Activity Report 2014

Section Highlights of the Team

BACCHUS Team (section vide)

CAGIRE Team (section vide)

CARMEN Team

6.1. Highlights of the Year

- New associated team EPICARD (principal investigator N. zemzemi, Y. Coudière and J. Henry). The aim of of this associated team for the first year is to overcome the technical difficulties that we pointed out during the year 2014 in inverse problem for the heart.

- June 2014: Based on a peer-reviewed proposal, the Grand équipement national de calcul intensif (GENCI) has attributed us 3 million core-hours on the national high-performance computing system Turing, to be used in the year 2014.

- December 2014: Based on a peer-reviewed proposal, the Grand équipement national de calcul intensif (GENCI) has attributed us 3.5 million core-hours on the national high-performance computing machines Turing, Curie, and Occigen, to be used in the year 2015.

- LIRYC will fund a 2-year postdoctoral position on simulation of Brugada syndrome, a rare ECG anomaly predictive of sudden cardiac death in young, apparently healthy subjects. This work will be performed in tight collaboration with clinicians at the Haut-Lévèque hospital

CQFD Project-Team

6.1. Highlights of the Year

Creation of the Associate Team Inria: CDSS (2014-2016) with the University of Sao Paulo, Brasil.

FLOWERS Project-Team

6.1. Highlights of the Year

PY. Oudeyer and M. Lopes, together with J. Gottlieb (Univ. Columbia, NY) organized the first International Symposium on Neurocuriosity symposium on Information Seeking, Curiosity and Attention, pioneering a gathering of world experts on curiosity from developmental psychology, neuroscience, ethology and computational modelling (see https://openlab-flowers.inria.fr/t/first-interdisciplinary-symposium-on-information-seeking-curiosity-and-attention/21). This was achieved in the context of associated team Neurocuriosity with the cognitive neuroscience lab of J. Gottlieb at Univ. Columbia, NY, US. The first results investigating predictions of theoretical formal models of curiosity on human exploration were also published [25].

O. Mangin obtained the Best thesis poster from Bordeaux doctoral school of mathematics and computer science, for his PhD thesis "The Emergence of Multimodal Concepts: From Perceptual Motion Primitives to Grounded Acoustic Words" [24].

The team, in collaboration with Inaki Iturrate and Luis Montesano, published major results on calibration-free brain-computer interface methods, where incremental machine learning algorithms are used to remove the phase of calibration for an important family of use contexts [44] [45].

In october 2014, the team announced the release of a new version of the Poppy Project platform, dedicated in particular to the use of tools for creating and programming interactive robots in Education and Art. This platform, which is a result of research on the role of morphology in skill acquisition within ERC project Explorers, was selected as finalist for the Global Fab Awards 2014 (https://www.fab10.org/en/awards) which select the best worldwide projects in the Makers ecosystem. It was also presented in major international press and media (https://www.poppy-project.org/in-the-press/), in multiple hackatons and demos, in particular at the major international conference LeWeb (https://www.poppy-project.org/social-life/, and its video on the web was seen 125k times. Poppy Project was presented at Elysée, during a French Tech event, to François Hollande (http://www.inria.fr/centre/bordeaux/actualites/poppy-le-robot-humanoide-a-l-elysee), and in Bordeaux to Axelle Lemaire. Web site: http://www.poppy-project.org

The Flowers team made major achievements in diffusing science and technology towards the general public. The team developed the IniRobot pedagogical kit, for the discovery of computer science and robotics in primary schools. The kit was first developed and evaluated in schools, in collaboration with a group of teachers, and then began to be largely disseminated and used in september 2014 to schools in Talence, Bordeaux, Lormont, and Lille. A dedicated web site has been created, allowing all users and contributors to share their experiences with the kit: https://dm1r.inria.fr/c/kits-pedagogiques/inirobot. PY. Oudeyer was invited to give a TedX talk (https://www.youtube.com/watch?v=AP8i435ztwE, video viewed by more than 9000 people), and was interviewed and invited to talk about our research on major media channels (e.g. Le Monde, Les Echos, France Inter, see http://www.pyoudeyer.com/press/).

GEOSTAT Project-Team

6.1. Highlights of the Year

Paper **Spanning the Scales of Granular Materials through Microscopic Force Imaging** by N. Brodu *et al.* accepted in **Nature Communications** (will appear in 2015).

BEST PAPER AWARD :

[36] **IEEE TENSYMP 2014**. B. XU, S. BINCZAK, S. JACQUIR, O. PONT, H. YAHIA.

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HIEPACS Project-Team

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6.1. Highlights of the Year

In the context of HPC-PME initiative, we started a collaboration with ALGO'TECH INFORMATIQUE and we have organised one of the first PhD-consultant action implemented by Xavier Lacoste led by Pierre Ramet. ALGO'TECH is one of the most innovative SMEs (small and medium sized enterprises) in the field of cabling embedded systems, and more broadly, automatic devices. The main target of the project is to validate the possibility to use the sparse linear solvers of our team in the area of electromagnetic simulation tools developed by ALGO'TECH. This collaboration will be developed next year in the context of the European project FORSTISSIMO. The principal objective of FORTISSIMO is to enable European manufacturing, particularly SMEs, to benefit from the efficiency and competitive advantage inherent in the use of simulation.

As a conclusion of the OPTIDIS project we organized the first International Workshop on Dislocation Dynamics Simulations that was devoted to the latest developments realized worldwide in the field of Discrete Dislocation Dynamics simulations. This international event held in December 10th to the 12th at "Maison de la Simulation" in Saclay, France and attracted 55 participants from many different countries including England, Germany, France, USA, ... The workshop gathered most of the active researchers working on dislocation dynamics from numerical simulations to experimentatios. Thanks to the success of this workshop, a second one will be scheduled in England during 2016.

LFANT Project-Team

5.1. Highlights of the Year

Aurel Page has defended his PhD thesis on *Méthodes explicites pour les groupes arithmétiques* [12] in July 2014. Nicolas Mascot has defended his PhD thesis on *Computing modular Galois representations* [11], in July 2014.

MAGIQUE-3D Project-Team (section vide)

MAGNOME Project-Team

6.1. Highlights of the Year

In collaboration with colleagues from the Institut du Vigne et du Vin (ISVV), Bordeaux and the Universidade Nova de Lisboa, Lisbon we used a population genomics approach to investigate the global phylogeography and domestication fingerprints of winemaking yeasts, using a collection of isolates obtained from fermented beverages and from natural environments on five continents. These results appeared in *Nature Communications* [11].

MANAO Project-Team

5.1. Highlights of the Year

We are still developping our expertise in fitting techniques. As an illustration, we have solved of a long-standing problem in fluid capture: the non-invasive three-dimensional digitization of dynamic gas flows *including their three-dimensional velocity fields* [17] (cf. Figure 8). We solve the three-dimensional flow tracking problem by fitting a full 3D Navier-Stokes simulation to the acquired data. To our knowledge, this is a world-first in this area that considerably improves the results by incorporating high-level prior knowledge into the estimate. The resulting mathematical framework can be generalized easily and lends itself to editing operations. The technique has applications, e.g., in aerospace engineering. We are exploring the possibilities with ONERA, the French space agency. In fact, parts of the developed techniques have been validated by them and are now being installed in a wind tunnel facility for real-world tests.
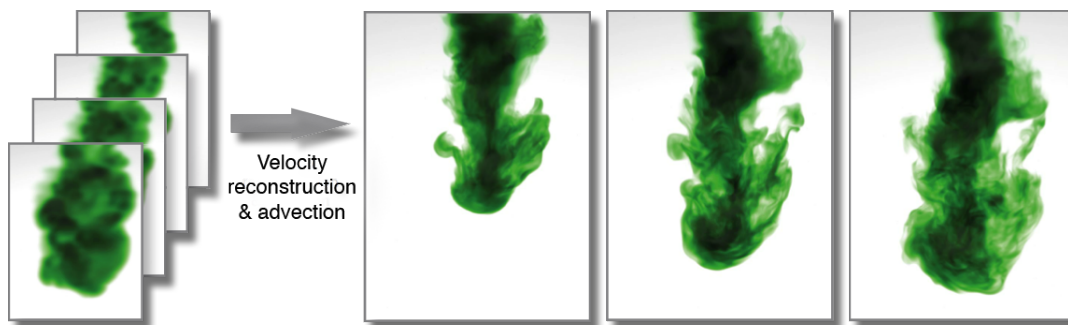

Figure 8. Low-resolution captures obtained by tomographic scanning (left) are used as inputs to our method which estimates physically plausible dense velocity fields. Such velocity fields fully determine the fluid state and can be applied in a variety of applications including fluid super-resolution (right) allowing capture to be integrated into pipelines for visual effects simulation.

This year, the collaboration between Optics and Computer Graphics has grown to a now long-term project, under the initiative of the MANAO team. First, from an institutional point of view, a framework agreement has been signed the 10th of July 2014 between the IOGS and Inria. This is an important and institutional recognition of the potential trans-disciplinary impacts of our work. Second, we have begun to set-up the COEL experimentation facility inside the LP2N laboratory. It has been made possible thanks to the support of the "Région Aquitaine" and upcoming supports from l'"Initiative d'excellence de l'université de Bordeaux". With this trans-disciplinary experimentation facility – rather unique in Europe – we can now put into practice a long-term vision of the researches that we want to achieve.

In term of visibility, we managed to published our first paper in the Optics scientific community [15], highlighting our trans-disciplinary research. We have also been part of the final and transnational exhibition of the V-Must.net network of excellence: Keys2Rome - http://keys2rome.eu. It was launched simultaneously in Rome, Sarajevo, Amsterdam and Alexandria on September 23, 2014. The exhibition uses immersive technology to present and connect these regional cultures within the Roman Empire, highlighting their diversity and commonality over centuries of Roman rule. Our spatial augmented reality solution [21] was included in this event.

MC2 Team

6.1. Highlights of the Year

- **Models for gliomas**
  Glioblastoma multiforme (GBM) causes significant neurological morbidity and short survival times. Brain invasion by GBM is associated with poor prognosis. Recent clinical trials of bevacizumab in newly-diagnosed GBM found no beneficial effects on overall survival times; however, the baseline health-related quality of life and performance status were maintained longer in the bevacizumab group and the glucocorticoid requirement was lower. In a recent work in collaboration with UAB, we have constructed a clinical-scale model of GBM whose predictions uncover a new pattern of recurrence in 11/70 bevacizumab-treated patients. The findings support an exception to the Folkman hypothesis: GBM grows in the absence of angiogenesis by a cycle of proliferation and brain invasion that expands necrosis. Furthermore, necrosis is positively correlated with brain invasion in 26 newly-diagnosed GBM. The unintuitive results explain the unusual clinical effects of bevacizumab and suggest new hypotheses on the dynamic clinical effects of migration by active transport, a mechanism of hypoxia-driven brain invasion.

- **Electroporation modeling** (M. Leguebe, C. Poignard)
  Based on the new discovery of the team of Vectorolgy and anti-cancerous therapies on the membrane lipid oxidation during the pulse delivery, we have provided a model of cell permeabilization that makes it possible to explain the process of electroporation : pore formation during the pulse and surface diffusion of altered lipids after the pulse. Our model explains the long-term effect of electroporation (the permeable state of the membrane lasts a few minutes after the pulse delivery). A 3D-code in C++ has been implemented during the PhD thesis of M. Leguèbe. The team MC2 is now part of the European Lab EBAM on electroporation modeling. An international workshop on Electroporation and Biophysical Therapies was held in Bordeaux the 15th and 16th December.

- Simulation of **multiphysic fluid-structure impacts in 3D**. See http://www.math.u-bordeaux1.fr/ adebrauer/ for astinishing videos.

MNEMOSYNE Project-Team (section vide)

PHOENIX Project-Team

6.1. Highlights of the Year

- A best paper award was obtained at ASSETS 2014 (The 16th International ACM SIGACCESS Conference on Computers and Accessibility), by the 5 authors of the paper "Tablet-Based Activity Schedule for Children with Autism in Mainstream Environment" .

BEST PAPERS AWARDS :

[26] **ASSETS 2014 - The 16th International ACM SIGACCESS Conference on Computers and Accessibility**. C. FAGE, L. POMMEREAU, C. CONSEL, E. BALLAND, H. SAUZÉON.

POTIOC Project-Team

6.1. Highlights of the Year

- Acceptance of the ANR project "ISAR" (Interacting with Spatial Augmented Reality) lead by Martin Hachet (Potioc)
- Publication of "Teegi" (Tangible EEG Interface) at UIST14 [15] and more than 13000 views on vimeo until December 2014 (http://vimeo.com/potioc/teegi)

REALOPT Project-Team

6.1. Highlights of the Year

- Olivier Beaumont and Lionel Eyraud-Dubois have received the HiPC best paper award for their work on resource allocation for large scale virtualized platforms with reliability guarantees. They provided a formulation based on a thorough analysis of a real life usage trace, and a very efficient two-step allocation algorithm.

- The team organized the annual conference of the French Operations Research Society ROADEF14 in Feb 2014.

- An Inria Innovation Lab has been created between Realopt and Ertus Consulting.

- The SAMBA associated team project with Brazil was renewed for 3 years including new collaborators from Chili.

- François Vanderbeck was invited as a plenary speaker at the conference OPTIMIZATION 2014, in Portugal [19].

RUNTIME Team

6.1. Highlights of the Year

- This year we started very large collaborations with the BULL/Atos company. WE started one European project, one PIA french project and one PhD thesis. The amount of Person Year funded with this project exceed 10. The research we will do with Bull covers resource management, process placement, platform modeling, application modeling, affinity abstraction.

- The StarPU software is used by CEA for automatically distributing linear algebra on their cluster of 144 hybrid nodes.

SISTM Team

6.1. Highlights of the Year

A work (described below), in collaboration with M. Davis and R. Tibshirani from Standford University, has been published in the "Proceedings of the National Academy of Sciences" : [8].

Females have generally more robust immune responses than males for reasons that are not well-understood. Here we used a systems analysis to investigate these differences by analyzing the neutralizing antibody response to a trivalent inactivated seasonal influenza vaccine (TIV) and a large number of immune system components, including serum cytokines and chemokines, blood cell subset frequencies, genome-wide gene expression, and cellular responses to diverse in vitro stimuli, in 53 females and 34 males of different ages. We found elevated antibody responses to TIV and expression of inflammatory cytokines in the serum of females compared with males regardless of age. This inflammatory profile correlated with the levels of phosphorylated STAT3 proteins in monocytes but not with the serological response to the vaccine. In contrast, using a machine learning approach, we identified a cluster of genes involved in lipid biosynthesis and previously shown to be up-regulated by testosterone that correlated with poor virus-neutralizing activity in men. Moreover, men with elevated serum testosterone levels and associated gene signatures exhibited the lowest antibody responses to TIV. These results demonstrate a strong association between androgens and genes involved in lipid metabolism, suggesting that these could be important drivers of the differences in immune responses between males and females.