RESEARCH CENTER

FIELD
Applied Mathematics, Computation and Simulation

Activity Report 2014

Section Highlights of the Team

Edition: 2015-06-01

BACCHUS Team (section vide)

CAGIRE Team (section vide)

DEFI Project-Team (section vide)

ECUADOR Project-Team (section vide)

GAMMA3 Project-Team (section vide)

IPSO Project-Team

5.1. Highlights of the Year

- E. Faou was plenary speaker at the CANUM, Congrès d'analyse numérique, France, June 2014
- E. Faou was invited to give two presentations in the Analysis and applied mathematics seminars, Cambridge, UK, February 2014.

MATHERIALS Team (section vide)

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.

MEPHYSTO Team

6.1. Highlights of the Year

A. Gloria, S. Neukamm, and F. Otto published their recent contribution [17] on quantitative homogenization in Inventiones Mathematicae.

As a plenary speaker of the World Congress of Computational Mechanics in Barcelone in July 2014, P. Le Tallec (Ecole polytechnique) presented our joint results [15], [25].

MOKAPLAN Team

6.1. Highlights of the Year

All of the new results below are important break through and most of them non-incremental research.

Mokaplan has extended its collaborations to several researchers at Ceremade and is under review to become a project team.

NACHOS Project-Team (section vide)

NANO-D Project-Team (section vide)

OPALE Project-Team

6.1. Highlights of the Year

Paola Goatin was awarded the *"Prix Inria - Académie des sciences du jeune chercheur"*.

POEMS Project-Team (section vide)

APICS Project-Team (section vide)

BIPOP Project-Team

6.1. Highlights of the Year

- Bernard Brogliato: keynote speaker at ICDVC-2014, 4th International Conference on Dynamics, Vibration and Control, August 23-25, 2014 in Shanghai, China. http://www.icdvc2014.org/

COMMANDS Project-Team

6.1. Highlights of the Year

6.1.1. Optimization of running strategies based on anaerobic energy and variations of velocity

Participant: Frédéric Bonnans.

The paper [10] about running strategies proves Keller's conjecture. It was highlighted in SIAM Connect,see http://connect.siam.org/insightful-mathematics-for-an-optimal-run/

6.1.2. Research and transfer collaboration in aeronautics with the startup Safety Line

Participants: Frédéric Bonnans, Daphné Giorgi, Stéphan Maindrault, Pierre Martinon.

Following the meeting with the startup Safety Line at Imatch "Optimisation and Control" in october 2013, we conducted a first collaboration of six months on optimizing the fuel consumption of civil airliners. This first step successfully established the proof of concept and was validated by actual test flights in June 2014, leading to a shared patent and the development of a specific module of our software 'Bocop', included in the tool 'OptiClimb' developed at Safety Line. Future prospects include improving the numerical robustness of the current tool, as well as expanding the optimization to the cruise flight in addition to the climb phase.

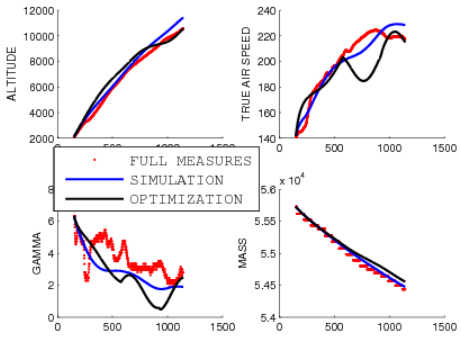

Figure 2. Plane climb phase (Boeing 737)

CORIDA Team

6.1. Highlights of the Year

The CORIDA team organized two scientific meetings in 2014.

The first workshop, “Observers for finite and infinite dimensional systems” in April 2014, gathered people working in the field of control theory for finite and infinite dimensional systems.

Ten speakers from France, India, Portugal and Germany were invited for the second workshop, “Workshop in Mathematical Fluid Dynamics", in November 2014.

DISCO Project-Team (section vide)

GECO Project-Team

6.1. Highlights of the Year

We organized a thematic trimester on “Geometry, analysis and dynamics on sub-Riemannian manifolds” at the Institut Henri Poincaré (IHP), including 4 workshops, 4 research courses, 8 thematic days, several seminars. We also organized an associated school at CIRM with 4 introductory courses. The web pages of the events are:
http://www.cmap.polytechnique.fr/subriemannian/
http://www.cmap.polytechnique.fr/subriemannian/cirm/

I4S Project-Team

6.1. Highlights of the Year

The team organized the 7th European Workshop on SHM in Nantes in July 2014 (http://ewshm2014.com) .

Maxplus Project-Team

6.1. Highlights of the Year

Nous avons donné un contre exemple inattendu à l'analogue continu de la conjecture de Hirsch, proposé par Deza, Terlaky et Zinchenko, voir Section 6.4.4 .

English version

We gave a somehow unexpected counter example to the continuous analogue of the Hirsch conjecture proposed by Deza, Terlaky and Zinchenko, see Section 6.4.4 .

MCTAO Project-Team (section vide)

NECS Project-Team

6.1. Highlights of the Year

- C. Canudas de Wit serves as General Chair for the Europeen Control Conference (ECC'14), Strasbourg, France, Jul. 2014 (http://www.ecc14.eu/).
- Launch of the SPEEDD EU FP7 project in Feb. 2014.
- Launch of the COMFORT project, which supports the associate Team between Inria project-team NeCS and the Berkeley University project PATH (http://necs.inrialpes.fr/pages/projects/comfort.php).
- Launch of the LOCATE-ME Persyval project (Apr. 2014 to Aug. 2015) in collaboration with the Tyrex team.
- The team has organized the Hycon2 Show day in May 2014 (http://www.inria.fr/en/centre/grenoble/calendar/hycon2-show-day-traffic-modeling-estimation-and-control).

NON-A Project-Team

6.1. Highlights of the Year

- We are becoming world-recognized on homogeneous approach to estimation and control [13], [24].
- New method of stability analysis and control design for time-delay systems: Implicit Lyapunov-Krasovski Functionals [72].
- New dynamical model of population of oysters for water quality monitoring [44].
- New local path planning algorithm for mobile robots based on intermediate objectives [33].
- New patent on method and device for detecting a failure on an aircraft [85].
- New book on robust control design [82].

QUANTIC Team

5.1. Highlights of the Year

- Experimental results in continuous measurement of error syndromes for a quantum error correction scheme developed by Mazyar Mirrahimi and his former PhD student Zaki Leghtas in close collaboration with the teams of Michel Devoret and Robert Schoelkopf (Department of Applied Physics of Yale University) have been published in Nature [13].
- Theoretical proposal on a new paradigm for universal quantum computation [12] has been chosen by the editors of the New Journal of Physics as an IOPselect paper for the novelty, significance and potential impact on future research.
- The EPOQ2 ANR Young Researcher project, led by Mazyar Mirrahimi, was highlighted in the 2013 annual report of Agence Nationale de la Recherche.

CLASSIC Project-Team (section vide)

DOLPHIN Project-Team

6.1. Highlights of the Year

In [23], we have revisited the design and implementation of the Branch and Bound algorithm for solving on large scale distributed environments challenging permutation-based optimization problems such as Q3AP. The new approach includes original ways to efficiently deal with some crucial issues mainly, dynamic adaptive load balancing and fault tolerance. The approach allowed to solve to optimality for the first time a difficult Q3AP instance (Nug15) on the nation-wide Grid'5000 computational grid. The resolution was completed within less than 12 days using an average of 1,123 processing cores distributed over 6 Grid'5000 sites and peaked at 3,427.

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.

MISTIS Project-Team

6.1. Highlights of the Year

6.1.1. P-Locus software and Pixyl start-up project

The work on the P-Locus software has been exploited in order to create a start-up in January 2015. The project called Pixyl have been accepted by the GATE1 incubator and has been awarded a BPI emergence prize. It is leaded by Senan Doyle (future CEO). The other co-founders are Michel Dojat (INSERM, GIN), Florence Forbes (Inria, Mistis) and IT-Translation.

MODAL Project-Team

6.1. Highlights of the Year

Thanks to the development technological action MPAGenomics, the team has created one of the first french instances of Galaxy publicly available on the French Bioinformatics cloud. This instance is original as it offers complex statistical tools for genomic data analysis in a user-friendly interface (see 5.9).
The team obtained bilateral contracts with companies as Auchan or RougeGorge thanks to its just emerging, but promising, clustering software MixtComp (see 5.14), dedicated to full mixed and missing data.

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].

SELECT Project-Team (section vide)

SEQUEL Project-Team

6.1. Highlights of the Year

- New startup by Rémi Coulom on AI in games (go, chess, $\cdots$).
- Successful Collaboration with Deezer and the victory at the ACM RecSys Recommendation Systems Challenge
- We were selected and working on preparation of ICML 2015 in Lille. ICML is the most important conference in the field of machine learning. This is the first time after more than 30 years of existence, that this conference will be held in France.

SIERRA Project-Team (section vide)

TAO Project-Team

6.1. Highlights of the Year

- The European commission has chosen Crystal-Supergrids (http://www.artelys.com/news/120/90/Energy-The-European-Commission-Chooses-Artelys-Crystal) for energy modeling and planning in Europe. Crystal-Supergrids is based on the Post project, an ADEME project between Artelys and Inria-TAO.
- The HiggsML challenge was the all-time most popular challenge organized by Kaggle. Cécile Germain-Renaud, Balázs Kégl and Marc Schoenauer were part of the organizing committee.
- Creation of the Center for Data Science, an interdisciplinary institute of the Université Paris-Saclay. Co-chaired by Balázs Kégl, with more than 250 permanent researchers in 35 laboratories, the CDS organizes continued cross-fertilization of machine learning and domain sciences.
- Best Paper Award at PPSN .

BEST PAPERS AWARDS :
[36] **13th International Conference on Parallel Problem Solving from Nature**. I. LOSHCHILOV, M. SCHOENAUER, M. SEBAG, N. HANSEN.

ASPI Project-Team (section vide)

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.

MATHRISK Project-Team

6.1. Highlights of the Year

B. Jourdain and A. Sulem : Guest editors of the special issue "Systemic Risk" of *Statistics and Risk Modeling*, 2014. [27]

The research project "Stochastic Control of Systemic Risk" has been awarded by the scientific council and Professional Fellows of Institut Europlace de Finance (EIF) and Labex Louis Bachelier (December 2014).

Roxana Dumitrescu, PhD student, received the price for collaborative actions during her PhD studies, delivered by Fondation des Sciences Mathématiques de Paris and CASDEN (November 2014).

Pierre Blanc, PhD student, has got the award of "Rising star of quantitative finance" for his talk on a price impact models with an exogeneous (Hawkes) flow of orders [29]. This prize was given by the Global Derivatives conference (Amsterdam, 12-16 May) to indicate the best work among PhD students.

REGULARITY Project-Team

6.1. Highlights of the Year

The article "Christiane's Hair" by Jacques Lévy-Véhel and Franklin Mendivil has received the Paul R. Halmos - Lester R. Ford award of the Mathematical Association of America.

TOSCA Project-Team (section vide)