RESEARCH CENTER

FIELD
Applied Mathematics, Computation and Simulation

Activity Report 2017

Section Highlights of the Team

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ACUMES Project-Team (section vide)

CAGIRE Project-Team

5. Highlights of the Year

5.1. ANR MONACO_2025

The MONACO_2025 proposal has been selected by ANR. In addition to Cagire, the consortium of this project, coordinated by [RM], consists in an academic partner, the institute PPrime of Poitiers, and two industrial partners, PSA and EDF. It is focused on the the development of a CFD methodology for transient, buoyancy-affected turbulent flows, that are crucial for the two industrial partners. This project built up on the long-term collaboration with EDF, and the more recent collaboration with PSA through a master internship and the CIFRE PhD thesis of Saad Jameel.

5.2. First implementation of a turbulence model in AeroSol

In the long-term strategy of the CAGIRE team, the development of agile simulation, a first step towards auto-adaptive RANS/LES methods was made this summer during the internship of Axelle Perraud. This step consisted in the implementation in AeroSol of a first near-wall resolving turbulence model. Before focusing on innovative RANS and hybrid RANS/LES methods developed in CAGIRE, it was chosen to implement the standard, well-established k-ω RANS model, in order to make possible a straightforward validation in comparison with other CFD codes.

CARDAMOM Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- CARDAMOM has passed with success its first evaluation in March 2017
- The associated team HAMSTER between CARDAMOM and the Department of Civil engineering of Duke University has been created in January 2017
- The associated team COMMUNES between CARDAMOM and the CWI in the Netherlands has been created in January 2017
- The open-source consortium around the Mmg platform has been created, and Mmg will now be part of the projects managed by Inria Soft

DEFI Project-Team (section vide)

ECUADOR Project-Team (section vide)

GAMMA3 Project-Team (section vide)

IPSO Project-Team (section vide)

MATHERIALS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

E. Cancès was awarded the 2017 Dargelos Prize from the Alumni of Ecole Polytechnique.

MEMPHIS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Memphis team of Inria and VALOREM are both involved in the european project AeroGust (Aeroelastic gust modelling). One of the task aims to investigate the behaviour of wind turbine blades submitted to gust using incompressible flow model and Octree grids. An other task is to carry on an experimental work on a wind turbine. Interests will be first to have real data and use it to better understand the effects of wind and more precisely of gusts, on wind blades. A second interest is to use experimental data to calibrate our numerical schemes in the high-fidelity CFD code.
The measurement of the wind was considered as the most important data to be obtained from the very start of the project. Indeed, this data will be used as a key input for the numerical simulations. This is needed to represent the wind as it arrives at the wind turbine. Then, wind turbine data collection aims to observe the aero-elastic behaviour of wind blades. So, the measurement of blade deformations will allow to check the structural beam model of the blade and to observe its structural behaviour. To observe the aerodynamic load on the wind blade, the measurement of pressure of air on the blade is of significant interest.
A meteorological mast has so been installed in March 2017 in Brittany (France) to measure wind on-site. In figure 5 can be seen a photograph of the whole mast after its installation. Figure 6 contains a picture focused on the sensors of the met mast which are wind vanes for the direction and anemometers for the velocity.

Figure 5. Photo of the met mast after its installation

For the instrumentation of the wind blade, the setup consists of 4 optical fibres along the blade. Each fibre has 4 sensors (pressure or strain gauges) and also temperature sensors at different lengths in order to calibrate the other sensors with respect to temperature. 10 strain gauges and 6 pressure sensors have so been installed on a wind blade located near the meteorological mast (in a way that in the main wind direction, the met mast and the wind turbine are aligned). In figure 7 , the 2 lines of sensors going along the pressure side and the leading edge of the wind blade can be seen.

Figure 6. Photo of the sensors on the met mast

Figure 7. Photo of the pressure side of the wind blade after instrumentation

Work is now in progress with the experimental data in order to identify different gust conditions in the field and to analyse the effects on the blade deformations. One of the outcomes will be then to compute simulations with our high-fidelity numerical tool developed with VALOREM. This comparison will allow us to calibrate the numerical schemes thanks to real test data.

MEPHYSTO Project-Team (section vide)

MOKAPLAN Project-Team (section vide)

NACHOS Project-Team (section vide)

NANO-D Project-Team (section vide)

POEMS Project-Team

5. Highlights of the Year

5.1. Waves diffracted by Patrick Joly

On the occasion of Patrick Joly's 60th birthday, a conference with about hundred attendees has been organized by Sonia Fliss, Xavier Claeys, Bérangère Delourme and Julien Diaz, from August 28th to August 30th 2017, to acknowledge and celebrate his decisive scientific contributions in the mathematical and numerical analysis of wave propagation.

Below is the list of invited Speakers

- Grégoire Allaire (CMAP, Ecole Polytechnique)
- Jean-David Benamou (Inria Paris)
- Anne-Sophie Bonnet-BenDhia (ENSTA/CNRS/Inria POems)
- Yann Brenier (Centre de Mathématiques Laurent Schwarz)
- Antoine Chaigne (MDW Vienna, Autriche)
- Simon Chandler-Wilde (Univ. Reading, UK)
- Lucas Chesnel (Inria Defi / CMAP Ecole Polytechnique)
- Bernardo Cockburn (Univ. Minnesota, USA)
- Francis Collino (freelance)
- Alexander Comech (Vienna University, Autriche)
- Martin Costabel (IRMAR, Univ. Rennes)
- Bruno Despres (LJLL UPMC)
- Bjorn Engquist (Univ. Texas Austin, USA)
- Martin Gander (Univ. Genève Suisse)
- Marcus Grote (Univ. Bâle Suisse)
- Houssem Haddar (Inria Defi / CMAP Ecole Polytechnique)
- Laurence Halpern (LAGA Univ. Paris 13)
- Thomas Hagstrom (Southern Methodist University Dallas, USA)
- Jan Hesthaven (EPF Lauzanne Suisse)
- Ralf Hiptmair (ETH Zurich Suisse)
- Andreas Kirsch (Karlsruhe Institute of Technology Allemagne)
- Claude Le Bris (CERMICS ENPC)
- Jérome Le Rousseau (LAGA Univ. Paris 13)
- Pierre Louis Lions (College de France)
- Peter Monk (Univ. Delaware)
- Serge Nicaise (Univ. Valenciennes)
- Konstantin Pankrashkin (Univ. Paris 11 Orsay)
- George Papanicolaou (Stanford University USA)
- Jerónimo Rodriguez (Univ. Saint Jacques de Compostelle)
- Chrysoula Tsogka (University of Crete Grèce)
- Ricardo Weder (University of Mexico Mexique)

A short presentation of former PhD students of Patrick Joly has also given an overview of his recent activities:

- Antoine Bensalah (ENSTA/CNRS/Inria Poems)
- Maxence Cassier (University of Utah)
- Juliette Chabassier (Inria Bordeaux, EPI Magique 3D)
- Julien Coatleven (IFP)
- Sebastien Imperiale (Inria Saclay, EPI M3DISIM)
- Elizaveta Vasilevskaya (High School teacher)

5.2. A day for Marc Lenoir

A day entitled *Un Lenoir... ça Marc... donc ça se fête* was organized at ENSTA on June, 23th, and gathered about 60 people. This day was intended to make a festive tribute to Marc Lenoir for his role in what has become the Applied Mathematics Laboratory of ENSTA (including POEMS). Two scientific talks have been given by longtime friends of Marc: Michel Crouzeix (University of Rennes) and Jacques Rappaz (Ecole Polytechnique Fédérale de Lausanne, Switzerland). The other talks, which emphasized the scientific and human qualities of Marc, were given by four former students: Nicolas Salles, Eric Lunéville and Christophe Hazard (all from POEMS) and Nabil Gmati (LAMSIN, Tunis).

RAPSODI Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Organization of the FVCA8 conference

The team RAPSODI was deeply involved in the organization of the eighth edition of the conference *Finite Volumes for Complex Application* (FVCA8). The conference was held in Lille on June 2017. The conference was a great success. It gathered about 150 specialists —mostly academics and research engineers from the industry— of the finite volume methods and of their application to real world problems. Claire Chainais-Hillairet headed the organization committee, Clément Cancès was in charge of the publication of the proceedings, Caterina Calgaro and Emmanuel Creusé organized the social events, and all the members of the team were in charge of the reception of the participants.

5.1.2. From a team to a project team

The research team RAPSODI was created on August 2015, but its evolution to the project team level was effective on Nov. 1, 2017. This evolution was based on the positive evaluation by several internationally recognized experts of an extended version of our research program.

APICS Project-Team (section vide)

BIPOP Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- Gilles Daviet has been awarded the 2017 PhD award of the national GdR IG-RV, http://www.af-rv.fr/blog/2017/07/10/resultats-du-prix-de-these-du-gdr-ig-rv-2017/, for his PhD thesis entitled 'Modèles et algorithmes pour la simulation du contact frottant dans les matériaux complexes, application aux milieux fibreux et granulaires'.

COMMANDS Project-Team

5. Highlights of the Year

5.1. Suboptimal feedback control of PDEs

In [13], J. Garcke (SCAI-Fraunhofer I.) and A. Kröner were able to solve finite time horizon suboptimal feedback control problems for partial differential equations is proposed by solving dynamic programming equations on adaptive sparse grids. The approach is illustrated for the wave equation and an extension to equations of Schrödinger type is discussed. A semi-discrete optimal control problem is introduced and the feedback control is derived from the corresponding value function. A semi-Lagrangian scheme is combined with spatially adaptive sparse grids. An adaptive grid refinement procedure is explored. We present several numerical examples studying the effect the parameters characterizing the sparse grid have on the accuracy of the value function and the optimal trajectory. Problems with dimensions up to eight were solved.

DISCO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Silviu-Iulian Niculescu is a 2018 IEEE Control Systems Society Fellow for research on the effects of delays in system dynamics.

GECO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

GECO has ended in June 2017, after being evaluated earlier in the year. A new team, including all former members of GECO, has started in July 2017 in the Inria Paris center. Its name is CAGE, for *Control And GEometry*.

I4S Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The Structual Health Monitoring system developed by Vincent Le Cam and SDEL-CC for lightning detection and localization on electrical lines, has received the VINCI Innovation Award for Western France 2017. https://team.inria.fr/i4s/vinci-2017-innovation-award/

5.1.1. Awards

BEST PAPERS AWARDS :

[29] **SPIE - Thermosense: Thermal Infrared Applications XXXIX**. J. DUMOULIN, A. CRINIÈRE.

[30] **IOMAC - 7th International Operational Modal Analysis Conference**. M. DÖHLER, P. ANDERSEN, L. MEVEL.

MCTAO Project-Team (section vide)

NECS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- M. L. Delle Monache received the prize “France -Berkeley Fund Award” for young researcher awarded by the College de France for her works in collaboration with United States
- P. Frasca published the book “Introduction to averaging dynamics over networks”, with F. Fagnani.
- P. Frasca has been selected as a member of the “Comité de Direction du GdR MACS ”, term 2019-2023.
- The team organized the international ERC Scale-free Back workshop on “Modelling reduction tools for large-scale complex networks”, Grenoble, September 2017

NON-A Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- Maxime Feingesicht won The Creativity Prize of the FR CNRS TTM.
- Gabriele Perozzi won the Best Student Paper Award of the conference EUCASS 2017.
- The IPL COSY has been launched!
- Hafiz Ahmed won a CNRS PhD award by GDR MACS.

BEST PAPERS AWARDS :
[68] **7th European Conference for Aeronautics and Space Science**. G. PEROZZI, D. EFIMOV, J.-M. BIANNIC, L. PLANCKAERT, P. COTON.

QUANTIC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Rémi Azouit (supervisor: Pierre Rouchon; co-supervisor: Alain Sarlette) has successfully defended his PhD thesis on October 27th and is now moving as a postdoc to Sherbrooke University. This thesis provides a systematic approach towards model reduction through adiabatic elimination for open quantum systems.
- Joachim Cohen (supervisor: Mazyar Mirrahimi) has successfully defended his PhD thesis on February 2nd. This thesis provides a roadmap for future experiments on autonomous hardware efficient quantum error correction with superconducting circuits.

5.1.1. Awards

- Mazyar Mirrahimi has received the “Inria-Academie des Sciences young researcher award 2017”.
- Pierre Rouchon has received the “Grand Prix IMT-Academie ses Sciences 2017”.

SPHINX Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Sphinx was evaluated in March 2017.
- A new ANR project (QUACO) has been accepted; its coordinator is Thomas Chambrion.

TROPICAL Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Performance evaluation of the 17-18-112 call center in Paris

Vianney Bœuf completed his PhD, done in collaboration with Brigade des Sapeurs Pompiers de Paris, on the performance evaluation of the new organization of the Paris emergency call center developed by Préfecture de Police. See Section 7.5.2 .

5.1.2. Maximal upper bounds in Löwner order

A classical theorem of Kadison (1951) shows that the set of real quadratic forms, equipped with the pointwise order, is an antilattice, meaning that two quadratic forms have a least upper bound (or dually, a greatest lower bound) if and only if they are comparable. In [23], Nikolas Stott gave a quantitative version of Kadison theorem, characterizing the set of minimal upper bound as the quotient an indefinite orthogonal group. Applications of these ideas to hybrid systems verification appeared in [16], [30].

5.1.3. Formal proofs in linear programming

Xavier Allamigeon and Ricardo Katz have formalized in the proof assistant Coq several basic results in the theory of convex polyhedra and linear optimization. These include Farkas Lemma, the duality theorem of linear programming, separation from convex hulls, Minkowski Theorem, etc. See [27] and Section 7.3.1 .

DOLPHIN Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- Patent with Beckman & Coulter on Intelligent handling of materials: joint selection and configuration optimization of machines (Prof. E-G. Talbi, S. Faramarzi-oghani, M. Bué)
- Best student paper award at conference SEAL'2017

BEST PAPERS AWARDS :
[27] **11th International Conference on Simulated Evolution and Learning (SEAL 2017)**. J. SHI, Q. ZHANG, B. DERBEL, A. LIEFOOGHE, S. VEREL.

GEOSTAT Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Innovation LAB GEOSTAT-I2S based on 3 year contract with I2S company on non convex optimization methods for image processing.

5.1.1. Awards

A. Tamim, PhD Student in Geostat, wins the gold medal of Hubert Curien PhD prize 2017. A. Tamim's PhD title: "Segmentation et classification des images satellitaires : application à la détection des zones d'upwelling côtier marocain et mise en place d'un logiciel de suivi spatiotemporel". See https://www.inria.fr/centre/bordeaux/actualites/prix-de-these-pour-ayoub-tamim.

INOCS Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Personnel

- Markus Sinnl joined us in October as Inria researcher.

5.1.2. Awards

- A joint team between Ecole des Mines de St Etienne and INOCS involving N. Absi, D. Cattaruzza, D. Feillet, M. Ogier, F. Semet won the scientific prize of the EURO/ROADEF Challenge 2016 devoted to an Inventory Routing Problem proposed by Air Liquid.

5.1.3. Publications & dissemination

- Martine Labbé was the EURO Plenary Speaker at the Conference of the International Federation of Operational Research Societies (IFORS) in Québec, Canada, July 2017 [42].

MISTIS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Veronica Munoz Ramirez supervised by F. Forbes, J. Arbel (MISTIS) and M. Dojat (Grenoble Institute of neuroscience) was granted a PhD grant from the Idex NeuroCoG project. The PhD project is part of a work package, dedicated to Parkinson's Disease (PD), which aims at identifying multidimensional cognitive and neurophysiological biomarkers for early diagnosis, outcome prediction and novel neurorehabilitation methods for de novo PD patients.
- In the context of another Idex project named Grenoble Data Institute, two 2-years multi-disciplinary projects were granted in November 2017 to Mistis in collaboration respectively with Team Necs from Inria and Gipsa-lab (DATASAFE project: understanding Data Accidents for TrAffic SAFEty) and with IPAG and Univ. Paris Sud Orsay (Regression techniques for Massive Mars hyperspectral image analysis from physical model inversion).

MODAL Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. NIPS 2017 workshop

Benjamin Guedj, Pascal Germain (both at Modal) and Francis Bach (SIERRA, Inria Paris) co-organize a NIPS 2017 workshop, called “(Almost) 50 shades of Bayesian learning: PAC-Bayesian trends and insights". A large audience is expected, and the workshop has a series of prestigious international speakers. See the website.

5.1.2. Recruitment of a new researcher

Pascal Germain has been recruited has CR2 in the team, three years after the recruitment of Benjamin Guedj the first CR recruited in the team.

RANDOPT Team

5. Highlights of the Year

5.1. Highlights of the Year

- A Auger has been (re)-elected member of the ACM-SIGEVO executive board.

REALOPT Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Olivier Beaumont was the Track Chair of the Algorithm Track of Super Computing 2017 (November, Denver, USA); "The International Conference for High Performance Computing, Networking, Storage and Analysis" https://sc17.supercomputing.org. SuperComputing is the major international conference on High Performance Computing.

We have contributed to the JULIA mathematical programming ecosystem by providing tools to decompose a mixed integer programming model into blocks. This makes it very convenient to model Benders or Dantzig-Wolfe decomposition using JUMP and to compare different decomposition for a given problem formulation.

Our generic software platform BaPCod is now giving rise to specific branches for classes of applications. The first such release concerns the classic benchmark Vehicle Routing Problem variants that arise in logistics. The methods that are build in the platform emerge from our collaboration with our Brazilian partners of the SAMBA associated team. For their anterior work, our partners have received the 2017 best paper award from the prestigious journal "Mathematical Programming Computation". With the new version that is built under BaPCod, we have managed to solve to optimality many more open instances of classic and very competitive Vehicle Routing Problem with Time Windows [37]. This study has been an opportunity to improve significantly the performance on the generic Branch-Cut-and-Price platform and to highlight the interests of such generic methodologies.

SELECT Project-Team (section vide)

SEQUEL Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- under the supervision of O. Pietquin and J. Mary, F. Strub and collaborators (among which University of Montreal) have introduced the **Guesswhat?!** game to study visually grounded dialogues interleaving vision and natural language. A dataset of 150k human-human dialogues has been collected and is freely available on the Internet. Supervised learning baselines and state-of-the-art reinforcement learning algoritms have been implemented and are available as open-source code. This work resulted in publications in prestigious conferences: as a spotlight at CVPR 2017, an oral at IJCAI 2017, and an other spotlight at NIPS 2017 [51], [29], [30]. Spotlight presentations concern less than 3.5% of submisisons to NIPS, and 5% of submissions to CVPR.

  See https://www.guesswhat.ai
- under the supervision of M. Valko and A. Lazaric, D. Calandriello and collaborators have provided the first breaking quadratic barrier for nonparametric learning. An open source implementation is available on the Internet. The work has been published in prestigious conferences: AI & STATS, ICML and NIPS [26], [28], [27].

SIERRA Project-Team (section vide)

TAU Team

5. Highlights of the Year

5.1. Organisation and Distinctions

- Isabelle Guyon, General Chair, **NIPS 2017** in Los Angleles (8000+ attendees). She also co-organized several workshops (two *See.4C* workshops, *Connecting the dots* at LAL, *AutoML* a ICML, BayLearn, and CiML at NIPS).
- Flora Jay co-organized **JDSE17**, the second edition of the Junior Conference on Data Science and Engineering, Paris-Saclay (September 2017).
- Yann Ollivier coordinated several events in France (workshop, public conferences, initiatives with school teachers, ...) related to **Shannon100**, the celebration of the Claude Shannon's hundredth birthday, a world-wide event. In particular he created a public exhibit that took place from December 2016 to April 2017 in the Musee des Arts et Metiers in Paris, with extremely positive feedback.
- Marc Schoenauer, expert with Cédric Villani for his national mission on the French AI strategy.
- Michèle Sebag, elected at the *Académie Française des Technologies*; ephemeral nominated member of the *Conseil National du Numérique* (Dec. 2017); member of TransAlgo; head of the DataIA Research programme.
- Paola Tubaro organized **RECSNA17**, an international conference on Recent Ethical Challenges in Social Network Analysis with support from Maison des Sciences de l'Homme Paris-Saclay and Institute for Advanced Studies, in partnership with British Sociological Association, Association Française de Sociologie and European Network on Digital Labor.

5.2. Awards and Prizes

- **AS-AC-CMA-ES Winner**, single objective track at **BBComp**, the Black Box Competition for continuous optimization at ACM-GECCO 2017 (July, Berlin). Nacim Belkhir, Johann Dréo, Pierre Savéant and Marc Schoenauer.
- **ASAP** V2 and V3 [23] ranked **first and second** at the **Open Algorithm Selection Challenge 2017** (see the official results – slide 22). François Gonard, Marc Schoenauer, and Michèle Sebag.

BEST PAPERS AWARDS :
[28] **GSI 2017 - 3rd conference on Geometric Science of Information**. Y. OLLIVIER, G. MARCEAU-CARON.

ASPI Team (section vide)

CQFD Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Pierre Del Moral is a Simons foundation CRM Professor, Montréal Math. Research Center 2017

Google scholar classic paper in Probability and Statistics (ten most-cited articles published ten years earlier): Del Moral, P., Doucet A., Jasra A.. *Sequential Monte Carlo Samplers* Journal of the Royal Statistical Society, Series B, vol. 68, no. 3, pp. 411-436 (2006).

MATHRISK Project-Team (section vide)

TOSCA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

BEST PAPERS AWARDS :
[] **A simple spiking neuron model based on stochastic STDP**.