



RESEARCH CENTER  
Saclay - Île-de-France

FIELD

Activity Report 2013

# Section highlights of the Team

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**COMETE Project-Team (section vide)**

## **GEOMETRICA Project-Team**

### **2.2. Highlights of the Year**

Jean-Daniel Boissonnat has obtained an "advanced" grant from the ERC (European Research Council) for his project Gudhi : Geometry Understanding in Higher Dimensions.

## GRACE Project-Team

### 2.2. Highlights of the Year

- *Number-Theoretic Algorithms for Asymmetric Cryptology* Workshop. On June 20 and 21, 2013, GRACE hosted an international workshop on number-theoretic algorithms for asymmetric cryptology (with the support of Digicosme). Our invited speakers included Steven Galbraith (Auckland), Florian Hess (Oldenburg), Razvan Barbulescu (LORIA), Andreas Enge (Inria Bordeaux), Antoine Joux (UVSQ and Cryptoexperts), and Vadim Lyubashevsky (Inria Paris–Rocquencourt). Forty researchers attended over the two days. This workshop saw the first public announcement and presentation of what is undoubtedly the most remarkable new result in algorithmic number theory in 2013, if not the last decade: Barbulescu, Gaudry, Joux, and Thomé’s quasi-polynomial time algorithm for discrete logarithms in a large class of finite fields.
- ISN-Privacy. In year 2013, N. Boujemaa’s proposal for an *Institut de la société du numérique* (Digital Society Institute) was accepted within IDEX Paris-Saclay. This proposal aims to foster interdisciplinary research involving both computer scientists and researchers in the humanities. Daniel Augot joined researchers from project-teams COMETE (Saclay) and SMIS (Paris–Rocquencourt) in regular monthly discussions with economists and lawyers; a seminar will be held in Summer 2014. Funding was allocated from the IDEX to the PAIP (*Pour une Approche Interdisciplinaire de la Privacy*) project for all the partners of the privacy group.
- A special issue of *Designs, Codes and Cryptography* co-edited by Daniel Augot, devoted to the WCC2011 conference proceedings, was published in January 2013 [16].

## MEXICO Project-Team

### 2.2. Highlights of the Year

- We have made two major progresses in diagnosis this year:
  - For non-diagnosable discrete event systems, *active* diagnosis aims at synthesizing a partial-observability based control for the system in order to make it diagnosable. While some solutions had already been proposed for the active diagnosis problem, their complexity remained to be improved. In [40], we solved both the active diagnosability decision problem and the active diagnoser synthesis problem, proving that (1) our procedures are optimal w.r.t. to computational complexity, and (2) the memory required for the active diagnoser produced by the synthesis is minimal. Furthermore, focusing on the minimal delay before detection, we establish that the memory required for any active diagnoser achieving this delay may be highly greater than the previous one. So we refine our construction to build with the same complexity and memory requirement an active diagnoser that realizes a delay bounded by twice the minimal delay. An extension to *probabilistic* systems has been accepted to *FoSSaCS 2014*.
  - In [41], we present a methodology for fault diagnosis in concurrent, partially observable systems with additional fairness constraints. In this *weak* diagnosis, one asks whether a concurrent chronicle of observed events allows to determine that a non-observable fault will inevitably occur, sooner or later, on any maximal system run compatible with the observation. The approach builds on strengths and techniques of unfoldings of safe Petri nets, striving to compute a compact prefix of the unfolding that carries sufficient information for the diagnosis algorithm. Our work extends and generalizes the unfolding-based diagnosis approaches by Benveniste et al. as well as Esparza and Kern. Both of these focused mostly on the use of sequential observations, in particular did not exploit the capacity of unfoldings to reveal inevitable occurrences of concurrent or future events studied by Balaguer et al. [19]. Our diagnosis method captures such indirect, revealed dependencies. We develop theoretical foundations and an algorithmic solution to the diagnosis problem, and present a SAT solving method for practical diagnosis with our approach.
- The article *Complexity Analysis of Continuous Petri Nets* by Estébaliz Fraca and Serge Haddad [39] received the *outstanding paper award* at the *International Conference on Application and Theory of Petri Nets and Concurrency, June 24-28, 2013, Milano, Italy*.

BEST PAPER AWARD :

[39] **34th International Conference on Applications and Theory of Petri Nets (ICATPN'13)**. E. FRACA, S. HADDAD.

## **PARSIFAL Project-Team**

### **2.2. Highlights of the Year**

- The team organized the LIX Colloquium 2013: The Theory and Application of Formal Proofs, November 5–7. Webpage: <http://www.lix.polytechnique.fr/colloquium2013/>



**SECSI Project-Team (section vide)**

## **Specfun Team**

### **2.3. Highlights of the Year**

This year, we complete a first work emblematic of the interdisciplinary activity of the team: a computer-algebra based formal proof of irrationality of the mathematical constant  $\zeta(3)$ , that is, the evaluation at 3 of the Riemann zeta function of number theory. This motivated collateral enhancements of libraries for the interactive theorem prover Coq. This is described in more details in the new results.

## TOCCATA Team

### 2.2. Highlights of the Year

- The *Castor informatique* <http://castor-informatique.fr/>, is an international competition to present computer science to pupils (from *6ème* to *terminale*). More than 170,000 teenagers played on more than 30 proposed exercises in November 2013. Two members of the Toccata team (S. Boldo and A. Charguéraud) belong to the organization committee (5 people).
- The full formalization of the JavaScript language specification (ECMAScript 5) was recently completed by the *JsCert* team [24], which includes A. Charguéraud and 7 collaborators from Imperial College and Inria Rennes (<http://jscert.org>). The formalization, which involves more than 10,000 lines of code and an inductive semantics with over 600 reduction rules, is the result of 2 years of effort. It led to the discovery of bugs in the official standard, in the official test suites, and in all major browsers. In particular, it has raised the interest of several members of the ECMAScript standardization committee, and that of the developers of secure subsets for JavaScript.
- J.-C. Filliâtre was invited as keynote speaker (“One Logic To Use Them All” [19]) at the International Conference on Automated Deduction in 2013. It is the main conference of the year in the domain of Automated Reasoning. In this talk he presented the *Why3* approach for interacting with dozens of provers on the same theories and goals. This invited talk is a recognition by the community of this unique feature of *Why3*.
- Most 18-year old French students pass an exam called Baccalaureate which ends the high school and is required for attending the university. The idea was to try our Coq library *Coquelicot* on the 2013 mathematics test of the scientific Baccalaureate. C. Lelay went to the “Parc de Vilgénis” high school in Massy, France and took the 2013 test at the same time as the students, but had to formally prove the answers [45] (see also <https://www.lri.fr/~lelay/>).
- The Coq proof assistant received the ACM *Programming Languages Software Award* in 2013 <http://www.sigplan.org/Awards/Software/Main>. The development of Coq was initiated by Thierry Coquand and Gérard Huet in 1984. The current environment is the result of the work of more than 40 direct contributors, including major contributions by Christine Paulin-Mohring and Jean-Christophe Filliâtre from our team.

## **COMMANDS Project-Team**

### **2.3. Highlights of the Year**

In collaboration with L. Giraldi and M. Zopello, we started in 2013 to study the optimal swimming strategies for micro-swimmers. Our approach allows us to solve the optimal control problem without making restrictive assumptions on the shape of the swimming movements. The first numerical results on the 3-link swimmer indicate the existence of a periodic stroke with a better displacement speed than the canonical stroke presented by Purcell in 1977. Further directions include optimal design of micro-swimmers and comparing our simulations to the movement of live micro-organisms.

In collaboration with CNES, a trajectory optimization problem for Ariane 5 was studied and analyzed by HJB approach. In this study, the flight model is considered in dimension 6 without simplification. The problem consists in maximizing the payload to steer the launcher from the launch base (Kourou) to the GEO orbit. The mission includes ballistic phases and the optimization also encompasses the intermediate GTO orbit parameters. The optimization criterion is the mass of the payload to be injected on the GEO.

Finally, the team completed 3 PhD and 4 patents in 2013.

## **DEFI Project-Team**

### **2.2. Highlights of the Year**

G. Allaire received the 2013 Dargelos Prize of AX, the alumni association of Ecole Polytechnique.

## **DISCO Project-Team**

### **2.2. Highlights of the Year**

Frédéric Mazenc in June 2013 for his presentation of the paper was awarded by the *IEEE Control Systems Society* the *Best Presentation of Session Presenter*.

Sorin Olaru got the Best paper award at the 17th International Conference on System Theory, Control and Computing .

BEST PAPERS AWARDS :

[55] ACC. F. MAZENC, T. DINH, S.-I. NICULESCU.

[52] ICSTCC 2013. C. KOITI IDE, S. OLARU, P. RODRIGUEZ-AYERBE, A. RACHID.

## **GECO Project-Team**

### **2.2. Highlights of the Year**

We edited two volumes on two different and challenging subjects, that is hybrid systems with constraints [12] and sub-Riemannian geometry [13].

**Maxplus Project-Team (section vide)**



**POEMS Project-Team (section vide)**

## **REGULARITY Project-Team**

### **2.2. Highlights of the Year**

J. Lévy Véhel was a finalist at the 2013 Humies competition in Amsterdam.

**SELECT Project-Team (section vide)**

## TAO Project-Team

### 2.3. Highlights of the Year

#### 2.3.1. Extensions of Multi-Armed Bandits and Monte-Carlo Tree Search

**Risk Avoidance** Exploration might exert a toll on the agent/system safety in real-world contexts (e.g., controlling a power system or a robot). Risk adverse criteria have been pioneered in MAB, together with multi-objective reinforcement learning – see [12] and [19].

**Continuous Options** The Rapid Action Value Estimate (RAVE) has been extended to continuous settings [27].

#### 2.3.2. Information Theory and Natural Gradient

**Information-geometric Optimization: convergence results.** Theoretical guarantees have been obtained for continuous optimization algorithms in the framework of *information geometry* (IGO). Previous improvement guarantees for gradient descent-based methods were valid only for infinitesimally small step sizes. Information geometry and using the *natural gradient* provide improvement guarantees for finite step sizes as is the case in practice [22]. Along the same lines, geodesics in statistical manifolds have been used for estimation of distribution optimization algorithms.

**Neural Network Training** is a hard optimization problem, sensitive to the problem representation and the optimization trajectory. Within a Riemannian geometry framework, the use of intrinsic Riemannian gradient has been shown to support an affine transformation-invariant optimization approach, with significant robustness improvements at the same cost as the state of the art [66]. This Riemannian approach has been applied to recurrent neural nets, with very satisfactory results on difficult symbolic sequences with non-local dependencies [65]. In the related field of stacked restricted Boltzman machines, we have shown that the layer-wise approach supporting the celebrated deep learning approach yields *globally optimal* results provided the inference (as opposed to generative) model is rich enough, with quantitative estimates [60]. This result is the first of its kind on layerwise deep learning.

## **AMIB Project-Team**

### **2.2. Highlights of the Year**

Michael Levitt, our international collaborator of the ITSNAP Associated team, was awarded the Nobel Prize in Chemistry *for the development of multiscale models for complex chemical systems*. The Nobel lecture is available at [http://www.nobelprize.org/nobel\\_prizes/chemistry/laureates/2013/levitt-lecture.html](http://www.nobelprize.org/nobel_prizes/chemistry/laureates/2013/levitt-lecture.html).

The *Best application paper* at EGC 2013 was awarded to [34].

## **GALEN Project-Team**

### **2.2. Highlights of the Year**

- **BIOMED Summer School:** Galen has organized the Biomedical Image Analysis Summer School : Modalities, Methodologies & Clinical Research at Paris between July 8<sup>th</sup> and July 12<sup>th</sup>, 2013 involving international leaders/contributors in the field of biomedical image analysis as instructors where approx 100 participants were selected from an outstanding number of applications.
- **Coursera:** Pawan Kumar Mudigonda & Nikos Paragios introduced a new course on discrete inference and learning in artificial vision on the Coursera platform with approx 15,000 student enrollments.
- **Editor in Chief:** Nikos Paragios was named editor in chief of the Computer Vision and Image Understanding Journal (CVIU). CVIU is published by Elsevier Publishing House and is one of the oldest and leading journals in the field of computer vision and image understanding. In 2009, it was named one of the top 20 journals in computer science by Times Higher Education.

## **M3DISIM Team**

### **2.1. Highlights of the Year**

- Hiring of one new permanent researcher: Sébastien Imperiale (CR2);
- New European project named VP2HF, see [7.2.1.2](#) ;
- First paper with experimental validations of our cardiac model, see [\[13\]](#).

## **PARIETAL Project-Team**

### **2.1. Highlights of the Year**

- The **Therapixel** start-up was created by Pierre Fillard (effective on July 1<sup>st</sup>, 2013) <http://www.therapixel.com/company/>. Therapixel is designing a device to look at and interact with images without any contact to a screen or a keyboard. This technical solution is very handy for surgeons who have to avoid any contact while in the operating room, and yet need pre-operative images. The technologies developed at Therapixel are based on those of the medInria software. Therapixel got an OSEO 2013 grant.
- The **Human Brain Project** European flagship project has been accepted in 2013 for a ten years duration (see section 7.3.1 ). Parietal is part of it and took part to the kick-off in October 2013.



## Popix Team

### 2.2. Highlights of the Year

The Inria Innovation Lab *Lollipop* was created. This i-Lab brings together POPIX and the start-up Lixoft. It aims to boost the transfer of new statistical methods developed by POPIX to new tools developed by Lixoft.

We have built a comprehensive online wiki (WikiPopix, <https://wiki.inria.fr/popix>) for the population approach with mixed-effects models. This wiki aims to be an invaluable resource for all pharmacometricians, statisticians, teachers, graduate and undergraduate students in academia, industry and regulatory agencies. It is freely available online for all these communities.

Bertrand Maury published the book, *The Respiratory System in Equations* (Springer), which gives an introduction to the mathematical modeling of the respiratory system. The book starts with detailed introduction to physiological aspects, and then different levels of description are proposed, from lumped models with a small number of parameters (ordinary differential equations), up to infinite dimensional models based on partial differential equations.

**GRAND-LARGE Project-Team (section vide)**

## AVIZ Project-Team

### 2.3. Highlights of the Year

AVIZ received one best paper award and one best paper honorable mention award at the ACM CHI Conference on Human Factors in Computing Systems.

AVIZ received one best paper honorable mention award and one best poster award [30] at the IEEE Visualization conference.

AVIZ received one best paper honorable mention award at the IFIP TC13 Conference on Human-Computer Interaction (INTERACT).

Petra Isenberg co-organized the Dagstuhl seminar on “Interaction with Information for Visual Reasoning”, August 25–30.

Aviz hired a Fab manager for Digiscope’s Fab Lab (<http://fablabdigiscope.wordpress.com/>).

Aviz organized a Workshop on The New Statistics: Estimation for Better Research (<http://www.aviz.fr/Research/NewStatisticsWorkshop>).

Aviz organized a visit with demos for the CHI 2013 conference attendees (<http://www.aviz.fr/Research/Visit2013>).

Aviz co-organized the International Workshop on Interactive Ultra-High-Resolution Displays (<http://www.powerwall.mdx.ac.uk/>) as part of CHI 2013.

Yvonne Jansen and Pierre Dragicevic were interviewed by Enrico Bertini and Moritz Stefaner (<http://datastori.es/episode17-data-sculptures/>) on physical visualizations.

Petra Isenberg was interviewed by Enrico Bertini and Moritz Stefaner (<http://datastori.es/ds26-visualization-beyond-desktop/>) about her work on Visualization Beyond the Desktop.

BEST PAPERS AWARDS :

[28] **Proceedings of the 2013 Annual Conference on Human Factors in Computing Systems (CHI 2013).**

B. ALPER, B. BACH, N. HENRY RICHE, T. ISENBERG, J.-D. FEKETE.

[36] **Proceedings of the Conference on Human Factors in Computing Systems (CHI).** J. FUCHS, F. FISCHER, F. MANSMANN, E. BERTINI, P. ISENBERG.

[] **IEEE Transactions on Visualization and Computer Graphics.** C. PERIN, R. VUILLEMOT, J.-D. FEKETE.

[38] **Proceedings of the IFIP TC13 Conference on Human-Computer Interaction (INTERACT).** S. HURON, P. ISENBERG, J.-D. FEKETE.

## **DAHU Project-Team**

### **2.2. Highlights of the Year**

Serge Abiteboul was awarded the 2013 Milner awards.

## IN-SITU Project-Team

### 2.3. Highlights of the Year

- InSitu received two best paper awards, one at INTERACT [21] (Brian Shackel award) and the other at IEEE/VRST [28], and one honorable mention at ACM/CHI [34].
- InSitu (Wendy Mackay, General Chair, Michel Beaudouin-Lafon, Technical Program co-chair) organised the 31st ACM Conference on Human Factors in Computing Systems (CHI '13), which took place in Paris and was a great success (3500 participants, 1000 presentations).
- W. Mackay's ERC Advanced Grant, "CREATIV: Creating Human Computer Partnerships", started on June 1, 2013

#### BEST PAPERS AWARDS :

[21] **INTERACT 2013 - 14th IFIP TC13 Conference on Human-Computer Interaction.** M. ELIAS, M.-A. AUFAURE, A. BEZERIANOS.

[28] **VRST '13: 19th ACM Symposium on Virtual Reality Software and Technology.** C. PINDAT, E. PIETRIGA, O. CHAPUIS, C. PUECH.

[34] **CHI'13 - 31st International Conference on Human Factors in Computing Systems.** J. WAGNER, M. NANCEL, S. GUSTAFSON, S. HUOT, W. E. MACKAY.

## **OAK Project-Team**

### **2.1. Highlights of the Year**

The year has seen the finalization of five major research activities: XML materialized view maintenance [4], XML static type analysis [5], document management through semantic annotations [7], scalable dissemination of Web data [8], and XML type-based projection [13]. The respective five publications appeared in A\* journals (according to the CORE ERA ranking).