and or their implementation at large scale.

7.3.2. Project ECOS-Sud with Chile

In the 3-years project "A network for computational neuroscience, from vision to robotics", funded by ECOS-Sud and Conicyt, we collaborate with University Santa Maria and University of Valparaiso in Chile, and also with another Inria EPI, NeuroMathComp. The goal of the project is to rely on our experience of previous collaborations with these teams, to develop original tools and experimental frameworks to open our scientific domains of investigation to new fields of valorization, including medical (neurodegeneration) and technological aspects (robotics).

7.4. International Research Visitors

7.4.1. Internships

P Mehta Hima

Date: June - Dec 2014

Institution: Univ. Hyderabad (India)

7.4.2. Visits to International Teams

M. Topalidou, N. Rougier and F. Alexandre visited IIIT of Hyderabad (India) from 7 to 12 Dec. 2014 (*cf.* the BGaL project in § 7.3).

SISTM Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The team have strong links with Bordeaux CHU ("Centre Hospitalier Universitaire").

8.2. National Initiatives

8.2.1. Labex Vaccine Research Institute (VRI)

There are strong collaborations with immunologists involved in the Labex Vaccine Research Institute (VRI) as RT is leading the Biostatistics/Bioinformatics division.

8.2.2. Expert Appraisals

Coordination with Jean Weissenbach of the presidential plan of 100 M€ for “Systems biology” (RT)

Deputy director of the Institut de Recherche en Santé Publique IRESP (RT)

8.3. International Initiatives

8.3.1. Participation In other International Programs

RT is participating to the EUROCOORD network on HIV cohort collaborations as :

a member of the scientific committee of IWHOD International Workshop on HIV Observational Databases from 2013,

a project leader on defining references for the CD4 count response to antiretrovirals.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Following the RHOMEO project (ANR-BBSRC Systems biology 2007 call, 2007-2011) steered by RT, a strong collaboration has been established with Pr Robin Callard (UCL Immunology) who is visiting the team in Bordeaux one month each year, Andy Yates (Physicists, Glasgow Univ) and Ben Seddon (NIMR, UCL Immunology).

Also, several other international collaboration have been initiated through the Labex:

Steve Self and Peter Gilbert in Seattle (HVTN HIV vaccine Trial Network),

Marcus Altfeld (Immunologists, Hambourg & Harvard).

This group in collaboration with other teams in Europe is writing a response to the H2020 call PHC 2 – 2015: Understanding diseases: systems medicine.

8.4.2. Visits to International Teams

8.4.2.1. Sabbatical programme

BL is on sabbatical in Queensland University, Australia.

8.4.2.2. Research stays abroad

Chloé Pasin is visiting Steve Self at HVTN, Seattle.

Boris Hejblum visited François Caron at Oxford University, United-Kingdom.

HIEPACS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Innovative simulation methods for large scale numeric prototypes on emerging architectures computers

Participants: Emmanuel Agullo, Olivier Coulaud, Aurélien Esnard, Mathieu Faverge, Luc Giraud, Abdou Guermouche, Pierre Ramet, Jean Roman.

Grant: Regional council
Dates: 2013 – 2015
Partners: EPIs REALOPT, RUNTIME from Inria Bordeaux Sud-Ouest, CEA-CESTA and l'Institut pluridisciplinaire de recherche sur l'environnement et les matériaux (IPREM) .
Overview: Numerical simulation is now integrated into all the design levels and the scientific studies for both academic and industrial contexts. Given the increasing size and sophistication of the simulations carried out, the use of parallel computing is inescapable. The complexity of such achievements requires collaboration of multidisciplinary teams capable of mastering all the necessary scientific skills for each component constituting the chain of expertise. In this project we consider each of these elements as well as efficient methods for parallel codes coupling. All these works are intended to contribute to the design of large scale parallel multi-physics simulations. In addition to this research human activities the regional council also support some innovative computing equipment that will be embedded in the PlaFRIM experimental plateform, project led by O. Coulaud.

8.2. National Initiatives

8.2.1. Inria Project Lab

8.2.1.1. C2S@Exa - Computer and Computational Sciences at Exascale

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

8.2.2. ANR

8.2.2.1. SOLHAR: SOLvers for Heterogeneous Architectures over Runtime systems

Participants: Emmanuel Agullo, Mathieu Faverge, Andra Hugo, Abdou Guermouche, Xavier Lacoste, Pierre Ramet, Jean Roman, Guillaume Sylvand.

Grant: ANR-MONU

Dates: 2013 – 2017
Partners: Inria (REALOPT, RUNTIME Bordeaux Sud-Ouest et ROMA Rhone-Alpes), IRIT/INPT, CEA-CESTA et Airbus Group Innovations.
Overview:

During the last five years, the interest of the scientific computing community towards accelerating devices has been rapidly growing. The reason for this interest lies in the massive computational power delivered by these devices. Several software libraries for dense linear algebra have been produced; the related algorithms are extremely rich in computation and exhibit a very regular pattern of access to data which makes them extremely good candidates for GPU execution. On the contrary, methods for the direct solution of sparse linear systems have irregular, indirect memory access patterns that adversely interact with typical GPU throughput optimizations.

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computer equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. To date, the approaches proposed to achieve this objective are mostly based on a simple offloading of some computational tasks to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems. The development of a production-quality, sparse direct solver requires a considerable research effort along three distinct axes:

- linear algebra: algorithms have to be adapted or redesigned in order to exhibit properties that make their implementation and execution on heterogeneous computing platforms efficient and reliable. This may require the development of novel methods for defining data access patterns that are more suitable for the dynamic scheduling of computational tasks on processing units with considerably different capabilities as well as techniques for guaranteeing a reliable and robust behavior and accurate solutions. In addition, it will be necessary to develop novel and efficient accelerator implementations of the specific dense linear algebra kernels that are used within sparse, direct solvers;
- runtime systems: tools such as the StarPU runtime system proved to be extremely efficient and robust for the implementation of dense linear algebra algorithms. Sparse linear algebra algorithms, however, are commonly characterized by complicated data access patterns, computational tasks with extremely variable granularity and complex dependencies. Therefore, a substantial research effort is necessary to design and implement features as well as interfaces to comply with the needs formalized by the research activity on direct methods;
- scheduling: executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.

Given the wide availability of computing platforms equipped with accelerators and the numerical robustness of direct solution methods for sparse linear systems, it is reasonable to expect that the outcome of this project will have a considerable impact on both academic and industrial scientific computing. This project will moreover provide a substantial contribution to the computational science and high-performance computing communities, as it will deliver an unprecedented example of a complex numerical code whose parallelization completely relies on runtime scheduling systems and which is, therefore, extremely portable, maintainable and evolvable towards future computing architectures.

8.2.2.2. SONGS: Simulation Of Next Generation Systems

Participant: Abdou Guermouche.

Grant: ANR 11 INFRA 13
Dates: 2011 – 2015

Partners: Inria (Bordeaux Sud-Ouest, Nancy - Grand Est, Rhone-Alpes, Sophia Antipolis - Méditerranée), I3S, LSIIT
Overview:

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently exploit such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

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.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

8.2.2.3. ANEMOS: Advanced Numeric for ELMs : Modeling and Optimized Schemes
Participants: Xavier Lacoste, Guillaume Latu, Pierre Ramet.

Grant: ANR-MN
Dates: 2012 – 2016
Partners: Univ. Nice, CEA/IRFM, CNRS/MDS.
Overview: The main goal of the project is to make a significant progress in understanding of active control methods of plasma edge MHD instabilities Edge Localized Modes (ELMs) wich represent particular danger with respect to heat and particle loads for Plasma Facing Components (PFC) in ITER. The project is focused in particular on the numerical modelling study of such ELM control methods as Resonant Magnetic Perturbations (RMPs) and pellet ELM pacing both foreseen in ITER. The goals of the project are to improve understanding of the related physics and propose possible new strategies to improve effectiveness of ELM control techniques. The tool for the non-linear MHD modeling is the JOREK code which was essentially developed within previous ANR ASTER. JOREK will be largerly developed within the present project to include corresponding new physical models in conjunction with new developments in mathematics and computer science strategy. The present project will put the non-linear MHD modeling of ELMs and ELM control on the solid ground theoretically, computationally, and applications-wise in order to progress in urgently needed solutions for ITER.

Regarding our contributions, the JOREK code is mainly composed of numerical computations on 3D data. The toroidal dimension of the tokamak is treated in Fourier space, while the poloidal plane is decomposed in Bezier patches. The numerical scheme used involves a direct solver on a large sparse matrix as a main computation of one time step. Two main costs are clearly identified: the assembly of the sparse matrix, and the direct factorization and solve of the system that includes communications between all processors. The efficient parallelization of JOREK is one of our main goals, to do so we will reconsider: data distribution, computation distribution or GMRES implementation. The quality of the sparse solver is also crucial, both in term of performance and accuracy. In the current release of JOREK, the memory scaling is not satisfactory to solve problems listed above , since at present as one increases the number of processes for a given problem size, the memory footprint on each process does not reduce as much as one can expect. In order to access finer meshes on available supercomputers, memory savings have to be done in the whole code. Another key point for improving parallelization is to carefully profile the application to understand the regions of the code that do not scale well. Depending on the timings obtained, strategies to diminish communication overheads will be evaluated and schemes that improve load balancing will be initiated. JOREK uses PaStiX sparse matrix library for matrix inversion. However, large number of toroidal harmonics and particular thin structures to resolve for realistic plasma parameters and ITER machine size still require more aggressive optimisation in numeric

dealing with numerical stability, adaptive meshes etc. However many possible applications of JOREK code we proposed here which represent urgent ITER relevant issues related to ELM control by RMPs and pellets remain to be solved.

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

Participants: Olivier Coulaud, Aurélien Esnard, Arnaud Etcheverry, Luc Giraud.

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 behavior of a single dislocation segment is perfectly understood since 1960 and analytical formulations are available in the literature. However, to understand the behavior 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 is to develop and validate the algorithms in order to optimize the numerical and performance efficiency 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 plastic deformation after irradiation. These kinds of studies where "local mechanisms" are correlated with macroscopic behavior is a key issue for nuclear industry in order to understand material aging under irradiation, and hence predict power plant secured service life. To carry out such studies, massive numerical optimizations 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 theses 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.

8.2.2.5. RESCUE: RÉsilience des applications SCientifiqUEs

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

Grant: ANR-Blanc (computer science theme)
Dates: 2010 – 2015
Partners: Inria EPI ROMA (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.

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

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

Grant: ANR-Blanc (applied math theme)
Dates: 2010 – 2014
Partners: Institut de Mathématiques de Toulouse (leader); Laboratoire d'Analyse, Topologie, Probabilités in Marseilles; Institut de Recherche sur la Fusion Magnétique, CEA/IRFM and 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 at 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.

8.2.2.7. DEDALES: Algebraic and Geometric Domain Decomposition for Subsurface/Groundwater Flows

Participants: Emmanuel Agullo, Luc Giraud, Mathieu Faverge, Louis Poirel.

Grant: ANR-14-CE23-0005
Dates: 2014 – 2018
Partners: Inria EPI POMDAPI (leader); Université Paris 13 - Laboratoire Analyse, Géométrie et Applications; Maison de la Simulation; Andra.

Overview: Project DEDALES aims at developing high performance software for the simulation of two phase flow in porous media. The project will specifically target parallel computers where each node is itself composed of a large number of processing cores, such as are found in new generation many-core architectures. The project will be driven by an application to radioactive waste deep geological disposal. Its main feature is phenomenological complexity: water-gas flow in highly heterogeneous medium, with widely varying space and time scales. The assessment of large scale model is of major importance and issue for this application, and realistic geological models have several million grid cells. Few, if at all, software codes provide the necessary physical features with massively parallel simulation capabilities. The aim of the DEDALES project is to study, and experiment with, new approaches to develop effective simulation tools with the capability to take advantage of modern computer architectures and their hierarchical structure. To achieve this goal, we will explore two complementary software approaches that both match the hierarchical hardware architecture: on the one hand, we will integrate a hybrid parallel linear solver into an existing flow and transport code, and on the other hand, we will explore a two level approach with the outer level using (space time) domain decomposition, parallelized with a distributed memory approach, and the inner level as a subdomain solver that will exploit thread level parallelism. Linear solvers have always been, and will continue to be, at the center of simulation codes. However, parallelizing implicit methods on unstructured meshes, such as are required to accurately represent the fine geological details of the heterogeneous media considered, is notoriously difficult. It has also been suggested that time level parallelism could be a useful avenue to provide an extra degree of parallelism, so as to exploit the very large number of computing elements that will be part of these next generation computers. Project DEDALES will show that space-time DD methods can provide this extra level, and can usefully be combined with parallel linear solvers at the subdomain level. For all tasks, realistic test cases will be used to show the validity and the parallel scalability of the chosen approach. The most demanding models will be at the frontier of what is currently feasible for the size of models.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. EXA2CT

Type: FP7

Defi: Special action

Instrument: Specific Targeted Research Project

Objectif: Exascale computing platforms, software and applications

Duration: September 2013 - August 2016

Coordinator: IMEC, Belgium

Partner: Particular specializations and experience of the partners are:

- Applications:
  - NAG - long experience in consultancy for HPC applications
  - Intel France - collaboration with industry on the migration of software for future HPC systems
  - TS-SFR - long experience in consultancy for HPC applications in Aerospace and Oil & Gas
- Algorithms – primarily numerical:
  - UA - broad experience in numerical solvers, with some taken up by the PETSc numerical library and other work published in high-ranking journals such as Science.
  - USI - expertise in parallel many-core algorithms for real-world applications on emerging architectures
  - Inria - expertise on large scale parallel numerical algorithms

  - IT4I - experience in the development of scalable solvers for large HPC systems (e.g. PRACE)
- Programming Models & Runtime Environments:
  - Imec - leads the programming model research within the Flanders ExaScience Lab
  - UVSQ - specialized in code optimization and performance evaluation in the area of HPC
  - TS-SFR - leading the BMBF funded GASPI project
  - Fraunhofer - developed a GASPI runtime environment used in industrial applications
- Hardware Optimization:
  - Intel France - investigates workloads for new hardware architectures within the context of the Exascale Computing Research centre

Inria contact: Luc Giraud

Abstract: The EXA2CT project brings together experts at the cutting edge of the development of solvers, related algorithmic techniques, and HPC software architects for programming models and communication. We will produce modular open source proto-applications that demonstrate the algorithms and programming techniques developed in the project, to help boot-strap the creation of genuine exascale codes.

Numerical simulation is a crucial part of science and industry in Europe. The advancement of simulation as a discipline relies on increasingly compute intensive models that require more computational resources to run. This is the driver for the evolution to exascale. Due to limits in the increase in single processor performance, exascale machines will rely on massive parallelism on and off chip, with a complex hierarchy of resources. The large number of components and the machine complexity introduce severe problems for reliability and programmability.

8.4. International Initiatives

8.4.1. Inria International Labs

We are involved in the Inria@SiliconValley initiative through the associate team FASTLA described below.

8.4.2. Inria Associate Teams

8.4.2.1. MORSE

Title: Matrices Over Runtime Systems @ Exascale

International Partner (Institution - Laboratory - Researcher):

KAUST Supercomputing Laboratory (ÉTATS-UNIS)

Duration: 2014 - 2016

See also: http://icl.cs.utk.edu/projectsdev/morse/index.html

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, runtime systems and scheduling 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.

8.4.2.2. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra

International Partner (Institution - Laboratory - Researcher):

Stanford University (ÉTATS-UNIS)

Lawrence Berkeley National Laboratory (ÉTATS-UNIS)

Duration: 2014 - 2016

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

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 $\mathcal{H}$-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 $\mathcal{H}$-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.

8.4.3. Participation In other International Programs

8.4.3.1. HOSCAR

We are involved in the Inria-CNPq HOSCAR project led by Stéphane Lanteri.

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models (Group 1), (ii) scientific data management (Group 2), and (iii) high-performance software systems (Group 3).

An annual meeting has been organized in Gramado, Brazil on September, 2014.

8.4.3.2. G8-ECS

Title: Enabling Climate Simulations at Extreme Scale

Inria principal investigator: Luc Giraud

International Partners (Institution - Researcher):

Univ. Illinois at Urbanna Champaign & Argonne National Lab. - Franck Cappello,

Univ. Tennessee at Knoxville - George Bosilca,

German Research School for Simulation Sciences - Felix Wolf,

Univ. Victoria - Andrew Weaver,

Titech - Satoshi Matsuoka,

Univ. Tsukuba - Mitsuhisa Sato,

NCAR - Rich Loft,

Barcelona Supercomputing Center - Jesus Labarta.

Duration: 2011 - 2014

See also: G8 ESC-Enabling Climate Simulations at Extreme Scale

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).

PHOENIX Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. HomeAssist: Platform for Assisted Living

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 includes a need analysis, the development of assistive applications and their experimental validation.

This work is funded by CARSAT Aquitaine ("Caisse d'Assurance Retraite et de la Santé au Travail"), Aquitaine Region and Conseil Général de la Gironde.

7.1.2. 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" research 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 Syndrome). 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.

7.1.3. 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 Aquitaine Region.

7.1.4. ANDDI

Five percent of the population have Intellectual Disabilities (ID). Individuals with ID have significant socio-adaptive limitations in a variety of daily activities, at home (task planification and execution, medication, home safety, etc.) as well as outside (route planning, itinerary in public transportation, etc.). Individuals with ID, their families, health institutions, caregiving services, and dedicated organizations strive to find ways in which these individuals can live as independently as possible, while promoting their social inclusion in every respect of their life (housing, professional training, employment, leisure, culture, etc.).

The research project ANDDI leverages the abilities of individuals with ID and the recent technological advances to develop a variety of assistive services addressing their daily needs. These services draw on our expertise in cognitive science and computer science, dedicated to assisting users with technologies. In particular, we use our platform, named HomeAssist, dedicated to the independently living of older adults. This platform relies on DiaSuite, our suite of tools for developing applications that orchestrate networked objects, and DiaSuiteBox, our platform that runs an open-ended set of applications, sensors, actuators and web services.

ANDDI addresses users with Down syndrome aiming to live independently; it pursues the following goals:

1. determining the key obstacles to perform daily activities autonomously and collecting the needs in assistive support expressed by individuals with ID and their family and caregivers;
2. developing and adapting assistive services available in HomeAssist across an iterative assessment (period of 6 months) of experiences of each individual;
3. evaluating the efficacy of our developed assistive services across the stages experienced by individuals progressively becoming independent in their daily life (pre-post comparison after 12 months of HomAssist intervention).

This project is funded by the “Conseil Régional d’Aquitaine” and “Trisomie 21”.

7.2. National Initiatives

7.2.1. 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.

7.2.2. 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.

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. OPALI

Title: OPen Assistive-technology platform for independent LIving

International Partner (Institution - Laboratory - Researcher):

Université du Québec à Trois Rivières (CANADA)

Duration: 2013 - 2015

See also: http://phoenix.inria.fr/opali

The goal of the OPALI project is to develop an Open Platform for Assisted Living targeting users with cognitive disabilities. It is a cross-disciplinary project combining expertise in (1) Computer Science focusing in development of applications orchestrating networked devices and (2) Psychology focusing in assistive technologies for users with cognitive disabilities. Furthermore, this project will leverage a unique research vehicle created by the University of Trois-Rivières consisting of a full-fledged apartment equipped with a range of networked devices and dedicated to experimental studies. The outcome of the project will include a large catalog of assistive applications allowing to match each user’s project life.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Catherine Plaisant visited the Phoenix team during the month of November 2014. Catherine Plaisant is a Senior Research Scientist at the University of Maryland Institute for Advanced Computer Studies and Associate Director of the Human-Computer Interaction Lab.

RUNTIME 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. REGION AQUITAINE

The Aquitaine Region Council is granting the PhD thesis of Bertrand Putigny about Performance Models for Heterogeneous Parallel Architectures.

REGION AQUITAINE - CEA The Aquitaine Region Council together with CEA is funding PhD thesis of Marc Sergent (2013-2016) on Scalability for Task-based Runtimes (See also Section Bilateral Grants with Industry)

8.2. National Initiatives

8.2.1. ANR

ANR SOLHAR (http://solhar.gforge.inria.fr/doku.php?id=start).

ANR MONU 2013 Program, 2013 - 2016 (36 months)

Identification: ANR-13-MONU-0007

Coordinator: Inria Bordeaux/LaBRI

Other partners: CNRS-IRIT, Inria-LIP Lyon, CEA/CESTA, EADS-IW

Abstract: This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. Several attempts have been made to accomplish the porting of these methods on such architectures; the proposed approaches are mostly based on a simple offloading of some computational tasks (the coarsest grained ones) to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool developed in the runtime team (Bordeaux). Although the SOLHAR project will focus on heterogeneous computers equipped with GPUs due to their wide availability and affordable cost, the research accomplished on algorithms, methods and programming models will be readily applicable to other accelerator devices such as ClearSpeed boards or Cell processors.

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.

ANR MOEBUS Scheduling in HPC (http://moebus.gforge.inria.fr/doku.php).

ANR INFRA 2013, 10/2013 - 9/2017 (48 months)

Coordinator: Denis Trystram (Inria Rhône-Alpes)

Other partners: Inria Bordeaux.

Abstract: This project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments

8.2.2. ADT - Inria Technological Development Actions

ADT K'Star (http://kstar.gforge.inria.fr/#!index.md)

Participants: Olivier Aumage, Nathalie Furmento, Samuel Pitoiset, Samuel Thibault.

Inria ADT Campaign 2013, 10/2013 - 9/2015 (24 months)

Coordinator: Thierry Gautier (team MOAIS, Inria Montbonnot) and Olivier Aumage (team RUNTIME, Inria Bordeaux - Sud-Ouest)

Abstract: The Inria action ADT K'Star is a joint effort from Inria teams MOAIS and RUNTIME to design the KLANG-OMP source-to-source OpenMP compiler to translate OpenMP directives into calls to the API of MOAIS and RUNTIME respective runtime systems (XKaapi for MOAIS, StarPU for RUNTIME).

8.2.3. IPL - Inria Project Lab

C2S@Exa - Computer and Computational Sciences at Exascale **Participant:** Olivier Aumage.

Inria IPL 2013 - 2017 (48 months)

Coordinator: Stéphane Lantéri (team Nachos, Inria Sophia)

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

MULTICORE - Large scale multicore virtualization for performance scaling and portability

Participants: Emmanuel Jeannot, Denis Barthou [RUNTIME project-team, Inria Bordeaux - Sud-Ouest].

Multicore processors are becoming the norm in most computing systems. However supporting them in an efficient way is still a scientific challenge. This large-scale initiative introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. It aims to build collaborative virtualization mechanisms that achieve essential tasks related to parallel execution and data management. We want to unify the analysis and transformation processes of programs and accompanying data into one unique virtual machine. We hope delivering a solution for compute-intensive applications running on general-purpose standard computers.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Mont-Blanc 2

Type: FP7

Defi: Special action

Instrument: Integrated Project

Objectif: Exascale computing platforms, software and applications

Duration: October 2013 - September 2016

Coordinator: Alex Ramirez (UPC)

Partner: UPC,Inria, Bull, ST, ARM, Gnodal, Juelich, BADW-LRZ, HLRS, CNRS, CEA, CINECA, Bristol, Allinea

Inria contact: Denis Barthou

Abstract: The Mont-Blanc project aims to develop a European Exascale approach leveraging on commodity power-efficient embedded technologies. The project has developed a HPC system software stack on ARM, and will deploy the first integrated ARM-based HPC prototype by 2014, and is also working on a set of 11 scientific applications to be ported and tuned to the prototype system. The rapid progress of Mont-Blanc towards defining a scalable power efficient Exascale platform has revealed a number of challenges and opportunities to broaden the scope of investigations and developments. Particularly, the growing interest of the HPC community in accessing the Mont-Blanc platform calls for increased efforts to setup a production-ready environment. The Mont-Blanc 2 proposal has 4 objectives:

- To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support
- To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system
- To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips)
- To provide continued support for the Mont-Blanc consortium, namely operations of the original Mont-Blanc prototype, the new small scale prototypes and hands-on support for our application developers

Mont-Blanc 2 contributes to the development of extreme scale energy-efficient platforms, with potential for Exascale computing, addressing the challenges of massive parallelism, heterogeneous computing, and resiliency. Mont-Blanc 2 has great potential to create new market opportunities for successful EU technology, by placing embedded architectures in servers and HPC.

8.3.1.2. HPC-GA

Type: FP7

Defi: NC

Instrument: International Research Staff Exchange Scheme

Objectif: NC

Duration: January 2012 - December 2014

Coordinator: Jean-François Méhaut (UJF, France)

Partner: UFRGS, Inria, BRGM, BCAM et UNAM.

Inria contact: Jean-François Mehaut

Abstract: The design and implementation of geophysics applications on top of nowadays supercomputers 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.

8.3.2. Collaborations in European Programs, except FP7 & H2020

Program: **ITEA2**

Project acronym: COLOC

Project title: The Concurrency and Locality Challenge

Duration: November 2014 - November 2017

Coordinator: BULL

Other partners: BULL SA (France); Dassault Aviation (France) ; Enfeild AB (Sweden); Scilab entreprise (France); Teratec (France); Inria (France); Swedish Defebnse Research Agency - FOI (France); UVSQ (France).

Abstract: The COLOC project aims at providing new models, mechanisms and tools for improving applications performance and supercomputer resources usage taking into account data locality and concurrency.

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Program: **COST**

Project acronym: NESUS

Project title:Network for Ultrascale Computing

Duration: April 2014 - April 2018

Coordinator: University Carlos III de Madrid

Other partners: More than 35 European Countries.

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society.

8.4. International Initiatives

8.4.1. Inria International Labs

JLPC Inria joint-Lab on Extreme Scale Computing:

Coordinators: Franck Cappello and Marc Snir.

Other partners: Argonne National Lab, Inria, University of Urbanna Champaign, Tokyo Riken, Jülich Supercomputing Center, Barcelona Supercomputing Center.

Abstract: The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, Riken, Jülich, and BSC. It focuses on software challenges found in extreme scale high-performance computers.

8.4.2. Inria Associate Teams

MORSE Matrices Over Runtime Systems at Exascale

Inria Associate-Teams program: 2011-2016

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.

8.4.3. Inria International Partners

8.4.3.1. Informal International Partners

We collaborate with the following team.

- INESC-ID, Lisbon, Portugal on appplication moldeling.
- UWLAX (Wisconsin) works with us on network topology modeling;
- we collaborate with ICL at University of Tennessee on instrumenting MPI applications and modeling platforms (works on HWLOC take place in the context of the OPEN MPI consortium) and MPI and process placement
- On the industrial side collaborate with Cisco Systems about network topologies and platform models and Intel on modeling many-core platforms and BULL on memory hierarchy modeling.
- ETH Zurich (Switzerland), on topology mapping;
- PPL (U. Illinois at Urbana Champaign) on topology-aware load-balancing (through the Inria-Urbana-Argonne Joint Lab).
- University of Tokyo and Riken on the adaptation of MPI and runtime systems to MIC processors.
- Oak Ridge National Laboratory on high-performance network programming interfaces.

8.4.4. Participation In other International Programs

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

ANR-JST 2010 Program, 01/09/2010 - 31/03/2014

Identification: ANR-10-JST-002

Coordinator: Serge Petiton (Inria Saclay)

Other partners: CNRS IRIT, CEA DEN Saclay, Inria Bordeaux, CNRS-Prism, 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.

SEHLOC Scheduling evaluation in heterogeneous systems with hwloc

STIC-AmSud 2012 Program, 01/2013 - 12/2014 (24 months)

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.

NextGN Preparing for Next Generation Numerical Simulation Platforms

PUF (Partner University Fund) - France USA, 01/2013 - 12-2016 (3 years)

Coordinator: Franck Capello, Marc Snir and Yves Robert

Other Partners: Inria, Argonne National Lab and University of Urbanna Chapaign

This PUF proposal builds on the existing successful joint laboratory between Inria and UIUC that has produced in past three years and half many top-level publications, some of which resulted in student awards; and several software packages that are making their way to production in Europe and USA. The proposal extends the collaboration to Argonne National Laboratory (ANL) and CNRS researchers who will bring their unique expertise and their skills to help addressing the scalability issue of simulation platforms.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Malik Muhammad Zaki Murtaza Khan from Dept. of Computer and Information Science (IDI), Norwegian University of Science and Technology, Trondheim, Norway visited us for one week in October.

FLOWERS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Comacina Capsule Creative

The artist community is a rich source of inspiration and can provide new perspectives to scientific and technological questions. This complementarity is a great opportunity that we want to enforce in the Poppy project by making the robot accessible to non-robotic-expert users. The first experimentation of the use of Poppy in an art project was an artist residency entitled "Étres et Numérique". Led by the artists [0] Amandine Braconnier (mixed media artist) and Marie-Aline Villard (dancer-researcher), supported by the Fabrik Pola and the Aquitaine Region, this contemporary art project focused on the way to express emotions through robotic body movement in physical interaction with a human dancer. This work took the form of a seven day art-science residency involving members of the Poppy project and the artists. During the residency, the ease of programming through the pypot library permitted to design a simple interface allowing the dancer to physically sculpt novel movements, which softness could be dynamically controlled. This residency took part in a French high school (Lycée Saintonge, Bordeaux) and was also an educational experiment where young students participated to workshops where they explored Poppy movements and physical interaction with the robot. The residency restitution was a contemporary art dance performance involving poetic choreography, alternating phases of autonomous robot movements and passive robot movements provoked by the dancer. A description of this experiment is available at: https://forum.poppy-project.org/t/artist-residency-etres-et-numerique/72.

8.1.2. Poppy at Saintonge Sainte-Famille highschool (Bordeaux)

After the artistic residency that took place in the chapel at the Saintonge Sainte Famille high school, some teachers have become interested in the educational potential of the Poppy project and would like to integrate it as a common thread into the school year.

Poppy was initially designed for research purposes and seems to be also adapted for higher education. Yet using Poppy in secondary education seems excessive as it is expensive and the use of high quality servo-actuators is not really justified. However, the experience with high-school students is still interesting and we accepted this opportunity to do a pilot experiment.

For the teachers, the main goal was to gain experience of using such tools in a project context and evaluate the potential and limitations for educational purposes. For us, we were interested in the reaction of young students to Poppy and in getting an opinion on the relevance of Poppy for education at this level. Also, it was a real crash test of our design (hardware and software) in non-experienced hands and outside the laboratory.

The experiment took place in the Saintonge Sainte Famille high school on May 26th & 27th, and involved near 40 *première STI2D* students (equivalent to UK Year 12) preparing a professional baccalaureate and three teachers (*"Energy and environment"*, *"Architecture and construction"*, and *"Digital information systems"*). It was organized as a workshop in three 4-hour sessions. The last two hours were dedicated to oral presentations in the lecture hall allowing students to share their experiences and work.

For this first pilot experiment, we decided to reduce the cost by using only a sub-part of the whole Poppy. For us the most relevant part for high-school students was the upper body (thorax, head and the two arms), because it avoids to work on complex sensory-motor behaviours such as balancing and walking while keeping the expressive potential of Poppy. The total cost of Robotis Dynamixel motors, electronics and 3D printing service was about €2500 (20 % tax included).

The student team managed to assemble a fully functional Poppy. Groups working on control were able to make a live demo of Poppy moving at the end of the workshop.

[0] Comacina Capsule Creative, http://www.comacina.org/

This experience was very instructive on several aspects relative to the usage of Poppy for education purpose. In particular, it raises some problems we would have never thought about without a "real world" experimentation in a school environement.

8.1.3. ENSAM

The orientation of a (high school) student, choosing a career, is often based on an imagined representation of a discipline, sector of activity or training. Moreover, higher education is sometimes for a college student or a student a self centered universe, with inaccessible teaching methodologies and level of competence.

The Arts and Métiers campus at Bordeaux-Talence in partnership with Inria wishes to contribute with its educational and scientific expertise to the development of new teaching methods and tools. The objective is to develop teaching sequences based on a project approach relying on an attractive multidisciplinary technological system: the humanoid Inria Poppy robot. These teaching sequences will be built and tailored to different levels of training, from high schools to Engineer schools.

The new formation "Bachelor of Technology", started in September 2014 at Ensam Bordeaux, is resolutely turned towards a project based pedagogy, outlining concepts from concrete situations. The humanoid Inria Poppy robot offers an open platform capable of providing an unifying thread for the different subjects covered during the 3-years of the Bachelor formation: mechanics, manufacturing (3D printing), electrical, mechatronics, computer sciences, design...

For the 1st and 2nd year of the ENSAM Engineer cursus, the Poppy robot can again be an interesting thread to support the teaching and to conduct further investigation.

8.1.4. DIGITEO

Alexander Gepperth is participating in two projects (PhD and PostDoc) financed by the local "Digiteo" initiative of the Plateau de Saclay.

8.2. National Initiatives

8.2.1. Hackathon at Universcience

On march 22th & 23th 2014, UniverSciences [0] organized a hackathon for the general public around the assembly of a Poppy robot. It involved 15 robotic enthusiasts, from children to adults. Participants were dispatched around several workshops during the two days. While a group was dedicated to the actual assembly of the different Poppy parts, others were exploring how to program the robot with the Python software or working on designing and 3D printing hardware improvements. Aside the workshops around Poppy, several presentations and conferences about robotics were set-up. In this context, participants are not only spectators of a scientific mediation act but also actors.

In two days, this group of new users, self-trained using online documentation have been able to build from scratch the whole robot and make it move using the Pypot library. They even designed a new original semi-passive solution for the ankle joint, as well as a robot helmet which was 3D printed and assembled within the time of the workshop. This experiment did not only show that the platform was easily usable in an educational context with users of all ages, and was rebuildable in two days by a little group, but it also showed high educational value as testified by users and educators (see https://forum.poppy-project.org/t/poppy-project-at-la-cite-des-sciences-et-de-lindustrie/)

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. 3rd HAND

Type: FP7

[0] Paris museum of sciences and technologies

Defi: Cognitive Systems and Robotics

Instrument: Specific Targeted Research Project

Objectif: Robotics, Cognitive Systems and Smart Spaces, Symbiotic Interaction

Duration: October 2013 - September 2016

Coordinator: Manuel Lopes

Partner: Universitaet Darmstadt, Germany

Partner: Stuttgart University, Germany

Partner: University of Innsbruck, Austria

Inria contact: Manuel Lopes

Abstract: Robots have been essential for keeping industrial manufacturing in Europe. Most factories have large numbers of robots in a fixed setup and few programs that produce the exact same product hundreds of thousands times. The only common interaction between the robot and the human worker has become the so-called ”emergency stop button”. As a result, re-programming robots for new or personalized products has become a key bottleneck for keeping manufacturing jobs in Europe. The core requirement to date has been the production in large numbers or at a high price. Robot-based small series production requires a major breakthrough in robotics: the development of a new class of semi-autonomous robots that can decrease this cost substantially. Such robots need to be aware of the human worker, alleviating him from the monotonous repetitive tasks while keeping him in the loop where his intelligence makes a substantial difference.

In this project, we pursue this breakthrough by developing a semi-autonomous robot assistant that acts as a third hand of a human worker. It will be straightforward to instruct even by an untrained layman worker, allow for efficient knowledge transfer between tasks and enable a effective collaboration between a human worker with a robot third hand. The main contributions of this project will be the scientific principles of semi-autonomous human-robot collaboration, a new semi-autonomous robotic system that is able to: i) learn cooperative tasks from demonstration; ii) learn from instruction; and iii) transfer knowledge between tasks and environments.

8.3.1.2. EXPLORERS

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

Duration: December 2009 - November 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.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. NEUROCURIOSITY

Title: NeuroCuriosity

International Partner (Institution - Laboratory - Researcher):

Columbia Neuroscience (ÉTATS-UNIS)

Duration: 2013 - 2015

One of the most striking aspects of human behavior is our enormous curiosity, drive for exploration. From a child feverishly examining a new toy with its hands and its eyes, to a tourist exploring a new city, to a scientist studying the brain, humans incessantly want to know. This exuberant curiosity shapes our private and social lives, and is arguably a key cognitive feature that allows our species to understand, control and alter our world. We aim to develop a novel unified biological and computational theory, which explains curiosity in the domain of visual exploration and attention as a deliberate decision motivated by learning progress. This theory will build and improve upon pioneer computational models of intrinsic motivation elaborated in developmental robotics, and be empirically evaluated in the context of visual exploration in monkeys through behavioral and brain imaging techniques. This will be the first attempt at a biological-computational framework of intrinsic motivation and perceptual exploration and their underlying cognitive mechanisms.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Jonathan Grizou, Manuel Lopes, and Pierre-Yves Oudeyer collaborated with Inaki Itturate (EPFL) and Luis Montesano (Zaragoza University) on Calibration-Free Brain-Computer Interaction. This collaboration leaded to the following publications [45], [44] . Since then, more experiments have been performed and a journal paper will be submitted in January 2015.

Jonathan Grizou and Manuel Lopes collaborated with Sammuel Barret and Peter Stone (LARG groupd, University of Texas at Austin) on extending our work on adaptive interaction to the multi-agent domain in the adhoc team framework. Their collaboration is still active and a joint paper is in preparation for beginning of 2015.

Anna-Lisa Vollmer, Jonathan Grizou, Manuel Lopes, and Pierre-Yves Oudeyer collaborated with Katharina Rohlfing (Bielefeld University) for studying the co-construction of interaction protocol in collaborative tasks with humans. We devellopped a new experimental setup to investigate the processes used by humans to negotiate a protocol of interaction when they do not already share one. This collaboration leaded to the following publication [66].

Pierre-Yves Oudeyer worked with Linda Smith (Psychological and brain sciences department, Indiana Univ., Bloomington, US) on computational modeling of cognitive development, in particular on the role of curiosity driven processes on the evolution of language (see http://www.pyoudeyer.com/OudeyerSmithTopicsCogSci14.pdf).

Thibaut Munzer and Manuel Lopes worked with Bilal Piot (Supelec), Mathieu Geist (Supelec) and Olivier Pietquin (Lille University) to develop an Inverse Reinforcement Learning algorithm for Relational Domains.

Thibaut Munzer and Freek Stulp worked with Olivier Sigaud (ISIR, UPMC) to study regression algorithm for DMP and their impact on DMP optimization. From this collaboration resulted the publication [61].

Freek Stulp has started a cooperation with Michael Mistry at the University of Birmingham on learning inverse dynamics models. This has lead to a joint publication at the 2014 IEEE International Conference on Humanoid Robotics, where Freek Stulp and Michael Mistry presented a poster.

A cooperation with Laura Herlant of Carnegie Mellon University on discovering skill options lead to a joint publication at the 2014 IEEE/RSJ International Conference on Intelligent Robots and Systems, where Laura Herlant gave a presentation.

Gennaro Raiola and Freek Stulp presented a poster titled “Libraries of Motion Primitives as Active Virtual Fixtures for Co-manipulation” at the Forum STIC Paris-Saclay http://www.digiteo.fr/forum-stic-paris-saclay.

Egor Sattarov and Alexander Gepperth presented a poster entitled "MODALSENSE-multimodal perception architecture for intelligent vehicles" at the Forum STIC Paris-Saclay http://www.digiteo.fr/forum-stic-paris-saclay.

Alexander Gepperth and Mathieu Lefort are collaborating with the university of applied sciences of Bottrop (Germany) on the subject of multimodal hand gesture recognition. In the context of this collaboration, Alexander Gepperth supervises a PhD student, Thomas Kopinski.

Gennaro Raiola has started partially working at CEA LIST to integrate his work on virtual mechanism on the Alfred robot at CEA. This is done under the joint supervision of Freek Stulp and Xavier Lamy (CEA LIST), in the context of the DIGITEO-funded project “PrActIx”

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Luis Montesano, University of Zaragoza, Spain
- Jacqueline Gottlieb, Columbia University, USA
- Thomas Kopinski, University of Applied Sciences Bottrop, Germany
- Thomas Schultz, McGill University, Canada
- Gary Cottrell, Univ. California San Diego
- Minoru Asada, Osaka University, Japan.
- Anne Warlaumont, Univ. California at Merced, US.

8.5.2. Visits to International Teams

- Manuel Lopes visited Jan Peters at Technical University of Darmstadt
- Manuel Lopes visited Zachary Pardos at University of Berkeley
- Pierre-Yves Oudeyer visited the Center for Brain and Cognitive Development, Birbeck College, London

8.5.2.1. Explorer programme

Jonathan Grizou

Date: Aug 2014 - Sep 2014

Institution: University of Texas at Austin (USA)

Jonathan Grizou received a Inria explorer fellowship to visit the LARG groupd headed by Peter Stone at the university of Texas at Austin. He visited their lab for a month in September 2014 and worked on adhoc team problems with Sammuel Barret and Peter Stone.

MANAO Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Carer xD: "Caractérisation et restitution du réel xD"

Currently, the characterization and display of the real world are limited to techniques focusing on a subset of the necessary physical phenomena. A lot of work has been done to acquire geometric properties. However, the acquisition of a geometry on an object with complex reflection property or dynamic behavior is still a challenge. Similarly, the characterization of a material is limited to a uniform object for complex material or a diffuse material when one is interested in its spatial variations.

To reach full interaction between real and virtual worlds (augmented reality, mixed reality), it is necessary to acquire the real world in all its aspects (spatial, spectral, temporal) and to return it as in all these dimensions. To achieve this goal, a number of theoretical and practical tools will be developed around the development of mixed reality solutions and the development of some theoretical framework that supports the entire project.

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. "Young Researcher" RichShape (2014-2018):

MANAO
Leader: G. Guennebaud
This project aims at the development of novel representations for the efficient rendering and manipulation of highly detailed shapes in a multi-resolution context.

7.2.1.2. 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 off-line, high-quality simulations or interactive simulations.

7.2.1.3. "Young Researcher" IM&M (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.

7.2.2. Competitivity Clusters

7.2.2.1. 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 in 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.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

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

Participants: cf. http://www.v-must.net/participants
Leader: S. Pescarin (CNR - Italy)
V-MusT.net is a 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.

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

Participants: Giessen University, Université Paris-Descartes, Bilkent University, Université de Leuven, Delft University, Birmingham University, Philips and NextLimit
Leader: R. 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.

7.3.2. Foreign grants

7.3.2.1. DFG Emmy-Noether grant "Plenoptic Acquisition and Projection - Theoretical Developments and Applications" (2012-2017)

Leader: I. Ihrke
This project aims to develop a comprehensive theory of the imaging process in optical-computational devices as developed in the newly emerging field of Computational Optics. The theory will be validated by a number of practical applications.

It will allow for the modeling of image formation processes in measurement systems employing novel computational imaging and projection devices. This makes it possible to optimize these systems with respect to particular imaging tasks, which is currently impossible due to limited models. A further interesting aspect of the project is that computational imaging devices will become comparable with respect to parameters such as their resolution and noise characteristics which is hardly possible at the moment.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. From University of Montréal

Since the summer 2014, we are welcoming in our team Dr. Laurent BELCOUR, a post-doc from the University of Montréal. We are working together on the development of theoretical and practical tools for the analysis and the modeling of light transport operators such as BRDFs [15], [23].

7.4.1.2. From Beijing Normal University

We have long-standing exchanges with the Beijing Normal University. This university is in charge of some virtual reconstruction of the Chinese Cultural Heritage (such as the terracota warrios and the old Beijing). In this context, we received Dr. SHUI Wuyang for a one month visit in February to work on the use of our results to help the reconstruction and the visualization of ancient artefacts.

POTIOC Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Cap Sciences:

- Potioc has strong relationships with the Cap Sciences museum (http://www.cap-sciences.net/), especially through its Living Lab.

Immersion:

- Potioc has strong relationships with Immersion. In 2014, Immersion and Potioc notably co-supervised a Master student (Dennis Wobrock) on the topic "Using brain and physiological signals to assess 3D User Interfaces".

8.2. National Initiatives

ANR Project ISAR:

- duration: 2014-2017
- coordinator: Martin Hachet
- partners: LIG-CNRS (Grenoble), Diotasoft (Paris)
- acronym: Interaction en Réalité Augmentée Spatiale / Interacting with Spatial Augmented Reality
- The ISAR project (Interaction with Spatial Augmented Reality) focuses on the design, implementation, and evaluation of new paradigms to improve interaction with the digital world when digital content is directly projected onto physical objects (e.g. a ball on the figure). It opens new perspectives for exciting tomorrow's applications, beyond traditional screen-based applications.
- website: http://isar.imag.fr/

Inria ADT OpenViBE-NT:

- duration: 2012-2014
- partners: Inria teams Hybrid, Neurosys and Athena
- coordinator: Anatole Lécuyer (Inria Rennes Bretagne Atlantique)
- funded by Inria (Technological Development Project)
- The aim of this project is to further develop OpenViBE, notably in order to (1) make the software evolve towards a new version that fits better current and future needs from its users, (2) to offer new and original functionalities and (3) to keep ensuring OpenViBE support and dissemination. The final objective is to further increase OpenViBE usability and appeal, in order to strengthen the users' community surrounding the software and enable us to make it as viable and useful as possible, on the long term. The developments will also enable the Inria teams involved (Potioc, Hybrid, Neurosys and Athena) to explore new research directions on BCI, such as adaptive BCI, hybrid BCI, that combines EEG with other physiological sensors (e.g., heart rate, galvanic skin response, gaze, etc.), or new coupling between BCI and virtual reality in order to improve human training for BCI, thanks to new immersive feedback types.
- website: http://openvibe.inria.fr

Inria ADT OpenViBE-X:

- duration: 2014-2016
- partners: Inria teams Hybrid and Athena
- coordinator: Maureen Clerc (Inria Sophia Antipolis)
- This is the follow-up project of OpenViBE-NT
- website: http://openvibe.inria.fr

Inria Project Lab BCI-LIFT:

- partners: Inria team Athena (Inria Sophia-Antipolis), Inria team Hybrid (Inria Rennes), Inria team Neurosys (Inria Nancy), LITIS (Université de Rouen), Inria team DEMAR (Inria Sophia-Antipolis), Inria team MINT (Inria Lille), DyCOG (INSERM Lyon)
- coordinator: Maureen Clerc (Inria Sophia Antipolis)
- Project around BCI in the evaluation process, first meeting with all the partners was in October 2013
- The aim is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. With this concern of usability as our driving objective, we will build non-invasive systems that benefit from advanced signal processing and machine learning methods, from smart interface design, and where the user immediately receives supportive feedback. What drives this project is the concern that a substantial proportion of human participants is currently categorized “BCI-illiterate” because of their apparent inability to communicate through BCI. Through this project we aim at making it easier for people to learn to use the BCI, by implementing appropriate machine learning methods and developping user training scenarios.
- website: http://bci-lift.inria.fr/

AIBLE-Helios:

- duration: 2014-2015
- partners: SATT Nancy Grand Est, Université de Lorraine
- coordinator: Stṕhanie Fleck (Université de Lorraine)
- The AIBLE project (Augmented, Inquiry-Based, Learning, Environment) aims to provide a methodology and innovative media for the improvement of learning of basic astronomical phenomena for school groups (8-11 years). As part of this project, Potioc will focus on the development of the final application for augmented reality based and 3D manipulation, for providing a high-fidelity prototype.

PIA ville numérique "Villes transparentes":

- duration: 2012-2014
- partners: Pages Jaunes/Mappy, Vectuel/Virtuelcity
- In the context of the call for proposal Ville numérique (Digital city) by the Investissement d’Avenir Program, the Potioc team was selected for the project “Villes transparentes” (Transparent city) in collaboration with Mappy (Pages Jaunes group) and Vectuel. In this project of a duration of two years, the Potioc team focused on the development of innovative interaction techniques for the navigation in urban 3D environments.

DRAO:

- duration: 2012-2014
- partners: Inria teams Reves, manao, In-Situ
- ANR Young Researcher Program (Adrien Bousseau, Reves team)
- DRAO is a research project dedicated to the creation of drawing. Its first focus is on the understanding of how people draw through studies and interviews with professionals.The second goal is the automation of some parts of the drawing process. Finally, the third goal is the creation of tools to teach drawing with digital tools.
- website: https://www-sop.inria.fr/members/Adrien.Bousseau/drao/index.html

Interco3D:

- partners: IRIT Toulouse
- Recognized as official working group by AFIHM
- The objective of this working group is to unite a community of actors involved in the design and use of interaction techniques for 3D spaces, ie perceive, understand, manipulate and move within virtual 3D spaces.
- website: http://www.irit.fr/INTERCO3D/

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7 & H2020

Program: DGA-DSTL Project

Project title: Assessing and Optimising Human-Machine Symbiosis through Neural signals for Big Data Analytics

Duration: 2014-2018

Coordinators: Ulster University (Nothern Ireland, UK), Inria Bordeaux Sud-Ouest (France)

Abstract: This project's objective is to design new tools for Big Data analysis, and in particular visual analytics tools that tap onto human cognitive skills as well as on Brain-Computer Interfaces. The goal is to enable the user to identify and select relevant information much faster than what can be achieved by using automatic tools or traditional human-computer interfaces. More specifically, this project will aim at identifying in a passive way various mental states (e.g., different kinds of attention, mental workload, relevant stimulus perception, etc.) in order to optimize the display, the arrangement or the selection of relevant information.

8.3.2. Collaborations with Major European Organizations

Collaboration with the University of Bristol, BIG (UK), Bristol Interaction and Graphics (BIG) group, UK (Head: Pr. Sriram Subramanian)

We have strong relationships with Sriram Subramanian. This has led to joint paper publications, numerous visits and a co-supervision of a PhD thesis (Camille Jeunet)

Bordeaux Idex project "Conception de Système d'interfaces cerveau-ordinateur prenant en compte les facteurs humains afin d'optimiser l'apprentissage de l'utilisateur" for international PhD project

partners: Bordeaux Segalen University (Handicap & Système nerveux team), Bristol University (BIG team)

duration: October 2013 - September 2016

LIRA Stress and Relaxation project: LIfe-style Research Association, Lifestyle Management: Stress and Relaxation

Accord cadre Européen

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

duration: 2011 - 2021

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- Pr. Roger N'KAMBOU, department of Computer Sciences at the UQAM (Université du Québec à Montréal) who is a specialist of Intelligent Tutoring Systems (ITS). We are setting up a collaboration with him to develop such a system in order to optimise human learning in Brain-Computer Interfaces (BCI), and thus improve the performances with such systems. We visited Pr. N'Kambou and UQAM in May in Montreal, and he visited us at Inria in December, where we organized a Workshop on human learning and computer sciences.
- We are collaborating with Dr. Cuntai Guan (I2R, Singapore), Pr. Jonathan Bromberg (Kansas University, USA) and Pr. Gerwin Schalk (Wadsworth center, USA) on ElectroCorticoGraphic (ECoG) signal analysis.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

This year, the Potioc team has hosted two international PhD students :

- Flavio Bertini, University of Bologna, Italy (December 2013-February 2014)
- Nicholaos Katzakis, Osaka University, Japan (September 2014 until November 2014)

Potioc has also hosted an international Master student :

- Julia Schumacher, Technische Universitaet Berlin, Germany (April 2014 - October 2014)

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

Camille Jeunet was working at the University of Bristol, UK, in the BIG (Bristol Interaction and Graphics) groups of Pr. Sriram Subramanian, from July to September 2014.