



RESEARCH CENTER
Bordeaux - Sud-Ouest

FIELD

Activity Report 2016

Section Highlights of the Team

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CAGIRE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

From Cagire to ... Cagire !

Last April 2016, after near five years of existence and a 1-year preparation/evaluation process of the new project, the common team Cagire (Computational Approximation with discontinuous Galerkin methods and comparison with Experiments) died and was reborn as the common **project** team Cagire (Computational AGility for internal flows sImulations and compaRisons with Experiments) with the much broader scope presented above.

A first step towards the dissemination of the AeroSol library

A deposit procedure of the AeroSol library (around 78000 lines of C++) with APP⁰ has been finalized in 2016. This will protect the library authors' rights and will open the possibility of disseminating the library in a sound way.

Launching of a long-term collaboration with a new industrial partner, PSA

In January 2016, we have been contacted by the R & D department of the PSA Group (Peugeot Citroën Automobile SA) in order to elaborate a long-term, 10-year project on the modelling and simulation of the turbulent flow in the under-hood space of road vehicles, in the framework of their *Full Digital 2025 Ambition*, i.e, their plan to switch to a design of future vehicles entirely based on simulation. In order to overcome the technological barrier of the prediction of the natural convection regime, a long-term collaboration program has been established, starting with an internship (Saad Jameel), defended in September 2016, a CIFRE PhD (same student), going to start in February 2017, and the deposit of the ANR PRCE project MONACO-2025, coordinated by R. Manceau, involving the institute PPrime of Poitiers, PSA and EDF.

⁰<http://www.app.asso.fr/en/welcome.html>

CARDAMOM Project-Team (section vide)

CARMEN Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Events

On 4 November 2016 the new building of the IHU Liryc was officially opened in the presence of representatives from the municipal, departmental, regional, and national authorities.

On 9 December 2016 A. Davidović defended her thesis Multiscale Mathematical Modeling of Structural Heterogeneities in Cardiac Electrophysiology.

5.1.2. Recruitments

M. Potse, whose work had been funded by IHU Liryc since 2013, has become a full-time member of the Carmen team and has won an Inria Advanced Research Position in June 2016. He will continue his numerical studies on cardiac sudden-death syndromes and atrial fibrillation and is developing a new project on the application of electrocardiographic inverse methods in the catheterization laboratory.

We recruited the engineer P. Migerditichan; she started working in November 2016 on a project named EPICARDial electrical signals VIZualisation (EPICARD-VIZ). The aim of this project is to build a software solution for the electrocardiographic inverse problem, coded in the MUSIC platform. The goal of the project is twofold: First, we aim at building a semi-automatic functionality that allows to obtain meshes of the epicardium, torso, lungs, liver, and skeletal muscle with minimal human interaction. Second, our aim is to include a dense linear algebra library and to construct a computational framework in which we will be able to compare different methods of solving the inverse problem.

After the completion of her PhD thesis A. Davidović was hired as an Engineer, granted by the ANR HR-CEM project. She continues her work on multiscale modelling of heterogeneities in cardiac tissue. She is going to use the experimental high-resolution MRI data on animal and human hearts that are provided by the imaging team of IHU Liryc. By means of image analysis and numerical simulations she is going to study the effects of fibrotic, fatty, and other kinds of tissue on AP propagation.

CQFD Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Publication of the book: *Stochastic Processes. From Applications to Theory* written by P. Del Moral and S. Penev, CRC Press, 1290 pages, Jan 2017.

Pierre del Moral has been invited to the IMS World Congress in Toronto to give a Medallion lectures in May 2016.

FLOWERS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The Flowers team spin-off company Pollen Robotics was created in may 2016, targeting to develop and commercialize technologies for entertainment robotics: <http://pollen-robotics.com/en/>

Didier Roy was award the prize Serge Hocquenguem for his work on educational robotics, <http://psh.aid-creem.org/spip.php?rubrique1> et <http://binaire.blog.lemonde.fr/2016/12/09/pourquoi-didier-et-eva-jouent-avec-le-meme-robot/>

Sébastien Forestier, Yoan Mollard, Damien Caselli and Pierre-Yves Oudeyer obtained the notable mention demonstration award (2nd place) at the NIPS 2016 conference for their demonstration on Autonomous exploration, active learning and human guidance with open-source Poppy humanoid robot platform and Explauto library <https://hal.inria.fr/hal-01404399/document>

PY. Oudeyer and M. Lopes co-organized with J. Gottlieb and T. Gliga the Second Interdisciplinary Symposium on Information-Seeking, Curiosity and Attention (Neurocuriosity 2016) in London, gathering 150 researchers from neuroscience, psychology, education and machine learning/computational modelling. This was achieved in the context of the associated team Neurocuriosity. Web: <https://openlab-flowers.inria.fr/t/second-interdisciplinary-symposium-on-information-seeking-curiosity-and-attention-neurocuriosity-2016/187>

PY. Oudeyer and M. Lopes were awarded a 3 year-long HFSP grant with J. Gottlieb (Univ. Columbia, US) and C. Kidd (Univ. Rochester, US) for a research program targeting the understanding of active exploration in humans and monkeys through experimentation and modelling. Web: <https://flowers.inria.fr/neurocuriosityproject/>.

PY. Oudeyer was awarded the Lifetime Achievement Award from the Evolutionary Linguistics Association.

GEOSTAT Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

- N. Brodu is joining GEOSTAT as a research associate (2016).
- K. Daoudi has been invited to the Senate on June 20th 2016 to accompany BatVoice which was finalist of the 2016 edition of “Tremplin Entreprises”.

4.1.1. Award

Hicham Badri is winning the AFRIF PhD price 2015 for his PhD *Sparse and Scale-Invariant Methods in Image Processing* [<https://hal.inria.fr/tel-01239958>].

HIEPACS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Conference organization

We organized the 9th International workshop on Parallel Matrix Algorithms and Application (PMAA'16 - July 6-8) in collaboration with Bordeaux INP, CNRS and Université de Bordeaux. The conference that was composed of 4 invited plenary presentations and 76 regular talks. Around 120 people attended the conference, 70 % were from Europe, 20 % from North America, 7 % from Asia; among them more than 25 % were students. We succeeded to offer free registration to the students thanks to the sponsorship we arose from Airbus DS, CEA, CERFACS, Clustervision, Labex CPU, DELL, EDF, IBM and Total that contributed to balance our budget.

More details can be found on <http://pmaa16.inria.fr>

LFANT Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Release of Pari 2.9 after two years of development. This stable releases includes three brand new modules (*L*-functions, Associative and Central Simple Algebras, and Modular Symbols), a major overhaul of the Elliptic Curves and Number Fields modules.

Iuliana Ciocanea-Teodorescu has defended her PhD thesis on *Algorithms for finite rings* in June 2016 <http://www.theses.fr/2016BORD0121>.

Pinar Kiliçer has defended her PhD thesis on *The class number one problem for genus-2 curves* in July 2016 [11].

MAGIQUE-3D Project-Team (section vide)

MANAO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

In term of publication, we are regularly publishing our work at the prestigious conference SIGGRAPH. This year was particularly successful with two plain papers [17], [16] and one talk [19]. But this year more especially, an image from our work [16] were selected as the front cover of the corresponding special issue of ACM Transactions on Graphics.

Another great success is the creation, led by members of the LP2N, of a first workshop on nano-appearance. The goal of this workshop was to bring together people from the industry and the academia, and from domains that seem very different considering the scale they are interested in but close by the object of their studies: the appearance of materials. A rare initiative, this workshop took place during two days in November 2016.

MEMPHIS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Numerical simulation of zebrafish larvae C-bend

This part is performed in collaboration with the MRGM laboratory (Laboratoire Maladies Rares : Génétique et Métabolisme, <https://mrgm.u-bordeaux.fr/>). 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 the power [39]. This simulation is challenging due to coupling several methods like image treatment (from movies given by MRGM), optimal transport [58] and numerical simulations.

First 2D numerical results have been performed from a series of 615 pictures obtained at a rate equal to 15 000 images per second. The fish is a 8-day zebrafish larvae (length is $\ell = 7\text{ mm}$) presented in figure 5 .



Figure 5. Pictures of a 8-day zebrafish larvae. Source: MRGM.

All the 615 pictures have been post-processed to remove the displacement of the center of mass (due to the hydrodynamic forces) as well as the rotation angle (due to the hydrodynamic torques) to isolate the kinematic of the deformation. Indeed, the displacement of the mass center and the rotation angle have to be computed as being the results of the flow effects generated by the fish deformation. The numerical solver requires however more than 615 images for the overall simulation due to small times steps limitation. The missing images are thus computed using optimal transportation with the algorithm presented in [40]. This method gives also the deformation velocity inside the body that is necessary for our numerical simulation based on the penalty method (see figure 4 for an example of deformation velocity computation).

A comparison between experimental and numerical swimming behaviors is presented in figure 6 . The qualitative behaviors look quite similar. In a more quantitative way, figures 7 and 8 show the temporal evolution of the rotating angle as well as the position of the center of mass. The numerical results (displacement of the mass center and the rotation) are quite close to the experimental ones (the ones removed in the post-processed of the original pictures).

The small differences can be explained by the fact the the actual simulation is only two-dimensional. Another explanation is that the deformation velocity obtained by optimal transportation is by definition irrotational and *a priori* non divergence free. We are now working on the 3D simulation as well as a modified (sub-)optimal transportation including rotational effects for a divergence free field.

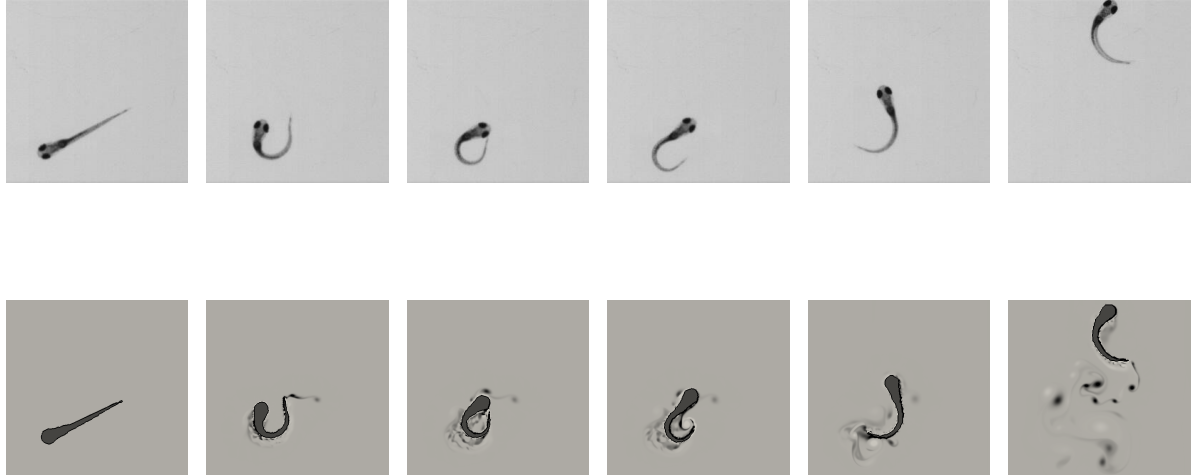


Figure 6. Comparison between experimental (top) and numerical results (bottom) at t_0 , $t_0 + 0.7$ ms, $t_0 + 1.1$ ms, $t_0 + 1.3$ ms, $t_0 + 2$ ms and $t_0 + 4.1$ ms from left to right. Experiments results given by MRGM.

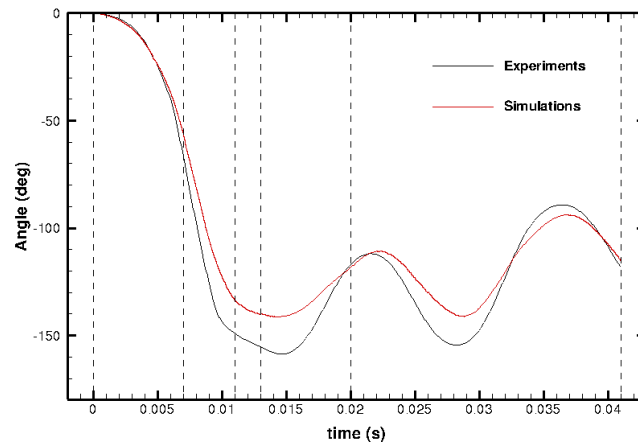
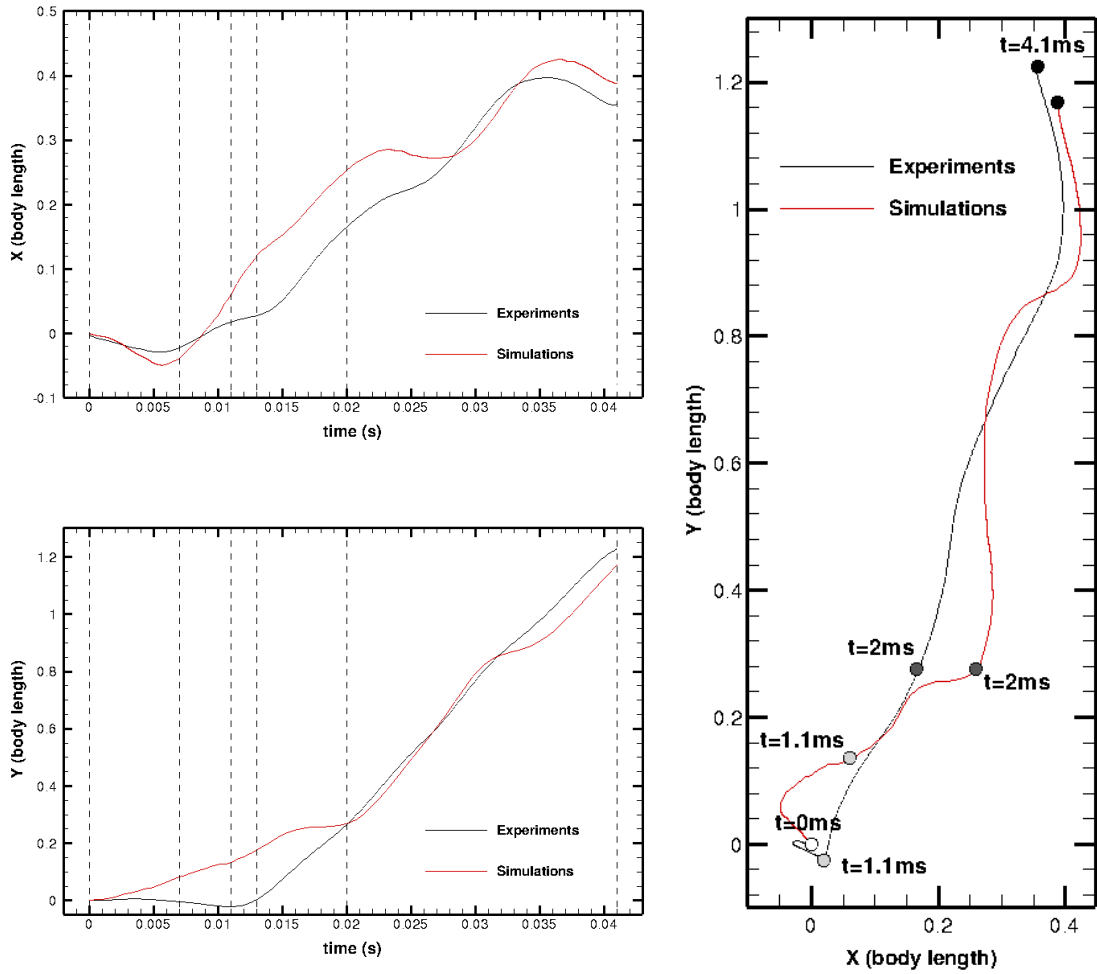


Figure 7. Temporal evolution of the rotation angle.



(a) Temporal evolution of the center of mass.

(b) Position of the center of mass.

Figure 8. Kinematic results for the zebrafish swimming.

MNEMOSYNE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. First PhDs defended

2016 is a very special year for our young team Mnemosyne, since our first three PhDs have been defended in October and November [1], [2], [3].

MONC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Last year saw a net increase in the diffusion of our work outside our own academic circle. Perrine Berment has clinched a seat in the national final of *Ma thèse en 180 secondes* after winning regional competition. Research achieved in the team was mentioned in popular radio shows like https://www.franceinter.fr/emissions/futur-proche/futur-proche-28-octobre-2016?xtmc=kurde_medecin&xtnp=1&xter=14. This opens new collaboration opportunities locally and nationally for the team.

On a scientific point of view, the team has significantly increased its work on modeling tumor heterogeneity and texture analysis with very promising results so far, particularly in the thesis of Thibaut Kritter, Agathe Peretti, Cynthia Perier. We have developed a model for texture evolution over time which may offer a much better insight than approaches using statistical methods on texture features (*e.g.* radiomics).

5.1.1. Awards

Julien Jouganous has won *Prix Le Monde de la Recherche Universitaire*, http://www.lemonde.fr/sciences/article/2016/11/23/prix-le-monde-de-la-recherche-2016-1-evolution-du-cancer-en-equations_5036804_1650684.html.

PHOENIX Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- The paper “Designing Parallel Data Processing for Large-Scale Sensor Orchestration” by Milan Kabac and Charles Consel received a Best Paper award at UIC 2016, the 13th IEEE International Conference on Ubiquitous Intelligence and Computing, held in July 2016 in Toulouse, France.
- The web application “It’s my life. I choose it!”, developed by the Phoenix team in collaboration with the University of Bordeaux (Laboratoire handicap action cognition santé), the University of Mons (Service d’ortho-pédagogie clinique), and the association Trisomie 21 France, received the Universal Accessibility Prize at APAJH 2016, held on November 14th, 2016, in Paris. The web application is available at <http://www.monprojetdevie.trisomie21-france.org/>.
- The pitch for a startup based on technology from the HomeAssist project received a prize at the “Journée Horizon Startup”, held on December, 1st, 2016, in Paris.

BEST PAPERS AWARDS :

[26] **13th IEEE International Conference on Ubiquitous Intelligence and Computing (UIC 2016)**. M. KABÁČ, C. CONSEL.

PLEIADE Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Biotechnology

In collaboration with MIAT INRA and UMR 5234 CNRS/Université de Bordeaux, PLEIADE assembled and analyzed *Clavispora lusitaniae*, an ubiquitous environmental ascomycetous yeast that can be pathogenic and is responsible for invasive candidiasis in pediatric and onco-haematology patients [24].

In collaboration with UMR 5200 CNRS/Université de Bordeaux, PLEIADE assembled and analyzed transcriptomes from three tissues of the oil palm tree *Elaeis guineensis* Jacq., whose mesocarp contains oil up to 90% of its dry weight. Our goal is to increase, by synthetic biology approaches, the yield in oil for crops grown in Europe. The yield and the composition of oil measured from wild-type palm tree specimens varies dramatically, indicating a high level of bio-diversity.

5.1.2. Biodiversity

PLEIADE and the HIEPACS team developed connections between random projection methods and multi-dimensional scaling, in order to compute eigenvectors and eigenvalues in space of reasonable dimension. The method for MDS developed by Pierre Blanchard has proved to be surprisingly efficient and precise. It was presented at PASC 2016 Lausanne. This work improves the analysis of microbial communities, where the shape of the point cloud built from pairwise distances between a large set of NGS reads is used to describe the diversity of the community.

POSET Team

5. Highlights of the Year

5.1. Highlights of the Year

An α -version of the T-calculus [21] have been released ⁰.

It has been experimented in an Art & Science project ⁰ that have illustrated its expressiveness and simplicity for describing reactive music [19], [23]. This Art & Science project will be “on stage” in february 2017 via a “Duo solo for piano and computer”.

The software *i-score* have also been further experimented [24], [16] especially during the visit of Shlomo Dubnov (UCSD) in 2016.

⁰see [the T-calculus url](#)

⁰see [the Interpolation project](#)

POTIOC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- ERC Grant "BrainConquest : Boosting Brain-Computer Communication with high Quality User Training" (Fabien Lotte)
- EFRAN project e-tac "Tangible and augmented interface for collaborative learning" (Martin Hachet)
- First book in French about BCI [50] [51] (Fabien Lotte)
- First accessible MOOC on "Accessibilité numérique" <https://www.fun-mooc.fr/courses/inria/41012/session01/about> (Pascal Guitton)

REALOPT Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The Inria Innovation Lab with Ertus-consulting has reached the state of outputting a strategic planner for phytosanitary treatments in viticulture, showing significant potential saving margins. The prototype was presented to the press and the wine-making industry in September 2016. This event has been followed by some articles in the specialized press (such as “Réussir Vigne”) and more generalist output (such as “Les Echos”). Industrial partnerships are being pursued with EDF (on nuclear maintenance planning) and Saint Gobain (on glas cutting optimization) and a new project has been launched with SNCF.

François Clautiaux published a book [24] about dual-feasible functions, their use to improve the resolution of several combinatorial optimization problems involving knapsack inequalities like cutting and packing, scheduling, and vehicle routing problems, and their strong links with column generation models and the underlying Dantzig-Wolfe decomposition. This book explores the general properties that identify the best dual-feasible functions, describes the general approaches that can be followed to derive new non-dominated functions, which leads on several problems to the best results reported in the literature.

Our research on decomposition based math-heuristics has led to new benchmarks, highlighting the performance of our generic procedures: for instance, we have managed to improve the best known solutions for several open Generalized Assignment Problem (GAP) instances of the litterature. Similarly, our algorithms based on aggregation and disaggregation techniques [6] allowed us to outperform previous approaches for the cutting-stock problem, which is a classical benchmark problem. On the most difficult instances to date, we were able to solve optimally 240 instances out of 250, whereas previous algorithms were only able to solve 29 instances. In a more practical setting, we have developed algorithms to compute team schedules for a roster of employees [9], and these algorithms are now embedded in a professional employee **scheduling software** of the Asys company. We have also obtained strong results for scheduling problems in a high performance computing context [27], [19], which allowed to significantly improve the performance of linear algebra routines on high-end heterogeneous systems.

SISTM Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Modeling clinical trials of IL7

We have published the results of two clinical trials [17] that are showing the feasibility of repeating IL-7 cycles and confirmed the predictions performed with our dynamical model published in [49]. This mecanistic modeling allow to propose protocol which decrease the number of injection within each IL-7 cycle while keeping the same efficacy [35].

Awards Mélanie Prague published an invited paper on her PhD works (which was supervized by Daniel Commenges and co-supervized by Rodolphe Thiébaud) as a perks for the attribution of the "Marie-Jeanne Laurent-Duhamel PhD award (2015) by the SFdS (Société Francaise de statistiques). [15]

STORM Team (section vide)

TADAAM Team

5. Highlights of the Year

5.1. Highlights of the Year

The NETLOC (See Section 6.1) tools have been run on one of the largest European supercomputers (the TGCC/Genci CURIE machine) and successfully modeled its 5200 nodes and its interconnection network (more than 800 switches). This is a joint work with CEA and the COLOC European project.