RESEARCH CENTER
Bordeaux - Sud-Ouest

FIELD

Activity Report 2017

Section Partnerships and Cooperations

Edition: 2018-02-19

LFANT Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Alambic – AppLicAtions of MalleaBIlity in Cryptography

Participant: Guilhem Castagnos.

https://crypto.di.ens.fr/projects:alambic:main

The ALAMBIC project is a research project formed by members of the Inria Project-Team CASCADE of ENS Paris, members of the AriC Inria project-team of ENS Lyon, and members of the CRYPTIS of the university of Limoges. G. Castagnos is an external member of the team of Lyon for this project.

Non-malleability is a security notion for public key cryptographic encryption schemes that ensures that it is infeasible for an adversary to modify ciphertexts into other ciphertexts of messages which are related to the decryption of the first ones. On the other hand, it has been realized that, in specific settings, malleability in cryptographic protocols can actually be a very useful feature. For example, the notion of homomorphic encryption allows specific types of computations to be carried out on ciphertexts and generate an encrypted result which, when decrypted, matches the result of operations performed on the plaintexts. The homomorphic property can be used to create secure voting systems, collision-resistant hash functions, private information retrieval schemes, and for fully homomorphic encryption enables widespread use of cloud computing by ensuring the confidentiality of processed data.

The aim of the ALAMBIC project to investigate further theoretical and practical applications of malleability in cryptography. More precisely, this project focuses on three different aspects: secure computation outsourcing and server-aided cryptography, homomorphic encryption and applications and << paradoxical >> applications of malleability.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

Title: OpenDreamKit

Program: H2020

Duration: January 2016 - December 2020

Coordinator: Nicolas Thiéry

Inria contact: Karim Belabas

Description http://cordis.europa.eu/project/rcn/198334_en.html, http://opendreamkit.org

OpenDreamKit is a Horizon 2020 European Research Infrastructure project (#676541) that will run for four years, starting from September 2015. It provides substantial funding to the open source computational mathematics ecosystem, and in particular popular tools such as LinBox, MPIR, SageMath, GAP, Pari/GP, LMFDB, Singular, MathHub, and the IPython/Jupyter interactive computing environment.

7.3. International Initiatives

7.3.1. Inria International Labs

7.3.1.1. FAST

Title: (Harder Better) FAster STronger cryptography

International Partner

Université des Sciences et Techniques de Masuku (Gabon) - Tony Ezome and the PRMAIS project

Start year: 2017

See also: https://www.inria.fr/en/associate-team/fast

The project aims to develop better algorithms for elliptic curve cryptography with prospect of the two challenges ahead: - securing the internet of things - preparing towards quantum computers.

Elliptic curves are currently the fastest public-key cryptosystem (with a key size that can fit on embeded devices) while still through a different mode of operation beeing (possibly) able to resist quantum based computers.

Activities for this year involved the funding of Luca De Feo to speak at the EMA "Mathématiques pour la Cryptographie Post-quantique et Mathématiques pour le Traitement du Signal", organised by Djiby Sow and Abdoul Asiz Ciss organised an EMA at the École Polytechnique de Thiès (Sénégal) from May 10 to May 23, about "Cryptographie à base d'isogénies"; the visit of Abdoulaye Maiga to the LFANT team where he worked with Damien Robert to find absolute invariants of good reduction modulo 2 for abelian surfaces; and the organisation by Damien Robert of a workshop in Bordeaux with most of the team members from September 04 to September 08. The slides or proceedings are available at https://lfant.math.u-bordeaux.fr/index.php?category=seminar&page=2017.

7.3.2. Inria International Partners

7.3.2.1. 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).

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Researchers visiting the team to give a talk to the team seminar include Damien Stehlé (ENS Lyon), Cécile Pierrot (Centrum Wiskunde and Informatica, Amsterdam), Christophe Petit (Oxford), Benjamin Wesolowski (EPFL), Bernhard Schmidt (Nanyang Technological University, Singapore), Mohamadou Sall (Université Cheikh Anta Diop, Dakar, Sénégal), Emmanuel Fouotsa (The University of Bamenda, Cameroon), Abdoulaye Maiga (Université Cheikh Anta Diop, Dakar, Sénégal), Tony Ezome (Université des Sciences et Techniques de Masuku (USTM), Franceville, Gabon), Abdoul Aziz Ciss (Université Cheikh Anta Diop, Dakar, Sénégal), José Manuel Rodriguez Caballero (Labri), Jean Kieffer (ENS Paris), Christian Klein (Institut de Mathématiques de Bourgogne), Frank Vallentin (Mathematisches Institut, Universität zu Köln).

7.4.2. Visits to International Teams

Jared Asuncion went to the Autumn school: Topics in arithmetic and algebraic geometry last 9 - 13 October 2017 at the University of Mainz in Mainz, Germany.

Jared Asuncion went to see his cosupervisor, Marco String last 6 - 10 November 2017 at the Universiteit Leiden in Leiden, The Netherlands. It is planned to stay in Leiden for a period of six months while working on his PhD.

Jared Asuncion went to the 21st Workshop on Elliptic Curve Cryptography last 13 - 15 November 2017 at the Radboud University in Nijmegen, The Netherlands.

A. Page visited C. Maire in Cornell University (Ithaca, US) from November 27th to December 4th and gave a research talk there on December 1st. He then visited Michael Lipnowski in the Institute for Advanced Studies (Princeton, US) from December 4th to December 14th.

A. Enge visited Bernhard Schmidt in Nanyang Technological University, Singapore for three weeks.

Fredrik Johansson participated in the OSCAR: Antic workshop at TU Kaiserslautern, Germany and gave an invited talk on "Fundamental algorithms in Arb".

Fredrik Johansson participated in the workshop on Elliptic Integrals, Elliptic Functions and Modular Forms in Quantum Field Theory at DESY, Zeuthen, Germany, and gave an invited talk on "Numerics of classical elliptic functions, elliptic integrals and modular forms".

CAGIRE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Predicting head losses in aeronautical fuel injectors

This is a 3-year programme, started mid-2015 and funded by Conseil Régional d'Aquitaine (2014 Call) and two small-size companies, AD Industrie (Gurmençon, France) and GDTECH (Bordes, France). The objective is to investigate the possibility of using advanced RANS or hybrid RANS-LES approaches to better predict the pressure losses in aeronautical fuel nozzles. [PB,RM]

9.1.2. SEIGLE

SEIGLE means "Simulation Expérimentation pour l'Interaction de Gouttes Liquides avec un Ecoulement fortement compressible". It is a 3-year program which has started since October 2017 and was funded by Régional Nouvelle-Aquitaine, ISAE-ENSMA, CESTA and Inria. The interest of understanding aerodynamic mechanisms and liquid drops atomization is explained by the field of applications where they play a key role, specially in the new propulsion technologies through detonation in the aerospace as well as in the securities field. The SEIGLE project was articulated around a triptych experimentation, modeling and simulation. An experimental database will be constituted. It will rely on a newly installed facility (Pprime), similar to a supersonic gust wind tunnel/ hypersonic from a gaseous detonation tube at high pressure. This will allow to test modeling approaches (Pprime / CEA) and numerical simulation (Inria / CEA) with high order schemes for multiphasic compressible flows, suitable for processing shock waves in two-phase media [VP, JJ].

9.2. National Initiatives

9.2.1. GIS Success

We are members of the CNRS GIS Success (Groupement d'Intérêt Scientifique) organised around two of the major CFD codes employed by the Safran group, namely AVBP and Yales 2. No scientific activity has been devoted around those codes during 2017 but Yales2 has been installed and tested on one of our workstation to prepare some planned scientific activity to come in 2018 in the field of low Mach flows and low Reynolds flows simulations [PB].

9.2.2. ANR MONACO_2025 [RM]

The ambition of the MONACO_2025 project, coordinated by Rémi Manceau, is to join the efforts made in *two different industrial sectors* in order to tackle the industrial simulation of transient, turbulent flows affected by buoyancy effects. It brings together two academic partners, the project-team Cagire hosted by the university of Pau, and the institute Pprime of the CNRS/ENSMA/university of Poitiers (PPRIME), and R&D departments of two industrial partners, the PSA group and the EDF group, who are major players of the automobile and energy production sectors, respectively.

- The main **scientific objective** of the project is to make a breakthrough in *the unresolved issue* of the modelling of turbulence/buoyancy interactions in transient situations, within the continuous hybrid RANS/LES paradigm, which consists in preserving a computational cost compatible with industrial needs by relying on statistical approaches where a fine-grained description of the turbulent dynamics is not necessary. The transient cavity flow experiments acquired during MONACO_2025 will provide the partners and the scientific community with *an unrivalled source of knowledge* of the physical mechanisms that must be accounted for in turbulence models.

- The main **industrial objective** is *to make available computational methodologies* to address dimensioning, reliability and security issues in buoyancy-affected transient flows. It is to be emphasized that such problems are *not tackled using CFD at present in the industry*. At the end of MONACO_2025, a panel of methodologies, ranging from simple URANS to sophisticated hybrid model based on improved RANS models, will be evaluated in transient situations, against the dedicated cavity flow experiments and a real car underhood configuration. This final benchmark exercise will form *a decision-making tool* for the industrial partners, and will thus pave the way towards high-performance design of low-emission vehicles and highly secure power plants. In particular, the project is in line with the *Full Digital 2025 ambition*, e.g., the declared ambition of the PSA group to migrate, within the next decade, to a design cycle of new vehicles nearly entirely based on CAE (computer aided engineering), without recourse to expensive full-scale experiments.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. SOPRANO

Participants: Rémi Manceau, Pascal Bruel, [Post doc starting in 2018].

Topic: MG-1.2-2015 - Enhancing resource efficiency of aviation

Project acronym: SOPRANO

Project title: Soot Processes and Radiation in Aeronautical inNOvative combustors

Duration: 01/09/2016 - 31/08/2020

Coordinator: SAFRAN

Other partners:

- France: CNRS, CERFACS, INSA Rouen, SAFRAN SA, Snecma SAS, Turbomeca SA.
- Germany: DLR, GE-DE Gmbh, KIT, MTU, RRD,
- Italy: GE AVIO SRL, University of Florence
- United Kingdom: Rolls Royce PLC, Imperial College of Science, Technology and Medecine, Loughborough University.

Abstract: For decades, most of the aviation research activities have been focused on the reduction of noise and NOx and CO2 emissions. However, emissions from aircraft gas turbine engines of non-volatile PM, consisting primarily of soot particles, are of international concern today. Despite the lack of knowledge toward soot formation processes and characterization in terms of mass and size, engine manufacturers have now to deal with both gas and particles emissions. Furthermore, heat transfer understanding, that is also influenced by soot radiation, is an important matter for the improvement of the combustor's durability, as the key point when dealing with low-emissions combustor architectures is to adjust the air flow split between the injection system and the combustor's walls. The SOPRANO initiative consequently aims at providing new elements of knowledge, analysis and improved design tools, opening the way to: • Alternative designs of combustion systems for future aircrafts that will enter into service after 2025 capable of simultaneously reducing gaseous pollutants and particles, • Improved liner lifetime assessment methods. Therefore, the SOPRANO project will deliver more accurate experimental and numerical methodologies for predicting the soot emissions in academic or semi-technical combustion systems. This will contribute to enhance the comprehension of soot particles formation and their impact on heat transfer through radiation. In parallel, the durability of cooling liner materials, related to the walls air flow rate, will be addressed by heat transfer measurements and predictions. Finally, the expected contribution of SOPRANO is to apply these developments in order to determine the main promising concepts, in the framework of current low-NOx technologies, able to control the emitted soot particles in terms of mass and size over a large range of operating conditions without compromising combustor's liner durability and performance toward NOx emissions.

In the SOPRANO project, our objective is to complement the experimental (ONERA) and LES (CERFACS) work by RANS computations of the flow around a multiperforated plate, in order to build a database making possible a parametric study of mass, momentum and heat transfer through the plate and the development of multi-parameter-dependent equivalent boundary conditions. Our activity is due to start in September 2018.

9.4. International Initiatives

9.4.1. Informal International Partners

- Collaboration with Alireza Mazaheri, from NASA Langley Research Center on the first order formulation of the compressible Navier-Stokes system (2-month leave of V. Perrier at National Institute of Aerospace, Hampton, VA).
- Collaboration with E. Dick (University of Ghent, Belgium) and Y. Moguen (UPPA) on the determination of the best splitting of variables for handling low Mach flows with a pressure-energy based coupling. [PB]
- Collaboration with A. Beketaeva and A. Naïmanova (Institute of Mathematics, Almaty, Kazakhstan) related to the simulations of a supersonic jet in crossflow configuration. Contacts were also made with Axel Vincent from Onera Palaiseau in order to have access to recent experimental data on supersonic combustion.The low-Mach preconditioning of an in-house ENO based compressible flow solver was also adressed. [PB] (10-day stay in Almaty).
- Collaboration with P. Correia (University of Evora, Portugal) related to the development of enhanced boundary conditions for the simulations of Mach zero flows with the artificial compressibility method. [PB] (5-day stay in Evora).
- Collaboration with S. Lardeau (Siemens Industry Software Computational Dynamics, Nuremberg, Germany) on the EB-RSM model and hybrid RANS/LES model for industrial applications. [RM]

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Prof. Sergio Elaskar (Conicet and University National of Cordoba, Argentina) visited LMAP-Cagire for a 1-week stay from August 28 to September 1, 2017.
- Prof. Ezequiel Del Rio (Polytechnic University of Madrid) visited LMAP-Cagire for a 4-day stay from August 21 to August 31, 2017. The objective of these two simultaneous visits was to determine the possibility of generating data on the Maveric test facility to validate the intermittency model (mapping) jointly developed by S. Elaskar and E. Del Rio.

CARDAMOM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR MAIDESC

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

Type: ANR

Duration: 48 months

Starting date : 1st Oct 2013

Coordinator: Dervieux Alain (Inria Sophia)

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

9.1.2. PIA TANDEM

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

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

Duration: 48 months

Starting date : 1st Jan 2014

Coordinator: H. Hebert (CEA)

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

9.1.3. FUI ICARUS

Title: Intensive Calculation for AeRo and automotive engines Unsteady Simulations.

Type: FUI

Duration: January 2017 - December 2019

Coordinator: Turbomeca, Safran group

9.1.4. 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 oxidation. The obtained lifetimes can be of the order of hundreds of thousands of hours. These time spans make most experimental investigations impractical. In this direction, the aim of this project is to furnish predictions based on computer models that have to take into account: 1. the multidimensional topology of the composite made up of a woven ceramic fabric; 2. the complex chemistry taking place in the material cracks; 3. the flow of the healing oxide in the material cracks.

9.1.5. APP University of Bordeaux

Title : Modélisation d'un système de dégivrage thermique

Type : Project University of Bordeaux

Duration : 36 months

Starting : October 2016

Coordinator : H. Beaugendre and M. Colin

Abstract : From the beginning of aeronautics, icing has been classified as a serious issue : ice accretion on airplanes is due to the presence of supercooled droplets inside clouds and can lead to major risks such as aircrash for example. As a consequence, each airplane has its own protection system : the most important one is an anti-icing system which runs permanently. In order to reduce gas consumption, de-icing systems are developed by manufacturers. One alternative to real experiment consists in developing robust and reliable numerical models : this is the aim of this project. These new models have to take into account multi-physics and multi-scale environnement : phase change, thermal transfer, aerodynamics flows, etc. We aim to use thin films equations coupled to level-set methods in order to describe the phase change of water. The overall objective is to provide a simulation plateform, able to provide a complete design of these systems.

9.1.6. CRA - Region Aquitaine

Title : Virtual prototyping of EVE engines

Type : Co-funded from Region Aquitaine and Inria

Duration : 36 months

Starting : January 2017

Coordinator : P.M. Congedo

Abstract : The main objective of this thesis is the construction of a numerical platform, for permitting an efficient virtual prototyping of the EVE expander. This will provide EXOES with a numerical tool, that is much more predictive with respect to the tools currently available and used in EXOES, by respecting an optimal trade-off in terms of complexity/cost needed during an industrial design process.i Two research axes will be mainly developed. First, the objective is to perform some high-predictive numerical simulation for reducing the amount of experiments, thanks to a specific development of RANS tools (Reynolds Averaged Navier-Stokes equations) for the fluids of interest for EXOES. These tools would rely on complex thermodynamic models and a turbulence model that should be modified. The second axis is focused on the integration of the solvers of different fidelity in a multi-fidelity platform for performing optimization under uncertainties. The idea is to evaluate the system perfor- mances by using massively the low-fidelity models, and by correcting these estimations via only few calculations with the high-fidelity code.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: Ocean ERANET

Project acronym: **MIDWEST**

Project title: Multi-fidelity decision making tools for wave energy systems

Duration: October 2015- October 2018

Coordinator: M. Ricchiuto

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

MIDWEST is a project starting in 2016 (kick-off in December 2015) and funded by the EU-OceaneraNET program by the French ADEME, by the Swedish SWEA, and by the Portuguese FCT, aiming at proposing new tools for the wave energy industry. Wave energy converters (WECs) design currently relies on low-fidelity linear hydrodynamic models. While these models disregard fundamental nonlinear and viscous effects – which might lead provide sub-optimal designs – high-fidelity fully nonlinear Navier-Stokes models are prohibitively computational expensive for optimization. The MIDWEST project will provide an efficient asymptotic nonlinear finite element model of intermediate fidelity, investigate the required fidelity level to resolve a given engineering output, construct a multi-fidelity optimization platform using surrogate models blending different fidelity models. Combining know how in wave energy technology, finite element modelling, high performance computing, and robust optimization, the MIDWEST project will provide a new efficient decision making framework for the design of the next generation WECs which will benefit all industrial actors of the European wave energy sector.

Program: H2020 MSCA-ITN

Project acronym: **UTOPIAE**

Project title: Handling the unknown at the edge of tomorrow

Duration: January 2017- December 2020

Coordinator: M. Vasile (Strathclyde University)

Other partners: see http://utopiae.eu/ for additional details

UTOPIAE is a European research and training network looking at cutting edge methods bridging optimisation and uncertainty quantification applied to aerospace systems. The network will run from 2017 to 2021, and is funded by the European Commission through the Marie Skłodowska-Curie Actions of H2020. The network is made up of 15 partners across 6 European countries, including the UK, and one international partner in the USA, collecting mathematicians, engineers and computer scientists from academia, industry, public and private sectors.

Mission statement : To train, by research and by example, 15 Early Stage Researchers in the field of uncertainty quantification and optimisation to become leading independent researchers and entrepreneurs that will increase the innovation capacity of the EU. To equip the researchers with the skills they will need for successful careers in academia and industry. To develop fundamental mathematical methods and algorithms to bridge the gap between Uncertainty Quantification and Optimisation and between Probability Theory and Imprecise Probability Theory for Uncertainty Quantification to efficiently solve high-dimensional, expensive and complex engineering problems.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. COMMUNES

Title: Computational Methods for Uncertainties in Fluids and Energy Systems

International Partner (Institution - Laboratory - Researcher):

CWI (Netherlands) - Scientific Computing Group - Daan Crommelin

Start year: 2017

This project aims to develop numerical methods capable to take into account efficiently unsteady experimental data, synthetic data coming from numerical simulation and the global amount of uncertainty associated to measurements, and physical-model parameters. We aim to propose novel algorithms combining data-inferred stochastic modeling, uncertainty propagation through computer codes and data assimilation techniques. The applications of interest are both related to the exploitation of renewable energy sources: wind farms and solar Organic Rankine Cycles (ORCs).

9.3.1.2. HAMster

Title: High order Adaptive moving MeSh finiTE elements in immeRsed computational mechanics

International Partner (Institution - Laboratory - Researcher):

Duke (United States) - Civil & Environmental Engineering and Mechanical Engineering & Material Science - Guglielmo Scovazzi

Start year: 2017

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

This project focuses on adaptive unstructured mesh finite element-type methods for fluid flows with moving fronts. These fronts may be interfaces between different fluids, or fluid/solid, and modelling or physical Â fronts (e.g. shock waves) present in the flow. The two teams involved in the project have developed over the years complementary strategies, Â one focusing more on an Eulerian description aiming at capturing fronts on adaptive unstructured grids, Â the other Â working more on Lagrangian approaches aiming at following exactly some of these features. Unfortunately, classical Lagrangian methods are at a disadvantage in the presence of complex deformation patterns, especially for fronts undergoing large deformations, since the onset of vorticity quickly leads to mesh rotation and eventually tangling. On the other end, capturing approaches, as well as Immersed Boundary/Embedded (IB/EB) methods, while providing Â enormous flexibility when considering complex cases, Â require a careful use of mesh adaptivity to guarantee an accurate capturing of interface physics. The objective of this team is to study advanced hybrid methods combining high order, adaptive, monotone capturing techniques developed in an Eulerian or ALE setting, with fitting techniques and fully Lagrangian approaches.

9.3.2. Inria International Partners

9.3.2.1. 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

NASA Langley: Dr. Alireza Mazaheri. Collaboration on high order schemes for PDEs with second and third order derivatives, with particular emphasis on high order approximations of solution derivatives.

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 ;

University of Delaware: F. Veron. Collaboration on the modelling of rain effects on wave propagation.

CNRS-LIMSI: O. Le Maitre. Collaboration on Uncertainty Quantification methods.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- From 14/07/17 to 23/07/17 and from 18/12/2017 to 13/01/2018 Guglielmo SCOVAZZI, professor at Duke University, US has visited Mario Ricchiuto to work on...
- From 25/07/2017 to 28/07/2017, Anne EGGELS (PhD / CWI) has visited P.M. Congedo and F. Sanson for working around clustering in UQ methods.
- From 02/2017 to 07/2017, Luca Cirrottola (PhD/ Politecnico di Milano) has visited Cecile Dobrzynski to work on..
- From 2/10/17 to 20/10/2017, Loic GIRALDI , post doc at Ecole Centrale de Nantes has visited P.M. Congedo for working on UQ methods.
- From 13/11/17 to 17/11/2017 Ting SONG (PhD / Duke University) has visited Mario Ricchiuto to work on..
- From 15/12/17to 07/01/18 Leo NOUVEAU,post doc at Duke University, has visited Héloise Beaugendre and Mario Ricchiuto to work on..
- From 19/03/17 to 25/03/17, Hossein GORJI, post-doc at the RWTH Aachen University (Germany), has visited Luc Mieussens to work on the modelling of collisions in gases by Fokker-Planck models
- From 06/09/17 to 13/09/17, Kazuo AOKI, professor at the National Cheng Kung University (Taiwan), has visited Luc Mieussens to work on kinetic modelling of rarefied gases.

9.4.1.1. Internships

- From June 2017 to Sep 2017 Alexandre Bourriaud (Inria, M. Sc. Student)
- From Apr 2017 to Aug 2017 Khawla Msheik (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Loic Hale (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Lola Bouet (Inria, M. Sc. Student)
- From Apr 2017 to Sep 2017 Remi Chassagne (Inria, M. Sc. Student)
- From Mar 2017 to Aug 2017 Saad Abouelfateh (Inria, M. Sc. Student)
- From Jun 2017 to Aug 2017 Stephane Capitaine–Vaillant (Inria, M. Sc. Student)
- From Mar 2017 to Aug 2017 Yamina Hamidi (Inria, M. Sc. Student)

CQFD Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Piece (2013-2017) of the program Jeunes chercheuses et jeunes chercheurs of the ANR

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 ofcomplex systems. Their mathematical study has been intensively carried out in the past two decades but many challenging problems remain completely open. This project aims at federating a group of experts with different backgrounds (probability, statistics, analysis, partial derivative equations, modelling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

9.1.2. ANR StocMC (2014-2018) of the program Project Blanc of the ANR

The involved research groups are Inria Rennes/IRISA Team SUMO; Inria Rocquencourt Team Lifeware; LIAFA University Paris 7; Bordeaux University.
The aim of this research project is to develop scalable model checking techniques that can handle large stochastic systems. Large stochastic systems arise naturally in many different contexts, from network systems to system biology. A key stochastic model we will consider is from the biological pathway of apoptosis, the programmed cell death.

9.1.3. ANR BNPSI: Bayesian Non Parametric methods for Signal and Image Processing

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

9.1.4. Gaspard Monge Program for Optimisation and Operational Research (2017-2018)

The involved research groups are Inria Bordeaux Sud-Ouest Team CQFD and Thales Optronique. This new collaboration with Thales Optronique that started in October 2017 is funded by the Fondation Mathématique Jacques Hadamard. This is the continuation of the PhD Thesis of A. Geeraert. The objective of this project is to optimize the maintenance of a multi-component equipment that can break down randomly. The underlying problem is to choose the best dates to repair or replace components in order to minimize a cost criterion that takes into account costs of maintenance but also the cost associated to the unavailability of the system for the customer. In the PhD thesis of A. Geeraert, the model under consideration was rather simple and only a numerical approximation of the value function was provided. Here, our objective is more ambitious. A more realistic model will be considered and our aim is to provide a tractable quasi-optimal control strategy that can be applied in practice to optimize the maintenance of such equipments.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

- Program: Direcion General de Investigacion Cientifica y Tecnica, Gobierno de Espana
- Project acronym: GAMECONAPX
- Project title: Numerical approximations for Markov decision processes and Markov games
- Duration: 01/2017 - 12/2019
- Coordinator: Tomas Prieto-Rumeau, Department of Statistics and Operations Research, UNED (Spain)
- Abstract:

  This project is funded by the Gobierno de Espana, Direcion General de Investigacion Cientifica y Tecnica (reference number: MTM2016-75497-P) for three years to support the scientific collaboration between Tomas Prieto-Rumeau, Jonatha Anselmi and Francois Dufour. This research project is concerned with numerical approximations for Markov decision processes and Markov games. Our goal is to propose techniques allowing to approximate numerically the optimal value function and the optimal strategies of such problems. Although such decision models have been widely studied theoretically and, in general, it is well known how to characterize their optimal value function and their optimal strategies, the explicit calculation of these optimal solutions is not possible except for a few particular cases. This shows the need for numerical procedures to estimate or to approximate the optimal solutions of Markov decision processes and Markov games, so that the decision maker can really have at hand some approximation of his optimal strategies and his optimal value function. This project will explore areas of research that have been, so far, very little investigated. In this sense, we expect our techniques to be a breakthrough in the field of numerical methods for continuous-time Markov decision processes, but particularly in the area of numerical methods for Markov game models. Our techniques herein will cover a wide range of models, including discrete- and continuous-time models, problems with unbounded cost and transition rates, even allowing for discontinuities of these rate functions. Our research results will combine, on one hand, mathematical rigor (with the application of advanced tools from probability and measure theory) and, on the other hand, computational efficiency (providing accurate and ?applicable? numerical methods). In this sense, particular attention will be paid to models of practical interest, including population dynamics, queueing systems, or birth-and-death processes, among others. So, we expect to develop a generic and robust methodology in which, by suitably specifying the data of the decision problem, an algorithm will provide the approximations of the value function and the optimal strategies. Therefore, the results that we intend to obtain in this research project will be of interest for researchers in the fields of Markov decision processes and Markov games, both for the theoretical and the applied or practitioners communities

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

Tree-Lab, ITT. TREE-LAB is part of the Cybernetics research line within the Engineering Science graduate program offered by the Department of Electric and Electronic Engineering at Tijuana's Institute of Technology (ITT), in Tijuana Mexico. TREE-LAB is mainly focused on scientific and engineering research within the intersection of broad scientific fields, particularly Computer Science, Heuristic Optimization and Pattern Analysis. In particular, specific domains studied at TREE-LAB include Genetic Programming, Classification, Feature Based Recognition, Bio-Medical signal analysis and Behavior-Based Robotics. Currently, TREE-LAB incorporates the collaboration of several top researchers, as well as the participation of graduate (doctoral and masters) and undergraduate students, from ITT. Moreover, TREE-LAB is actively collaborating with top researchers from around the world, including Mexico, France, Spain, Portugal and USA.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Tomas Prieto-Rumeau (Department of Statistics and Operations Research, UNED, Madrid, Spain) visited the team during 2 weeks in 2017. 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 2017.

GEOSTAT Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

GEOSTAT is working with the following regional partners:

- CNRS LOMA (Laboratoire Ondes et Matière d'Aquitaine) and RAS Institute (Russia): collaboration on the analysis/modeling of heartbeat physiological time series (A. Arneodo, E. Gerasimova, F. Argoul).
- GEOSTAT has a decade-long close scientific collaboration with team SYSCO2 (LEGOS LAboratoryUMR 5566): V. Garçon, B. Dewitte, J. Sudre.
- Laboratoire d'Astrophysique de Bordeaux (S. Bontemps, N. Schneider, GENESIS project).
- Collaboration with L. Bourrel (GET Toulouse / IRD) and F. Frappart (GET/UMR EPOC)Flood monitoring in Equator.
- With Bruno Castelle (EPOC).
- With D. Gibert (OSUR) on signal and image processing.
- CHU Bordeaux : Prof. Wassilios Meissner (IMN), Dr. Solange Milhé de Saint Victor (service ORL).
- CHU Toulouse : Dr. Anne Pavy Le traon (service Neurologie), Prof. Virginie Woisard (service ORL).
- IRIT : Prof. Régine André-Obrecht, Dr. Julie Mauclair.
- IMT (Institut de Mathématique de Toulouse) : Dr. Sébastien Déjean, Dr. Laurent Risser.
- Mercator Océan: Dr. A. El Moussaoui. UMR EPOC).

9.2. National Initiatives

- ANR project *Voice4PD-MSA*, led by K. Daoudi, which targets the differential diagnosis between Parkinson's disease and Multiple System Atrophy. The total amount of the grant is 468555 euros, from which GeoStat has 203078 euros. The duration of the project is 42 months. Partners: CHU Bordeaux (Bordeaux), CHU Toulouse, IRIT, IMT (Toulouse).
- PhD grant for C. Artnana from UPMC University, under co-supervision with H. Yahia and C. Provost (LOCEAN, Paris).
- PhD grant for G. Singh from IIT Roorkee, under co-supervision with D. Singh (IIT Roorkee).
- The PHC-Toubkal project "Caractérisation multi-capteurs et suivi spatio-temporel de l'Upwelling sur la côte atlantique marocaine par imagerie satellitaire", led by K. Daoudi, is in its second year. The partners in this project are: Faculté des sciences de Rabat, Centre Royal de Télédetection Spatiale, Mercator-Ocean and GEOSTAT.
- GEOSTAT is a member of ISIS (Information, Image & Vision) and AMF (Multifractal Analysis) GDRs.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: supported by Deutsche Forschungsgemeinde (DFG) and the Agence national de recherche (ANR).

Project acronym: GENESIS.

Project title: GENeration and Evolution of Structures in the ISm.

Duration: start 1.5. 2017, 3 years.

Coordinator: N. Schneider (I. Physik, Cologne).

Other partners: Cologne (R. Simon, N. Schneider, V. Ossenkopf, M. Roellig), LAB (S. Bontemps, A. Roy, L. Bonne, F. Herpin, J. Braine, N. Brouillet, T. Jacq), ATN Canberra (Australia), LERMA Paris (France), MPIfR Bonn (Germany), CEA Saclay (France), ITA/ZAH Heidelberg (Germany), Institute of Astronomy, Cardiff (UK), ESO (Germany, Chile), CfA Harvard (USA), IPAG Grenoble (France), Argelander Institut Bonn (Germany), CASS San Diego (USA), University of Sofia (Bulgaria).

Abstract: The formation of stars is intimately linked to the structure and evolution of molecular clouds in the interstellar medium (ISM). We propose to explore this link with a new approach by combining far infrared maps of dust (Herschel) and cooling lines(C+ with SOFIA) with molecular line maps. Dedicated analysis tools will be used and developed to analyze the maps and compare them to simulations in order to identify for the underlying physical processes. This joint project relies on the complementary expertise of the members of the Cologne KOSMA group (structure identification methods and SOFIA), the Bordeaux LAB star formation group (Herschel and spectro-imaging maps), and the Bordeaux GEOSTAT team of Inria. To understand the genesis of stars, it is necessary to disentangle the relative importance of gravity, turbulence, magnetic fields, and radiation from diffuse gas, to molecular clouds and collapsing cores, and to study the role of filaments. Using innovative new analying tools developed by the GeoStat team, we will analyze the Herschel images as well as new spectro-imaging surveys from ground-based telescopes, and THz spectroscopy using SOFIA. The comparison with similar analysis on simulated clouds will allow us to derive the underlying physical process which explains cloud evolution and the formation of dense structures. The project does not aim at a full understanding of star formation within 3 years, but it constitutes an important step forward as it will make systematic use of a wealth of existing, yet not fully exploited archival data, carefully chosen new observations, and sophisticated tools to analyze and interpret the data. As such, it will shed new light on how molecular clouds and stars form and may well be the starting point for many studies to follow.

9.4. International Initiatives

9.4.1. Inria International Partners

Funding from French-Indian IFCAM program (Visit of Prof. D. Singh in GEOSTAT, 2017).

9.4.1.1. Informal International Partners

- Visit of N. Brodu to Univ. UC Davis in the team of Prof. J. Crutchfield. Setting up of a collaboration on a formalism of statistical reconstruction from dynamic empirical data; the formalism involves markovian automata called Epsilon machines. The internal states of these machine correspond to equivalence classes of a physical system having similar causal relations.
- Laboratory LRIT from Rabat University (K. Minaoui, D. Aboutajdine).

9.4.2. Participation in Other International Programs

Participation in the IFCAM project with India (funding of the visit of Prof. D. Singh in 2017).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- N. Schneider (Cologne University, GENESIS project).
- Prof. D. Singh (IIT roorkee, on CEFIPRA-CNRS funding). Duration: 8 weeks, August and December 2017. Co-supervision of G. Singh PhD stdudent, scientific collaboration with N. Brodu and K. Daoudi.

9.5.1.1. Internships

- G. Li. Master2, University Paris-Saclay.
- Q. Robin. Engineer, INP-Grenble.
- F. G. Satsou. Master1, University Bordeaux 1.

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

June-July 2017: PhD student A. El Aouni was invited in the MERCATOR project by A. Moussaoui in the framework of the Toubkal project on ocean modeling.

MEMPHIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Leading team of the regional project "Investigation and Modeling of Suspensions with the LOMA and LOF labs in Bordeaux

9.2. National Initiatives

We belong to the GDR AMORE on ROMs.

9.2.1. Starting grants

NEMO (A Numerical Enabler for MultiPhysics Simulations on Octrees) is an action to improve and merge all the main MEMPHIS numerical codes. To achieve this goal we have a 12 months financial support (Inria BSO FRM) for a young engineer. This work will be done with strong interaction the the local Inria BSO SED as well as Philippe Depouilly from the IMB "SED".
SMecH is a start-up project in software edition, carried on by Florian Bernard, research engineer in the MEMPHIS team. The project aims at porting to an industrial level the numerical codes developed by the MEMPHIS team. The different collaboration with industrial partners have highlighted the need of new numerical tools to simulate high complexity phenomena such as atmospheric reentries, multi-material flows or fund-structure interactions, but also to highly automatize the numerical simulation workflow to save engineer time. The research codes developed in the MEMPHIS team could match perfectly to this need thanks to:

- the various innovative multi-physics models implemented
- the use of Hierarchical Cartesian schemes that automatize the treatment of moving geometry with accuracy
- the development of schemes suitable for High Parallel Computing.

This year, the project has been submitted to the DGDT, the Inria department in charge of technological transfert, and has been granted an engineer for 6 months as well as the support of IT-Translation.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

EU research projects were and will be a privileged instrument of diffusion and transfer of our results. The AEROGUST H2020 project involves aeronautical industry (Airbus, Dassault, Piaggio..) and research labs (University of Bristol, DLR, NLR, University of Cape Town) and is dedicated to modeling of aerodynamic gust response for applications. We take part in this project by developing simulation models for unsteady aeroelastic problems and data-driven reduced-order models. We played a similar role for the past in the FP7 project FFAST with the same partners.

9.3.1.1. AEROGUST

Title: Aeroelastic Gust Modelling

Programm: H2020

Duration: May 2015 - April 2018

Coordinator: University of Bristol

Partners:

Airbus Defence and Space (Germany)

University of Cape Town (South Africa)

Dassault Aviation (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Stichting Nationaal Lucht- en Ruimtevaartlaboratorium (Netherlands)

Numerical Mechanics Applications International (Belgium)

Optimad Engineering S.R.L. (Italy)

Piaggio Aero Industries Spa (Italy)

The University of Liverpool (United Kingdom)

University of Bristol (United Kingdom)

Valeol (France)

Inria contact: Angelo IOLLO and Michel Bergmann

Encounters with atmospheric turbulence are a vitally important in the design and certification of many manmade structures such as aircraft and wind turbines. Gusts cause rapid changes in the flow about the structures which leads to rigid and flexible unsteady responses. Knowledge of aircraft/gust interactions is therefore vital for loads estimation during aircraft design as it impacts on control systems and often defines the maximum loads that these structures will experience in service. At present industry typically uses the linear doublet lattice method with static loads corrections from expensive wind tunnel data. The wind tunnel data is created using the final aerodynamic surface in the predicted cruise shape. This means that gust loads come relatively late when the design options have been narrowed. Increased competition and environmental concerns are likely to lead to the adoption of more flexible materials and the consideration of novel configurations, in which case the linear assumptions of the current gust loads process will become unacceptable. To introduce non-linearity into the gust loads process without significantly increasing the cost and time, this project has three main objectives: to carry out investigations using CFD so that the non-linearities in gust interactions are understood; to create a gust loads process that does not require wind tunnel data and hence reduces the need for wind tunnel testing; to develop updated reduced order models for gust prediction that account for non-linearity at an acceptable cost. These investigations will reduce the need for expensive wind tunnel testing and hence lead to time and cost savings at the design stage therefore ensuring that the European aerospace and defense industry remain competitive in the future. The wind turbine industry has similar concerns, with gusts and wind shear restricting the locations available for wind farms. The project will also address these issues using common methodology.

9.3.2. Collaborations with Major European Organizations

Partner 1: Chalmers University (Sweden)

This activity is complemented by several international interactions, in particular with Chalmers University in order to converge towards the real implementation of new control technologies on cars, buses and trucks.

Partner 2: Optimad Engineering , Torino (Italy)

We have a crucial partnership with Optimad Engineering, a spin-off of the Politecnico di Torino. This society has implemented in industrial codes several schemes that we have developed for the past. In exchange, we have access to these codes. One example is Pablo, an octree managing parallel library (http://www.optimad.it/products/pablo/). Three former PhD students at Inria are presently employed in Optimad and several others have spent or will spend a research period in this company in order to get acquainted with code architecture and massive parallelism. This company represents for us an ideal partner for the actual industrial feedback on our methods. As mentioned, we plan to create a local start-up in close collaboration with Optimad. This start-up will respond to actual industrial needs by specific software packages built starting from open source tools that are made available to the applied research community via a consortium. Florian Bernard has been recruited in Memphis for two years with the objective of bringing to a higher maturity level a set of modules developed within the team. He plans to fully invest himself in the creation of the start-up. As for the consortium, we are discussing with several partners including Cineca (Italy HPC center) and Optimad about how to structure such a mutual effort. The Storm Inria team is included in the discussions as a possible partner.

Partner 3: W4E (Wave for Energy) (Italy)

One project is the design of an ISWEC (Inertial See Wave Energy Converter) in collaboration with W4E (Wave for Energy), Optimad and others. The ISWEC is a floater prototype that can extract energy form the sea waves. The mechanism is based on a gyroscope that is rotating due to the passive motion of the floater. This prototype is actually tested in the Mediterranean sea in Italy. We will develop the numerical simulation as well as the shape optimization of the ISWEC.

Partner 4: MRGM (Maladies Rares : Génétique et Métabolisme), Bordeaux University (France)

We develop a collaboration with the MRGM lab. They are interested in the swimming of a zebrafish larvae under genetic modifications. One aim is to quantify the power spent by such fishes to swim after a stimuli reaction. The numerical simulation we develop can help computing integral quantities such as the power. This simulation is challenging due to the coupling several methods like image treatment (from movies given by MRGM), optimal transport and numerical simulations.

Partner 5: CRPP (Centre de recherche Paul Pascal), LOF (Laboratoire du Futur) and LOMA (Laboratoire Ondes et Matière d'Aquitaine) labs, Bordeaux University, France.

We established collaborations with physics and chemistry labs in Bordeaux, namely the CRPP, the LOF and the LOMA. They are concerned with the behavior of many passive (CRPP and LOF) and active (LOMA) particles in an incompressible flow. With these partners, we intend to use a combined experimental and computational approach to calibrate models in the case of dilute and concentrated suspensions. The numerical simulations of such particles can help to understand some underlying phenomena at the particles scale and thus to develop mesoscopic models for the whole system (PhD of Baptiste Lambert, oct. 2015).

9.4. International Research Visitors

9.4.1. Visits to International Teams

We have obtained a grant from the Idex Bordeaux of $10keuro$ to start a collaboration with Charbel Farhat of Stanford University on ROMs.

REALOPT Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Solhar (ANR-13-MONU-0007)

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computing platforms equipped with accelerators. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool. The focus of RealOpt in this project is on the scheduling aspect. Indeed, executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.
See also: http://solhar.gforge.inria.fr/

9.2. International Initiatives

9.2.1. Inria International Partners

In the follow-up of our 6 year Inria Associate Team project SAMBA , we have set an important research collaboration with Brazil (Universidade Federal Fluminense, Pontificia Universidade Catolica do Rio de Janeiro) and Chile (Universidad Adolfo Ibanez). This results in joint publications and frequent visits, including long stay by research students.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Teobaldo LEITE BULHOES, from Universidade Federal Fluminense (Niteroi, Brazil), visited the team from October 23rd to December 13th 2017.
- Orlando Rivera Letelier, from (Universidad Adolfo Ibanez, Chile, visited the team for January 2017.
- Eduardo UCHOA, from Universidade Federal Fluminense (Niteroi, Brazil), visited the team during two weeks from November 5th to 18th 2017.
- Xuding ZHU, from Zhejiang Normal University (Jinhua, China) visited the team during one month in June 2017.

CARMEN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CALM

The project "Cardiac Arrhythmia Localization Methods" has been granted by the Région Nouvelle-Aquitaine, with matching from funds held by our clinical collaboraters Dr. Hubert Cochet and Dr. Pierre Jaïs, and from Inria. The purpose of this project is to develop a tool that can predict the exit site of an arrhythmia with moderate accuracy (1 cm) in an absolute sense, with respect to the anatomy of the heart in situ, and with a resolution of about 2 mm in a relative sense, with respect to a nearby pacing site. This tool must fulfill the following criteria:

- it uses only data that are already recorded in the cathlab by other systems: ECG data and electroanatomical mapping data;
- it must work in nearly real-time; catheter displacement advice must be available within 5 seconds after a paced beat;
- it must work automatically, requiring the operator only to indicate which ECG data correspond to the target arrhythmia; and
- it must be safe and easy to operate.

We will in the first place test a number of proposed methods using synthetic data, produced with our realistic models of cardiac electrophysiology and accurate geometric models of different patients. This in-silico testing phase will answer a number of important practical questions. Subsequently we will use offline clinical data, and within 2 years we aim to build a clinical prototype that can be tested (without interfering in the procedure) in the cathlab. In order to work real-time we will initially use very simple methods. However, the clinical prototype and the collectoin of synthetic data that we created will later serve also as a platform to test also more sophisticated inverse methods.

8.1.2. EXACARD

We started a collaboration with the STORM team at Inria Bordeaux Sud-Ouest to work on further scaling of the Propag code, to push the limit from about 10^4 to 10^6 parallel processors. A pre-proposal has been submitted to the ANR, and we are doing preparatory work.

8.2. National Initiatives

8.2.1. ANR HR-CEM

The project "High Resolution Cardiac Electrophysiology Models: HR-CEM" within the ANR call *Modèles Numériques* started in November 2013 and lasted until November 2017.

This international project involved three partners: Inria (coordinator), IHU LIRYC, and UMI-CRM in Montréal (Canada). The project has 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 who 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.

8.2.2. ANR MITOCARD

The MITOCARD project (Electrophysiology of Cardiac Mitochondria), coordinated by S. Arbault (Université de Bordeaux, ISM), was granted by the ANR in July 2017. The objective of MITOCARD is to improve understanding of cardiac physiology by integrating the mitochondrial properties of cell signaling in the comprehensive view of cardiac energetics and rhythm pathologies. It was recently demonstrated that in the heart, in striking contrast with skeletal muscle, a parallel activation by calcium of mitochondria and myofibrils occurs during contraction, which indicates that mitochondria actively participate in Ca2+ signaling in the cardiomyocyte. We hypothesize that the mitochondrial permeability transition pore (mPTP), by rhythmically depolarizing inner mitochondrial membrane, plays a crucial role in mitochondrial Ca2+ regulation and, as a result, of cardiomyocyte Ca2+ homeostasis. Moreover, mitochondrial reactive oxygen species (ROS) may play a key role in the regulation of the mPTP by sensing mitochondrial energetics balance. Consequently, a deeper understanding of mitochondrial electrophysiology is mandatory to decipher their exact role in the heart's excitation-contraction coupling processes. However, this is currently prevented by the absence of adequate methodological tools (lack of sensitivity or selectivity, time resolution, averaged responses of numerous biological entities). The MITOCARD project will solve that issue by developing analytical tools and biophysical approaches to monitor kinetically and quantitatively the Ca2+ handling by isolated mitochondria in the cardiomyocyte.

MITOCARD is a multi-disciplinary project involving 4 partners of different scientific fields: the CARMEN team as well as

ISM, the largest chemistry laboratory of the Université de Bordeaux, where the necessary measurement methods will be developed;

Liryc, where mitochondria are studied at all levels of integration from the isolated mitochondrion to the intact heart; and

LAAS, the MiCrosystèmes d'Analyse (MICA) group at the Laboratory of Analysis and Architecture of Systems, which develops the biological microsensors for this project.

The project will

- develop chips integrating 4 different electrochemical microsensors to monitor in real-time key mitochondrial signaling parameters: Ca2+, membrane potential, quinone reduction status, O2 consumption, and ROS production;
- develop microwell arrays integrating ring nanoelectrodes to trap single mitochondria within micrometric chambers and measure locally by combined fluorescence microscopy and electrochemical techniques intra- (by fluorescence) and extra-mitochondrial (electrochemistry) metabolites; and
- develop a mathematical model of mitochondrial Ca2+ and ROS handling built on existing knowledge, new hypotheses, and the measured data.

The model may serve both to assess biological assumptions on the role of mitochondria in Ca2+ signaling and to integrate pathological data and provide clues for their global understanding.

8.2.3. GENCI

GENCI (*grand équipement national de calcul intensif*) is the agency that grants access to all national high-performance resources for scientific purposes in France. GENCI projects have to be renewed yearly. Our project renewal *Interaction between tissue structure and ion-channel function in cardiac arrhythmia*, submitted in September 2017, has been granted 9 million core-hours on the three major systems Curie, Occigen, and Turing. This compute time is primarily destined for our research into the interaction between ionic and structural heart disease in atrial fibrillation, Brugada syndrome, and early repolarisation syndrome [7] [61].

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

We participated in two H2020 Research and Innovation Action proposals.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

We coordinated a proposal with 5 European partners. The proposal could not be submitted due to administrative problems related to one of the partners, but we will benefit from the existing consortium to submit a new proposal in April 2018.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. EPICARD

Title: inversE Problems In CARDiac electrophysiology

International Partner (Institution - Laboratory - Researcher):

ENIT (Tunisia) – Department of Intelligence Science and Technology - Nabil Gmati

Start year: 2015

See also: https://team.inria.fr/carmen/epicard/

Improving the information that we can extract from electrical signals measured on patients with heart diseases is a major priority for the IHU LIRYC in Bordeaux headed by Professor Michel Haïssaguerre. We would like to non-invasively construct the electrical potential on the heart surface only from measurements of the electrical potential on the the chest of the patient.

This helps the medical doctor to visualise an image of the electrical potential of the heart of the patient. It is known that have been used in the literature for solving this electrocardiography imaging (ECGI) problem, including those used in commercial medical devices have several limitations. This problem could be mathematically seen as a boundary data completion problem for elliptic equations.

Many works in the literature have been carried out in order to solve this Cauchy problem, but have never been used for solving the ECGI problem. Our goal from the associate team is to develop an experimental platform allowing to test various methods and compare their performance on real life experimental data.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Y. Coudière works with the group of Prof. Y. Bourgault from the Department of Mathematics and Statistics of the University of Ottawa (Canada). Some results on the numerical analysis of time-stepping methods from C. Douanla's PhD were carried out together, as well as some theoretical results on parameter identification in the PhD of A. Gérard.

M. Potse and O. Bernus (Liryc) work with the group of Prof. A. Panfilov in Ghent, Belgium, on simulation and analysis of complex reentrant arrhythmia.

M. Potse works with the group of Prof. U. Schotten at Maastricht University (The Netherlands) and the Center for Computational Medicine in Cardiology at the *Università della Svizzera italiana* (Lugano, Switzerland) on simulation studies of atrial fibrillation [51]. The Maastricht group was partially funded by the FP7 project EUTRAF and our simulations were supported by GENCI (section 8.2.3).

M. Potse set up a project and recruited a PhD student to co-direct with Dr. Esther Pueyo of the University of Zaragoza, within the context of the H2020 International Training Network "Personalised In-silico Cardiology" (PIC), coordinated by Dr. Pablo Lamata of King's College London.

N. Zemzemi works with Cesare Corrado at King's College London on the development of new eikonal models allowing conduction velocity adaptation [14].

N. Zemzemi collaborated with Jesús Requena-Carrión from the Queen Mary University of London to study the effects of the spatial resolution of electrode systems on the spectrum of cardiac signals in cardiac electrocardiography [12].

N. Zemzemi worked with R. Aboulaich group from Mohamed V university in Morocco on sensitivity of the electrocardiographic problem to multiple independent sources of uncertainty including noise in the measurements and the heterogenity in the torso [34].

MAGIQUE-3D Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Partnership with I2M in Bordeaux supported by Conseil Régional d'Aquitaine

Title: Imaging complex materials.

Coordinator: Hélène Barucq

Other partners: I2M CNRS Université Bordeaux I

The detection, localization and monitoring of the defect evolution in composite materials, concrete and more generally heterogeneous materials is a challenging problem for Aeronautics and energy production. It is already possible to localize defects in homogeneous materials by using methods based on ultrasonic inspection and sometimes, they are usable in particular heterogeneous materials, most of the time in 2D. Classical methods rely on the correspondence between the distance and the propagation time of the wave traveling between the defect and the receivers. In complex media, such a correspondence may be lapsed, for instance when the velocity depends on the frequency (dispersion) or of the propagation direction (anisotropy). The defect signature can also be embedded in the acoustic field sent by the structure (multiple reflections). The complexity of the propagation in heterogeneous materials makes then difficult the accurate localization of the defect, in particular in 3D.

Topological imaging techniques can be applied to heterogeneous media. They can find the positions of defects from two simulations performed in a safe experimental medium. They have been developed at I2M laboratory to carry on 2D single/multi mode inspection in isotropic and anisotropic waveguides. They have also been applied to a highly reflecting medium observed with a single sensor. The objective of this work is to extend the technique to 3D problems. In particular, we are going to handle detection in composite plates and in highly heterogeneous media including a collection of small scatterers.

This project is supported by the Conseil Régional d'Aquitaine, for a duration of 2 years.

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 has involved 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 with Inria .

In 2014, the second phase of DIP has begun. Lionel Boillot has been hired as engineer to work on the DIP platform. Six PhD students have defended their PhD since 2014 and they are now post-doctoral researchers or engineers in Europe. DIP is currently employing 2 PhD students and one post-doctoral researcher.

8.2.2. ANR Num4Sun

The ANR has launched a specific program for supporting and promoting applications to European or more generally International projects. Magique-3D has been selected in 2016 after proposing a project to be applied as a FET project on the occasion of a call that will open in 2017 April. This project will gather researchers of the MPS (https://www.mps.mpg.de/en), of the BSC (https://www.bsc.es/), of the BCAM (http://www.bcamath.org/en/), of Heriot-Watt University (https://www.hw.ac.uk/) and Inria teams.

A kick-off meeting has been held in November 2016 in Strasbourg and a second one in Paris in July 2017. Thanks to this support, we have submitted a ETPHPC proposal in September 2017 The project is funded for 18 months starting from August 2016. The funding amounts 30000€.

8.2.3. ANR NonLocalDD

Magique 3-D is a partner of the ANR project entitled "Non Local Domain Decomposition Methods in Electromagnetics" that begins in october 2015. The aim of this project is to develop domain decomposition methods for the efficient solution of acoustics and Maxwell's equation either with boundary integral equations or finite element volume method. To obtain an exponential convergence of the iterative solution, non-local operators are studied and optimized to achieve a faster convergence. A post-doctoral student Marcella Bonazzoli has been hired by Magique 3-D in 2017 to study multi-domain integral equations for wave propagation. This student is supervised by Xavier Claeys, a partner of the NonLocalDD ANR project.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. GEAGAM

Title: Geophysical Exploration using Advanced GAlerkin Methods

Program: H2020

Duration: January 2015 - December 2017

Coordinator: Universidad Del Pais Vasco (EHU UPV)

Partners:

Bcam - Basque Center for Applied Mathematics Asociacion (Spain)

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Total S.A. (France)

Universidad Del Pais Vasco Ehu Upv (Spain)

Pontificia Universidad Catolica de Valparaiso (Chile)

Universidad de Chile (Chile)

Universidad Tecnica Federico Santa Maria (Chile)

University of Texas at Austin (USA)

Inria contact: Hélène BARUCQ

The main objective of this Marie Curie RISE action is to improve and exchange interdisciplinary knowledge on applied mathematics, high performance computing, and geophysics to be able to better simulate and understand the materials composing the Earth's subsurface. This is essential for a variety of applications such as CO2 storage, hydrocarbon extraction, mining, and geothermal energy production, among others. All these problems have in common the need to obtain an accurate characterization of the Earth's subsurface, and to achieve this goal, several complementary areas will be studied, including the mathematical foundations of various high-order Galerkin multiphysics simulation methods, the efficient computer implementation of these methods in large parallel machines and GPUs, and some crucial geophysical aspects such as the design of measurement acquisition systems in different scenarios. Results will be widely disseminated through publications, workshops, post-graduate courses to train new researchers, a dedicated webpage, and visits to companies working in the area. In that way, we will perform an important role in technology transfer between the most advanced numerical methods and mathematics of the moment and the area of applied geophysics.

8.3.1.2. HPC4E

Title: HPC for Energy

Program: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partners:

Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)

Iberdrola Renovables Energia (Spain)

Repsol (Spain)

Lancaster University (United Kingdom)

Total S.A. (France)

Fundação Coordenação de Projetos, Pesquisas e Estudos Tecnològicos, (Brazil)

National Laboratory for Scientific Computation, (Brazil)

Instituto Tecnològico de Aeronàutica, (Brazil)

Petrobras, (Brazil)

Universidade Federal do Rio Grande do Sul, (Brazil)

Universidade Federal de Pernambuco, (Brazil)

Inria contact: Stéphane Lanteri

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO2 emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

8.4.1.1.1. MAGIC2

Title: Advance Modeling in Geophysics

International Partner (Institution - Laboratory - Researcher):

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

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 the framework of Magic2, Izar Azpiroz visited CSUN in May 2017 and Rabia Djellouli (CSUN) visited Magique 3D in December 2017

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Rabia Djellouli (CSUN) visited Magique 3D in December 2017.
- Damien Fournier (MPS) visited Magique 3D in October 2017.
- Morgane Bergot (Univ Lyon) visited Magique 3D in November 2017.

8.5.2. Visits to International Teams

8.5.2.1. Research Stays Abroad

- In the framework of the European project Geagam, Izar Azpiroz and Justine Labat visited Ignacio Muga, PUCV, Chile, in April 2017.
- In the framework of the International Partnership Magic2, Izar Azpiroz visited Rabia Djellouli, CSUN (California State University at Northridge), USA, in May 2017.

MNEMOSYNE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. PsyPhINe

Participant: Nicolas Rougier.

Project gathering researchers from: MSH Lorraine (USR3261), InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Loria (UMR7503) & Mnemosyne.

PsyPhiNe is a pluridisciplinary and exploratory project between philosophers, psychologists, neuroscientists and computer scientists. The goal of the project is to explore cognition and behavior from different perspectives. The project aims at exploring the idea of assignments of intelligence or intentionality, assuming that our intersubjectivity and our natural tendency to anthropomorphize play a central role: we project onto others parts of our own cognition. To test these hypotheses, we ran a series of experiments with human subject confronted to a motorized lamp that can or cannot interact with them while they're doing a specific task. We've organized our third national conference in Nancy gathering speakers from philosophy, robotics, art and psychology and closed a three years cycle. The group now aims at publishing a book gathering text from all the invited speakers.

9.2. National Initiatives

9.2.1. FUI Sumatra

Participants: Frédéric Alexandre, Thalita Firmo Drumond, Xavier Hinaut, Randa Kassab, Nicolas Rougier, Thierry Viéville.

This FUI project, supported by the Aerospace Valley Innovation Pole, gathers two industrial groups (Safran Helicopter and SPIE), three research labs and four SME. Its goal is to provide contextualized information to maintenance operators by the online analysis of the operating scene. We are concerned in this project with the analysis of visual scenes, in industrial contexts, and the extraction of visual primitives, categories and pertinent features, best decribing the scenes, with biologically inspired neuronal models.

Firstly, this is an opportunity for us to revisit the principles of deep network architectures by adapting principles that we will elaborate from the context of the hierarchical architecture of the temporal visual cortex. Secondly, we intend to exploit and adapt our model of hippocampus to extract more heterogenous features. This project is an excellent opportunity to associate and combine our models and also to evaluate the robustness of our models in real-world applications.

9.2.2. ANR SOMA (PRCI)

Participant: Nicolas Rougier.

This new project is a convergence point between past research approaches toward new computational paradigms: adaptive reconfigurable architecture, cellular computing, computational neuroscience, and neuromorphic hardware:

1. SOMA is an adaptive reconfigurable architecture to the extent that it will dynamically re-organize both its computation and its communication by adapting itself to the data to process.
2. SOMA is based on cellular computing since it targets a massively parallel, distributed and decentralized neuromorphic architecture.
3. SOMA is based on computational neuroscience since its self-organization capabilities are inspired from neural mechanisms.
4. SOMA is a neuromorphic hardware system since its organization emerges from the interactions between neural maps transposed into hardware from brain observation.

This project represents a significant step toward the definition of a true fine-grained distributed, adaptive and decentralized neural computation framework. Using self-organized neural populations onto a cellular machine where local routing resources are not separated from computational resources, it will ensure natural scalability and adaptability as well as a better performance/power consumption tradeoff compared to other conventional embedded solutions.

9.2.3. ANR MACAQUE40

Participant: Nicolas Rougier.

Most of the theoretical models in economics proposed so far to describe money emergence are based on three intangible assumptions: the omniscience of economic agents, an infinite time and an extremely large number of agents (not bounded). The goal of this interdisciplinary study is to investigate the condition of apparition of a monetary economy in a more ecological framework provided with the assumption that the market is made up of a finite number of agents having a bounded rationality and facing a time constraint.

In this study, we propose a generic model and environment of monetary prospecting. Our first objective is to artificially identify structural (trading organisation, agents specialisation) and cognitive conditions (learning skills, memory and strategic anticipation abilities, tradeoff exploration/exploitation) that allowed money emergence. This will provide relevant environmental constraints that we will use during our manipulations in the laboratory. The agents that will be involved in these manipulations will be of two types: non-human primates (rhesus macaques) and humans.

9.2.4. Project Motus of the ANSES

Participant: André Garenne.

The MOTUS project (MOdulaTion dU Signal RF et effets sur le cerveau : approche in vivo et in vitro) is financed by the ANSES (the french national agency for health security). This 3 years project is studying the effects of GSM-RF on living matter and especially neuronal activity and development. Our main involvement concerns electrophysiological data and spike trains analysis as well as the development of pharmacological protocols to test GSM-RF effects hypotheses.

This year, we have designed and realised new experiments in order to better caracterize the effect of 1800 Mz RF field of GSM on the spontaneous activity of in-vitro cortical cell cultures. In the current study, our aim was to highlight a dose-response relationship for this effect. To do this, we have recorded the spontaneous bursting activity of cortical neurons cultures on multi-electrodes arrays. We have thus shown that at SAR (Specific Absorption Rate) ranging from 0.01 to 9.2 W/kg the signal elicited a clear decrease in bursting rate during the RF exposure phase that lasted even after the end of the exposure. Moreover, the effect grew larger with increasing SAR, and the amplitude of the change was greater with a GSM signal than with a continuous wave RF field of the same energy level. These experimental findings provide evidence for clear effects of RF signals on the bursting rate of neuronal cultures.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. Braincraft

Title: Braincraft

International Partner (Institution - Laboratory - Researcher):

University of Colorado, Boulder (United States) - Computational Cognitive Neuroscience - Randall O'Reilly

What are the processes by which animals and humans select their actions based on their motivations and on the consequences of past actions? This is a fundamental question in neurosciences, with implications to ethology, psychology, economics, sociology and computer science. Through a unique combination of expertise in cognitive psychology, neurosciences and computer science, this associate team will foster a collaboration for developing a computationally-based understanding of the neural circuits involved in decision making, namely basal ganglia and prefrontal cortex. One of the key question is to know the overall contribution of these structures and their function in the decision process.

9.3.2. Participation in Other International Programs

9.3.2.1. Project LingoRob with Germany

LingoRob - Learning Language in Developmental Robots - is a project of the Programme Hubert Curien PHC Procope with Germany (University of Hamburg). The scientific objective of the collaboration is to better understand the mechanisms underlying language acquisition and enable more natural interaction between humans and robots in different languages, while modelling how the brain processes sentences and integrates semantic information of scenes. Models developed in both labs involve artificial neural networks, and in particular Echo State Networks (ESN), also known as pertaining to the Reservoir Computing framework. These neural models allow insights on high-level processes of the human brain, and at the same time are well suited as robot control platform, because they can be trained and executed online with low computational resources. The collaborators will also combine Deep Learning networks to the reservoir models already used in order to benefit from their very good feature extraction abilities.

9.3.2.2. 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 and for their implementation at large scale as well as for their relation with other brain structures. This year we have worked on a model of a dopaminergic region, VTA, central for reinforcement learning in the basal ganglia.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Prof. Chakravarthy Srinivasa

Date: Nov-Dec 2017

Institution: IIT Madras, Chennai (India)

Johannes Twiefel

Date: 10 days, Sep 2017; 1 week, Nov 2017.

Institution: University of Hamburg, Germany.

Luiza Mici

Date: 10 days, Sep 2017.

Institution: University of Hamburg, Germany.

9.4.1.1. Internships

Remya Sankar

Date: June 2017 - Dec 2017

Institution: IIIT Hyderabad (India)

MONC Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Plan Cancer

8.1.1.1. NUMEP

Plan Cancer NUMEP: 2016–2019. Numerics for Clinical Electroporation Funding: 460 kE Partners: Inria Team MONC, Institut de Pharmacologie de Toulouse, CHU J. Verdier de Bondy Duration: Octobre 2016—Septembre 2019 Project leader: C. Poignard Co-PI: M-P. Rols (IPBS), O. Séror (CHU J. Verdier)

8.1.1.2. Dynamo

Plan Cancer DYNAMO: 2015–2018. Dynamical Models for Tissue Electroporation Funding: 370 kE Partners: Laboratoire Ampère, Lab. Vectorology and Anticancerous Therapies (IGR), Inria Team MONC Duration: Octobre 2015—Septembre 2018 Project leader: R. Scorretti (Laboratoire Ampère) Co-PI: L.M. Mir (IGR), C. Poignard (Inria Team MONC)

8.1.1.3. Moglimaging

- Project acronym - Moglimaging: Modeling of Glioblastoma treatment-induced resistance and heterogeneity by multi-modal imaging.
- Partners -
- Duration - from Nov. 2016 to Nov 2019.
- Coordinator - E. Cohen-Jonathan Moyal, Institut Universitaire du Cancer Toulouse / Local coordinator - O. Saut.
- Team participants - S. Benzekry, A. Collin, C. Poignard, O. Saut.

8.1.1.4. MIMOSA

- Project acronym - Plan Cancer MIMOSA (Physique, Mathématiques et Sciences de l'ingénieur appliqués au Cancer)
- Partner - ITAV, Toulouse
- Duration - from 2014 to 2017
- Coordinator - Th. Colin
- Team participants - Th. Colin, C. Poignard, O. Saut
- Title - Mathematical modeling for exploration of the impact of mechanical constraints on tumor growth

8.1.2. Systems Biology of Renal Carcinoma using a Mouse RCC model

- Title: Plan Cancer Systems Biology of Renal Carcinoma using a Mouse RCC model
- Partners : LAMC, INSERM-Univ. Bordeaux.
- Team participants: O. Saut, S. Benzekry (co-PI)
- 116.64k€

8.1.3. Transnation call: INCA/ARC

- Title: Minimally and non-invasive methods for early detection and/or progression of cancer
- Acronym: TRANSCAN
- Team participants: A. Collin, C. Poignard, O. Saut (local PI)
- Total funds: 1M150, Monc's share 275k€.

8.1.4. Competitivity Clusters

- Labex TRAIL (http://trail.labex.u-bordeaux.fr): MOD Project Consolidation. 1 2-years post-doc position (100k€), led by A. Collin, 1 PhD funding (100k€) led by O. Saut.

8.2. European Initiatives

MONC is partner of the European Lab EBAM devoted to electroporation. C.Poignard is member of the steering committee.

8.3. International Initiatives

MONC is partner of the Japanese Core-to-Core project « Establishing networks in mathematical medicine » coordinated by T. Suzuki (Osaka University) with Vanderbilt Univ, and St Andrews Univ. Local PIs are V. Quaranta (Vanderbilt), M. Chaplain (St Andrews) and C.Poignard (MONC).

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. METAMATS

Title: Modeling ExperimenTAl MetAsTasiS

International Partner (Institution - Laboratory - Researcher):

Roswell Park Cancer Institute (United States) - Department of Cancer Genetics Department of Medicine Department of Pharmacology and Therapeutics (Graduate Program) - John Ebos

Start year: 2017

See also: http://metamats.bordeaux.inria.fr/

The aim of the METAMATS associate team is to bring together a cancer biology experimental laboratory led by John ML Ebos (Roswell Park Cancer Institute) and the inria MONC team composed of applied mathematicians. The Ebos laboratory is specialized in the study of anti-cancer therapeutics (in particular, novel biologically targeted therapeutics such as anti-angiogenics and immunotherapies) on the development of metastases and produces unique, hard-to-obtain data sets on this process' dynamics. The MONC team is specialized in mathematical models in oncology, with a dedicated axis about modeling support and methodological development for analysis of data from preclinical studies. In particular, the work of S. Benzekry puts emphasis on proposing, studying and validating mathematical models of metastatic development under the action of various therapeutic modalities. Indeed, metastatic expansion remains the main challenge in the treatment of cancer and integrative studies combining experiments, mathematical models and clinical data have the potential to yield predictive computational tools of help to assist both the design of clinical trials and clinical oncologists in therapeutic decisions such as the control of the toxicity/efficacy balance or the optimal combination of treatment modalities.

8.3.1.2. Num4SEP

Title: Numerics for Spherical Electroporation

International Partner (Institution - Laboratory - Researcher):

University of California, Santa Barbara (United States) - ___Mechanical Engineering___ - Frederic Gibou

Start year: 2017

See also: http://num4sep.bordeaux.inria.fr/

Electroporation-based therapies (EPTs) consist in applying high voltage short pulses to cells in order to create defects in the plasma membrane. They provide interesting alternatives to standard ablative techniques, for instance for deep seated badly located tumors. However their use is still limited due to a lack of knowledge of tissue electroporation. The goal of the associate team is to focus on the multiscale numerical modeling of spheroid electroporation, in order to provide new insights in electroporation at the mesoscopic scales (spheroids provide interesting tumor-like biological models). Benefiting from the expertise of F. Gibou's team in HPC for multiphysics, and the expertise of the team MONC in tumor growth and cell electroporation modeling, the goal of the associate team Num4SEP is to obtain accurate and efficient numerical tools for the quantitative evaluation of the EPTs at the mesoscopic scale.

PLEIADE Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. COTE – Continental to Coastal Ecosystems

The Labex cluster of excellence COTE (Continental To coastal Ecosystems: evolution, adaptability and governance) develops tools to understand and predict ecosystem responses to human-induced changes as well as methods of adaptative management and governance to ensure their sustainability. The LabEx includes nine laboratories of the University of Bordeaux and major national research institutes involved in research on terrestrial and aquatic ecosystems (INRA, CNRS, IFREMER and IRSTEA). PLEIADE is a partner in one project funded by COTE:

- *Aerobarcoding: détection de pollens allergenisants*. 2017-18.

7.2. National Initiatives

7.2.1. Biocontamination in aircraft reservoirs

ANTICOR is an industrial-academic research and development working group coordinated by Dassault Aviation, investigating the causes of microbial contamination in aircraft reservoirs and aimed at developing mitigating procedures and equipment. Previous results have shown that this contamination forms biofilms at the fuel-water interface and is comprised of complex communities of hundreds of bacterial and fungal species. PLEIADE is particularly interested in measuring and modeling these communities, especially as concerns understanding how they change based on environmental conditions and on reservoir geometry.

This working group continues work started in CAER – Alternative Fuels for Aeronautics, a 6 M-Euro contract with the Civil Aviation Directorate (Direction Générale de l'Aviation Civile, DGAC), coordinated by the French Petroleum Institute (Institut français de pétrole-énergies nouvelles, IFPEN) on behalf of a large consortium of industrial (EADS, Dassault, Snecma, Turbomeca, Airbus, Air France, Total) and academic (CNRS, INRA, Inria) partners to explore different technologies for alternative fuels for aviation.

7.2.2. Agence Française pour la Biodiversité

The AFB is a public law agency of the French Ministry of Ecology that supports public policy in the domains of knowledge, preservation, management, and restoration of biodiversity in terrestrial, aquatic, and marine environments. PLEIADE is a partner in two AFB projects developed with the former ONEMA:

- *Methods for metabarcoding*. 2017-18.
- *Molecular diagnosis of freshwater quality*. 2014-present.

7.2.3. Inria Projet Lab in silico Algae

In 2017 PLEIADE joined the IPL "In silico Algae" coordinated by Olivier Bernard. The IPL addresses challenges in modeling and optimizing microalgae growth for industrial applications. PLEIADE worked this year on comparative genomic analysis of genes implicated in lipid production by the picoalgae *Ostreococcus tauri*, in collaboration with Florence Corellou of the CNRS UMR 5200 (Laboratoire de Biogénèse Membranaire). The goal of this work is the production of long-chain polyunsaturated fatty acids, developed as nutritional additives. Mercia Ngoma Komb's two-month internship in PLEIADE contributed to this work.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, Except FP7 & H2020

Alain Franc has been appointed co-chair of Working Group 4 (Data Analysis and Storage) of COST DNAqua.net [0], at the Sarajevo meeting in Fall 2017, with the main task of developing contact with HPC and metabarcoding for serving the whole community. The goal of DNAqua-Net is to nucleate a group of researchers across disciplines with the task to identify gold-standard genomic tools and novel eco-genomic indices and metrics for routine application for biodiversity assessments and biomonitoring of European water bodies.

7.4. International Initiatives

7.4.1. CEBA – Center for the study of biodiversity in Amazonia

The Laboratoire of excellence CEBA promotes innovation in research on tropical biodiversity. It brings together a network of internationally-recognized French research teams, contributes to university education, and encourages scientific collaboration with South American countries. PLEIADE participates in three current international projects funded by CEBA:

- *MicroBIOMES: Microbial Biodiversities*. 2017-19.
- *Neutrophyl: Inferring the drivers of Neotropical diversification*. 2017-19.
- *Phyloguianas: Biogeography and pace of diversification in the Guiana Shield*. 2015-present

[0] http://dnaqua.net/

SISTM Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The team have strong links with :

- Research teams of the research center INSERM U1219 : "Injury Epidemiology, Transport, Occupation" (IETO), "Biostatistics", "Pharmacoepidemiology and population impact of drugs", "Multimorbidity and public health in patients with HIV or Hepatitis" (MORPH3Eus), "Computer research applied to health" (ERIAS) emerging research team.
- Bordeaux and Limoges CHU ("Centre Hospitalier Universitaire").
- Institut Bergonié, Univ Bordeaux through the Euclid platform
- Inria Project-team MONC and CQFD

The project team members are involved in:

- EUCLID/F-CRIN clinical trials platform (Laura Richert)
- The research project “Self-management of injury risk and decision support systems based on predictive computer modelling. Development, implementation and evaluation in the MAVIE cohort study” funded by the Nouvelle-Aquitaine regional council (Marta Avalos).
- Phenotyping from Electronic Health Records pilot project in cooperation with with the ERIAS Inserm emerging team in Bordeaux and the Rheumatology service from the Bordeaux Hospital (Boris Hejblum)

9.2. National Initiatives

9.2.1. Labex Vaccine Research Institute (VRI)

There are strong collaborations with immunologists involved in the Labex Vaccine Research Institute (VRI) as Rodolphe Thiébaut is leading the Biostatistics/Bioinformatics division http://vaccine-research-institute.fr.

Collaboration with Inserm PRC (pôle Recherche clinique).

9.2.2. Expert Appraisals

- Rodolphe Thiébaut is an expert for INCA (Institut National du Cancer) for the PHRC (Programme hospitalier de recherche Clinique en cancérologie) and for the PRME (Programme de recherche médico-économique en cancérologie).
- Rodolphe Thiébaut is a member of the CNU 46.04 (Biostatistiques, informatique médicale et technologies de communication).
- Rodolphe Thiébaut is a member of the Scientific Council of INSERM.
- Mélanie Prague is an expert for ANRS (France Recherche Nord&Sud Sida-HIV Hépatites) in the CSS 3 (Recherches cliniques et physiopathologiques dans l’infection à VIH).
- Laura Richert is an expert for the PHRC (Programme hospitalier de recherche Clinique).
- Marta Avalos is an expert for L’ANSM (Agence nationale de sécurité du médicament et des produits de santé)

9.2.3. Various Partnership

The project team members are involved in:

- DRUGS-SAFE platform funded by ANSM (Marta Avalos).

- F-CRIN (French clinical research infrastructure network) was initiated in 2012 by ANR under two sources of founding "INBS/Infrastructures nationales en biologie et en santé" and "Programme des Investissements d'avenir". (Laura Richert)
- I-REIVAC is the French vaccine research network. This network is part of the "Consortium de Recherche en Vaccinologie (CoReVac)" created by the "Institut de Microbiologie et des Maladies Infectieuses (IMMI)". (Laura Richert)
- INCA (Institut National du Cancer) funded the project « Evaluation de l'efficacité d'un traitement sur l'évolution de la taille tumorale et autres critères de survie : développement de modèles conjoints. » (Principal PI Virginie Rondeau Inserm U1219, Mélanie Prague is responsible of Work package 4 mechanistic modeling of cancer: 5800 euros).
- Contrat Initiation ANRS MoDeL-CI: Modeling the HIV epidemic in Ivory Coast (Principal PI Eric Ouattara Inserm U1219 in collaboration with University College London, Mélanie Prague is listed as a collaborator).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The member of SISTM Team are involved in EHVA (European HIV Vaccine Alliance):

Program: Most information about this program can be found at http://www.ehv-a.eu.

Coordinator: Rodolphe Thiébaut is Work Package leader of the WP10 "Data Integration".

Other partners: The EHVA encompasses 39 partners, each with the expertise to promote a comprehensive approach to the development of an effective HIV vaccine. The international alliance, which includes academic and industrial research partners from all over Europe, as well as sub-Saharan Africa and North America, will work to discover and progress novel vaccine candidates through the clinic.

Abstract: With 37 million people living with HIV worldwide, and over 2 million new infections diagnosed each year, an effective vaccine is regarded as the most potent public health strategy for addressing the pandemic. Despite the many advances in the understanding, treatment and prevention of HIV made over the past 30 years, the development of broadly-effective HIV vaccine has remained unachievable. EHVA plans to develop and implement:

Discovery Platform with the goal of generating novel vaccine candidates inducing potent neutralizing and non-neutralizing antibody responses and T-cell responses

Immune Profiling Platform with the goal of ranking novel and existing (benchmark) vaccine candidates on the basis of the immune profile

Data Management/Integration/Down-Selection Platform, with the goal of providing statistical tools for the analysis and interpretation of complex data and algorithms for the efficient selection of vaccines

Clinical Trials Platform with the goal of accelerating the clinical development of novel vaccines and the early prediction of vaccine failure.

The member of SISTM Team and particularly Laura Richert are also involved in other H2020 projects such as SenseCog, Medit'aging and Orthunion.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: The EBOVAC2 project is one of 8 projects funded under IMI Ebola+ programme that was launched in response to the Ebola virus disease outbreak. The project aims to assess the safety and efficacy of a novel prime boost preventive vaccine regimen against Ebola Virus Disease (EVD).

Project acronym: EBOVAC2

Project title: EBOVAC2

Coordinator: Rodolphe Thiébaut

Other partners: Inserm (France), Labex VRI (France), Janssen Pharmaceutical Companies of Johnson & Johnson, London School of Hygiene & Tropical Medicine (United Kingdom), The Chancellor, Masters and Scholars of the University of Oxford (United Kingdom), Le Centre Muraz (Burknia Faso), Inserm Transfert (France)

Abstract: Given the urgent need for an preventive Ebola vaccine strategy in the context of the current epidemic, the clinical development plan follows an expedited scheme, aiming at starting a Phase 2B large scale safety and immunogenicity study as soon as possible while assuring the safety of the trial participants.

Phase 1 trials to assess the safety and immunogenicity data of the candidate prime-boost regimen in healthy volunteers are ongoing in the UK, the US and Kenya and Uganda. A further study site has been approved to start in Tanzania. Both prime-boost combinations (Ad26.ZEBOV prime + MVA-BN-Filo boost; and MVA-BN-Filo prime + Ad26.ZEBOV boost) administered at different intervals are being tested in these trials.

Phase 2 trials (this project) are planned to start as soon as the post-prime safety and immunogenicity data from the UK Phase I are available. Phase 2 trials will be conducted in healthy volunteers in Europe (France and UK) and non-epidemic African countries (to be determined). HIV positive adults will also be vaccinated in African countries. The rationale for inclusion of European volunteers in Phase 2, in addition to the trials in Africa, is to allow for higher sensitivity in safety signal detection in populations with low incidence of febrile illnesses, to generate negative control specimens for assay development, to allow for inclusion of health care workers or military personnel that may be deployed to Ebola-endemic regions.

9.3.3. Collaborations with Major European Organizations

University of Oxford;

London School of Hygiene and Tropical Medicine;

University Hospital Hamburg;

Heinrich Pette Institute for Experimental Virology, Hambourg;

MRC, University College London

9.4. International Initiatives

9.4.1. Inria International Labs

Fred Hutchinson Cancer center, Seattle;

Baylor Institute for Immunology (Dallas);

Duke University;

Collaborations through clinical trials: NIH for the Prevac trial, NGO Alima for the Prevac trial, Several African clinical sites for Ebovac2 and Prevac trials;

NIH program project grant "Revealing Reservoirs During Rebound", Harvard School of Public Health (HSPH) and the University of California, San Diego (P01AI131385, total budget $1.5M/yr for 5 years starting Oct 2017, both university manage the funding. Mélanie Prague is part of modelling unit of the "Quantitative Methods" research project (budget $220,000/yr). The principal investigator for this core is Victor de Grutolla (HSPH) The overall goal of this grant is to characterize viral rebound following antiretroviral therapy cessation in cohorts of patients who have started therapy early in infection, as well as in a cohort of terminally-ill patients who will interrupt therapy before death and subsequently donate their bodies to research.

Project submitted by the Inria DYNMO-HIVE team with the laboratory "Program for evolutionary Dynamics" at Harvard (head Martin Nowak).

Denis Agniel from the RAND Corporation on developing statistical methods for the analysis of RNA-seq data (Boris Hejblum).

Tianxi Cai from Harvard University on developing methods for the linkage and analysis of Electronic Health Records data (Boris Hejblum).

Katherine Liao from Harvard University on the analysis of Electronic Health Records data in the context of Rheumatoid Arthritis (Boris Hejblum).

Machine learning team Data61 at CSIRO, Australia

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Alison Hill from "Program for evolutionary Dynamics" at Harvard visited the SISTM team twice (each time for 5 days) in May 2017 and July 2017. Main topic discussed was mechanistic modelling of new agents in HIV cure.

Linda Valeri from "Harvard medical school" visited the SISTM team 3 days. Main topic discussed was mediation analysis in high dimension.

Denis Agniel (RAND Corporation) visited B. Hejblum in Bordeaux for a week in May for a research collaboration

Visiting PhD student from Marcus Altfeld's team: Annika Niehrs (2 week stay with SISTM).

9.5.2. Visits to International Teams

Marta Avalos visited David Conesa 1 week in October through the Erasmus+ program Universidad de Valencia (Espagne).

Mélanie Prague got invited in University of Pennsylvania (Philadelphia) for a 2-days research trip in the Biostatistics department on April 2-3 2017.

Mélanie Prague spend 10 days in Boston as an invited researcher in Harvard School of Public Health, Biostatistics department on April 10-15 2017.

Boris Hejblum visited Harvard University for a week in November 2017 for a research collaboration with Katherine Liao & Tianxi Cai.

9.5.2.1. Research Stays Abroad

Marta Avalos was a research visitor at CSIRO's Data61 in Canberra, Australia from Dec. 2016 until June 2017. Collaboration with Cheng Soon Ong http://www.ong-home.my/

Perrine Soret was a research student visitor at CSIRO's Data61 in Canberra (Australia) from Feb. 2017 to April 2017. Collaboration with Cheng Soon Ong. Funding: The University of Bordeaux Initiative of Excellence and Zellidja travel grants for a research visit of 3 months.

HIEPACS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. SOLHAR: SOLvers for Heterogeneous Architectures over Runtime systems

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

Grant: ANR-MONU
Dates: 2013 – 2017
Partners: Inria (REALOPT, STORM 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.

9.1.1.2. DEDALES: Algebraic and geometric domain decomposition for subsurface/groundwater flows

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

9.1.1.3. TECSER: Novel high performance numerical solution techniques for RCS computations

Participants: Emmanuel Agullo, Luc Giraud, Matthieu Kuhn.

Grant: ANR-14-ASTRID
Dates: 2014 – 2017
Partners: Inria EPI NACHOS (leader), Corida, HiePACS; Airbus Group Innovations, Nucletudes.
Overview: the objective of the TECSER projet is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Commissariat A L Energie Atomique et Aux Energies Alternatives (France)

Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)

Consiglio Nazionale Delle Ricerche (Italy)

The Cyprus Institute (Cyprus)

Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Forschungszentrum Julich (Germany)

Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany)

University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

The aim of the present proposal is to establish an Energy Oriented Centre of Excellence for computing applications, (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

9.2.1.2. HPC4E

Title: HPC for Energy

Programm: H2020
Duration: December 2015 - November 2017
Coordinator: Barcelona Supercomputing Center
Partners:

Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)
Iberdrola Renovables Energia (Spain)
Repsol (Spain)
Total S.A. (France)
Lancaster University (United Kingdom)

Inria contact: Stéphane Lanteri
This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO2 emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra
International Partner (Institution - Laboratory - Researcher):

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

Start year: 2012
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 linear solvers that appear in many intensive numerical simulations in computational sciences. For the solution of large linear systems, the ultimate goal is to design parallel scalable methods that rely on efficient sparse and dense direct methods using H-matrix arithmetic. Finally, the innovative algorithmic design will be essentially focused on heterogeneous manycore platforms by using task based runtime systems. The partners, Inria HiePACS, Lawrence Berkeley Nat. Lab and Stanford University, have strong, complementary and recognized experiences and backgrounds in these fields

PHOENIX Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Independent living with intellectual disabilities – ANDDI – 2014 - 2017

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 project is funded by the Region of Aquitaine.

8.1.2. Populational Study of HomeAssist – HomeAssist 500 – 2015 - 2017

We conduct a Randomized Controlled Trial (RCT) of HomeAssist with older adults, ranging from autonomous to mildly cognitively impaired (e.g., Alzheimer disease (AD) in its early stage). The RCT is considered as the gold standard of a true experimental design. Furthermore, it provides strong evidence for causal relationships, as well as the ability to generalize the results to people outside the study's sample. The study design will thus be a single-blinded RCT. It will include up to 500 participants, matched with non-equipped participants. The HomeAssist intervention will involve monitoring as well as compensation services to support independent living in place. The duration of the HomeAssist intervention is of 12 months. This project is funded by the Region of Aquitaine, the Districts of Gironde and Pyrénées Atlantique, CARSAT Aquitaine, UDCCAS, and CNSA.

8.2. National Initiatives

8.2.1. 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 and Orange Foundation.

8.3. International Initiatives

8.3.1. Participation in Other International Programs

- International exchange program Idex (2016-17) — "Memory, aging, Parkinson disease, and Virtual Reality", with Pr. Luc Noreau, Centre Interdisciplinaire de Recherche en réadaptation et intégration sociale-University of Laval, Canada. Coordinated by P. Dehail.
- Mobility program Idex UB-University of Waterloo, Canada — "Aging, Neurological conditions, and Assistance technologies" (2016-17). Coordinated by M. Fernandes and H. Sauzéon.

STORM Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. PIA

ELCI The ELCI project (Software Environment for HPC) aims to develop a new generation of software stack for supercomputers, numerical solvers, runtime and programming development environments for HPC simulation. The ELCI project also aims to validate this software stack by showing its capacity to offer improved scalability, resilience, security, modularity and abstraction on real applications. The coordinator is Bull, and the different partners are CEA, Inria, SAFRAN, CERFACS, CNRS CORIA, CENAERO, ONERA, UVSQ, Kitware and AlgoTech.

8.1.2. ANR

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

ANR MONU 2013 Program, 2013 - 2017 (36 months extended)

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.

8.1.3. ADT - Inria Technological Development Actions

ADT SwLoc (http://swloc.gforge.inria.fr/)

Participants: Raymond Namyst, Pierre-André Wacrenier, Andra Hugo, Brice Goglin, Corentin Salingue.

Inria ADT Campaign 2017, 10/2017 - 9/2019 (24 months)

Coordinator: Raymond Namyst

Abstract: The Inria action ADT SwLoc has the aim to develop a new library allowing dynamic flexible partitioning of computing resources in order to execute parallel regions.

8.1.4. 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.

HAC-SPECIS - High-performance Application and Computers, Studying PErformance and Correctness In Simulation **Participants:** Samuel Thibault, Luka Stanisic, Emmanuelle Saillard.

Inria IPL 2016 - 2020 (48 months)

Coordinator: Arnaud Legrand (team Polaris, Inria Rhône Alpes)

Since June 2016, the team is participating to the HAC-SPECIS http://hacspecis.gforge.inria.fr/ Inria Project Lab (IPL). This national initiative aims at answering methodological needs of HPC application and runtime developers and allowing to study real HPC systems both from the correctness and performance point of view. To this end, it gathers experts from the HPC, formal verification and performance evaluation community.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. INTERTWINE

Title: Programming Model INTERoperability ToWards Exascale

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: EPCC

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Institut National de Recherche en Informatique et en Automatique (France)

Kungliga Tekniska Hoegskolan (Sweden)

T-Systems Solutions for Research (Germany)

The University of Edinburgh (United Kingdom)

Universitat Jaume I de Castellon (Spain)

The University of Manchester (United Kingdom)

Inria contact: Olivier Aumage

This project addresses the problem of programming model design and implementation for the Exascale. The first Exascale computers will be very highly parallel systems, consisting of a hierarchy of architectural levels. To program such systems effectively and portably, programming APIs with efficient and robust implementations must be ready in the appropriate timescale. A single, "silver bullet" API which addresses all the architectural levels does not exist and seems very unlikely to emerge soon enough. We must therefore expect that using combinations of different APIs at different system levels will be the only practical solution in the short to medium term. Although there remains room for improvement in individual programming models and their implementations, the main challenges lie in interoperability between APIs. It is this interoperability, both at the specification level and at the implementation level, which this project seeks to address and to further the state of the art. INTERTWinE brings together the principal European organisations driving the evolution of programming models and their implementations. The project will focus on seven key programming APIs: MPI, GASPI, OpenMP, OmpSs, StarPU, QUARK and PaRSEC, each of which has a project partner with extensive experience in API design and implementation. Interoperability requirements, and evaluation of implementations will be driven by a set of kernels and applications, each of which has a project partner with a major role in their development. The project will implement a co- design cycle, by feeding back advances in API design and implementation into the applications and kernels, thereby driving new requirements and hence further advances.

8.2.1.2. Mont-Blanc 2

Title: Mont-Blanc

Programm: FP7

Duration: Sep. 2013 - Mar. 2017

Coordinator: BSC

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Atos/Bull (France)

ARM (United Kingdom)

Jülich (Germany)

LRZ (Germany)

University of Stuttgart (Germany)

CINECA (Italy)

CNRS (France)

CEA (France)

University of Bristol (United Kingdom)

Allinea Software (United Kingdom)

University of Cantabria (Spain)

Inria contact: Olivier Aumage

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.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

Program: PRACE

Project acronym: PRACE-5IP

Project title: PRACE Fifth Implementation Phase

Duration: 01/2017

Coordinator: PRACE

Abstract: The objectives of PRACE-5IP are to build on and seamlessly continue the successes of PRACE and start new innovative and collaborative activities proposed by the consortium. These include:

- assisting the transition to PRACE2 including analysis of TransNational Access;
- strengthening the internationally recognised PRACE brand;
- continuing and extend advanced training which so far provided more than 18 800 person-training days;
- preparing strategies and best practices towards Exascale computing;
- coordinating and enhancing the operation of the multi-tier HPC systems and services;
- supporting users to exploit massively parallel systems and novel architectures.

A high level Service Catalogue is provided. The proven project structure will be used to achieve each of the objectives in 6 dedicated work packages. The activities are designed to increase Europe's research and innovation potential especially through:

- seamless and efficient Tier-0 services and a pan-European HPC ecosystem including national capabilities;
- promoting take-up by industry and new communities and special offers to SMEs;
- implementing a new flexible business model for PRACE 2;
- proposing strategies for deployment of leadership systems;
- collaborating with the ETP4HPC, CoEs and other European and international organisations on future architectures, training, application support and policies.

Inria contact for team STORM: Olivier Aumage

TADaaM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PIA ELCI, Environnement Logiciel pour le Calcul Intensif, 2014-2018

The ELCI PIA project is coordinated by BULL with several partners: CEA, Inria, SAFRAN, UVSQ.

This project aims to improve the support for numerical simulations and High Performance Computing (HPC) by providing a new generation software stack to control supercomputers, to improve numerical solvers, and pre- and post computing software, as well as programming and execution environment. It also aims at validating the relevance of these developments by demonstrating their capacity to deliver better scalability, resilience, modularity, abstraction, and interaction on some application use-cases. TADAAM is involved in WP1 and WP2 ELCI Work Packages. Emmanuel JEANNOT is the Inria representative in the ELCI steering committee.

9.1.2. ANR

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 Sud-Ouest, Bull/ATOS

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.

ANR SATAS SAT as a Service (http://www.agence-nationale-recherche.fr/Project-ANR-15-CE40-0017).

AP générique 2015, 01/2016 - 12-2019 (48 months)

Coordinator: Laurent Simon (LaBRI)

Other partners: CRIL (Univ. Artois), Inria Lille (Spirals)

Abstract: The SATAS project aims to advance the state of the art in massively parallel SAT solving. The final goal of the project is to provide a “pay as you go” interface to SAT solving services and will extend the reach of SAT solving technologies, daily used in many critical and industrial applications, to new application areas, which were previously considered too hard, and lower the cost of deploying massively parallel SAT solvers on the cloud.

ANR DASH Data-Aware Scheduling at Higher scale (https://project.inria.fr/dash/).

AP générique JCJC 2017, 03/2018 - 02-2022 (48 months)

Coordinator: Guillaume AUPY (Tadaam)

Abstract: This project focuses on the effecient execution of I/O for High-Performance applications. The idea is to take into account some knowledge on the behavior of the different I/O steps to compute efficient schedules, and to update them dynamically with the online information.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

COLOC: the Concurrency and Locality Challenge (http://www.coloc-itea.org).

Program: ITEA2

Project acronym: COLOC

Project title: The Concurrency and Locality Challenge

Duration: November 2014 - November 2017

Coordinator: BULL/ATOS

Other partners: BULL/ATOS (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.

NESUS: Network for Ultrascale Computing (http://www.nesus.eu)

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 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. Emmanuel JEANNOT is the vice-chair of this Action.

9.2.2. Collaborations with Major European Organizations

Partner 1: INESC-ID, Lisbon, (Portugal)

Subject 1: Application modeling for hierarchical memory system

9.3. International Initiatives

9.3.1. Inria International Labs

Joint-Lab on Extreme Scale Computing (JLESC):

Coordinators: Franck Cappello (general) and Yves Robert (Inria coordinator).

Other partners: Argonne National Lab, University of Urbanna Champaign (NCSA), Tokyo Riken, Jülich Supercomputing Center, Barcelona Supercomputing Center (BSC).

Abstract: The purpose of the Joint Laboratory for Extreme Scale Computing (JLESC) is to be an international, virtual organization whose goal is to enhance the ability of member organizations and investigators to make the bridge between Petascale and Extreme computing. The founding partners of the JLESC are Inria and UIUC. Further members are ANL, BSC, JSC and RIKEN-AICS.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Partner 1: ICL at University of Tennessee

Subject 1: 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

Partner 2: Argonne National Lab

Subject 2: Topology-aware data aggregation for I/O intensive application

Partner 3: Vanderbilt University

Subject 3: Data-scheduling on hierarchical memories

9.4. Close cooperation with Industry

- Advanced Micro Devices, Inc. (AMD): AMD Zen micro-architecture and EPYC processors topology support in the Linux kernel.
- Oracle Corporation: Topology detection for SPARC processors and Solaris operating systems.
- ARM Holdings and Cavium, Inc.: ARM processor ACPI PPTT firmwares and Linux kernel topology information.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Aleksandar Ilic from University of Lisbon visited us to continue our collaboration on the Locality-aware Roofline Model [19].
- Tobias Fuchs from Ludwig-Maximilians-University of Munich visited us to improve the use of hardware locality in the DYLOC runtime system.

FLOWERS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Poppy Education

Poppy Education

Program: Feder - Région Aquitaine

Duration: January 2014 - December 2017

Coordinator: PY Oudeyer, Inria Flowers

Partners: Inria Flowers

Funding: 1 million euros (co-funded by Feder/EU Commission, Region Aquitaine and Inria)

Poppy Education aims to create, evaluate and disseminate pedagogical kits “turnkey solutions” complete, open-source and low cost, for teaching computer science and robotics. It is designed to help young people to take ownership with concepts and technologies of the digital world, and provide the tools they need to allow them to become actors of this world, with a considerable socio-economic potential. It is carried out in collaboration with teachers and several official french structures (French National Education/Rectorat, Highschools, engineering schools, ...). It targets secondary education and higher education, scientific literacy centers, Fablabs.

Poppy robotic platform used in the project is free hardware and software, printed in 3D, and is intended primarily for:

- learning of computer science and robotics,
- introduction to digital manufacturing (3D printing ...)
- initiation to the integration of IT in physical objects in humanoid robotics, mechatronics.
- artistic activities.

Educational sectors covered by the project are mainly: Enseignement d’exploration ICN en seconde, enseignement ISN en terminale S et bientôt en 1ère , filière STI2D, MPS seconde. Web: http://www.poppy-project.org/education .

9.1.1.1. Perseverons Project

The Perseverons project (Perseverance with / by digital objects), carried by the university via the ESPE (Higher School of Teaching and Education) of Aquitaine, and by the Rectorate of Bordeaux via the DANE (Academic Delegation digital education), aims to measure the real effectiveness of digital techniques in education to improve school motivation and perseverance, and, in the long term, reduce dropout. The project proposes to analyze the real effects of the use of two types of objects, robots, tablets, by comparing the school and non-school contexts of the *fablabs*. He is one of the 22 winners http://www.gouvernement.fr/efran-les-22-laureats of the "E-Fran" call for projects (training, research and digital animation spaces), following the Monteil mission on digital education, as part of the Investissement d’Avenir 2 program http://ecolenumerique.education.gouv.fr/2016/09/23/1244/. Formed of 12 sub-projects, "perseverons" has many partnerships, especially with the Poppy Education project http://perseverons.espe-aquitaine.fr/sp6-robotique-inria/.

9.1.1.2. Partner schools

In 2017, we have 36 partner schools (show Fig 25). 15 directly from the Poppy Education project. 19 new establishments were equipped in September 2017 by the Perseverons project. 21 of these establishments are located in Gironde. We have 27 high schools, 5 middle school.

Attachement	Type	Name	Adresse	Tel	Web
Poppy Éducation	High School	Alfred Kastler	14 Avenue de l'Université,33402 Talence, France	+33 5 57 35 40 70	http://www.lyceekastler.fr/
Poppy Éducation	Middle School	Anatole France	28 Rue des Micocouliers,33410 Cadillac, France	+33 5 56 62 98 42	http://www.afcadillac.net/
PERSEVERONS	High School	André Malraux	3 Rue du 8 Mai 1945,64200 Biarritz, France	+33 5 59 01 20 40	http://lycee-malraux-biarritz.fr/
Poppy Éducation	High School	Camille Jullian	29 Rue de la Croix Blanche,33000 Bordeaux, France	+33 5 56 01 47 47	http://www.camillejullian.com/
Poppy Éducation	Middle School	de France	Rue du Cimetière Saint-Benoist,75005 Paris, France	+33 1 44 27 12 11	http://www.college-de-france.fr/
Poppy Éducation	High School	des Graves	238 Cours du Général de Gaulle,33170 Gradignan, France	+33 5 56 75 77 56	http://www.grandlebrun.com/
PERSEVERONS	High School	Élie Faure	63 Avenue de la Libération,33310 Lormont, France	+33 5 56 38 23 23	http://www.lyc-eliefaure.fr/
PERSEVERONS	High School	Elisée Reclus	7 Avenue de Verdun,33220 Pineuilh, France	+33 5 57 41 92 50	http://lycee-foyen.fr/
Poppy Éducation	High School	François Mauriac	1 Rue Henri Dunant,33000 Bordeaux, France	+33 5 56 38 52 82	http://lyceemauriac.fr/
PERSEVERONS	High School	Gaston Febus	20 Avenue Georges Moutet,64300 Orthez, France	+33 5 59 67 07 26	http://webetab.ac-bordeaux.fr/cite-gaston-febus-orthez/
PERSEVERONS	Middle School	Giraud de Borneil	10 Boulevard André Dupuy,24160 Excideuil, France	+33 5 53 62 21 16	http://www.gdeborneil.fr/
PERSEVERONS	High School	Grand Air	Avenue du Docteur Lorentz Monod,33120 Arcachon, France	+33 5 56 22 38 00	http://webetab.ac-bordeaux.fr/lycee-grand-air/
PERSEVERONS	High School	Gustave Eiffel	143 Rue Ferbos,33000 Bordeaux, France	+33 5 56 33 83 00	http://www.eiffel-bordeaux.org/
PERSEVERONS	High School	Jacques Monod	10 Rue du Parvis,64230 Lescar, France	+33 5 59 77 92 00	http://lyceejacquesmonod.fr/
Poppy Éducation	High School	Jean Moulin	Avenue de la République,33210 Langon, France	+33 5 56 63 62 30	http://webetab.ac-bordeaux.fr/lycee-jean-moulin-langon/
Poppy Éducation	Middle School	Jean Zay	41 Rue Henri Cochet,33380 Biganos, France	+33 5 57 17 01 70	http://collegebiganos.fr/
Poppy Éducation	High School	La Morlette	62 Rue du Docteur Roux,33150 Cenon, France	+33 5 57 80 37 00	http://lycee-lamorlette.fr/
PERSEVERONS	High School	Les Iris	13 Rue Sourbès,33310 Lormont, France	+33 5 57 80 10 60	http://www.lyceelesiris.fr/
PERSEVERONS	High School	Louis Barthou	2 Boulevard Barbanègre,64000 Pau, France	+33 5 59 98 98 00	http://www.cyberlycee.fr/
PERSEVERONS	High School	Louis de Foix	4 Avenue Jean Rostand,64100 Bayonne/Bayona/Baiona, France	+33 5 59 63 31 10	http://www.louisdefoix.com/
PERSEVERONS	High School	Maine de Biran	108 Rue Valette,24100 Bergerac, France	+33 5 53 74 50 00	http://webetab.ac-bordeaux.fr/lycee-maine-de-biran/
Poppy Éducation	Middle School	Mios	Route du Pujeau,33380 Mios, France	+33 5 56 03 00 77	http://www.villemios.fr/enfance-jeunesse/college/
PERSEVERONS	High School	Nord Bassin	128 Avenue de Bordeaux,33510 Andernos-les-Bains, France	+33 5 56 82 20 77	http://www.lyceenordbassin.com/
Forum Poppy	Primary School	Notre-Dame du Mur	19 Rue de Kermadiou,29600 Morlaix, France	+33 2 98 88 18 69	http://lycee.ecmorlaix.fr/
PERSEVERONS	High School	Pape Clément	1 Rue Léo Lagrange,33600 Pessac, France	+33 5 57 26 63 00	http://lyceepapeclement.fr/
PERSEVERONS	High School	Pays de Soule	Avenue Jean Monnet,64130 Chéraute, France	+33 5 59 28 22 28	http://www.lyceedupaysdesoule.fr/index.php
PERSEVERONS	High School	Pré De Cordy	5 Avenue Joséphine Baker,24200 Sarlat-la-Canéda, France	+33 5 53 31 70 70	http://lycee-predecordy-sarlat.com/
Poppy Éducation	High School	Raoul Follereau	9 Boulevard Saint-Exupéry,58000 Nevers, France	+33 3 86 60 36 00	http://lyc58-renardfollereau.ac-dijon.fr/
PERSEVERONS	High School	René Cassin	2 Rue de Lasseguette,64100 Bayonne/Bayona/Baiona, France	+33 5 59 58 42 00	http://webetab.ac-bordeaux.fr/lycee-rene-cassin/
PERSEVERONS	High School	Saint-Cricq	4 Piste Cyclable,64000 Pau, France	+33 5 59 30 50 55	http://www.lycee-saint-cricq.org/
Poppy Éducation	High School	Saint-Genès	160 Rue de Saint-Genès,33000 Bordeaux, France	+33 5 56 33 84 84	http://www.saint-genes.com/
PERSEVERONS	High School	Saint-John Perse	2 Chemin de Barincou,64000 Pau, France	+33 5 59 62 73 11	http://www.lycee-saint-john-perse.fr/
Poppy Éducation	High School	Sainte-Marie Grand Lebrun	164 Rue François Mauriac,33200 Bordeaux, France	+33 5 56 08 32 13	http://www.grandlebrun.com/
inria	High School	Sainte-Saintonge	12 Rue de Saintonge,33000 Bordeaux, France	+33 5 56 99 39 29	http://www.lyceesaintefamille.com/
Poppy Éducation	High School	Sud-Médoc	Piste du Médoc Bleu,33320 Le Taillan-Médoc, France	+33 5 56 70 10 10	http://www.lyceesudmedoc.fr/
Poppy Éducation	High School	Victor Louis	2 Rue de Mégret,33400 Talence, France	+33 5 56 80 76 40	http://lyceevictorlouis.fr/

Figure 25. List of partner schools of the Poppy Education project

9.1.2. 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 contributes 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 is now used to support the teaching and to conduct further investigation.

9.1.3. KidLearn and Region Aquitaine

A Conseil Régional d'Aquitaine Project (KidLearn, 2015-) began, coordinated by Manuel Lopes entitled KidLearn. Will fund 50% of a 3 years PhD student.

We propose here a research project that aims at elaborating algorithms and software systems to help humans learn efficiently, at school, at home or at work, by adapting and personalizing sequences of learning activities to the particularities of each individual student. This project leverages recent innovative algorithmic models of human learning (curiosity in particular, developed as a result of ERC European project of the Flowers team), and combines it with state-of-the-art optimization algorithms and an original integration with existing expert knowledge (human teachers). Given a knowledge domain and a set of possible learning activities, it will be able to propose the right activity at the right time to maximize learning progress. It can be applied to many learning situations and potential users: children learning basic knowledge in schools and with the support of their teachers, older kids using educational software at home, of adults needing to acquire new skills through professional training ("formation professionnelle"). Because it combines innovations in computational sciences (machine learning and optimization) with theories of human cognition (theories of human learning and of education), this project is also implementing a strong cross-fertilization between technology and human sciences (SHS).

9.1.4. Comacina Capsule Creative Art/Science project and Idex/Univ. Bordeaux

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 Comacina project, in collaboration with the Flowers team and supported by funding from Idex/Univ. Bordeaux, explored the role of movements and light in expressing emotions: http://comacina.org . This project was implemented through several residencies during the year, and several performances at various cultural places in Aquitaine, including at Pole Evasion in Ambares-et-Lagrave. a report is available at https://flowers.inria.fr/RencontreAutourDuGeste.pdf . It benefitted from funding from the Art/Science Idex call for project.

9.2. National Initiatives

PY Oudeyer collaborated with Aymar de Rugy, Daniel Cattaert, Mathilde Couraud, Sébastien Mick and Florent Paclet (INCIA, CNRS/Univ. Bordeaux) about the design of myoelectric robotic prostheses based on the Poppy platform, and on the design of algorithms for co-adaptation learning between the human user and the prosthesis. This was funded by a PEPS CNRS grant.

D. Roy is the Inria leader of project "Voyageurs du Code - Code Décode" https://www.bibliosansfrontieres.org/tag/les-voyageurs-du-codecode-decode/, https://www.code-decode.net/ which provides teachers and animators formations and learning games to initiate young people to computer science and robotics.

Around Robotics for education, many collaborations were put in place. With the LSRO Laboratory from EPFL (Lausanne) and others collaborations with French National Education/Rectorat d'Aquitaine, with Canopé Educational Network, with ESPE (teacher's school) Aquitaine, ESPE Martinique, ESPE Poitiers, LINE Laboratory (ESPE Nice University), National Directorate of Digital Education, Fondation "La Main à la Pâte", Maison for Science in Bordeaux University, Orange Fondation.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. 3rd HAND

Title: Semi-Autonomous 3rd Hand

Programm: FP7

Duration: October 2013 - September 2017

Coordinator: Inria

Partners:

Technische Universität Darmstadt (Germany)

Universität Innsbruck (Austria)

Universität Stuttgart (Germany)

Inria contact: Manuel Lopes

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. We will demonstrate its efficiency in the collaborative assembly of an IKEA-like shelf where the robot acts as a semiautonomous 3rd-Hand .

9.3.1.2. DREAM

Title: Deferred Restructuring of Experience in Autonomous Machines

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: UPMC

Partners:

Armines (ENSTA ParisTech)

Queen Mary University London (England)

University of A Coruna (Spain)

Vrije University Amsterdam (Holland)

Contact: David Filliat

Abstract: A holy grail in robotics and artificial intelligence is to design a machine that can accumulate adaptations on developmental time scales of months and years. From infancy through adult- hood, such a system must continually consolidate and bootstrap its knowledge, to ensure that the learned knowledge and skills are compositional, and organized into meaningful hierarchies. Consolidation of previous experience and knowledge appears to be one of the main purposes of sleep and dreams for humans, that serve to tidy the brain by removing excess information, to recombine concepts to improve information processing, and to consolidate memory. Our approach – Deferred Restructuring of Experience in Autonomous Machines (DREAM) – incorporates sleep and dream-like processes within a cognitive architecture. This enables an individual robot or groups of robots to consolidate their experience into more useful and generic formats, thus improving their future ability to learn and adapt. DREAM relies on Evo- lutionary Neurodynamic ensemble methods (Fernando et al, 2012 Frontiers in Comp Neuro; Bellas et al., IEEE-TAMD, 2010) as a unifying principle for discovery, optimization, re- structuring and consolidation of knowledge. This new paradigm will make the robot more autonomous in its acquisition, organization and use of knowledge and skills just as long as they comply with the satisfaction of pre-established basic motivations. DREAM will enable robots to cope with the complexity of being an information-processing entity in domains that are open-ended both in terms of space and time. It paves the way for a new generation of robots whose existence and purpose goes far beyond the mere execution of dull tasks. http://www.robotsthatdream.eu

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. IGLU

Title: Interactive Grounded Language Understanding (IGLU)

Programm: CHIST-ERA

Duration: October 2015 - September 2018

Coordinator: University of Sherbrooke, Canada

Partners:

University of Sherbrooke, Canada

Inria Bordeaux, France

University of Mons, Belgium

KTH Royal Institute of Technology, Sweden

University of Zaragoza, Spain

University of Lille 1 , France

University of Montreal, Canada

Inria contact: Pierre-Yves Oudeyer

Language is an ability that develops in young children through joint interaction with their caretakers and their physical environment. At this level, human language understanding could be referred as interpreting and expressing semantic concepts (e.g. objects, actions and relations) through what can be perceived (or inferred) from current context in the environment. Previous work in the field of artificial intelligence has failed to address the acquisition of such perceptually-grounded knowledge in virtual agents (avatars), mainly because of the lack of physical embodiment (ability to interact physically) and dialogue, communication skills (ability to interact verbally). We believe that robotic agents are more appropriate for this task, and that interaction is a so important aspect of human language learning and understanding that pragmatic knowledge (identifying or conveying intention)

must be present to complement semantic knowledge. Through a developmental approach where knowledge grows in complexity while driven by multimodal experience and language interaction with a human, we propose an agent that will incorporate models of dialogues, human emotions and intentions as part of its decision-making process. This will lead anticipation and reaction not only based on its internal state (own goal and intention, perception of the environment), but also on the perceived state and intention of the human interactant. This will be possible through the development of advanced machine learning methods (combining developmental, deep and reinforcement learning) to handle large-scale multimodal inputs, besides leveraging state-of-the-art technological components involved in a language-based dialog system available within the consortium. Evaluations of learned skills and knowledge will be performed using an integrated architecture in a culinary use-case, and novel databases enabling research in grounded human language understanding will be released. IGLU will gather an interdisciplinary consortium composed of committed and experienced researchers in machine learning, neurosciences and cognitive sciences, developmental robotics, speech and language technologies, and multimodal/multimedia signal processing. We expect to have key impacts in the development of more interactive and adaptable systems sharing our environment in everyday life. http://iglu-chistera.github.io/

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. NEUROCURIOSITY

Title: NeuroCuriosity

International Partner (Institution - Laboratory - Researcher):

Columbia Neuroscience (United States) - Cognitive Neuroscience - JACQUELINE GOTTLIEB

Start year: 2016

See also: https://flowers.inria.fr/neurocuriosity

Curiosity can be understood as a family of mechanisms that evolved to allow agents to maximize their knowledge of the useful properties of the world. In this project we will study how different internal drives of an animal, e.g. for novelty, for action, for liking, are combined to generate the rich variety of behaviors found in nature. We will approach such challenge by studying monkeys, children and by developing new computational tools.

9.4.1.2. Informal International Partners

Pierre-Yves Oudeyer and Didier Roy have create a collaboration with LSRO EPFL and Pr Francesco Mondada, about Robotics and education. The two teams co-organize the annual conference "Robotics and Education"in Bordeaux. Didier Roy teaches "Robotics and Education" in EPFL several times a year.

Pierre-Yves Oudeyer collaborated with Edith Law's HCI research group at University of Waterloo on the topic of "Curiosity in HCI system". They co-organized the "Designing for curiosity" workshop at CHI 2017, Denver, Colorado, and obtained a grant from Univ. Bordeaux to set up a project with Inria Potioc team and with Dana Kulic, Robotics lab, Univ. Waterloo.

Didier Roy has created a collaboration with HEP VAud (Teachers High School) and Bernard Baumberger and Morgane Chevalier, about Robotics and education. Scientific discussions and shared professional training.

Florian Golemo is in an active collaboration with Aaron Courville from MILA Montreal to work on the IGLU project together.

William Schueller visited Vittorio Loreto's team in Rome from January till August 2017, funded by the Idex program of the University of Bordeaux. Vittorio Loreto is an Associate Professor in Physics at University Sapienza of Rome, and head of the research team Social Dynamics Lab. William Schueller also participated to a conference organized by V. Loreto in Rome, the Kreyon Conference, by giving a talk and presenting a user experiment: an interactive Naming Game.

9.4.2. Participation in Other International Programs

David Filliat participates in the ITEA3 DANGUN project with Renault S.A.S. in france and partners in Korea. The purpose of the DANGUN project is to develop a Traffic Jam Pilot function with autonomous capabilities using low-cost automotive components operating in France and Korea. By incorporating low-cost advanced sensors and simplifying the vehicle designs as well as testing in different scenarios (France & Korea), a solution that is the result of technical cooperation between both countries should lead to more affordable propositions to respond to client needs in the fast moving market of intelligent mobility.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Georges Kachergis, University of Radboud, The Netherlands
- Cynthia Liem, University of Delft, The Netherlands
- Mike Schaekermann, Univ. Waterloo, Canada
- Roboy team, Univiersity of Munich, Germany
- Lauriane Rat-Fiseher, Univ. Toulouse, France
- Lisa Jacquey, LPP, Paris (May 12th, 2017)
- Mai Nguyen, ENST Bretagne, France

9.5.1.1. Internships

- Kelian Schindowski, project Poppy Education
- Octave Delorme, project Poppy Education
- Alexandre Péré, Deep learning and intrinsic motivation
- Pierre Manceron, Deep Reinforcement Learning
- Timothée Anne, Intrinsically Motivated Goal Exploration

MANAO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. 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.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. "Young Researcher" VIDA (2017-2021)

LP2N-CNRS-IOGS Inria
Leader R. Pacanowski (LP2N-CNRS-IOGS)
Participant P. Barla (Inria)

9.2.1.2. Context.

Since the beginning of the industrial era, prototyping has been an important stage for manufacturers as a preliminary step before mass production. With the rise of Computer Science and the recent advances of intensive computation, the industry is progressively shifting from a tangible prototype to a fully numerical and virtual prototype with the goal of reducing costs during the R&D phase. During the past few years, the emergence of 3D printers has enabled virtual prototyping methods to take into account, at an early stage, some degree of fabricability, especially regarding the shape of the manufactured object. Beyond the shape of an object, predicting the final appearance of a virtual prototype remains a challenge of high potential for many domains (e.g., furniture, textile, architecture). The challenge is mainly due to the fact that the final appearance of an object is dependent on its shape, the material(s) applied on it as well as the viewing and lighting conditions. As shown in Figure 13 , solving the inverse problem that goes from Pictorial Design [A] to the Operational Design [D], where a specialist controls the fabrication process, is very hard and ill-posed.

9.2.1.3. Scientific Objectives.

The VIDA project aims at removing the several scientific locks by establishing a framework for direct and inverse design of material appearance for objects of complex shape. Since the manufacturing processes are always changing and evolving, our goal is to establish a framework that is not tied to a fabrication stage. To provide a rich variety of possible appearances, we will target multi-layered materials. We will ensure that every step of our framework is **validated** by either predictive simulation and/or measurements of the appearance. To illustrate the fabricability of our results, material samples as well as object samples will be fabricated locally or out-sourced to *Ecole des Mines de Saint-Etienne* (http://www.mines-stetienne.fr/en/EMSE) or http://www.saint-gobain-recherche.frSaint-Gobain Recherche and their appearance will also be validated with specific devices developed at the *https://www.institutoptique.fr/enInstitut d'Optique*-http://www.lp2n.frLP2N.

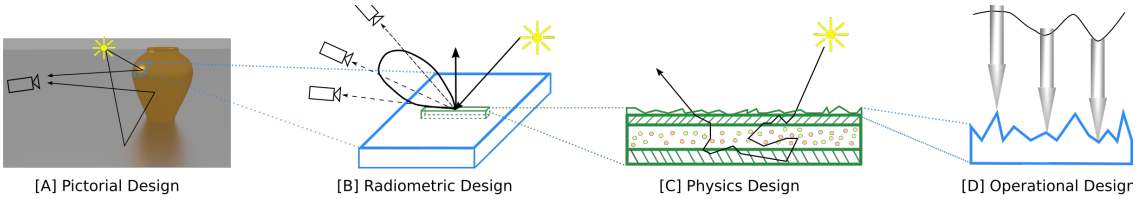

Figure 13. The different scales involved in the design of object appearance. [A] Pictorial scale: the object is seen as a whole. [B] Radiometric scale: represents the behaviour of a material when light interacts with it. [C] Microscopic scale: the material is described by physical parameters (e.g., index of refraction, absorption coefficient). [D] Operational scale: the parameters control the machine-dependent fabrication process.

9.2.1.4. "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.

9.2.1.5. ISAR (2014-2018)

POTIOC, MANAO, LIG-CNRS-UJF, Diotasoft
Leader M. Hachet (POTIOC)
The ISAR project focuses on the design, implementation and evaluation of new interaction paradigms for spatial augmented reality, and to systematically explore the design space.

9.2.1.6. MATERIALS (2015-2019)

MAVERICK, LP2N-CNRS (MANAO), Musée d'Ethnographie de Bordeaux, OCÉ-Print
Leader N. Holzschuch (MAVERICK)
Local Leader R. Pacanowski (LP2N-CNRS)
Museums are operating under conflicting constraints: they have to preserve the artifacts they are storing, while making them available to the public and to researchers. Cultural artifacts are so fragile that simply exposing them to light degrades them. 3D scanning, combined with virtual reality and 3D printing has been used for the preservation and study of sculptures. The approach is limited: it acquires the geometry and the color, but not complex material properties. Current 3D printers are also limited in the range of colors they can reproduce. Our goal in this project is to address the entire chain of material acquisition and restitution. Our idea is to scan complex cultural artifacts, such as silk cloths, capturing all the geometry of their materials at the microscopic level, then reproduce them for study by public and researchers. Reproduction can be either done through 2.5D printing or virtual reality displays.

9.2.1.7. FOLD-Dyn (2017-2021)

IRIT, IMAGINE, MANAO, TeamTo, Mercenaries
Leader L. Barthe (IRIT)
Local Leader G. Guennebaud (Inria)

The FOLD-Dyn project proposes the study of new theoretical approaches for the effective generation of virtual characters deformations, when they are animated. These deformations are two-folds: character skin deformations (skinning) and garment simulations. We propose to explore the possibilities offered by a novel theoretical way of addressing character deformations: the implicit skinning. This method jointly uses meshes and volumetric scalar functions. By improving the theoretical properties of scalar functions, the study of their joint use with meshes, and the introduction of a new approach and its formalism - called multi-layer 3D scalar functions - we aim at finding effective solutions allowing production studios to easily integrate in their pipeline plausible character deformations together with garment simulations.

9.2.2. Competitivity Clusters

9.2.2.1. 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.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Invited professor: Pierre Poulin, professor at Université de Montréal, Visiting scholar program of IdEx Bordeaux

POTIOC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Introspectibles - Collaborative research project :

Funding: Région Aquitaine

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: ULLO,

Following our work with the Introspectibles (Teegi, TOBE, Inner Garden), we are currently working with the ULLO company to bring these new interfaces to healthcare centers.

HOBIT - Maturation project :

Funding: Aquitaine Science Transfer

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: Université de Bordeaux

We are currently moving our platform HOBIT from his lab state to a commercial product.

Km 2.0 - Arts an Sciences program :

Funding: Idex Université Bordeaux

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: Léna D'Azy

We work with Cécile Léna for creating artistic installations based on interactive projection. See http://www.facts-bordeaux.fr/RESIDENCES/KM-2.0

Telekinetik juggling - Arts an Sciences program :

Funding: Idex Université Bordeaux

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: Le Cirque Inachevé

We work with Antoine Cléé from Cirque Inachevé for the design of an interactive environment where the artist will be able to juggle with zero gravity objects. The artist wear gloves, and interact with mini-drones supporting balls. See http://www.facts-bordeaux.fr/RESIDENCES/Jonglerie-telekinetique

Neuroperf :

Funding: Idex Université Bordeaux

Duration: 2017-2019

Coordinator: Jean-Arthur Micoulaud Franci

Local coordinator: Fabien Lotte

Partners: SANPSY - Potioc

This project aims at studying EEG-based Neurofeedback to reduce fatigue symptoms in sleep-deprived individuals. See http://brain.labex.u-bordeaux.fr/Actualites/Selection-projets-recherche-Clinique-2017-i5064.html

9.2. National Initiatives

eTAC: Tangible and Augmented Interfaces for Collaborative Learning:

Funding: EFRAN

Duration: 2017-2021

Coordinator: Université de Lorraine

Local coordinator: Martin Hachet

Partners: Université de Lorraine, Inria, ESPE, Canopé, OpenEdge,

the e-TAC project proposes to investigate the potential of technologies ”beyond the mouse” in order to promote collaborative learning in a school context. In particular, we will explore augmented reality and tangible interfaces, which supports active learning and favors social interaction.

ANR Rebel:

Duration: 2016-2019

Coordinator: Fabien Lotte

Funding: ANR Jeune Chercheur Jeune Chercheuse Project

Partners: Disabilities and Nervous Systems Laboratory Bordeaux

Brain-Computer Interfaces (BCI) are communication systems that enable their users to send commands to computers through brain activity only. While BCI are very promising for assistive technologies or human-computer interaction (HCI), they are barely used outside laboratories, due to a poor reliability. Designing a BCI requires 1) its user to learn to produce distinct brain activity patterns and 2) the machine to recognize these patterns using signal processing. Most research efforts focused on signal processing. However, BCI user training is as essential but is only scarcely studied and based on heuristics that do not satisfy human learning principles. Thus, currently poor BCI reliability is probably due to suboptimal user training. Thus, we propose to create a new generation of BCI that apply human learning principles in their design to ensure the users can learn high quality control skills, hence making BCI reliable. This could change HCI as BCI have promised but failed to do so far.

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. It opens new perspectives for exciting tomorrow’s applications, beyond traditional screen-based applications.

website: https://team.inria.fr/potioc/scientific-subjects/papart/

Inria Project Lab BCI-LIFT:

Duration: 2015-2018

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)

Local coordinator: Fabien Lotte

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/

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: ERC Starting Grant

Project acronym: BrainConquest

Project title: Boosting Brain-Computer Communication with High Quality User Training

Duration: 07/2017-06/2022

Coordinator: Fabien Lotte

Abstract: Brain-Computer Interfaces (BCIs) are communication systems that enable users to send commands to computers through brain signals only, by measuring and processing these signals. Making computer control possible without any physical activity, BCIs have promised to revolutionize many application areas, notably assistive technologies, e.g., for wheelchair control, and man-machine interaction. Despite this promising potential, BCIs are still barely used outside laboratories, due to their current poor reliability. For instance, BCIs only using two imagined hand movements as mental commands decode, on average, less than 80% of these commands correctly, while 10 to 30% of users cannot control a BCI at all. A BCI should be considered a co-adaptive communication system: its users learn to encode commands in their brain signals (with mental imagery) that the machine learns to decode using signal processing. Most research efforts so far have been dedicated to decoding the commands. However, BCI control is a skill that users have to learn too. Unfortunately how BCI users learn to encode the commands is essential but is barely studied, i.e., fundamental knowledge about how users learn BCI control is lacking. Moreover standard training approaches are only based on heuristics, without satisfying human learning principles. Thus, poor BCI reliability is probably largely due to highly suboptimal user training. In order to obtain a truly reliable BCI we need to completely redefine user training approaches. To do so, I propose to study and statistically model how users learn to encode BCI commands. Then, based on human learning principles and this model, I propose to create a new generation of BCIs which ensure that users learn how to successfully encode commands with high signal-to-noise ratio in their brain signals, hence making BCIs dramatically more reliable. Such a reliable BCI could positively change man-machine interaction as BCIs have promised but failed to do so far.

9.3.2. 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

  Coordinator: Damien Coyle and Fabien Lotte

  Partners: Ulster University, UK, Potioc, France

  Abstract: This project 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 of the selection of relevant information.

- Program: ERASMUS+

  Project acronym: VISTE

  Project title: Empowering spatial thinking of students with visual impairment

  Duration: 2016-2019

  Coordinator: National Technical University of Athens (Greece)

  Local coordinator: Anke Brock

  Other partners: Intrasoft International SA (Greece), Casa Corpolui Didatic Cluj (Romania), Liceul Special pentru Deficienti de Vedere Cluj-Napoca (Romania), Eidiko Dimotiko Sxolio Tiflon Kallitheas (Greece)

  Abstract: VISTE addresses inclusion and diversity through an innovative, integrated approach for enhancing spatial thinking focusing on the unique needs of students with blindness or visual impairment. However, since spatial thinking is a critical competence for all students, the VISTE framework and associated resources and tools will focus on cultivating this competence through collaborative learning of spatial concepts and skills both for sighted and visually impaired students to foster inclusion within mainstream education. The VISTE project will introduce innovative educational practices for empowering students with blindness or visual impairment with spatial skills through specially designed educational scenarios and learning activities as well as through a spatial augmented reality prototype to support collaborative learning of spatial skills both for sighted and visually impaired students.

9.3.3. Collaborations with Major European Organizations

Partner 1: Univ. Freiburg, Brain State Decoding Laboratory (M. Tangermann), Germany

Topic 1: robust EEG spatial filters for single trial regression

Partner 2: TU Graz, Neural Engineering lab (R. Scherer), Austria

Topic 2: BCI pitfalls, negative results in BCI, guidelines for BCI design

Partner 3: EPFL, Defitech Foundation Chair in Brain-machine Interface (R. Chavarriaga), Switzerland

Topic 3: BCI pitfalls, negative results in BCI

Partner 4: Oldenbourg University, Neuropsychology department (S. Debener, C. Zich), Germany

Topic 4: guidelines for BCI design

Partner: Twente University (A. Nijholt), Enschede, The Netherlands

Topic: Handbook of Brain-Computer Interfaces

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. Other IIL projects

Presentation of Potioc research activities during the annual Inria-EPFL Workshop (Session MOOCS & e-learning)

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Partner: Université du Québec à Montréal, Institut des Sciences Cognitives (R. N'Kambou), Montreal, Canada

Topic: Learning companions for Brain-Computer Interfaces

Partner: North Carolina State University (Chang S. Nam), USA

Topic: Handbook of Brain-Computer Interfaces

9.4.3. Participation in Other International Programs

Partner: Flowers & Potioc teams, Inria Bordeaux, University of Waterloo, Canada

Funding: Univ. Bordeaux/Univ Waterloo joint grant call for project

Date: 2017-2018

Topic: Designing for Curiosity in Physical Spaces

9.5. International Research Visitors

9.5.1. Visits to International Teams

9.5.1.1. Research Stays Abroad

3 Members of team Potioc spend several months at the RIKEN Brain Science Institute (BSI), Cichocki's advanced brain signal processing laboratory, Wakoshi, Japan.

- Fabien Lotte: 10 months in total, with the JSPS (Japan Society for the Promotion of Science) Invitation fellowship program
- Léa Pillette: 6 months in total, funded by the RIKEN BSI
- Aurélien Appriou: 3 months in total, funded by the RIKEN BSI