RESEARCH CENTER

FIELD

Activity Report 2015

Section Highlights of the Team

Edition: 2016-03-21

ALGORITHMICS, PROGRAMMING, SOFTWARE AND ARCHITECTURE

ALF Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Pierre Michaud won the 2nd Data Prefetching Championship held in conjunction with ISCA 2015 (Portland, June 2015).

BEST PAPERS AWARDS :

[27] **2nd Data Prefetching Championship**. P. MICHAUD.

ANTIQUE Project-Team (section vide)

AOSTE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Robert Davis, from York University, got awarded an Inria International Chair to spend a year over a duration of five years as full member of the Aoste EPI.

ARIC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. ARITH conference in Lyon

Since 1969, ARITH is the primary and reference international conference for presenting scientific work on the latest research in computer arithmetic. In June 2015, we organized it in Lyon.

5.1.2. Best student paper

At ISSAC'2015 [20].

5.1.3. Best papers

Best papers at Eurocrypt'2015 , Asiacrypt'2015 and ISSAC'2015 .
BEST PAPERS AWARDS :
[14] **EUROCRYPT**. J. H. CHEON, K. HAN, C. LEE, H. RYU, D. STEHLÉ.
[11] **ASIACRYPT**. S. BAI, A. LANGLOIS, T. LEPOINT, D. STEHLÉ, R. STEINFELD.
[16] **ISSAC**. J.-G. DUMAS, C. PERNET, Z. SULTAN.

ATEAMS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

Prof.dr. Paul Klint won the IEEE TCSE Software Engineering Distinguished Service Award 2015. This award is presented “annually for outstanding and/or sustained contributions and service to the software engineering community”.

CAIRN Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Our work on accuracy evaluation and optimisation for fixed point arithmetic was presented during a tutorial "Fixed-point refinement, a guaranteed approach towards energy efficient computing" at IEEE/ACM Design Automation and Test in Europe (DATE'15) [70].

Some Granit out of Cairn... The GRANIT team at IRISA is a spin-off of the CAIRN team created in January 2015, and all of the GRANIT members were formerly belonging to CAIRN. This decision was motivated by two main reasons: CAIRN had reached a critical size (nearly twenty permanent researchers) and the scope of its research was becoming really broad. During the last period, the global scope of CAIRN was the research of new architectures, algorithms and design methods for flexible and energy efficiency domain-specific system-on-chip (SoC), promoting the use of reconfigurable hardware. The research activities of CAIRN were organized around three main topics: (i) The invention and the design of new reconfigurable platforms with an emphasis on flexible arithmetic operator design, dynamic reconfiguration management and low-power consumption. (ii) The development of their corresponding design flows (compilation and synthesis tools) to enable their automatic design from high-level specifications. (iii) The interaction between algorithms and architectures especially for wireless communications and wireless sensor networks. In brief, the two first topics will still be investigated by CAIRN, while GRANIT will explore the third one, with a new focus on algorithm and architecture adaptivity and cooperation between wireless nodes.

Awards The paper "Energy-Aware Computing via Adaptive Precision under Performance Constraints in OFDM Wireless Receivers" [39] received the best paper at the IEEE Computer Society Annual Symposium on VLSI (ISVLSI).

BEST PAPER AWARD :

[39] **IEEE Computer Society Annual Symposium on VLSI (ISVLSI 15)**. F. CLADERA, M. GAUTIER, O. SENTIEYS.

CAMUS Team

5. Highlights of the Year

5.1. Highlights of the Year

Aravind Sukumaran-Rajam has shown in his PhD work [13] that the polyhedral model, usually exclusively dedicated to advanced static analysis and optimization of linear loops, can also be applied to nonlinear loops. This noteworthy extension of the scope of polyhedral techniques has been made possible thanks to the speculative and dynamic parallelization strategy implemented in the Apollo framework. Significant parallel speed-ups can now be obtained automatically for loops and loop nest that could not be handled before by compilers. Aravind Sukumaran-Rajam and Philippe Clauss have published a paper on this topic in the ACM journal Transactions on Architecture and Code Optimization in 2015 [14].

CARAMEL Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

The LOGJAM attack has received the best paper award at the conference ACM CCS 2015 (Conference on Computer and Communications Security). It has also received a Pwnie award [0] in the category *Most innovative research*.

The Tower NFS article was one of the two ASIACRYPT 2015 papers invited to submit a long version to Journal of Cryptology.

BEST PAPERS AWARDS :

[15] **ACM CCS 2015**. D. ADRIAN, K. BHARGAVAN, Z. DURUMERIC, P. GAUDRY, M. GREEN, J. A. HALDERMAN, N. HENINGER, D. SPRINGALL, E. THOMÉ, L. VALENTA, B. VANDERSLOOT, E. WUSTROW, S. ZANELLA-BÉGUELIN, P. ZIMMERMANN.

[17] **ASIACRYPT 2015**. R. BARBULESCU, P. GAUDRY, T. KLEINJUNG.

[0] http://pwnies.com/

CARTE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The paper [21] published at the International Conference on Functional Programming (ICFP 2015) has given a positive answer to an open problem, conjectured to be true for a long time: the question is to know whether inductive and coinductive data types can be added to light logic based systems without breaking the complexity of the system (i.e. staying within the class of polynomial time computable functions). This issue is analog to the issue of adding inductive and coinductive data types to system F without breaking normalization, which is known to hold for a long time. To tackle this challenging question, we have studied the problem of defining algebras and coalgebras in the Light Affine Lambda Calculus, a system characterizing the complexity class FPTIME. In this system, the principle of stratification limits the ways we can use parametric polymorphism, and in general the way we can write our programs. We have shown that while stratification poses some issues to the standard System F encodings, it still permits to encode some weak form of algebra and coalgebra. Using the algebra encoding one can define in the Light Affine Lambda Calculus the traditional inductive types. Unfortunately, the corresponding coalgebra encoding permits only a very limited form of coinductive data types. To extend this class, we have studied an extension of the Light Affine Lambda Calculus by distributive laws for the modality §.

5.1.1. Awards

Hugo Férée has received the Ackermann award for his PhD thesis “complexité d’ordre supérieur et analyse récursive”.

CASCADE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Conferences

Our group presented 8 papers (among 57) at Eurocrypt, 7 (among 74) at Crypto, and 3 (among 64) at Asiacrypt, the main general IACR conferences, and 6 papers (among 36) at PKC and 2 (among 34) at CHES, the two thematic IACR conferences on our domains (public-key cryptography and hardware-oriented cryptography).

5.1.2. Awards

In February 2015, Tancrède Lepoint has received the Gilles Kahn PhD Thesis Award 2014.

CASSIS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Véronique Cortier has obtained the prestigious Inria-French Académie des sciences Young Researcher Award.

Steve Kremer has been awarded an European Research Council (ERC) Consolidator Grant to fund his work on the specification and formal verification of new security properties.

Two junior permanent members have been hired: Vincent Cheval as CR Inria and Jannik Dreier as associate professor at Université de Lorraine.

CELTIQUE Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

Alan Schmitt has received the 2015 Most Influential POPL Paper Award for the 2005 paper “Combinators for Bi-Directional Tree Transformations: A Linguistic Approach to the View Update Problem” [8].

COMETE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- SIGSAC Doctoral Dissertation Award 2015 for the thesis “Measuring Privacy with Distinguishability Metrics: Definitions, Mechanisms and Application to Location Privacy” [29] by Nicolás Bordenabe (Defended on Sep 12, 2014)
- Prix de thèse de l’Ecole Polytechnique 2015 for the thesis “Measuring Privacy with Distinguishability Metrics: Definitions, Mechanisms and Application to Location Privacy” [29] by Nicolás Bordenabe (Defended on Sep 12, 2014)

COMPSYS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Scientific Results

2015 showed good successes, in terms of scientific results, with respect to the objectives we fixed for Compsys III, i.e., pushing static compilation beyond its present limits, both in terms of techniques and applications, bridging the gap between polyhedral techniques and abstract interpretation, sequential codes and parallel specifications, back-end and front-end techniques. Important advances in 2015 are as follows:

- **Towards a polynomial model** We developed new techniques to handle polynomials (see Section 7.11) and thereby generalizing polyhedral (e.g., affine) techniques, with applications to the analysis of the OpenStream parallel language (see Section 7.10).
- **Handling parallel specifications** In complement to our current studies of parallel languages such as X10 (see Sections 7.8 and 7.9) and OpenStream (see Section 7.10), and kernel offloading with pipelined specifications (see Section 7.7), we succeeded to extend liveness analysis (see Section 7.12) and array contraction (see Section 7.13) to parallel specifications.
- **Enhancing interactions between programmer and compiler** This is an important challenge for the expansion of the applicability of our techniques. The work exposed in Sections 7.9 and 7.15 (effort for collecting and analyzing real applications), as well as the interaction with users of HPC, including the organization a joint spring school in 2016, are important steps in this direction.
- **Links with abstract interpretation and SMT solvers** The extension of our previous work on loop termination, with an iterative technique relying on SMT solvers for exhibiting counter-examples (see Section 7.4), is an interesting combination of polyhedral and abstract interpretation techniques. This is the case also for the array analysis of Section 7.3 .
- **Back-end analysis** Considering back-end optimizations remains important, as complementary to front-end optimizations. See the results on register spilling (Section 7.1), pointer analysis (Section 7.2), liveness analysis (Section 7.12), the latter exploiting the fact that a polyhedral representation of arrays and loops is a symbolic unrolled view of registers and traces.

Awards

The CC'15 paper on parametric tiling [3] was nominated as a best paper candidate for the group of conferences ETAPS'15 where, unfortunately, CC papers never finally got an award.

End of Compsys

Compsys exists since 2012 as an Inria team. It has been created in 2004 as an Inria project-team, and evaluated by Inria first in 2007, then in 2012. It will again be evaluated in March 2016, which will be its final evaluation as an Inria project-team is limited to 12 years. The construction of a new project is thus necessary. The research directions of Compsys III were already a shift towards this future project. A few tentative research directions may be:

- Shift the application domain from embedded systems to high performance computing (HPC) but at small scale (desktop HPC: FPGA, GPU, multicores). In fact, the two ecosystems are nowadays slowly converging.
- A stronger attention to real HPC users and real HPC applications may lead to better programming models ("putting the programmer in the loop").
- Design new models of programs. The polynomial model is but an example.
- Explore the synergy between parallel programming and program verification and certification; in particular, import approximation methods from one field to the other. Abstract interpretation is a case in point.

However, while its field of expertise, compilation for parallel and heterogeneous systems, is still of crucial importance, the unexpected departure in Sep. 2015 of two of its staff members makes it difficult to have a clear view of the future.

CONVECS Project-Team (section vide)

CORSE Team (section vide)

CRYPT Team

4. Highlights of the Year

4.1. Highlights of the Year

In [16], the team introduced a new method to construct truncated differential characteristics of block ciphers: truncated differential cryptanalysis is a popular generalization of differential cryptanalysis. Using this method, the team has found improved attacks on the block ciphers CLEFIA and Camellia, which are both standardized by ISO.

DECENTRALISE Team (section vide)

DEDUCTEAM Team

5. Highlights of the Year

5.1. Highlights of the Year

Deducteam released a new version of Dedukti, more efficient, and with new features (e.g. higher-order patterns, confluence checking).

DICE Team (section vide)

DREAMPAL Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

2015 has been a good year in terms of journal publications for Dreampal, with 8 articles mostly in very high-quality venues.

ESTASYS Team

4. Highlights of the Year

4.1. Highlights of the Year

The ESTASYS team has developped a full tool chain for the rigorous design of Systems of Systems and has achieved its two years objectives. The team has also prepared its reconfiguration into a new team where security issues will become fundamental.

4.1.1. Awards

Axel Legay has received a Villumn award from Aalborg University.

GALAAD2 Team (section vide)

GALLIUM Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

In 2015, Xavier Leroy was appointed Fellow of the ACM "for contributions to safe, high-performance functional programming languages and compilers, and to compiler verification".

Xavier Leroy will receive the 2016 Royal Society Milner Award.

GEOMETRICA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Clément Maria has been awarded the Prix de thèse Gilles Kahn - Académie des Sciences.

5.1.2. Books

Steve Oudot published a book on persistence theory in the AMS series *Mathematical Surveys and Monographs* [35].

GRACE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Freestart collision for the full SHA-1.

Together with M. Stevens and T. Peyrin, P. Karpman gave the first freestart collision for the full SHA-1 hash function [32]. Although theoretical attacks on this function were known since 2005, this work is an important milestone in SHA-1 cryptanalysis and it had a concrete impact on the use of SHA-1 in existing systems, such as TLS certificates. In particular, the CA/Browser forum (which regroups some of the major industries of the internet) withdrew an internal ballot proposing to extend the use of SHA-1 in new certificates through 2016. Major browser developers such as Mozilla are also encouraging the timely withdrawal of SHA-1 certificates by updating the in-browser security warnings when such certificates are used. This result was also vulgarised in technical press such as *Ars Technica* and more general newspapers such as *Le monde*.

Discrete logarithm record computation in finite fields

F. Morain and A. Guillevic together with P. Gaudry (CARAMEL team, Inria Nancy Grand Est) and R. Barbulescu (CNRS, IMJ) published a new discrete logarithm record in a finite field of 180 decimal digits (dd), i.e. 595 bits. This result was presented at the Eurocrypt 2015 conference [19]. The Discrete Logarithm Problem (DLP) is widely studied in prime fields GF(p) and was broken in small characteristic finite fields of the form GF(2^n) and GF(3^n) with smooth n very recently. It was not known whether the DLP is as hard in extensions of finite fields compared to prime fields, for the same global size. With this record of the same size as the most recent record in a prime field, F. Morain and A. Guillevic showed that DLP in GF(p^2) is much faster than in a prime field of the same size, and even faster than a factorization of an RSA modulus of the same size.

Table 1. Comparison of running time for integer factorization (NFS-IF), discrete logarithm in prime field (NFS-DL(p)) and in quadratic field (NFS-DL(p 2)) of same global size 180 dd.

Algorithm	relation collection	linear algebra	total
NFS-IF	5 years	5.5 months	5.5 years
NFS-DL(p)	50 years	80 years	130 years
NFS-DL(p^2)	157 days	18 days (GPU)	0.5 years

F. Morain and A. Guillevic contributed with P. Gaudry and E. Thomé to other DL computation records in finite fields GF(p^3) of 508 bits and 512 bits, and GF(p^4) of 392 bits. The practical difficulty is increasing with the extension degree.

CATREL conference

The 1st and 2nd of October 2015, F. Morain, B. Smith and A. Guillevic organized an international workshop to conclude the CATREL project. There were 14 invited speakers from all around the world, from Palaiseau with A. Guillevic to as far as Auckland in New Zealand with S. Galbraith. A. Joux presented an historical summary of DL computation from the 80's. P. Gaudry, E. Thomé and C. Bouvier from the Caramel Team (Inria Nancy), presented their contribution, and K. Bhargavan presented the Logjam attack. There were also members of abroad teams leader in discrete logarithm record breaking. G. Adj from Mexico and R. Granger and T. Kleinjung presented their recent records in small characteristic.

We hosted more than 50 participants for the two intensive days of the workshop. The schedule of the workshop is available on the following link. http://www.lix.polytechnique.fr/cryptologie/CATREL-workshop

AGC^{2}T 15

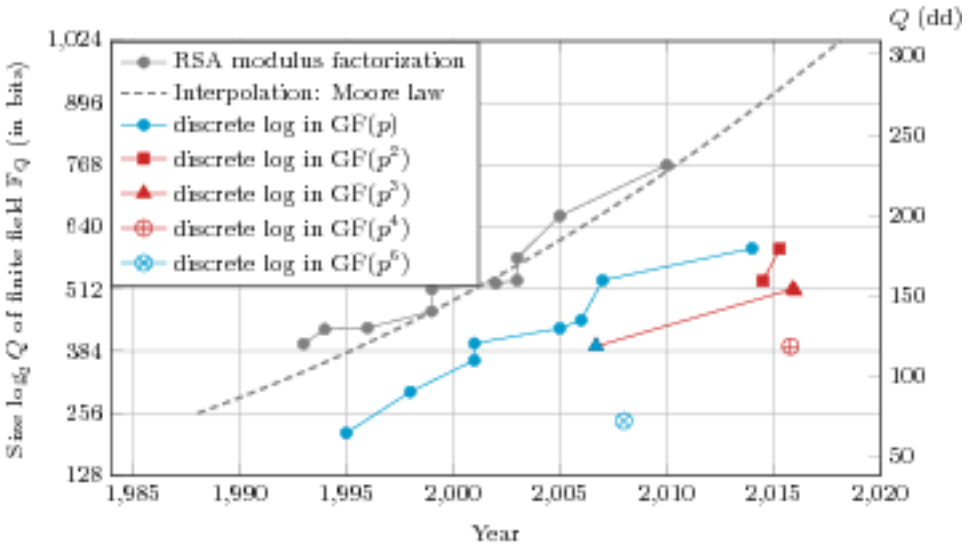

Figure 1. Records of DL computation in finite fields, and RSA modulus factorization. F. Morain and A. Guillevic contributed to the records in red in 2014–2015.

A. Couvreur was one of the organizers of the conference AGC^{2}T 15 (Arithmetic Geometry Cryptography and Coding Theory) at CIRM (Marseille).

HYCOMES Team

4. Highlights of the Year

4.1. Highlights of the Year

The main progress on hybrid systems modeling can be summarized as follows:

- As part of his PhD work, Ayman Aljarbouh has designed and implemented regularization techniques for hybrid systems with chattering behaviour [9]. His techniques enable the efficient simulation of chattering behavior that can not be simulated with pure *event-driven* simulation techniques.
- A constructive semantics for guarded DAE systems has been proposed. Guarded DAE systems are equivalent to the kernel language used as an intermediate format by several Modelica compilers. This semantics, based on a nonstandard (infinitesimal) time model [3], allows to determine the structural differentiation index and infer the causal dependencies of a system of guarded DAEs. The semantics has been implemented in SUNDAE, a prototype software, developed in the context of the Sys2soft (7.2) and Modrio projects (7.3.1).

LFANT Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

The team has been evaluated in 2015, and our scientific project for the next four years has been validated by the external reviewers.

Fredrik Johansson, who was already a postdoc last year, has been recruited as a full time researcher.

The team has organised the Atelier Pari/GP in January 2015 and the ECC 2015 international conference (with a summer school) in September 2015.

Athanasios Angelakis has defended his PhD thesis on *Universal Adelic Groups for Imaginary Quadratic Number Fields and Elliptic Curves* in September 2015.

Julio Brau has defended his PhD thesis on *Galois representations of elliptic curves and abelian entanglements* in December 2015.

Enea Milio has defended his PhD thesis on *Computing modular polynomials in dimension 2* [11] in December 2015.

The European H2020 project OpenDreamKit, in which the team participates, has been accepted.

MARELLE Project-Team (section vide)

MEXICO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Major Results

5.1.1.1. Approaching the Coverability Problem Continuously

The coverability problem for Petri nets plays a central role in the verification of concurrent shared-memory programs. However, its high EXPSPACE-complete complexity poses a challenge when encountered in real-world instances. In [39], we develop a new approach to this problem which is primarily based on applying forward coverability in continuous Petri nets as a pruning criterion inside a backward coverability framework. A cornerstone of our approach is the efficient encoding of a recently developed polynomial-time algorithm for reachability in continuous Petri nets into SMT. We demonstrate the effectiveness of our approach on standard benchmarks from the literature, which shows that our approach decides significantly more instances than any existing tool and is in addition often much faster, in particular on large instances.

5.1.1.2. An Automata-Theoretic Approach to the Verification of Distributed Algorithms

In [21] we introduce an automata-theoretic method for the verification of distributed algorithms running on ring networks. In a distributed algorithm, an arbitrary number of processes cooperate to achieve a common goal (e.g., elect a leader). Processes have unique identifiers (pids) from an infinite, totally ordered domain. An algorithm proceeds in synchronous rounds, each round allowing a process to perform a bounded sequence of actions such as send or receive a pid, store it in some register, and compare register contents w.r.t. the associated total order. An algorithm is supposed to be correct independently of the number of processes. To specify correctness properties, we introduce a logic that can reason about processes and pids. Referring to leader election, it may say that, at the end of an execution, each process stores the maximum pid in some dedicated register. Since the verification of distributed algorithms is undecidable, we propose an underapproximation technique, which bounds the number of rounds. This is an appealing approach, as the number of rounds needed by a distributed algorithm to conclude is often exponentially smaller than the number of processes. We provide an automata-theoretic solution, reducing model checking to emptiness for alternating two-way automata on words. Overall, we show that round-bounded verification of distributed algorithms over rings is PSPACE-complete.

5.1.1.3. Unfolding-Based Process Discovery

In [33] we presents a novel technique for process discovery. In contrast to the current trend, which only considers an event log for discovering a process model, we assume two additional inputs: an independence relation on the set of logged activities, and a collection of negative traces. After deriving an intermediate net unfolding from them, we perform a controlled folding giving rise to a Petri net which contains both the input log and all independence-equivalent traces arising from it. Remarkably, the derived Petri net cannot execute any trace from the negative collection. The entire chain of transformations is fully automated. A tool has been developed and experimental results are provided.

MUTANT Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Best Student Paper Award, *IEEE 2015 International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, in *Machine Learning for Signal Processing Category*

Best Student Paper award, *International Symposium on Computer Music Interdisciplinary Research 2015 (CMMR)*

Public Antescofo Open Mic Session, Ircam Open House on June 2015 (with 2000+ participants).

Numerous Public Concerts worldwide including performances with (2015 highlights) *Berlin Philharmonics* (March), *Barbican Center in London* (May), *Warsaw Autumn Festival*, and more.
BEST PAPERS AWARDS :
[11] **ICASSP 2015 - 40th IEEE International Conference on Acoustics, Speech and Signal Processing**. A. BIETTI, F. BACH, A. CONT.
[22] **International Symposium on Computer Music Multidisciplinary Research (CMMR)**. I. YUPING REN, R. DOURSAT, J.-L. GIAVITTO.

PARKAS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Awards

Albert Cohen received a HiPEAC Industry Transfer Award for the Polly Labs initiative, in collaboration with Sven Verdoolaege, Tobias Grosser (now ETH Zürich), and ARM. The award comes with a 1000 euro gift.

Louis Mandel and Marc Pouzet received the price for the “Most influential PPDP’05 paper “ReactiveML: a reactive extension to ML” given at the PPDP conference, in Siena (Italy), in July 2015.

PARSIFAL Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Accattoli's paper with Ugo Dal Lago titled "Beta Reduction is Invariant, Indeed" that appeared in CSL-LICS 2014 was invited to a special issue of LMCS of selected papers from that meeting.

Miller ended his second and final term as the Editor-in-Chief of the ACM Transactions on Computational Logic. He remains as an Area Editor for Proof Theory.

Miller was a plenary speaker at the joint meeting of LOPSTR 2015 and PPDP 2015 (Siena, Italy) and was an invited speaker at LSFA 2015 (Natal Brazil) and in the Session on History and Philosophy of Computing at the 15th Congress of Logic, Methodology and Philosophy of Science, Helsinki.

Miller spoke at the ETH Zurich Department of Computer Science Distinguished Colloquium Series on April 20.

Graham-Lengrand gave an invited talk at the IFIP Working Group 1.6 on Term Rewriting, on the occasion of its 2015 annual meeting in Warsaw, Poland.

Accattoli was an invited speaker at the 16th International Workshop on Logic and Computational Complexity (Kyoto, Japan, 5th of July).

PI.R2 Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Coq 8.5

Version 8.5 of Coq will remain as one of the most important versions of the history of Coq. It includes five big achievements affecting various components of the system: a new proof engine supporting multi-goal and deep backtracking by Arnaud Spiwack; a new asynchronous evaluation engine supporting efficient parallel development of interactive documents, parallel evaluation of tactics, modular compilation of files by Enrico Tassi; full universe polymorphism by Matthieu Sozeau; a new notion of primitive projections highlighting the negatively polarised view at record types by Matthieu Sozeau; a new evaluation machine by Maxime Dénès which works by compiling to OCaml.

The year 2015 was also a year of thinking on new ways to popularise Coq and further enhance the interaction between users and developers. In particular, a first Coq Coding Sprint gathered about 30 participants around about 10 developers.

4.1.2. EPIT 2015

This year, the French Spring School in Theoretical Computer Science (EPIT) was organised by Yann Régis-Gianas, Pierre Letouzey, Matthieu Sozeau and Pierre-Marie Pédrot in Fréjus (France). This CNRS “école thématique” was dedicated to the mechanisation of proofs of programs and of mathematical theorems in Coq. It was attended by 50 participants, coming from different research communities. Besides the courses introducing the basics of Coq and proof development in Coq, substantial efforts of formalisation in various areas such as formal language theory, number theory, or combinatorics were presented by their authors, and the attendants were encouraged to discuss their own formalisation projects with the Coq developers. The school has been sponsorised by the CNRS, the FIFP, the ADT Coq and the ANR Paral-ITP. The feedback from the participants was very positive.

POLSYS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Our joint research project GOAL@SiliconValley with Californian University UC Berkeley has been selected by Inria (2015-2018). GOAL led by Bernd Sturmfels (UC Berkeley) and Jean-Charles Faugère (POLSYS, Inria Paris-Rocquencourt) on "Geometry and Optimization with ALgebraic methods": The goal of this project is to develop algorithms and mathematical tools to solve geometric and optimization problems through algebraic techniques. As a long-term goal, the joint team plans to develop new software to solve these problems more efficiently. These objectives encompass the challenge of identifying instances of these problems that can be solved in polynomial time with respect to the number of solutions and modeling these problems with polynomial equations.

The webpage of the research project is http://www-polsys.lip6.fr/GOAL/index.html

The kickoff workshop was held at UC Berkeley in May 2015, see https://math.berkeley.edu/~bernd/GOALworkshop.html.

POSET Team

5. Highlights of the Year

5.1. Highlights of the Year

Two presentations, by D. Janin and S. Salvati, at ICALP 2013, a leading conference in the field of formal language theory and its applications to computer science, have eventually been selected among the 16 out of 120 papers for a complete version to appear this year in the associated special issue (see [15] and [16]).

POSTALE Team

4. Highlights of the Year

4.1. Highlights of the Year

Marc Baboulin was invited plenary speaker at the HPCSE conference, Solan, Czech Republic, May 25-28, 2015.

The Random Butterfly Transformations developed by Postale are now available in the MAGMA library for GPU (release 1.6) and Intel Xeon Phi (release 1.3).

Marc Baboulin is general vice-chair of the HPC Symposium to be held in April 2016, Pasadena, CA.

PRIVATICS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Our work on “Probabilistic k^m-anonymity” was published in the IEEE International Conference on Big Data (BigData) 2015.

Our results on Password security, “Faster Password Guessing Using an Ordered Markov Enumerator” and “Interleaving Cryptanalytic Time-memory Trade-offs on Non-Uniform Distributions”, were published at ESSOS’15 and ESORICS’15.

The team published 2 papers about his research in the newspaper “Lemonde”, 1 article in “Science & Avenir” and in “La Recherche”.

The team organized the 31 November 2015 the conference “Privacy across cultures, Convergences and divergences in a global world” in the context of the Rencontres Jacques Cartier.

4.1.1. Awards

The paper "Reasoning about privacy properties of biometric system architectures in the presence of information leakage" [15] received the best paper award at ISC 2015.
BEST PAPERS AWARDS :
[15] **Information Security Conference (ISC 2015)**. D. LE MÉTAYER, H. CHABANNE, L. ROCH, J. BRINGER.

PROSECCO Project-Team

5. Highlights of the Year

5.1. Highlights of the year

This year, we published 15 articles in international peer-reviewed journals and conferences, including papers in prestigious conferences such as IEEE S&P Oakland (2 papers), ACM CCS, NDSS, WWW, ASPLOS, and ITP, and we won four research awards for our work, detailed below.

We released updates to F*, miTLS, ProVerif, and CryptoVerif, along with our collaborators at other institutions. We discovered serious vulnerabilities in a number of TLS libraries, web browsers, and web servers, resulting in several published CVEs, and over a dozen software updates based on our recommendations in widely used software such as Firefox, Chrome, Internet Explorer, Safari, OpenSSL, Java, and Mono.

5.1.1. Awards

- Distinguished paper award, IEEE Symposium for Security and Privacy, 2015
- Best student paper award, ACM Conference on Computer and Communications Security, 2015
- Best paper award, Usenix Workshop on Offensive Technologies, 2015
- Pwnie award for Most Innovative Research, BlackHat USA, 2015

SECRET Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Resistance of equivalent Sboxes to differential and linear attacks

The so-called Sboxes highly influence the security of a block cipher since they are the only nonlinear component in the cipher. It was widely believed that Sboxes which are affine equivalent (i.e., which are the same up to the composition with affine functions) provide the same security level regarding differential and linear cryptanalyses. However, some simulation results on the maximum expected differential probability over two rounds of the AES show that this is not always the case. A. Canteaut and J. Roué [45] have then investigated the effect of affine transformations of the Sbox on the maximal expected differential probability and linear potential over two rounds of a substitution-permutation network, when the diffusion layer is linear over the finite field defined by the Sbox alphabet. They have been able to exhibit different behaviors depending on the choice of the Sbox within a given equivalence class. This includes some unexpected differences: for a given m-bit Sbox, the choice of the basis used for defining the finite field in the description of the linear layer may also affect the value of the two-round MEDP or MELP. They have also shown that the inversion is the mapping within its equivalence class which has the highest two-round MEDP and MELP, independently of the choice of the MDS linear layer. This situation mainly originates from the fact that this Sbox is an involution. This result has been awarded as one of the 3 best papers at Eurocrypt 2015.

5.1.2. Relativistic cryptography

Two-party cryptographic tasks are well-known to be impossible without complexity assumptions, either in the classical or the quantum world. Remarkably, such no-go theorems might become invalid when adding the physical assumption that no information can travel faster than the speed of light. This additional assumption gives rise to the emerging field of relativistic cryptography. We started investigating such questions through the task of bit commitment. In particular, an interesting bit commitment protocol was introduced in 2014 by Lunghi *et al.* and proven secure against arbitrary classical attacks. The drawback however was that the commitment time was quite constrained, as most a few milliseconds. In [16], K. Chakraborty, A. Chailloux and A. Leverrier showed that the same protocol could in fact achieve commitment times that were arbitrarily long, thereby establishing that relativistic cryptography is a very practical solution.

5.1.3. Quantum Expander Codes

In a paper presented at FOCS 2015 [55], A. Leverrier and JP. Tillich, together with G. Zémor, give an efficient decoding algorithm for a certain kind of quantum LDPC codes which provably corrects any pattern of errors of weight proportional to the square-root of the length of the code. The algorithm runs in time linear in the number of qubits, which makes its performance the strongest to date for linear-time decoding of quantum codes. This work can be considered as a further step towards proving that fault tolerant quantum computing is possible by using only a constant multiplicative overhead of additional qubits.

5.1.4. Organization of WCC 2015

The whole project-team has been involved in the organization of the international conference WCC 2015, which was held in Paris (at Institut Henri Poincaré) in April 2015. This was the ninth in the series of biannual workshops on *Coding and Cryptography*. This edition has gathered around 150 participants from many different countries. We received 90 submissions out of which 53 have been selected for presentation at the conference.

5.1.5. Awards

- 1st prize of the Streebog competition [90]
- 2nd prize of the underhanded crypto contest https://underhandedcrypto.com/archive/
- One of the best 3 papers at Eurocrypt 2015 [45]
- Best paper at PQCrypto 2016 [57].

BEST PAPERS AWARDS :

[45] **Advances in Cryptology - Eurocrypt 2015 (Part I)**. A. CANTEAUT, J. ROUÉ.

SPADES Project-Team (section vide)

SPECFUN Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

Pierre Lairez has been awarded this year the “Ecole Polytechnique thesis prize”, for his PhD thesis defended in 2014 [53].

SUMO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The book on "Petri Net Synthesis" [44] co-authored by Eric Badouel, Luca Bernardinello, and Philippe Darondeau was published in October 2015 by Springer-Verlag in the EATCS Series "Texts in Theoretical Computer Science". This book is a comprehensive, systematic survey of the synthesis problem, and of region theory which underlies its solution, covering the related theory, algorithms, and applications. It is also a tribute to Philippe who passed away two years ago and could not see the final result of this project.

The SUMO team also welcomes the arrival of Ocan Sankur as a CNRS researcher. After a PhD at LSV (ENS Cachan) in 2013 supervised by Patricia Bouyer and Nicolas Markey, Ocan Sankur did a post-doc at Université Libre de Bruxelles in the group of Jean-François Raskin. His research work focuses on the robustness of quantitative systems, for their verification and synthesis.

TASC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

1. The PhD thesis of Jean-Guillaume Fages about *the use of graph structure in constraint programming* got the following awards:
   - PhD thesis award by the French association for AI.
   - Doctoral research award by the Association for Constraint Programming.
2. The paper of the PhD student Anicet Bart (*Verifying a Real-Time Language with Constraints*, Anicet Bart, Charlotte Truchet and Eric Monfroy [29]) got the best paper award of the SAT/CSP track of the ICTAI 2015 conference.
3. The solver Choco3 got a bronze medal in the 2015 minizinc challenge.

BEST PAPERS AWARDS :
[29] **27th IEEE International Conference on Tools with Artificial Intelligence**. A. BART, C. TRUCHET, E. MONFROY.

TEA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

TEA became an Inria project-team in 2015 and developed new and promising collaborations with Mitsubishi, on factory automations, with UCSD on refinement type theory and with UCSD-UCLA again, on time synchronisation protocols verificaton.

We published a paper in the automotive session of the 52nd. Digital Automation Conference (core A*) on our project with Toyota ITC [19] as well as two patents filed with the USPTO.

5.1.1. Awards

Our paper on "Polychronous automata" [13] received the Best Paper Award at the TASE'15 conference.
BEST PAPERS AWARDS :
[13] **TASE 2015, 9th International Symposium on Theoretical Aspects of Software Engineering**. P. LE GUERNIC, T. GAUTIER, J.-P. TALPIN, L. BESNARD.

TOCCATA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- C. Paulin-Mohring received the award "Michel Monpetit – Institut National de Recherche en Informatique et en Automatique" of the French Academy of Sciences (http://www.academie-sciences.fr/fr/Laureats/laureats-2015-prix-thematiques.html).
- J.-C. Filliâtre and G. Melquiond received the "Best team" award of the VerifyThis@ETAPS2015 verification competition (http://verifythis2015.cost-ic0701.org/results). The Why3 tool also received the "Distinguished user-assistance tool feature" award.
- The *Concours Castor informatique* (http://castor-informatique.fr/) had an even larger success than in the previous years. In November 2015, more than 345,000 teenagers from over 2280 schools participated and solved the interactive tasks of the contest. Arthur Charguéraud and Sylvie Boldo, from the Toccata team, significantly contributed to the prepation of the tasks and to the organization of the contest.

VEGAS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

In the context of drawing plane algebraic curves with the correct topology, we have obtained and submitted this year major results on the resolution of bivariate algebraic systems. In particular, we presented algorithms whose worst-case and expected (Las Vegas) complexities are not likely to be easily improved as such improvments would essentially require to improve bounds on other fundamental problems (such as computing resultants, checking the squarefreeness of univariate polynomials, and isolating their roots) that have hold for decades. See section 6.3.1 for details.

VERIDIS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Pascal Fontaine and Thomas Sturm, together with Erika Abraham (RWTH Aachen) and Dongming Wang (Beihang University, Beijing) organized the Dagstuhl Seminar 15471 in November 2015, on the subject of *Symbolic Computation and Satisfiability Checking*, bringing together two communities on subjects that are particularly relevant for our team.

Jasmin Blanchette and Christoph Weidenbach, together with Nikolaj Bjørner (Microsoft) and Viorica Sofronie-Stokkermans (University of Koblenz-Landau) organized the Dagstuhl Seminar 15381 in September 2015, on the subject of *Information from Deduction: Models and Proofs*. That seminar focused on added value of deduction tools beyond a yes/no answer, in particular certificates of (un)satisfiability.

We have made considerable progresses with the symbolic analysis of reaction networks. Within this interdisciplinary project, our methods have been accepted at the leading conference in symbolic computation [33], and our results with those methods have been published in a renowned journal in the natural sciences [17].

ACUMES Team (section vide)

APICS Project-Team (section vide)

ASPI Project-Team (section vide)

BIPOP Project-Team (section vide)

CAGIRE Team

5. Highlights of the Year

5.1. Highlights of the Year

First DNS simulation of a turbulent flow with AeroSol

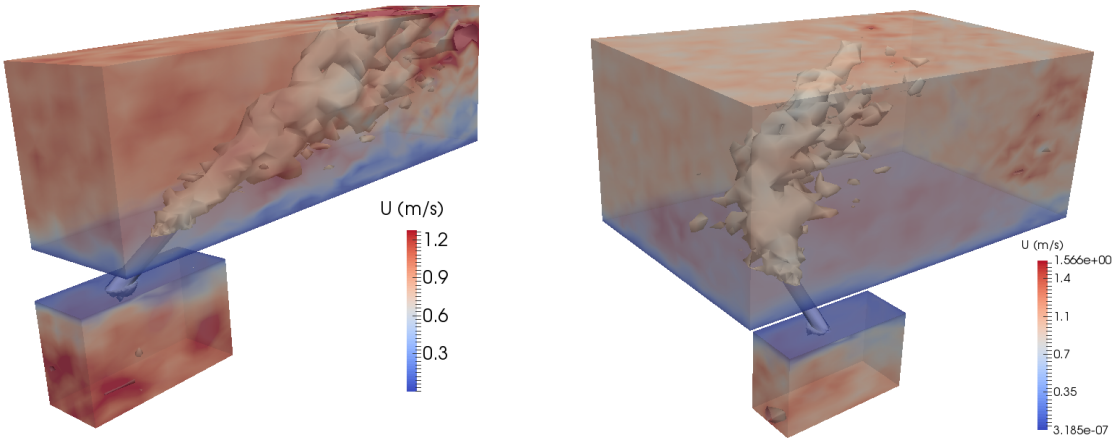

Figure 3. DNS of jets in crossflow (AeroSol-DG2): Examples of snapshots of instantaneous surfaces of the velocity norm. Left - With a 0-degree jet skidding (MAVERIC configuration). Right - With a 90-degree jet skidding.

In 2015, the first DNS of the configuration of a jet in turbulent crossflow have been carried out with the AeroSol library. Qualitativeley speaking, this represents the completion of the initial objective that the team was targeting in 2011 when it was created ! These computations were done within the IMPACT-AE project. The runs were using 1024 cores of the BlueGene /Q cluster Turing at IDRIS thanks to a 4400000-hour computing grant obtained in 2015. Examples of results obtained for the two flow configurations considered are presented in Fig. 3 .

Implementation of the EB-RSM model into StarCCM+

In close collaboration with the R&D team of Adapco, the company that develops and sells the commercial CFD package StarCCM+, the EB-RSM model has been implemented in this code, starting from release 10.02. This constitutes a significant achievement that our models are made widely available to the engineering community.

CARDAMOM Team

5. Highlights of the Year

5.1. Highlights of the Year

- A whole new release of the mesh adaptation platform `MMG` is available, with a brand new looking website : `http://www.mmgtools.org/` ;
- We have solved the conflict between the conservation of either mass and steady equilibria relevant in applications (lake at rest state) when performing mesh-adaptive computations of shallow water flows. This algorithm will be embedded in the `FMG` adaptation library which will be part of the `MMG` tools ;
- We have shown the potential of Boussinesq-type depth averaged codes for the simulation of Wave Energy Converters [97], [98]. This result paves the way to the construction of new medium fidelity models to be used in the optimization of converters. This will be achieved in the framework of the MIDWEST project funded this year (EU OCEANEranet call) ;
- We have finally proven that fully discrete asymptotic approaches allow to construct new discretizations of depth averaged weakly nonlinear Boussinesq models with greatly improved phase and linear shoaling. We are now working on the construction of improved genuinely nonlinear models ;

COMMANDS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- B. Heymann received a Siebel Scholar fellowship from the Siebel foundation. These fellowships are given to top graduate students of partner institutions, namely here the Ecole Polytechnique. See the List of Siebel Scholars

CQFD Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Publication of the book: *Numerical methods for simulation and optimization of piecewise deterministic Markov processes* written by Benoîte De Saporta; Francois Dufour and Huilong Zhang in Mathematics & Statistics, Wiley, 298 pages, 2015.

DEFI Project-Team (section vide)

DISCO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Dec. 2015 - Frédéric Mazenc is President of the "Commission Scientifique" Inria Saclay-Ile-de-France.

DOLPHIN Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- Best paper award at GECCO 2015 (ECOM track, Madrid, Spain, 2015) for the paper “Global vs local search on multi-objective NK-landscapes: contrasting the impact of problem features” , by F. Daolio, A. Liefooghe, S. Verel, H. Aguirre, K. Tanaka. This work is part of our collaboration with Shinshu University in Japan (Associate team s3-bbo and JSPS-MEXT project) on fitness landscape analysis and search performance. In this paper, we consider two prototypical multi-objective optimization algorithms and relate their performance on combinatorial optimization problems with tunable ruggedness, objective space dimension, and objective correlation. Our study departs from simple performance comparison by systematically analyzing the correlation between runtime and problem features, contrasting their association with search performance within and across problem classes. A mixed-model approach allows us to further generalize from the experimental design, supporting a sound assessment of the joint impact of problem features on the search performance.
- Best paper award of “11^{th} Intl. Conf. on Parallel Processing and Applied Mathematics" (PPAM’2015, Krakow, September 6-9). assigned to Jan Gmys, Mohand Mezmaz, Nouredine Melab and Daniel Tuyttens for their article entitled "IVM-based Work Stealing for Parallel Branch-and-Bound on GPU" . This work falls within the framework of the Ph.D thesis of Jan Gmys from University of Mons in cotutelle with Université Lille 1. The contribution consists in revisiting on GPU the parallel design and implementation (based on the Work Stealing paradigm) of the Branch-and-Bound algorithm applied to permutation problems. The raised challenge, which is the originality of the contribution, is to efficiently perform highly irregular exploration process entirely on the GPU having a SIMD architecture.
- Thesis Prize: 26th Nov 2015: Julie Jacques (Phd 2011) won the "Force Awards Nord de France" trophee in the category "thesis with an industrial". Her thesis work, in collaboration with the Dolphin team and the Alicante company, aimed at providing new datamining approaches in order to optimize inclusion in clinical trials.

BEST PAPERS AWARDS :

[31] **GECCO’15 - Proceedings of the 24th ACM Annual Conference on Genetic and Evolutionary Computation**. F. DAOLIO, A. LIEFOOGHE, S. VEREL, H. AGUIRRE, K. TANAKA.

[54] **11th Intl. Conf. on Parallel Processing and Applied Mathematics**. J. GMYS, M. MEZMAZ, N. MELAB, D. TUYTTENS.

ECUADOR Project-Team (section vide)

GAMMA3 Project-Team

3. Highlights of the Year

3.1. Highlights of the Year

3.1.1. Awards

BEST PAPERS AWARDS :

[] **Procedia Engineering**. A. LOSEILLE, V. MENIER, F. ALAUZET.

GECO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- GECO is one of one of the partners of the ANR SRGI, which has been funded in 2015. SRGI deals with sub-Riemannian geometry, hypoelliptic diffusion and geometric control.
- In the recent preprint [23] we answer an open problem proposed by J.P. Hespanha in 2003 in the volume "Unsolved Problems in Mathematical Systems & Control Theory". The problem deals with the characterization of the finiteness of the L_2-gain of a switched linear control systems, in dependence of the value of the minimal dwell-time of its switching laws.

GEOSTAT Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Article published on Inria web site: link to page on Nicolas Brodu's *Nature Communications* paper: *Spanning the scales of granular materials through microscopic force imaging*, [17].

I4S Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Paper [30]. was nominated for best paper at IFAC SAFEPROCESS in 2015.

A. Nassiopoulos is launching the startup Ecotropy from December 2015.

INOCS Team (section vide)

IPSO Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

E. Faou received the SIAM Germund Dahlquist prize in september 2015.

MATHERIALS Project-Team (section vide)

MATHRISK Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Conference in honor of Vlad Bally for his 60th birthday, Le Mans, October 6-9 2015 http://www.cmap.polytechnique.fr/~demarco/files/pageWebConfV/ConferenceVladBally.html

5.1.1. Awards

J. Reygner received the 2014 Jacques Neveu prize for his thesis entitled "Longtime behaviour of particle systems : applications in physics, finance and PDEs" co-supervised by B.Jourdain and L. Zambotti

Maxplus Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- Pascal Benchimol obtained in June 2015 a prize of Ecole polytechnique for his PhD thesis [70].
- Best paper award for the paper presented by Nikolas Stott of EMSOFT'15.

BEST PAPERS AWARDS :
[29] **International Conference on Embedded Software (EMSOFT'2015)**. X. ALLAMIGEON, S. GAUBERT, E. GOUBAULT, S. PUTOT, N. STOTT.

MCTAO Project-Team (section vide)

MEMPHIS Team

5. Highlights of the Year

5.1. Highlights of the Year

Capsule reentry in high atmosphere

The atmosphere reentry of a capsule is simulated in high atmosphere via a fully parallel code running on massive multi-thread platforms. In these flow conditions, rarefied flow models have to be used. We present here a simulation of a capsule reentry: the focus of this example is on dynamic octree-grid refinement as the geometry and the flow change. Adaptation is based on the distance to the geometry and on the temperature gradient. The dynamics of the capsule is taken into account: according to the force exerted by the fluid on the capsule, the geometry rotates around its center of mass up to the stationary position. The simulation is six-dimensional: three space dimensions and three velocity directions. Without parallelism and grid adaptation the simulation would be out of reach.

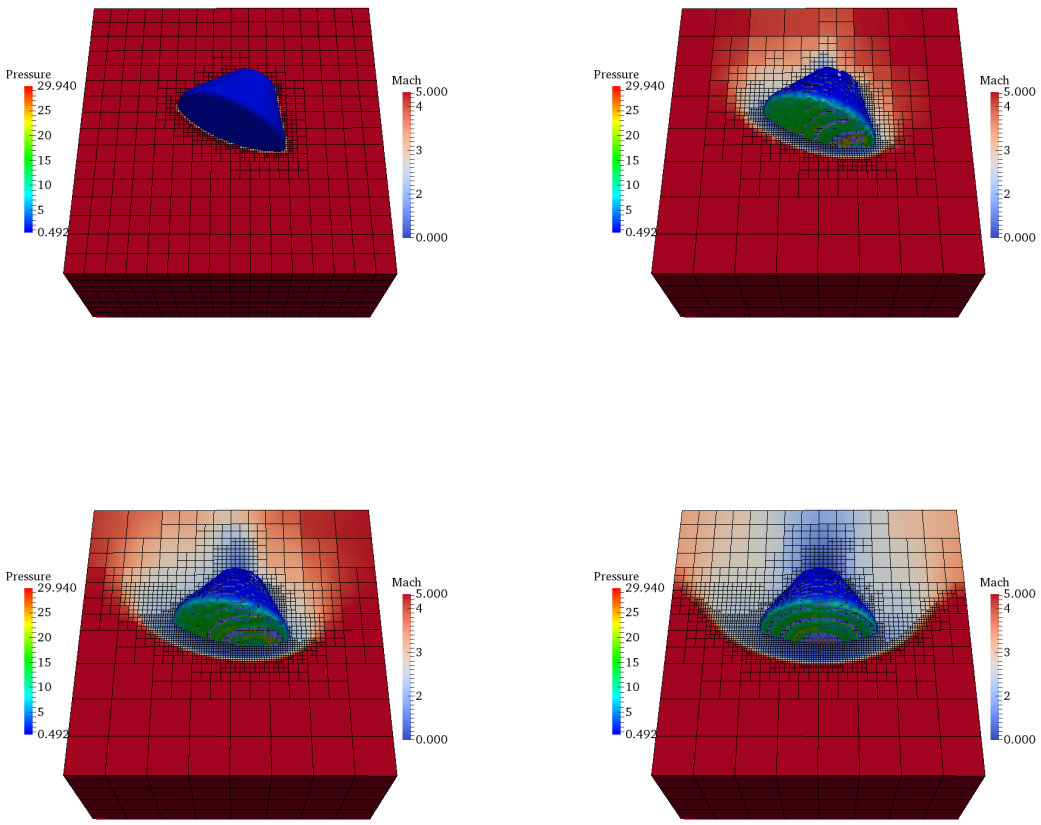

Figure 5. Capsule reentry dynamics in 3D. Rarefied flow and parallel adaptive grid refinement via Octrees.

MEPHYSTO Team

5. Highlights of the Year

5.1. Highlights of the Year

Scientific results

The team obtained two striking results in 2015.

- In collaboration with Felix Otto, Antoine Gloria obtained near-optimal estimates with optimal stochastic integrability in stochastic homogenization under a finite range of dependence assumption, cf. [35].
- In collaboration with physicists at PhLAM, Stephan De Bièvre and Guillaume Dujardin, proposed in [18] an analysis of the phenomenon of modulational instability in an optic fiber, induced by periodic modulation of the dispersion of the fiber. In particular, they characterized the frequencies at which the gain occurs and provided sharp estimates of that gain. Both numerical and physical experiments supported the analysis, cf. Figure 2 which displays the experimental gain (above) and the numerical gain (below).

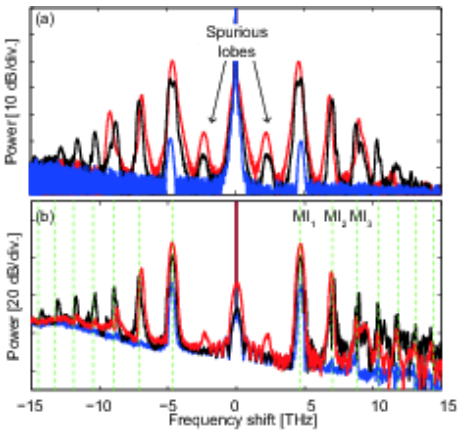

Figure 2. Experimental (above) and numerical (below) gain for the modulational instability in (periodic) optic fibers

Awards

Antoine Gloria was awarded the Agathon De Potter prize in mathematics from the Académie royale de Belgique.

MISTIS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Creation of the Pixyl startup (http://pixyl.io). Pixyl is a startup created in March 2015 by F. Forbes with M. Dojat (INSERM), a former post-doctoral fellow S. Doyle (CEO) and IT Translation. F. Forbes is a co-founder and a scientific advisor. Pixyl specializes in automatic pathological brain MRI segmentation. Pixyl delivers precise neuroimaging biomarker extraction for improved insight and decision-making in clinical studies. Our automatic neuroimaging solutions are designed for seamless integration into both web-based and locally deployed CRO platforms. Advanced algorithms are available for multiple sclerosis, chronic stroke, brain tumor and traumatic brain injury applications The technology transferred is based on the P-LOCUS software.
- Xerox Foundation University Affairs Committee (UAC) collaborative grant. F. Forbes was co-laureate (with R. Horaud) of this grant (90 k$) for a three year project (2014-2017) on Advanced and Scalable Graph Signal Processing Techniques. It was awarded in collaboration with Arijit Biswas and Anirban Mondal, research scientists at Xerox Research Center India (XRCI), Bangalore.

MODAL Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

MODAL was implicated at the first level (general chair) in the organization of the main annual French conference in statistics gathering more than 400 participants (JdS 2015, see Section 10.1.1.1. General chair, scientific chair). It is the first time this conference is held in Lille since about 30 years.

MixtComp is the first package for clustering data with full mixed data (continuous, categorical, counting, ordinal, rank) with possibly missing or partially missing (intervals) data (see Section 6.15. MixtComp).

MOKAPLAN Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Fast entropic methods for optimal transport problems: In a series of papers [19] [34] [10] [15] , MOKAPLAN's team members derived a new class of algorithm to obtain efficient approximations of the solution to various problems related to OT (including barycenters, Euler equation, unbalanced problems, gradient flows). This method makes use of entropic regularization and first order optimization method for the Kullback-Leibler divergence. See Section 6.3 for details about the software output.

Relaxing the mass conservation constraints: Our team derived a new theoretical and numerical framework to deal with "unbalanced" optimal transport problems [38], [39]. This contribution is a breakthrough that will open the door to application in image processing and machine learning. See Section 7.6 for more details.

NACHOS Project-Team (section vide)

NANO-D Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

We have released the first version of the SAMSON software platform for computational nanoscience on the SAMSON Connect website (http://www.samson-connect.net). Using the SAMSON Connect website, users may download SAMSON and choose which SAMSON Elements (modules for SAMSON) to add to their configuration (e.g. a nanotube creator, for users interested in materials science). Developers may download the SAMSON Software Development Kit (SDK) to develop SAMSON Elements and upload them to the SAMSON Connect website. We are frequently releasing updates, on Windows, Linux, and Mac (Figure 3).

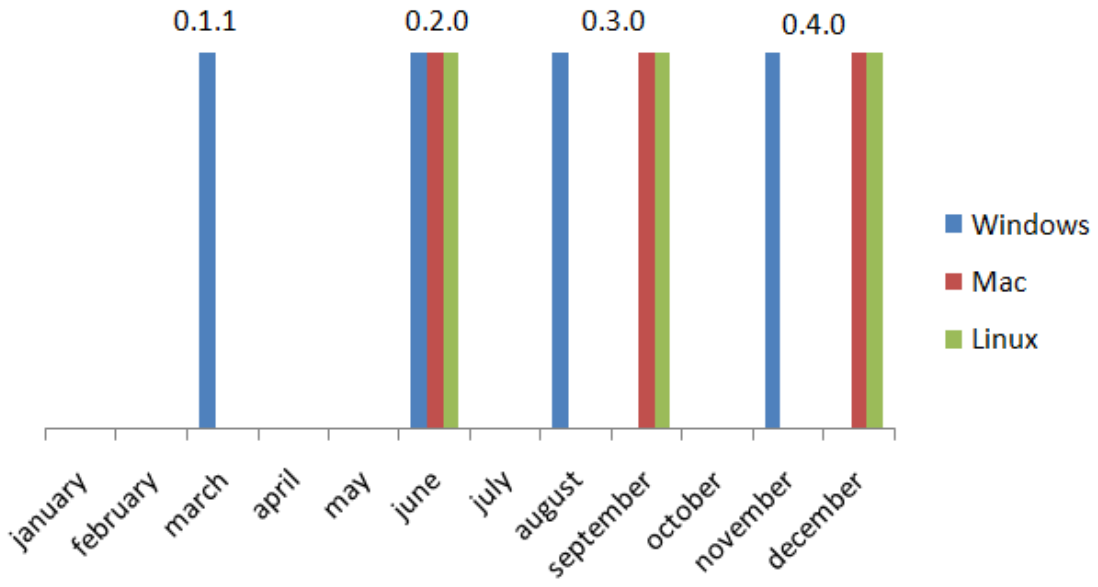

Figure 3. Release dates of the various versions of SAMSON

NECS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- The publication of the book *Multisensor Data Fusion: From Algorithms and Architectural Design to Applications*, edited by Hassen Fourati
- Carlos Canudas de Wit was in the organizing committee of IPAM Long Program 'New Directions in Mathematical Approaches for Traffic Flow Management'
- Hassen Fourati was elected at CNU 61 and Alain Kibangou was elected at Conseil du pôle MSTIC, UGA

NON-A Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

- Concepts of Homogenenty, Implicit Lyapunov Functions and Convergence in Finite/Fixed time are now extended to different classes of dynamic systems (e.g time delay systems [27], distributed parameters systems [67], time-varying systems [42], MIMO systems[38], [25], differential inclusions [37], multi agent systems [19],[23]). In this context, ANR Project Finite4SOS (cordinator: Wilfrid Perruquetti) is accepted for 2015-2020. It is aimed at development of different tools for non-asymptotic control and estimation for System of Systems.
- Living sensor is a biological organism, which can be utilized as a sensor of some enveronmental characteristics. In collaboration with Aquatic Ecotoxicology (EA) team from CNRS Lab "Environnements et Paleoenvironnements Oceaniques et Continentaux", University of Bordeaux 1, we developed innovative methods for monitoring the water quality using oysters as biological sensors [16], [51], [15]. The project ANR WAQMOS (coordinator: Denis Efimov) is supported for 2015-2020. It is aimed at creation of novel oyster-based living sensors (including hardware and software development).
- We provided a novel solution for motion control of wheeled mobile robots with obstacle avoidance (for single robot [32], [32] and a formation of robots [60]).
- From september 2015, model-free control [84],[7] is applied to control the traffic on A25 (access ramp « La Chapelle-d'Armentières »), users and DiRN are satified with results (http://www.lavoixdunord.fr/region/feu-intelligent-de-l-a25-quel-bilan-quatre-mois-apres-ia11b49733n3187841).

Awards

- Prize of "ABB AWARD: Best application/case study paper", IFAC Safeprocess, Paris, 2015, see [80].

POEMS Project-Team (section vide)

QUANTIC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- First demonstration of Quantum Zeno Dynamics of light: this important experimental result offers a new scheme to control quantum systems based on light modes and was published in Science in 2015 [13].
- In a collaboration with the team of Michel H. Devoret at Yale university, we engineered a new form of quantum friction. By engineering a particular non-linear interaction between a quantum harmonic oscillator (a superconducting cavity mode) and a driven bath, we were able to stabilize a manifold of quantum states. This result which was published in Science in 2015 [18] should lead to a new direction of research in quantum information processing with driven dissipative systems.
- In a collaboration with the team of Robert J. Schoelkopf at Yale university, we were able to realize a version of Schrdoinger's cat thought experiment. We were able to entangle an artificial atom to a cat state of a quantum harmonic oscillator. We were able to characterize this entanglement using the Clauser-Horne-Shimony-Holt formulation of a Bell test. This result was published in Nature Communications [25].

RAPSODI Team

5. Highlights of the Year

5.1. Highlights of the Year

The research team RAPSODI was created on August 1, 2015.

A new nonlinear numerical method for solving possibly degenerate parabolic problems with gradient flow structure was proposed and analyzed by C. Cancès & C. Guichard in [35]. This method is second order accurate in space and preserves the variational structure of the continuous problem, ensuring by the way the decay of the physical entropy. Moreover, it is more robust with respect to strong anisotropy ratios than the method proposed in [15] that was only first order accurate in space.

REALOPT Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The international society in Mathematical Optimisation (MOS) has selected the bid of Realopt for the organization of the next triennial international congress of mathematical optimization. Hence, the 23rd International Symposium on Mathematical Programming (ISMP 2018) shall take place in Bordeaux. The web site is in construction http://ismp2018.sciencesconf.org. This symposium is the most prestigious scientific event in the field of optimization by the quality of its program and its size (it can gather close to 2000 participants). This event has received strong support from the University of Bordeaux, Inria and CNRS, along side national scientific societies: Roadef and SMAI.
The team is tightening its links with industrial partners: our Inria Innovation Lab with Ertus-consulting has been launched; we have had two recruitements (a PhD and a Post-doc) this year on our production planning project with EDF; Saint Gobain is very enthousiastic about our progress in solving glass cutting problems, and Renault was quite happy with the challenge on logistic issues that we organized for them.
We are making progress on methodologic developments of algorithms for large scale optimization (convergence acceleration, filtering to reduce problem size, math heuristics, approximation algorithms) and their application (in cloud computing, sheduling, and planning). In particular, two of our papers were accepted at the prestigious conference IPDPS'16. Our research collaborations are being tightened in particular through the SAMBA associated team project: Ruslan Sadykov is spending a sabbatical year in Brasil in our associated team. We established a new partnership with KEDGE business school.

SELECT Project-Team (section vide)

SEQUEL Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- organization of the 32nd International Conference on Machine Learning (ICML), in Lille, from Jul 6th to Jul 11th, 2015.

  ICML is the leading international conference in Machine Learning. This is the first time of its history that France hosts ICML. This edition has been the largest of all the times, with 1690 registrants (the previous record was 1400 in Beijing, in 2014).
- as an outcome of a contract with this start-up, Nuukik has been awarded “best data analysis” during the “connected commerce night” - http://www.retail-network.fr", 1500 participants, 80 projects in competition.

5.1.1. Awards

- V. Gabillon and B. Piot both received an AFIA award for their respective PhD, defended in 2014. They were both ranked second in this competition.
- Olivier Pietquin, Fellow of the “Institut Universitaire de France”.
- A. Lazaric and M. Valko received best reviewer awards at ICML 2015.

SIERRA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

F. Bach has served as a program co-chair for the International Conference in Machine Learning (ICML) held in Lille, France, 2015.

SPHINX Team

5. Highlights of the Year

5.1. Highlights of the Year

In collaboration with Colin Guillarmou, Matti Lassas and Jérôme Le Rousseau, David Dos Santos Ferreira organized an IHP trimester on Inverse Problems hold in April-June 2015 (more than 100 participants).

TAO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- **DataScienc@LHC** First of a series of workshops officially organized at CERN - TAO leader on the ML side.

5.1.1. Awards

- Best Paper Award in the Genetic Programming track at GECCO 2015 (Madrid, July 2015) for the paper [39].
- First place in the Taxonomy Induction task of SemEval 2015 (Denver, June 2015) [55].

BEST PAPERS AWARDS :

[39] **Genetic and Evolutionary Computation COnference (GECCO 2015)**. R. FFRANCON, M. SCHOENAUER.

TOSCA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- M. Deaconu, B. Dumortier and E. Vincent won a poster award price (http://www.ewea.org/annual2015/conference/programme/ and http://www.inria.fr/centre/nancy/actualites/ewea-2015-baldwin-dumortier-recoit-un-prix-d-honneur) for their work with the Venathec SAS on the acoustic control of wind farms.

ABS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

In 2015, several achievements are worth noticing in three realms, namely in computer science, computational structural biology, and software.

4.1.1. Computer Science

► **Beyond Two-sample-tests: Localizing Data Discrepancies in High-dimensional Spaces**
Reference: [17]

In a nutshell: A classical problem in statistics is to decide whether two populations exhibit a statistically significant difference—the so-called two-sample test problem (TST). If so, another classical problem is to assess the magnitude of the difference—the so-called effect size calculation. While various effect size calculations were available for univariate data, hardly any existed for multivariate data.

Assessment: In this work, we provide one of the very first (if not the first) effect size calculation for multivariate data. The method combines techniques from machine learning (regression) and computational topology (topological persistence).

4.1.2. Computational Structural Biology

► **High Resolution Crystal Structures Leverage Protein Binding Affinity Predictions**
Reference: [20]

In a nutshell: The binding affinity of two proteins forming a complex is a key quantity, whose estimation from structural data has remained elusive, a difficulty owing to the variety of protein binding modes. In this work, we present sparse models using up to five variables describing enthalpic and entropic variations upon binding, and a (cross-validation based) model selection procedure identifying the best sparse models built from a subset of these variables.

Assessment: Our estimation method ranks amongst the top two or three known so far, and is possibly the most accurate when applied to high resolution crystal structures. One of its key limitations (similar to contenders) is that the crystal structures of the partners and that of the complex are required. This limitation motivates our work on energy landscapes, see below.

► **Unveiling Contacts within Macro-molecular assemblies by solving Minimum Weight Connectivity Inference Problems**
Reference: [14]

In a nutshell: Following the 2002 Nobel prize in chemistry of Fenn and Tanaka, and the recent developments led in particular by Carol Robinson (Oxford), native mass spectrometry is about to become a technique of major importance in structural biology, providing information on large assemblies (more than 10 subunits) studied in solution. One key question is to infer pairwise contacts between subunits from native mass spectrometry data.

Assessment: In this work, we provide a method to predict pairwise contacts between subunits of a large assembly, based on the composition of oligomers. The method is based on a mixed linear integer program, and essentially doubles the prediction performances of the method developed by Robinson et al.

► **Hybridizing Rapidly Growing Random Trees and Basin Hopping Yields an Improved Exploration of Energy Landscapes**
Reference: [22]

In a nutshell: Energy landscapes of biomolecular systems code their emergent thermodynamic and kinetic properties, so that their exploration is a question of paramount importance. This task requires in particular finding (metastable) states and their occupancy probabilities. Landscape exploration methods can be ascribed to two categories: continuous methods related to molecular dynamics, and discrete methods related to Monte Carlo sampling.

Assessment: In this work, we present a discrete sampling method combining features of robotics inspired methods (rapidly expanding random trees), and of biophysics inspired methods (basin hopping). Our hybrid algorithm outperforms contenders significantly. It is possibly one of the most efficient sampling method for energy landscapes known to date, but making such a statement will require testing thoroughly on a variety of systems. The method may strike a major impact if we manage to qualify the conformational ensembles generated from a thermodynamic standpoint.

► **Conformational Ensembles and Sampled Energy Landscapes: Analysis and Comparison**
Reference: [16]

In a nutshell: A paper presenting novel methods to analyze conformational ensembles and sampled energy landscapes, using techniques from optimal transportation theory and computational topology.

Assessment: The method proposed significantly enriches those classically used in biophysics, and triggered a collaboration with David Wales (Cambridge), one of the leading scientists on energy landscapes.

4.1.3. The Structural Bioinformatics Library

We released the Structural Bioinformatics Library, a library whose main features are detailed below.

AIRSEA Team

5. Highlights of the Year

5.1. Highlights of the Year

Early 2015 AIRSEA team succeed MOISE in developing of *mathematical and computational methods for the modeling of oceanic and atmospheric flows*.

The substantial changes compared to the scientific objectives of the MOISE team include a redefinition of the domains of applications now centered on oceanic and atmospheric modeling (the latter is a new target application for the team), the increased focus on statistical methods and hybrid deterministic/statistical approaches, as well as an emphasis on the development of numerical algorithms for high performance computing.

5.1.1. Awards

Clémentine Prieur was awarded by the Prix Blaise Pascal of GAMNI-SMAI.

Jose R. Leon was granted by an International Inria Chair.

AMIB Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Keynote addresses

Y. Ponty delivered one of the 8 plenary addresses at the 5th biennial Canadian Discrete and Algorithmic Mathematics Conference (CanaDAM) in University of Saskatchewan (Saskatoon, Canada). Held every two-years, with $\sim$300 participants and $\sim$150 contributed and invited talks, CanaDAM is the foremost event in Discrete Mathematics in Canada.

4.1.2. Awards

Alice Héliou received "Prix Poster École Doctorale Interfaces,Pôle : Science Du Vivant"

ANGE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Contracts and cooperations

- ANR project Hyflo-Eflu accepted
- Industrial contract with SAUR/Agence de l'eau Loire-Bretagne concerning the Vilaine River
- IPL Algae In Silico

Involvment of the team in a large popularisation process

In 2015, members of the team got involved in many popularisation events on behalf of Inria to emphasize the scope of research for the advantages of citizens, whether they be average people, entrepreneurs, decision-makers or students.

ARAMIS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Stanley Durrleman has been awarded an ERC Starting Grant by the European Research Council
- The team has been awarded the H2020 project EuroPOND, under societal challenge "Personalizing Health and Care"
- The team has been awarded the ANR-NIH project NETBCI, under the "Collaborative Research in Computational Neuroscience" program (CRCNS)

ASCLEPIOS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

- Thomas Benseghir received a Best Paper Award at the 2015 IPCAI conference, Barcelona, Spain, for his paper entitled "A tree-topology preserving pairing for 3D/2D registration", co-authored by Grégoire Malandain and Régis Vaillant.
- Matthieu Lê received a Young Scientist Award at the 2015 MICCAI conference, Munich, Germany, for his paper entitled "GPSSI: Gaussian Process for Sampling Segmentations of Images" , co-authored by Jan Unkelbach, Nicholas Ayache, and Hervé Delingette.
- Bjorn Menze received the Young Scientist Publication Impact Award at the 2015 MICCAI conference, Munich, Germany, for his article "A generative model for brain tumor segmentation in multi-modal images", co-authored by Koen Van Leemput, Danial Lashkari, Marc-André Weber, Nicholas Ayache and Polina Golland presented at MICCAI 2010 in Beijing, China [100].
- Marco Lorenzi received an honorary mention at the 2015 Cor Baayen Award for his PhD prepared jointly within the Asclepios project team at Inria Sophia Antipolis and the IRCCS San Giovanni di Dio Fatebenefratelli (Italy), and for his post-doctoral research performed at University College London (UCL).
- Hervé Delingette is the co-recipient of the Dirk Bartz First Prize for Visual Computing in Medicine awarded during the 2015 Eurographics conference. The prize was given to a group of 7 Inria researchers who pioneered the development of medical simulators based on the SOFA software platform.
- Nicholas Ayache received a research medal from the University Côte d'Azur on December 10th 2015.

BEST PAPERS AWARDS :

[26] **International Conference on Information Processing in Computer-Assisted Interventions, IPCAI 2015**. T. BENSEGHIR, G. MALANDAIN, R. VAILLANT.

[38] **MICCAI - Medical Image Computing and Computer Assisted Intervention - 2015**. M. LÊ, J. UNKELBACH, N. AYACHE, H. DELINGETTE.

ATHENA Project-Team (section vide)

BEAGLE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

We organized the first EvoEvo workshop (York, July 2015) as a satellite meeting of the 2015 ECAL conference (http://www.evoevo.eu).

5.1.1. Awards

Best paper award at the ACM Genetic and Evolutionary Computation Conference GECCO'15, in category Evolutionary Machine Learning, for the following paper: .
BEST PAPERS AWARDS :
[31] **Genetic and Evolutionary Computation Conference (GECCO)**. S. PEIGNIER, C. RIGOTTI, G. BESLON.

BIGS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The composition of the team was changed this year : Bruno Scherrer (Inria researcher) and Anne Gégout-Petit (Pr) joined the team (resp in January and in May). Samy Tindel moved to Purdue University as full Professor and Céline Lacaux has been promoted full Professor at Avignon University. Anne Gégout-Petit is temporary team leader since September.

BIOCORE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Metabolic mathematical models are required to fully understand and optimize the microalgae lipid metabolism and finally maximize biofuel production. However, unlike heterotrophic microorganisms that use the same substrate as sources of energy and carbon, photoautotrophic microorganisms require light for energy and CO2 as carbon source. Furthermore, they are submitted to permanent fluctuating light environments due to outdoor cultivation or mixing inducing a flashing effect. Modelling these nonstandard organisms is therefore a major challenge for which classical tools are often inadequate. This year, the work consisted in assessing and comparing the potential of several approaches for modelling microalgae. As a conclusion, the DRUM approach developed within Biocore seems highly promising since it requires a lowest number of parameters while it can predict internal accumulation during transients [14].
- We study the occurrence of periodic solutions in an n-dimensional class of negative feedback systems defined by smooth vector fields. By circumscribing the smooth system by two piecewise linear ones, we show that there exists an invariant toroidal region which contains a periodic orbit of the original smooth system [37]. The strong point of this work is is that it makes a link between hybrid piecewise linear systems (where computations are easier) and smooth classical systems.
- We developed a plant epidemic model to address the epidemiological and evolutionary management of plant virus epidemics in agricultural landscapes using resistant cultivars. Based on the principles of cultivar mixtures and cultivar rotations, we explored different resistance deployment strategies and their impact on disease prevalence and pathogen evolution. Overall, combining cultivar mixtures and rotations provided most efficient and durable pathogen control [25].

BONSAI Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. MyNorine invents the crowd sourcing for Non Ribosomal Peptides

For ten years, the team has been developing a unique knowledge base, Norine, dedicated to the modeling and analysis of Nonribosomal peptides (NRPs). NRPs are secondary metabolites produced by bacteria and fungi that represent a huge source of natural products with applications in agricultural or health areas. In January 2015, we have released a new version which contains several major advances. MyNorine is a user-friendly service, that allows to submit new NRPs and to edit existing ones [2]. It was tested and validated by a panel of expert users during an international workshop that we organized in Lille in October, and that attracted 32 attendees from 8 countries. Moreover, s2m is an innovative tools to infer the monomeric structure of the peptides [1].

5.1.2. 1,000 white blood cell samples processed by Vidjil

Vidjil is an open-source platform for the analysis of high-throughput sequencing data from lymphocytes developed by the team. In October 2014, we opened a web server to grant everyone an access to Vidjil, our white blood cell analysis software used for leukemia diagnosis and follow-up. For one year, Vidjil analyzed more than 1,000 samples totalling 5 billion DNA sequences. Our users come from about thirty hospitals and labs throughout the world [3]. About fifteen of them regularly submit new samples. In Lille, the hematology department of the hospital uses Vidjil to identify malignant white blood cells at diagnosis on every patient with acute leukemia.

CAPSID Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Large ANR Grant – Investissements d'Avenirs

Marie-Dominique Devignes and Malika Smaïl-Tabbone (Orpailleur Team) coordinated a work-package on network-based science for the project "FIGHT_HF" (Fight Heart Failure) that was submitted by Nancy University Hospital's Federation "CARTAGE" (http://www.fhu-cartage.com/) to the ANR "Investissements d'Avenirs" programme. This project aims to discover novel mechanisms for heart failure and to propose decision support for precision medicine. The project has been granted € 9M.

Journal Front Cover

A figure from our article in the *Journal of Chemical Information and Modeling* [15] was used to illustrate the front cover of the August issue of the journal.

CARMEN Team

5. Highlights of the Year

5.1. Highlights of the Year

A large part of the newly-constructed LIRYC building, hosting researchers' offices, has been taken in use. The extra space greatly facilitates collaboration between Carmen and LIRYC researchers.

The *service de cardiologie-électrophysiologie et stimulation cardiaque* of the CHU Haut-Leveque, the clinical partner in LIRYC, was ranked first in the classification 2015–2016 of Hospitals and Clinics published by the news magazine *L'Express*, while its director, professor M. Haissaguerre, has been awarded the Gold Medal of the European Society of Cardiology.

M. Potse published a high-profile paper with a group of internationally renowned researchers on terminology and criteria for the diagnosis of a rare but potentially fatal ECG abnormality named Early repolarisation syndrome [37].

In silico assessment of drugs effects on human embryonic stem cells derived cardiomyocytes electrical activity Computational modeling and simulation is extensively used to investigate diseases in cardiac electrophysiological activity and also drug effects, side effects and interactions. Human embryonic stem cell-derived cardiomyocytes (hESC-CMs) have been recently considered as a promising tool in regenerative medicine: their major role in repairing damaged tissue is due to pluripotency and ability to differentiate. These pluripotent cells are also used in early stages of drugs development. Pharmaceutical companies use the MultiElectrode Array (MEA) device in order to perform many in vitro experiments on hESC-CMs. The goal of our study is to derive a mathematical model and to simulate these in vitro experiments. Sensitivity of the Electrocardiography Inverse Solution to the Torso Conductivity Uncertainties Electrocardiography imaging (ECGI) is a new non invasive technology used for heart diagnosis. It allows to construct the electrical potential on the heart surface only from measurement on the body surface and some geometrical informations of the torso. The purpose of this work is twofold: First, we propose a new formulation to calculate the distribution of the electric potential on the heart, from measurements on the torso surface. Second, we study the influence of the errors and uncertainties on the conductivity parameters, on the ECGI solution. We use an optimal control formulation for the mathematical formulation of the problem with a stochastic diffusion equation as a constraint. The descretization is done using stochastic Galerkin method allowing to separate random and de-terministic variables. The optimal control problem is solved using a conjugate gradient method where the gradient of the cost function is computed with an ad-joint technique. The efficiency of this approach to solve the inverse problem and the usability to quantify the effect of conductivity uncertainties in the torso are demonstrated through a number of numerical simulations on a 2D geometrical model. Our results show that adding $\pm$50alter the inverse solution, whereas adding $\pm$50lung conductivity affects the reconstructed heart potential by almost 50

Inverse Localization of Ischemia in a 3D Realistic Geometry: A Level Set Approach The reconstruction of cardiac ischemic regions from body surface potential measurements (BSPMs) is usually performed at a single time instant which corresponds to the plateau or resting phase of the cardiac action potential. Using a different approach, we previously proposed a level set formulation that incorporates the knowledge of the cardiac excitation process in the inverse procedure, thus exploiting the spatio-temporal correlations contained in the BSPMs. In this study, we extend our inverse level-set formulation for the reconstruction of ischemic regions to 3D realistic geometries, and analyze its performance in different noisy scenarios. Our method is benchmarked against zero-order Tikhonov regularization. The inverse reconstruction of the ischemic region is evaluated using the correlation coefficient (CC), the sensitive error ratio (SN), and the specificity error ratio (SP). Our algorithm outperforms zero-order Tikhonov regularization, specially in highly noisy scenarios.

Inverse problem in electrocardography via the factorization method of boundary value problems We present a new mathematical approach for solving the inverse problem in electrocardiography. This approach is based on the factorization of boundary value problems method. In this paper we derive the mathematical equations and test this method on synthetical data generated on realistic heart and torso geometries using the state-of-the-art bidomain model in the heart coupled to the Laplace equation in the torso. We measure the accuracy of the inverse solution using spatial Relative Error (RE) and Correlation Coefficient (CC).

It is now possible for all Carmen members to go to the IHU LIRYC since the construction of the new building. This aims for the Carmen teams to follow doctors and researchers at Xavier Arnozan hospital.

CASTOR Project-Team (section vide)

CLIME Project-Team (section vide)

COFFEE Project-Team (section vide)

DEMAR Project-Team (section vide)

DRACULA Project-Team (section vide)

DYLISS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The main novelty in 2015 was the use of Semantic Web technologies to support the integration and query and investigation of large-scale heterogeneous databases. These technologies were applied in the framework of the MiRNAdapt project (funded by ANR) to design a tool for representing and querying bio-molecular information. The tool Askomics was designed in this perspective. In addition, Semantic Web technologies are currently combined with Formal Concept Analysis, to decipher the main regulators of complex systems, with application in cancer system biology (novel project funded by Plan Cancer).

ERABLE Project-Team (section vide)

FLUMINANCE Project-Team (section vide)

GALEN Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- Pr. Iasonas Kokkinos was appointed associate editor for the Computer Vision and Image Understandin Journal.
- Pr. Pawan Kumar was appointed associate editor for the Computer Vision and Image Understandin Journal.
- Pr. Nikos Paragios was admitted as a senior fellow at the Insitut Universitaire de France in the section of Mathematics.

GENSCALE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Special Issue

Publication of a special issue on Discrete Applied Mathematics. Guest Editors: A. Mucherino, R. de Freitas, C. Lavor [35]

Awards

For the third time in the last three editions of JOBIM (National workshop on Biology, Informatics and Mathematics), PhD students of the GenScale team won the best poster award:

- JOBIM 2015: Simka: fast kmer-based method for estimating the similarity between numerous metagenomic datasets [39] (https://hal.inria.fr/hal-01180603)
- JOBIM 2013 : MINIA on a Raspberry Pi, Assembling a 100 Mbp Genome on a Credit Card Sized Computer (https://hal.inria.fr/hal-00842027)
- JOBIM 2012 : Compareads: comparing huge metagenomic experiments (https://hal.inria.fr/hal-00760332)

In 2014, due to the ECCB conference in Strasbourg, France, there was no specific JOBIM event.

IBIS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

A paper based on the PhD thesis of Jérôme Izard and the post-doctoral work of Cindy Gomez Balderas was published in *Molecular Systems Biology* this year [18]. The paper describes foundational results for the RESET project (Section 8.2). A paper by Eugenio Cinquemani and colleagues from the LIFEWARE project-team and from the University of Pavia was accepted for *PLoS Computational Biology* this year [20], while a paper based on the PhD thesis of Valentin Zulkower was published in a special issue of *Bioinformatics* associated with the major bioinformatics conference ISMB/ECCB [24].

LEMON Team

5. Highlights of the Year

5.1. Highlights of the Year

- In 2015, the *Marine Energies Research International Center* (MERIC) was launched in Chile. Antoine ROUSSEAU will be the scientific coordinator for Inria, and several members of LEMON, CARDAMOM and TOSCA research teams will be involved in this 8 years project in partnership with DCNS and Enel.
- Antoine ROUSSEAU co-organized the CEMRACS 2015, in Marseilles: 6 weeks with more than 100 participants.
- Fabien MARCHE and Antoine ROUSSEAU co-organized the workshop Numerical Models for Coastal Hazards in Montpellier.

5.1.1. Awards

- Carole Delenne's project **Cart'Eaux** was selected in the Languedoc Roussillon *Chercheur d'avenir* competition.
- The GERIMU project has earned a distinction from the local Scientific Advisory Committee ("Coup de coeur du COSTI").

LIFEWARE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Four PhD Theses Defended this Year

Katherine Chiang defended her thesis [1] in three years at National Taiwan University and two internships with us in 2012 and 2013, on the computer-aided design of biomolecular systems, a subject co-supervised by Jie-Hong Jiang and François Fages which is of increasing importance in Lifeware and led to several publications this year [11], [6], [5].

Artemis Llamosi defended his thesis [3] in three years also, on the modeling of cell-to-cell variability, a subject co-supervised by Grégory Batt and Pascal Hersen, which led to a major publication in *PLoS Computational Biology* [8] to appear in 2016, and a cooperation with Marc Lavielle (EP POPIX).

Steven Gay finally defended his thesis [2] on subgraph epimorphisms and model reductions, a subject co-supervised by François Fages and Sylvain Soliman, 18 months after he leaved us for taking a Post Doc position at Univ. Louvain-la-Neuve, Belgium.

Thierry Martinez defended his thesis [4] supervised by François Fages, on a logical kernel for constraint programming, with direct impact on the design of the ClpZinc modeling language and the rewriting of Biocham v4, for which he got engineer positions n the last years.

In addition, François Bertaux has sent to reviewers his thesis on the modeling of cell-to-cell variability and cell apoptosis, co-supervised by Dirk Draso and Grégory Batt. Sylvain Soliman has sent to reviewers his *Habilitation à Diriger des Recherches* on the dynamics of biochemical systems. Pauline Traynard is also finishing her thesis co-supervised by François Fages and Denis Thieffry, on temporal logic patterns and solvers and the modeling of the interactions between the cell cycle and the circadian clock, for a defense in early 2016 in three years and half. Jean-Baptiste Lugagne is also expected to defend his thesis in 2016.

These theses are the foundations of some major themes of Lifeware for the next years.

M3DISIM Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

A. Collin (who did her PhD in the team) received the SMAI-GAMNI award 2015 for Best PhD thesis and the ECCOMAS PhD award 2015.

A. Aalto received the award for the best doctoral thesis in Aalto University School of Science during 2014.

MAGIQUE-3D Project-Team (section vide)

MAMBA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Awards

Benoît Perthame is the 2015 laureate of the Inria - French Académie des Sciences Grand Prize: http://www.inria.fr/en/institute/inria-in-brief/inria-awards/2015-prize-winners/benoit-perthame-grand-prize.

MIMESIS Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Translational Simulation: from pre-operative to intra-operative simulation

In recent years, an active development of novel technologies dealing with medical training, planning and guidance has become an increasingly important area of interest in both research and health-care manufacturing. With a combination of advanced physical models, realistic human-computer interaction and growing computational power, the MIMESIS team aims at bringing new solutions in order to help both medical students and experts to achieve a higher degree of accuracy and reliability in surgical interventions [26].

4.1.1.1. Pre-operative planning

In the context of cryoablation, planning the outcome of the procedure is key to ensure an optimal ablation. Cryotherapy is a rapidly growing minimally invasive technique for the treatment of certain tumors. It consists in destroying cancer cells by extreme cold delivered at the tip of a needle-like probe. As the resulting iceball is often smaller than the targeted tumor, a key to the success of cryotherapy is the planning of the position and orientation of the multiple probes required to treat a tumor, while avoiding any damage to the surrounding tissues. In order to provide such a planning tool, a number of challenges need to be addressed such as fast and accurate computation of the freezing process or interactive positioning of the virtual cryoprobes in the pre-operative image volume. To address these challenges, we developed a thermal model using the finite-element method and implemented on GPU. Our thermal model was intensively validated and specific solvers were built. From these simulations, we developed a prototype for cryotherapy planning.

4.1.1.2. Towards intra-operative guidance

Not only does the simulation bring a pre-operative support to the radiologist, but computational models can also be used intra-operatively. During the minimally-invasive liver surgery, only the partial surface view of the liver is usually provided to the surgeon via the laparoscopic camera. Therefore, it is necessary to estimate the actual position of the internal structures such as tumors and vessels from the pre-operative images. Nevertheless, such task can be highly challenging since during the intervention, the abdominal organs undergo significant deformations due to the pneumoperitoneum, respiratory and cardiac motion and the interaction with the surgical tools. Therefore, a reliable automatic system for intra-operative guidance requires fast and reliable registration of the pre- and intra-operative data. This year, we presented a complete pipeline for the registration of pre-operative patient-specific image data to the sparse and incomplete intra-operative data [21]. While the intra-operative data is represented by a point cloud extracted from the stereo-endoscopic images, the pre-operative data is used to reconstruct a biomechanical model which is necessary for accurate estimation of the position of the internal structures, considering the actual deformations. This model takes into account the patient-specific liver anatomy composed of parenchyma, vascularization and capsule, and is enriched with anatomical boundary conditions transferred from an atlas. The registration process employs the iterative closest point technique together with a penalty-based method. Following this work, we performed a quantitative assessment based on the evaluation of the target registration error on synthetic data as well as a qualitative assessment on real patient data. We demonstrated that the proposed registration method provides good results in terms of both accuracy and robustness w. r. t. the quality of the intra-operative data

4.1.2. Eurographics Award

In recent years, an active development of novel technologies dealing with medical training, planning and guidance has become an increasingly important area of interest in both research and health-care manufacturing. A combination of advanced physical models, realistic human-computer interaction and growing computational power is bringing new solutions in order to help both medical students and experts to achieve a higher degree

of accuracy and reliability in surgical interventions. In our work entitled "Surgery Training, Planning, and Guidance using the SOFA Framework" [26], we presented three different examples of medical physically-based simulations implemented in a common software platform called SOFA. Each example represented a different application: training for cardiac electrophysiology, pre-operative planning of cryosurgery and per-operative guidance for laparoscopy. This paper assessed the realism, accuracy and efficiency of the simulations, as well as the potential and flexibility of the SOFA platform.

Figure 6. First Dirk Medical Prize at Eurographics 2015

This work has been awarded at the Eurographics conference in Zurich and won the **1st prize of the Dirk Bartz Medical Prize**.

4.1.3. SOFA Consortium

After ten years of development, a Consortium around the simulation platform SOFA was founded by Inria in November 2015. The MIMESIS team intensively participated in the creation of this Consortium. The objectives of this Consortium are to make the SOFA community grow and encourage contributions from new SOFA users. The Consortium should also be a way to better answer to the needs of academic or industrial partners.

A member of the MIMESIS team is now in charge of the coordination of this Consortium. A new engineer was also hired to manage the support on the SOFA forum, handle the SOFA events and communicate about SOFA Consortium. The activity of the SOFA Consortium is expected to significantly grow in the coming years.

4.1.4. Evaluation by IHU Strasbourg

Every year, research done at IHU is evaluated by a group of 15 international experts, scientists and clinicians. The 2015 report highlighted our work in the field of modeling and augmented reality: "Interestingly, besides its numerous applications for computer assisted surgery, it paves the way to build a new science of anatomy, with the establishment of innovative, "big data" based organ atlases. The program truly shows the most disruptive results. It is scientifically impressive and potentially very practical. There is no doubt that this is the domain where IHU is close to be the leading group. The program has a real strategy beyond distinct projects, and clear synergies have been identified." This report attests to our involvement within the IHU Strasbourg.

4.1.5. Science & You

Science & You is an international event about scientific mediation in the field of digital technologies. In 2015, Science & You took place in Nancy from the 1st until the 6th June 2015. Inria co-organized the event with

INS2I and SIF. At this occasion, the MIMESIS team presented the results and prototypes developed in the team. This event drew a crowd and was a real success.

MNEMOSYNE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. ReScience journal

Nicolas Rougier has co-founded the ReScience journal (http://rescience.github.io/) with Konrad Hinsen and is one the Editor-in-chief. ReScience is a peer-reviewed journal that target computational research and encourage the explicit replication of already published research promoting new and open-source implementations in order to ensure the original research is replicable.

5.1.2. Most viewed and downloaded article

Our paper [4] is in the spotlight of the Frontiers blog (cf. http://blog.frontiersin.org/2015/12/22/spotlight100/): among the 100 articles the most viewed and downloaded among over 12,500 articles published by Frontiers in 2015.

5.1.3. Awards

Our paper was given the Best Paper Award at the 2015 International Conference on Neural Computation Theory and Applications, cf. http://www.ncta.ijcci.org/PreviousAwards.aspx
BEST PAPERS AWARDS :
[11] **International Joint Conference on Computational Intelligence**. R. KASSAB, F. ALEXANDRE.

MODEMIC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The project Soil$\mu 3D$, which Modemic is a partner, has been selected and funded by the ANR (French National Research Agency) for the 2015-2019 period.

Alain Rapaport has been invited to give a plenary session at the next CMPDE'16 [0] (Conference in Mathematical Population Dynamics and Epidemiology), Marseille, 5–9 September 2016.

[0] http://mpde16.mio.univ-amu.fr/

Monc Team

5. Highlights of the Year

5.1. Highlights of the Year

Awards

Perrine Berment won the third price of *Ma thèse en 180 secondes* of the Aquitaine region.

MORPHEME Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Prizes and distinctions

L. Blanc-Féraud has been declared Knight of the Legion of Honor september the 25th.

Awards

T. Benseghir and G. Malandain have received a best paper award at the IPCAI conference.

X. Descombes has co-authored of a paper that received the best student paper award at the Workshop on Diff - CV.

BEST PAPERS AWARDS :

[3] **International Conference on Information Processing in Computer-Assisted Interventions, IPCAI 2015**. T. BENSEGHIR, G. MALANDAIN, R. VAILLANT.

[5] **1st iInternational Workshop on Diff - CV: Differential Geometry in Computer Vision for Analysis of Shapes, Images and Trajectories (in conjunction with BMVC)**. A. DUNCAN, E. KLASSEN, X. DESCOMBES, S. ANUJ.

MYCENAE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- HDR defense of Jonathan Touboul : Contribution to the theoretical study of large neuronal ensembles. June 5th 2015, ED3C
- Co-organization of founding events to federate the national scientific communities in Reproduction: Reprosciences 2015, and in Modeling for cell and developmental biology: 2015 ITMO BCDE workshop on Modeling in Cell and Developmental Biology

NEUROMATHCOMP Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Awards

Olivier Faugeras received the Okawa Foundation Prize for "Pioneering contributions for computer vision and for computational neuroscience". The prize was awarded to him in Tokyo, Japan, in March 2015. He received the PAMI Azriel Rosenfeld Lifetime Achievement Award in December 2015 at the ICCV 2015 in Santiago, Chile. This award is given to researchers in Computer Vision who have made major contributions to the field over their career and who have influenced the field in an extraordinary way.

Habilitation à Diriger des Recherches (HDR) Mathieu Desroches has defended an habilitation thesis on the 11th December 2015 at the Université Pierre et Marie Curie - Paris 6. The title of his habilitation thesis is *Complex oscillations with multiple timescales - Application to neuronal dynamics* [15]. The reviewer of this HDR were: Eusebius J. Doedel (Concordia University, Canada), Christopher K. R. T. Jones (University of North Carolina at Chapel Hill, USA) and Daniel Panazzolo (Université de Haute-Alsace, France). The jury was formed by : Stephen Coombes (University of Nottingham, UK), Peter De Maesschalck (Hasselt University, Belgium), Olivier Faugeras (Inria Sophia Antipolis, France), Jean-Pierre Françoise (President of the Jury, Université Pierre et Marie Curie - Paris 6, France), Christopher K. R. T. Jones (University of North Carolina at Chapel Hill, USA) and Daniel Panazzolo (Université de Haute-Alsace, France).

NEUROSYS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Laurent Bougrain co-organized an **international Brain-Computer Interfaces competition** on *Error Potential Detection with Cross-subject Generalization* with Maureen Clerc, Fabien Lotte, Emmanuel Maby, Jérémie Mattout and Théodore Papadopoulo. **311 participants of 260 different teams** in the world participated to the competition. Gao Shangkai and Bin He were in the advisory board. IEEE EMBS, Inria, and Institute for Engineering in Medicine at University of Minnesota were sponsors of this event. The prizes have been presented to winners during the IEEE EMBS Neural Engineering conference, April 22-24, 2015. The winner has been invited to publish a manuscript at IEEE Transactions on Biomedical Engineering.
  https://www.kaggle.com/c/inria-bci-challenge
- **We stepped up our collaboration with the department of anesthesia of the university hospital in Nancy** (Dr. Denis Schmartz and Pr. Claude Meistelmann) leading to a **PhD thesis co-funded** by the school of medicine of the university of Lorraine, Inria, the Lorraine laboratory for research in computer science (LORIA), the Lorraine Region and the urban community of Nancy. The PhD will start in January 2016 on the study of the dynamics of cerebral motor patterns during general anesthesia with Sébastien Rimbert under the supervision of Axel Hutt and Laurent Bougrain.

NUMED Project-Team (section vide)

PARIETAL Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Michael Eickenberg got an oral presentation at the OHBM 2015 conference(success rate < 1%). Elvis Dohmatob got an oral presentation at the OHBM 2015 conference(success rate < 1%).

PLEIADE Team (section vide)

POPIX Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Marc Lavielle received the 2015 ISoP (International Society of Pharmacometrics) Innovation award

Marc Lavielle received the 2015 Inria – French Académie des Sciences – Dassault Systèmes Innovation Award

REO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Irène Vignon-Clementel: Article [16] selected for journal cover in Cardiovascular Engineering and Technology.

5.1.1. Awards

Jessica Oakes was awarded an American Lung Association Senior Research Training Grant for salary support for 1-2 years.

SAGE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The team SAGE ended in December 2015.

N. Nassif, J. Erhel and B. Philippe published a book entitled "introduction to computational linear algebra" [23]. E. Gallopoulos, B. Philippe and A. Sameh published a book entitled "Parallelism in Matrix Computations".

SERENA Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Martin Vohralík obtained the ERC consolidator grant in the 2015 campaign with his project GATIPOR "Guaranteed fully adaptive algorithms with tailored inexact solvers for complex porous media flows".

Jérôme Jaffré was awarded the 2015 SIAM Geosciences Senior Career Prize.

SERPICO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Publication of overview papers

Publication of two tutorial-style overview papers:

- D. Fortun, P. Bouthemy, C. Kervrann. Optic flow modeling and computation: a survey, Computer Vision and Image Understanding, 134:1-21, 2015.
- C. Kervrann, C.O.S. Sorzano, S.T. Acton, J.-C. Olivo-Marin, M. Unser. A guided tour of selected image processing and analysis methods for fluorescence and electron microscopy, IEEE Journal of Signal Topics in Signal Processing (Special issue on Advanced Signal Processing in Microscopy and Cell Imaging, Lead Guest Editor: C. Kervrann), 10(1):1-25, 2016.

SISTM Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Time-Course Gene Set Analysis for Longitudinal Gene Expression Data

A work in collaboration with J. Skinner has been published in *PLoS Computational Biology* : [10]

Gene set analysis methods, which consider predefined groups of genes in the analysis of genomic data, have been successfully applied for analyzing gene expression data in cross- sectional studies. The time-course gene set analysis (TcGSA) introduced here is an exten- sion of gene set analysis to longitudinal data. The proposed method relies on random effects modeling with maximum likelihood estimates. It allows to use all available repeated measurements while dealing with unbalanced data due to missing at random (MAR) mea- surements. TcGSA is a hypothesis driven method that identifies a priori defined gene sets with significant expression variations over time, taking into account the potential heteroge- neity of expression within gene sets. When biological conditions are compared, the method indicates if the time patterns of gene sets significantly differ according to these conditions. The interest of the method is illustrated by its application to two real life datasets: an HIV therapeutic vaccine trial (DALIA-1 trial), and data from a recent study on influenza and pneumococcal vaccines. In the DALIA-1 trial TcGSA revealed a significant change in gene expression over time within 69 gene sets during vaccination, while a standard univariate individual gene analysis corrected for multiple testing as well as a standard a Gene Set Enrichment Analysis (GSEA) for time series both failed to detect any significant pattern change over time. When applied to the second illustrative data set, TcGSA allowed the identification of 4 gene sets finally found to be linked with the influenza vaccine too although they were found to be associated to the pneumococcal vaccine only in previous analyses. In our simulation study TcGSA exhibits good statistical properties, and an increased power compared to other approaches for analyzing time-course expression patterns of gene sets. The method is made available for the community through an R package.

5.1.2. Two new books

DC is co-editor and RT is co-author of the two following books :

- Daniel Commenges and Héléne Jacqmin-Gadda (2015), Dynamical Biostatistical Models, Chapman & Hall.
- Daniel Commenges and Hélène Jacqmin-Gadda (2015), Modèles biostatistiques pour l'épidémiologie. De Boeck.

STEEP Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

The adventure continues!

The start of STEEP as an exploratory action in 2010 constituted a significant thematic change for all its members. This risky adventure was successfully consolidated in 2015, with the acceptance of STEEP as a full project-team. The adventure continues!

Various significant contributions

In other respects, two important results have been obtained this year on the ecological accounting front. First, a generic method of evaluation of environmental pressures from material flows has been developed and published (paper in press at the time of writing). Second, the errors associated to the national transport database which is heavily used in material flow analysis have been quantified; this work will be published in 2016 but is eagerly awaited by a number of researchers and agencies, as the disaggregated error is not evaluated in the database itself.

As a by-product of its investment in the ESNET project (Ecosystem Services Network), the team has developed an important expertise on the methodological aspects of LUCC modelling. This expertise has turned into a theoretical analysis of the foundations of LUCC theory itself, as important methodological flaws and their theoretical cures have been identified in the course of the project. These methodological and theoretical advances will be submitted to publication within the coming year.

Finally, our benchmarking tools designed for climate negotiations have been used by the "*Groupe Interdisciplinaire sur les Contributions Nationales*" (GICN) which has been mandated by french ministry of Sustainable Development to prepare the **climate change conference COP21** at Paris. Some contributions have been presented at the Side Events of COP 21, the 2nd of December 2015. Contributions have been published in a special working paper [11].

TONUS Team

5. Highlights of the Year

5.1. Highlights of the Year

We have launched the SCHNAPS project: http://schnaps.gforge.inria.fr/. Its goal is to develop a high performance software for plasma simulations. It is based on the runtime tool StarPU developed at Inria Bordeaux. The objective is to perform asynchronous hybrid CPU/GPU computations on HPC computers.

VIRTUAL PLANTS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

- *Statistical methods*: One of our main activities consists of identifying and characterizing developmental patterns in plant phenotyping data. Phenotyping data are very diverse ranging from the tissular to the whole plant scale but are often highly structured in space, time and scale. We intend to analyse such data using state-of-the-art methods at the crossroad between statistical modelling, machine learning and pattern recognition. This generates regularly new methodological results as illustrated this year by [17] and [22].
- *Scientific Workflows*: Analyzing biological data may involve very complex and interlinked steps where several tools are combined together. Scientific workflow systems have reached a level of maturity that makes them able to support the design and execution of such in-silico experiments, and thus making them increasingly popular in the bioinformatics community. However, in some emerging application domains such as system biology, developmental biology or ecology, the need for data analysis is combined with the need to model complex multi-scale biological systems, possibly involving multiple simulation steps. This requires the scientific workflow to deal with retroaction to understand and predict the relationships between structure and function of these complex systems. In collaboration with the Zenith EPI, we have proposed a conceptualisation of OpenAlea workflows [34] by introducing the concept of higher-order dataflows as a means to uniformly combine classical data analysis with modeling and simulation, in the context of plant phenotyping.
- *Mechanical model of meristem development*: The growth of plant tissues results from the growth of cells that are inflated by turgor pressure. In recent years, different bio-physical processes by which genes regulate locally the rate and the directions of cell growth have been identified. At tissue level, the growth of each region is mechanically constrained by the existence of neighboring regions. This creates stresses within the plant tissues, possibly with differential directional intensities, which in turn, can be sensed locally at the level of each individual cell by genes. Shapes thus results from the complex interplay between genes and growth, mediated by mechanics. In the recent years, we have been developing a model of growth of plant tissues that is able to represent this overall feedback mechanism [13]. This model is the first 3D approach of multicellular plant tissue development based on a tensorial representation of mechanical properties and stresses in cell walls. Its implementation relies on a coupling between OpenAlea and Sofa, two main sofware platforms for modeling in biology developed at Inria.

VISAGES Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- In 2015, the Neurinfo platform obtained the IBISA label. The IBISA label is a national label for technological platforms awarded by the GIS IBISA on an annual basis.
- In 2015, Edan G was elected Fellow of the European Academy of Neurologie.

ALPINES Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. FreeFem++

We have released a version of FreeFem++ (v 3.42) which introduces new and important features related to high performance computing:

- improved interface,
- improved interface with PETSc library,
- improved interface with HPDDM (see above).

This release enables, for the first time, end-users to run the very same code on computers ranging from laptops to clusters and even large scale computers with thousands of computing nodes.

5.1.2. Invited talk Supercomputing 2015

Laura Grigori was an Invited speaker at the ACM/IEEE Supercomputing'15, International Conference for High Performance Computing, Networking, Storage, and Analysis, Austin, November 2015, http://sc15.supercomputing.org/schedule/event_detail?evid=inv103. This is the major conference of high performance computing, attended by 12,000 people. A blog can be found at http://sc15blog.blogspot.com/2015/10/sc15-invited-talk-dr-laura-grigori.html.

5.1.3. SIAM Lecture Note book

Frédéric Nataf, with V. Dolean and P. Jolivet, published a SIAM lecture note book on domain decomposition methods. The four draft versions on HAL https://hal.archives-ouvertes.fr/cel-01100932 were downloaded more than 2 300 times.

5.1.4. SIAM SIAG on Supercomputing

Laura Grigori was elected the Chair of the SIAM SIAG on Supercomputing (SIAM special interest group on supercomputing) for the period of January 2016 - December 2017. She was nominated by a Committee and elected by the members of this SIAG.

ASAP Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Anne-Marie Kermarrec created the Mediego Startup in April 2015

Michel Raynal was accepted as a new member of the Academia Europaea.

4.1.1. Awards

Fabien André and Anne-Marie Kermarrec received the Award "Prix du magazine la recherche" in Computer science for the Eurosys 2014 paper "Archiving cold data in warehouses with clustered network coding"[1].

ASCOLA Project-Team (section vide)

ATLANMODELS Team

5. Highlights of the Year

5.1. Highlights of the Year

"Software Modernization Revisited: Challenges and Prospects" appears in IEEE Computer Magazine. Based on our past and present experience in software migration projects, this article puts the focus on some important factors/challenges to take into consideration when dealing with such projects and propose corresponding recommendations to maximize the chance of success. In this respect, it notably presents some concrete findings we have made while collaborating with our partners during the 3 years of the ARTIST EU project.

AVALON Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. VHGw Demo on Green-Touch Final Meeting

GreenTouch was founded five years ago with the ambitious goal to improve energy efficiency of communications and data networks by a factor of 1,000.

Avalon was invited to give one of the 15 demonstration of key technology to reduce power consumption. The VHGW (Virtual Home Gateway) demonstration gives a proof of concept and focuses on the main challenges related to the virtualization of home gateways through dense service aggregation and precise energy management.

5.1.2. Dissemination

Laurent Lefevre has given an invited keynote talk on "Towards energy proportional clouds, data centers and networks: the holy grail of energy efficiency ?", in IEEE Online Greencomm Conference, November 10, 2015

5.1.3. Awards

BEST PAPERS AWARDS :
[26] **CloudTech'2015**. D. BALOUEK-THOMERT, E. CARON, P. GALLARD, L. LEFÈVRE.

CIDRE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

This year, beside the continuation of the work we realized on intrusion detection, privacy, or trust management (see below), we started to investigate new areas, namely malware analysis and hardware security.

A classical problem in dynamic analysis of malware is to be able automatically execute functions / methods of applications under monitoring. Dynamic analysis is helpful only if a malicious action has been observed, unfortunately some malicious functionality might be hidden or was trimmed for not executing when being called under certain circumstances / in certain environments. We have developed a new approach in the automatic triggering of suspicious code [25]. In few words, our approach consists in identify suspicious code and modifying the bytecode of the infected application in order to force the execution of the suspicious code. We have implemented GroddDroid a tool dedicated to the automatic triggering of Android malware. This work has received the Best Paper award at the 10th International Conference on Malicious and Unwanted Software.

We have initiated this year different research activities in the domain of hardware security. Our goal is not to protect devices against hardware attacks such as side-channels but to use hardware mechanisms to strengthen the software stack against traditional software attacks. In this context, we are particularly interested in software/hardware co-design approaches. More precisely, we want to focus on two challenges :

- We want to use formal methods to evaluate the security guarantees provided by hardware platforms, which combine different CPUs, chipsets and memories;
- We want to investigate how dedicated hardware could be used to monitor the whole software stack (from the firmware to the user-mode applications).

The first challenge is the main objective of a bilateral research project with the French national agency for computer security (ANSSI) started in January 2015. We supervise the PhD of Thomas Lethan in the context of this project. The second challenge is studied in a bilateral research project with HP Inc Research Labs. This project started in 2012 but has been extended this year. The main objective of this extension is to propose an approach combining software instrumentation and external monitoring by a dedicated hardware to detect intrusions in UEFI firmware. The second challenge is also studied in the HardBlare collaborative project started in October 2015. The goal of this project is to use a dedicated co-processor to enforce Dynamic Information Flow Control on the main CPU.

This year, we also contributed in the organization and program committee of two major events of our communities:

- the 19-th edition of OPODIS, the International Conference on Principles of Distributed Systems (https://opodis2015.irisa.fr) was organized in Rennes, December 14-17th, with Emmanuelle Anceaume as the general chair of the conference ;
- Nicolas Prigent was the program chair of the 12th IEEE International Symposium on Visualization for Cyber Security (VizSec) that took place in Chicago, Illinois, USA on the 26th of October, 2015.

5.1.1. Awards

Our work on GroddDroid has received the best paper award at 10th International Conference on Malicious and Unwanted Software .
BEST PAPERS AWARDS :
[25] **10th International Conference on Malicious and Unwanted Software**. A. ABRAHAM, R. ANDRIATSIMANDEFITRA RATSISAHANANA, A. BRUNELAT, J.-F. LALANDE, V. VIET TRIEM TONG.

COAST Project-Team (section vide)

COATI Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Bi Li, former PhD student of COATI, is recipient of the Chinese government award for outstanding self-financed students abroad, edition 2014, for her PhD thesis entitled "Tree Decompositions and Routing Problems".

Fatima Zahra Moataz received the best student paper award of the conference ALGOTEL 2015.
BEST PAPERS AWARDS :
[51] **ALGOTEL 2015 — 17èmes Rencontres Francophones sur les Aspects Algorithmiques des Télécommunications**. F. ZAHRA MOATAZ.

CTRL-A Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Community

We have been invited to participate to the organization of events, which highlight our active presence in the scientific life in the two domains which we are bridging :

- autonomic computing: Eric Rutten is PC co-chair of the 3rd IEEE International Conference on Cloud and Autonomic Computing, CAC 2015 (http://autonomic-conference.org/) [19], Part of FAS* - Foundation and Applications of Self* Computing Conferences, Collocated with: The 9th IEEE Self-Adaptive and Self-Organizing System Conference, The 15th IEEE Peer-to-Peer Computing Conference ; and PC member, as well as workshops chair, of the 12th IEEE International Conference on Autonomic Computing, ICAC 2015 (http://icac2015.imag.fr/), the two major conferences on the topic.
- control: Eric Rutten is organizer of a Special Session on Dependable Discrete control for adaptive and reconfigurable computing systems at the 5th IFAC international workshop on Dependable Control of Discrete Systems , DCDS (http://www.gdl.cinvestav.mx/dcds2015) ; he is on the IFAC Technical Committee 1.3 on Discrete Event and Hybrid Systems, (http://tc.ifac-control.org/1/3/) and on the IEEE Control Systems Society Discrete Event Systems Technical Committee (http://discrete-event-systems.ieeecss.org).

5.1.2. Invited keynote talk

Eric Rutten was invited to give a talk at the 11th International Conference on Distributed Computing and Internet Technology (ICDCIT-2015) [13] and at the seminar of the College of Information and Computer Sciences (CICS), University of Massachusetts Amherst, USA, 28 sept.2015.

DANTE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. MOSAR results published

The joint analysis of carriage and Close proximity interactions (CPIs) showed that CPI paths linking incident cases to other individuals carrying the same strain (i.e. possible infectors) had fewer intermediaries than predicted by chance ($P < 0.001$), a feature that simulations showed to be the signature of transmission along CPIs. Additional analyses revealed a higher dissemination risk between patients via healthcare workers than via other patients. In conclusion, S. aureus transmission was consistent with contacts defined by electronically collected CPIs, illustrating their potential as a tool to control hospital-acquired infections and help direct surveillance [19], [18].

5.1.2. Time-varying social networks

. We introduce a temporal network model with adjustable community structure and emergent weight-topological correlations via the extension of the activity-driven time-varying network model. the model These model take into account: i) reinforcement processes to model memory-driven interaction dynamics of individuals; ii) focal and cyclic closure to capture patterns responsible for the emerging community structure,; iii) a node removal process. Using this temporal network model we demonstrate the effect of the scalable community structure and social reinforcement on information spreading, which co-evolves with the time-varying interactions [16].

5.1.3. Stationarity for graph signals

In a series of published works [14], [40], [36], [24], we formalised the concept of stationarity for graph signals. First, we had to introduce a new definition of graph-shift operator that, in contrast to the current alternatives, is isometric. Then, based on this operator preserving the L^2-norm of graph signals, we were able to rigorously characterise the statistical property of wide sense stationarity for graph signals. Stationarity is a central concept in the theory of signal and image processing but was still lacking for graph signals. This contribution should now foster the development of a mathematically sound framework for graph signal processing.

5.1.4. Awards

FIT IoT Lab and OneLab received the best demo award at TRIDENTCOM 2015, 10th EAI International Conference on Testbeds and Research Infrastructures for the Development of Networks & Communities, Vancouver, Canada, June 24–25, 2015.

DIANA Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

A second session of the Python MOOC by Arnaud Legout and Thierry Parmentelat has been programmed in 2015 and it was also a very big success: 9615 persons registered to the course, out of them 1487 qualified for the final attestation of achievement. This session is innovative in its form as well, since it introduced ipython notebooks as medium for complementing videos; this medium has allowed to add runnable/editable programs fragments inside written material, so that students can readily run and or modify the numerous examples that illustrate the languages' concepts. Arnaud and Thierry are preparing a sequel that will address python3; they also hope to be able to leverage on the notebooks technology, and to widen the spectrum of their day-to-day usages beyond educational purposes, and in particular towards research-oriented activities like runnable papers. For more details on this MOOC see https://www.france-universite-numerique-mooc.fr/courses/inria/41001S02/session02/about

4.1.1. Awards

Our paper Automating ns-3 Experimentation in Multi-Host Scenarios, got the Best Paper Award at the ns-3 Workshop (WNS3), May 2015, Barcelona, Spain. The NEPI experiment management framework is capable of automating deployment, execution, and result collection of experiment scenarios that combine ns-3 with multiple hosts in various ways, reducing the burden of manual scenario setup. The awarded paper describes the internals of the NEPI framework and demonstrates its usage for ns-3 multi-host scenarios with three example cases: a) running parallel simulations on a cluster of hosts, b) running distributed simulations spanning multiple hosts, and c) integrating live and simulated networks.

BEST PAPERS AWARDS :

[18] **WNS3 2015**. A. QUEREILHAC, D. SAUCEZ, T. TURLETTI, W. DABBOUS.

DIONYSOS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Awards

Pierre L'Ecuyer was named titan of simulation at the 2015 Winter Simulation Conference.

We had one best short paper award in 2015 on a novel access mechanism for M2M communications in LTE-Advanced Networks (see 6.4).
BEST PAPER AWARD :
[60] **18th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWIM)**. M. BOUZOUITA, Y. HADJADJ-AOUL, N. ZANGAR, G. RUBINO, S. TABBANE.

DIVERSE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

"Multi-tier diversification in Web-based software applications" appears in IEEE Software Magazine. This paper emphasizes a new type of software monoculture in Internet applications and introduces the idea of diversification in space and time at multiple levels of the software stacks. We experiment with a realistic Internet application to demonstrate the feasibility of multi-tier diversification. This experiment highlights the challenges that are ahead of software engineers if they want to systematically break the applicative monoculture of Internet applications.

The book "Globalizing Domain-Specific Languages" appears in the LNCS series. This book, edited by Benoit Combemale, Betty H.C. Cheng, Robert B. France, Jean-Marc Jézéquel, Bernhard Rumpe is the result of the Dagstuhl seminar organized by the GEMOC initiative in October 2014.

5.1.1. Awards

Ten years most influential paper award at MODELS'15 for the pioneering paper about the Kermeta meta-language [0] [117]

P.-A. Muller, F. Fleurey, J.-M. Jézéquel
Weaving executability into object-oriented meta-languages
Proc of MODELS/UML, p. 264-278, 2005.

[0] http://www.cnrs.fr/ins2i/spip.php?article1733

DYOGENE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Stochastic networks and stochastic geometry conference dedicated to François Baccelli on his 60th birthday

This three day event http://www.di.ens.fr/~blaszczy/FB60/ brought together about twenty invited talks given by leading researchers working on modeling and performance evaluation of computer/communication systems. Mathematical foundations of their work involve, but are not limited to, wireless stochastic geometry, information theory, discrete event dynamical systems, max-plus algebra, stationary-ergodic framework for stochastic networks. It was a wonderful occasion to celebrate the 60th birthday of François Baccelli, who has inspired the development of this field for almost 40 years. The organizers are grateful to all speakers and participants.

Awards

- Ana Busic and Sean Meyn received jointly a Google Faculty Research Award for their research on Distributed Control for Renewable Integration in Smart Communities.
  http://googleresearch.blogspot.com/2015/02/google-faculty-research-awards-winter.html

The Applied Probability Society of INFORMS presents a 2015 Best Publication Award to Mohsen Bayati, Marc Lelarge and Andrea Montanari for their paper
BEST PAPERS AWARDS :
[] **Annals of Applied Probability**. M. BAYATI, M. LELARGE, A. MONTANARI.

EVA Team

5. Highlights of the Year

5.1. Highlights of the Year

Awards

1. **Thomas Watteyne** and Brett Warneke (Linear Technology) received the IPSO CHALLENGE 2015 People's Choice Award with the project "HeadsUp! : Monitoring the Post-surgery Position of Retinal Detachment Patients". 3 December 2015.
2. Danny Hughes, Nelson Matthys, Fan Yang, Wilfried Daniels (KU Leuven, Belgium) and **Thomas Watteyne** received Third Place in the IPSO CHALLENGE 2015, with the project "MicroPnP: Harnessing the Power of IPv6 for Ultra Low Power, Zero-configuration IoT Networks". 2 December 2015.
3. **Thomas Watteyne** elevated to IEEE Senior Member. August 2015.

Meeting & Seminars

TUTORIALS AND KEYNOTES

1. **Keynote** address by **Thomas Watteyne**.
   Nuts and Bolts for Industrial IoT Middleware. ACM/IFIP/USENIX Middleware conference (Middleware), 7-11 December 2015, Vancouver, Canada.
2. **Tutorial** organized by Inria-EVA.
   OpenWSN & OpenMote: Hands-on Tutorial on Open Source Industrial IoT. Thomas Watteyne, Xavier Vilajosana, Pere Tuset. IEEE Global Telecommunications Conference (GLOBECOM), San Diego, CA, USA, 6-10 December 2015.
3. **Tutorial** organized by Inria-EVA.
   OpenWSN Tutorial [presented by Xavi Vilajosana] Workshop Internet Of Things / Equipex FIT IoT-LAB, Lille, France, 15 October 2015.
4. "Demi-heure de la science" presentation by **Thomas Watteyne**.
   Wireless In the Woods: Monitoring the Snow Melt Process in the Sierra Nevada. 3 September 2015, Rocquencourt, France.
5. **Keynote** address by **Thomas Watteyne**.
   The Rise of the Industrial IoT. International Conference on Ad Hoc Networks (AdHocNets), 31 August - 2 September 2015 San Remo, Italy.
6. **Invited Professor Leila Saidane**, from ENSI, Tunisia. She stayed in the EVA team from 18 November to 18 December 2015 to prepare common publications and identify further research directions.

STANDARDIZATION

1. **Standardization** meeting co-chaired by Inria-EVA
   6TiSCH working group meeting at IETF 94, 1-6 November 2015, Yokohama, Japan.
2. **Standardization** meeting co-chaired by Inria-EVA
   6TiSCH working group meeting at IETF 93, 19-24 July 2015, Prague, Czech Republic.
3. **Hackathon** organized by Inria-EVA.
   OpenWSN/6TiSCH Hackathon, Czech Republic, 19 July 2015.
4. **Interop event** organized by ETSI and Inria-EVA
   First ETSI 6TiSCH plugtest (interop event) in Prague, Czech Republic, 17-18 July 2015.
5. **Standardization** meeting co-chaired by Inria-EVA

6TiSCH working group meeting at IETF 92, 22-27 March 2015, Dallas, TX, USA.

ORGANIZATION OF WORKSHOPS AND CONFERENCES

1. **PEMWN 2015** international conference on Performance Evaluation and modeling in Wired and wireless Networks, cochaired by Leila Saidane, **Pascale Minet** and Farouk Kamoun, held in Hammamet, Tunisia, November 2015.
2. **Workshop** organized by Inria-EVA.
   Inria-DGA day on "Software Defined Network (SDN) & MANET" in Paris, October 2015.

INVITED PROFESSORS AND CELEBRATIONS

1. **Pascale Minet** and **Paul Muhlethaler** were invited to celebrate the 30 years of ENSI, Tunisia in November 2015.
2. **Leila Saidane**, professor at ENSI, Tunisia, stayed within the EVA team one month to initiate new common research directions.

FOCUS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- Ugo Dal Lago won the 2015 award of 'Best Young Researcher in Theoretical Computer Science' given by the Italian Chapter of the EATCS (European Association for Theoretical Computer Science).
- Ornela Dardha, former Focus PhD student, now at Glasgow University, won the award for 'Best Italian 2015 PhD Thesis in Theoretical Computer Science' given by the Italian Chapter of the EATCS.
- The Focus constraint programming solver, called `sunny-cp`, won the '2015 MiniZinc Challenge', http://www.minizinc.org/challenge.html, an annual competition of constraint programming solvers in the open category (the most challenging), featuring all the most efficient solvers in the world.
- Fabrizio Montesi, external collaborator in Focus, won the EAPLS (European Association for Programming Languages and Systems) 'Best PhD Dissertation Award 2014'.

BEST PAPERS AWARDS :

[44] **Proceedings of 6th IPM International Conference on Fundamentals of Software Engineering (FSEN 2015)**. D. HIRSCHKOFF, J.-M. MADIOT, X. XU.

FUN Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Inauguration of the FIT IoT Lab Lille's platform with its first robots open to the community.
- Full description of the TraxNet communication stack in the framework of our collaboration with TRAXENS, with real in situ experiments on the container ships Bougainville and America Vespucci. (3 pending patents)
- The FIT facility has been proposed as an "Infrastructure de Recherche" (Infrastructure for Research) by the CD TGIR.

5.1.1. Awards

The TRACAVERRE project has been nominated for the Prix de l'Innovation VINCI 2015.

GANG Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Roads

COMPUTATION OF ROAD NETWORK DIAMETER

Based on the algorithms presented in [5], Laurent Viennot has computed the diameter and radius of the worldwide road network. The diameter of a graph is the distance between two points that are furthest apart one from another. The interesting distance notion in a road network is often travel time. Finding the worldwide road network diameter thus amounts to find two points such that the travel time from one to another is maximal. Once such a pair of points is identified, we can compute the shortest path between them to obtain somehow the longest road trip in the world. Computing the diameter of a general graph usually requires to compute all pairwise distances, which is impractical for such a big graph. However, the team has developed heuristics that appear to work fast on many practical graphs including road networks. Thanks to OpenStreetMap data, the team has thus been able to compute the world road diameter (and the diameter of various restricted parts of the network). The results can be visualized on https://who.rocq.inria.fr/Laurent.Viennot/road/.

Erc

NEW ERC CONSOLIDATOR GRANT

Amos Korman has received an ERC Consolidator Grant, entitled "Distributed Biological Algorithms (DBA)", which started in May 2015. The goal of this interdisciplinary project is to demonstrate the usefulness of an algorithmic perspective in studies of complex biological systems. It focuses on the aspect of collective behavior, demonstrating the benefits of applying distributed computing techniques to establish algorithmic insights into the behavior of biological ensembles.

Highpapers

WORK ON DISTRIBUTED COMPUTING

The team has published a number of papers on Distributed Computing theory at high-profile venues. A subjective selection of these results includes: an almost-tight bound on the space complexity of set agreement [29], a study of the power of randomization in proof-labeling schemes [22] (both published at PODC'15), and a characterization of convergence in an important class of population protocols [28] (published at ICALP'15 track A).

HIEPACS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

The paper entitled “Task-based multi frontal QR solver for GPU-accelerated multicore architectures" by Emmanuel Agullo (Inria, France); Alfredo Buttari (CNRS - IRIT Toulouse, France); Abdou Guermouche (Université de Bordeaux, France); Florent Lopez (Université Paul Sabatier, France) received the best paper award at HiPC 2015 .

BEST PAPERS AWARDS :

[28] **High Performance Computing-HiPC**. E. AGULLO, A. BUTTARI, A. GUERMOUCHE, F. LOPEZ.

INDES Project-Team (section vide)

INFINE Team

4. Highlights of the Year

4.1. Highlights of the Year

1. In collaboration with Charles Bordenave (CNRS, Toulouse) and Marc Lelarge (Inria) we proved the so-called « spectral redemption conjecture » formulated by physicists in 2013, suggesting that a novel spectral method for community detection would perform non-trivial detection under optimal conditions. This has been presented in the IEEE FOCS conference, one of the top two theoretical computer science conferences.
2. In collaboration with Freie Universitaet Berlin we have further developed RIOT, which now aggregates open source contributions from 120+ people (and counting) from all over the world, coming both from academia and from industry.

4.1.1. Awards

Aline Viana was awarded the PEDR in 2015, the Inria award for research excellence.

KERDATA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Gilles Kahn honorary award of the SIF and the Academy of Science: 2nd prize for Matthieu Dorier in 2015.
The Gilles Kahn Honorary Award is given every year to at most the 3 best PhD theses in Computer Science in France and is jointly delivered by the *Société Informatique de France* (SIF) and the French Academy of Science. The candidates are judged on all aspects of their PhD work, including fundamental contributions to industrial transfers, publication impact, teaching, mentoring, and scientific dissemination activities. A Grand Prize and two *ex aequo* Accessit Prizes are given. Matthieu Dorier was given one of the latter.

PhD award of the Fondation Rennes 1: 2nd prize for Matthieu Dorier in the Matisse Doctoral School in 2015.
The Rennes 1 Foundation PhD award from the Fondation Rennes 1 is given every year to 8 outstanding new doctors from the 4 doctoral schools associated with the University of Rennes 1 (2 awards per doctoral school). The candidates are judged on the innovative aspects of their PhD thesis, "innovative" being understood in the sense of impact on socioeconomic development and technology transfers.

5.1.2. 5 International Journals

This year the team published 5 papers in high-quality journals including IEEE Transactions on Parallel and Distributed Systems, IEEE Transactions on Cloud Computing, Future Generation Computer Systems (2), World Wide Web.

MADYNES Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The Madynes team got involved this year in some new funded collaborations:

- in HUMA, funded at the french national level (FUI)
- in Orange and Inria laboratory “<I/O Lab>”

The *Alérion* spin off is definitively on track (http://www.alerion.fr).

MAESTRO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Project P11 “Data Communication Network Performance” with ALSTOM Transport (see §8.1.3) that was originally planned until May 2015 was extended for one additional year.
- The demonstration “Quantum random walk in networks” made at Bell Labs Future X days (Openday), Paris, France , on 10-11 June 2015 was the subject of an article in the journal *Industries & Technologies* titled “Une méthode quantique pour prédire l’évolution des réseaux”. (Link for subscribers only: http://www.industrie-techno.com/une-methode-quantique-pour-predire-l-evolution-des-reseaux.38856.)
- Giovanni Neglia was invited to give a 20-hour PhD course on Complex Networks at the Univ. of Pisa, Italy, on 23-27 March 2015.
- 2015 is the 7th year of official collaboration with Indian institutions (IISc and IIT Mumbai).

MESCAL Project-Team (section vide)

MIMOVE Team

5. Highlights of the Year

5.1. Highlights of the Year

On Wednesday July 8, 2015, Inria announced the launch of SoundCity, a mobile application to measure your personal exposure to noise pollution. The project is developed in the context of CityLab@Inria by the MiMove and CLIME teams, further involving collaboration with French and California startups. The project is supported by the City of Paris smart city initiative and Bernard Jomier, deputy mayor responsible for health, disability, and relations with Paris public hospital system. Noise pollution, which lowers quality of life and harms health, is a serious environmental challenge in almost every major city. The noise levels found in most cities today can interfere with memory and learning, disturb sleep, and contribute to heart disease. In Paris, the urban ecology agency and the Bruitparif association [0] currently rely on monitoring stations and computer simulations to understand noise exposure of citizens. SoundCity aims to complement these data with personal sound level exposure measurements collected with smartphones. SoundCity will also help citizens be more aware and engaged with noise in their environments. More at http://www.inria.fr/en/centre/paris/news/launch-of-soundcity-mobile-application.

[0] http://www.bruitparif.fr

MOAIS Project-Team (section vide)

MUSE Team (section vide)

MYRIADS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Christine Morin has been made Knight of the French legion of Honour by decret of the President of French Republic (December 31, 2014) for her contribution to Higher Education and Research. Antoine Petit, President of Inria, presented her with the insignia on February 24th, 2015.
- The HARNESS European project was successfully completed in September 2015. Although the final evaluation report is still pending, the verbal comments by project reviewers were very positive. The HARNESS project has developed a new generation cloud computing platform that integrates heterogeneous hardware (FPGAs, GPGPUs, programmable routers, etc.) and networking resources in order to provide vastly increased performance for a broader array of applications. With HARNESS, cloud providers can profitably manage specialized hardware and network technologies much as they do today's commodity resources, and software engineers can seamlessly integrate them into the design of their cloud-hosted applications.

PHOENIX Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

HomeAssist 500.

We are launching a massive deployment of HomeAssist in the homes of 500 older adults. This experiment will take the form of a randomized controlled trial and will be done over a period of 12 months. More details are given in Section 8.1.2 .

RAP Project-Team (section vide)

REGAL Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

- *Garbage collection for big data on large-memory NUMA machines*. We developed NumaGiC, a high-throughput garbage collector for big-data algorithms running on large-memory NUMA machines. This result, a collaboration with the Whisper team, has been presented at ASPLOS 2015 [49].
- *Explicit consistency*. We propose an alternative approach to the strong-vs.-weak consistency conundrum, *explicit consistency*. This result has been presented at EuroSys 2015 [80]. We have also developed a new sound logic for proving the correctness of a distributed database under concurrent updates. This result is published at POPL 2016 [50].
- *The weakest failure detector of implement eventual consistency*. We found the weakest failure detector to implement an eventually consistent replicated service. This theoretical result has been presented at PODC 2015 [46].

4.1.1. Awards

Gauthier Voron obtained best paper award at system track of Compas'2015.
BEST PAPERS AWARDS :
[64] **Conférence en Parallélisme, Architecture et Système, (COMPAS'15)**. V. GAUTHIER, G. THOMAS, P. SENS, V. QUEMA.

RMOD Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Pharo 4.0 has been released in April 2015.
- Moose 5.1 has been released in June 2015.
- The Synectique company, a spin-off of the RMod group with two members actively participating, got selected on the i-Lab 2015 contest (category: Creation and Development). 364 projects were submitted in this category and 54 got selected (<15%). This will allow the young company to expand its activities by hiring young developers and a sales person.
- Papers published at PLDI and OOPSLA, two important conferences of our field.

5.1.1. Awards

- The paper : **First Analysis of String APIs: the Case of Pharo [36] got a price at IWST 15 International Workshop On Smalltalk Technologies.**
- **A paper of Martin Dias [25] was a candidate for best paper (part of the best 5) at SANER http://saner.soccerlab.polymtl.ca/doku.php?id=en:awards**
- **Markiyan Rizun got the third price at ESUG 2015 for his Rewrite tool.**

ROMA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Yves Robert co-edited with Thomas Hérault (University of Tennessee, Knoxville) the book *Fault-Tolerance Techniques for High-Performance Computing* [38], which was published in May by Springer.

The version 5.0.0 of MUMPS was released in February 2015.

SCALE Team

5. Highlights of the Year

5.1. Highlights of the Year

Workshops and Conférence organization

- Organisation of a workshop on active object languages in September 2015

SOCRATE Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. FIT/CortexLab Interference Alignement Demo on Green-Touch Final Meeting

Join GreenTouch in New York City on June 18th to celebrate the announcement of its final results. GreenTouch was founded five years ago with the ambitious goal to improve energy efficiency of communications and data networks by a factor of 1,000.

Socrate was invited to give one of the 15 demos of key technology to reduce power consumption. The demo gives a proof of concept and focuses on the main challenges related to interference alignment, namely the knowledge of the interference footprint and the scheduling algorithms to make use of the interference information to maximize the spectral efficiency. A wireless network is emulated on CorteXlab (http://www.cortexlab.fr), a controlled hardware facility located in Lyon, France with remotely programmable radios and multi-node processing capabilities. During the live demo, a control laptop is remotely connected to the facility, deploying software on the radios and launching an interference alignment scenario and collecting real-time performance feedback. The efficiency gain of interference alignment is then shown for various experimental conditions that can be tuned from the control laptop.

4.1.2. Awards

The article *Code generators for mathematical functions* received the best paper award of the 22d IEEE Symposium on Computer Arithmetic, Jun 2015, Lyon, France; and

The article *A parallel unbalanced digitization architecture to reduce the dynamic range of multiple signals* [28] was one of the best student paper award finalists of the 1st URSI Atlantic Radio Science Conference (URSI AT-RASC), 2015 , May 2015, Gran Canaria, Spain.

Samir Perlaza was granted with a Marie Sklodowska-Curie Individual Fellowship (2015-2016) by the European Commission and he was elevated to *IEEE Senior Member* in June 2015.

BEST PAPERS AWARDS :

[13] **22d IEEE Symposium on Computer Arithmetic**. N. BRUNIE, F. DE DINECHIN, O. KUPRIIANOVA, C. LAUTER.

SPIRALS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

In 2015, we are particularly proud that our project-team received four awards. We are all the more proud of the fact these awards have been granted to PhD students and to young engineers involved in transfer activities.

Clément Quinton received the Best thesis award from the CNRS GDR GPL (*Génie de la programmation et du logiciel*). Clément Quinton PhD thesis [82] proposes an innovative solution for configuring and deploying software systems on cloud computing environments with software product lines and ontologies. The work of Clément Quinton led to the implementation of the Saloon software system (see Section 6.3) and contributed to the FP7 PaaSage project (see Section 9.3).

Maria Gomez Lacruz received an award in the ACM Best Student Research Competition for her paper [26] at the ACM MobileSoft conference on mobile software engineering and systems. Maria Gomez Lacruz proposes a solution for detecting buggy applications with a recommendation system that learns from software available on mobile application stores.

Gérard Paligot received two awards at the STAF Transformation Tool Contest for his work on the Spoon (see Section 6.4) library for Java source code analysis and transformation. The two awards were in the categories Java refactoring, and Java annotation processing live, respectively.

Nicolas Petitprez received the Bpifrance award in the *Création d'entreprise innovante* contest in the category *Emergence*. This award is linked to the work of Nicolas Petitprez and Martin Monperrus towards the creation of the Makitoo start-up company that is planned to be launched in 2016. This transfer project is built around the Spoon (see Section 6.4) library for Java source code analysis and transformation.

BEST PAPERS AWARDS :

[26] **2nd ACM International Conference on Mobile Software Engineering and Systems**. M. GOMEZ, R. ROUVOY, M. MONPERRUS, L. SEINTURIER.

STORM Team

5. Highlights of the Year

5.1. Highlights of the Year

STORM received an H2020 FETHPC Grant for taking part in the INTERTWinE European project to be run from Oct. 2015 to Sep. 2018, to promote interoperability between multiple runtime systems and application support layers.

TACOMA Team (section vide)

TADAAM Team (section vide)

URBANET Team

5. Highlights of the Year

5.1. Highlights of the Year

Awards

- The project "Mobile Traffic Signatures in the Urban Landscape" (participants: Angelo Furno, Razvan Stanica, Marco Fiore) was selected among the 10 finalists (from more than 200 submissions) of the Telecom Italia Big Data Challenge- http://www.telecomitalia.com/tit/en/bigdatachallenge/news-social/tim-big-data-challenge-2015-finalisti.html.

WHISPER Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The main highlight of the year is the continuous spreading of Coccinelle within the developer community of the Linux kernel. We submitted the first patches to the Linux kernel based on Coccinelle in 2007. Since then, over 4500 patches have been accepted into the Linux kernel based on the use of Coccinelle, including around 3000 by over 500 developers from outside our research group. Another testimonial of the impact of our work is the visit of Greg Kroah-Hartman in March and April 2015, as an Inria invited researcher. Kroah-Hartman is one of the leading developers of the Linux kernel, and at the time only one of two developers employed by the Linux Foundation, with the other being Linus Torvalds. Greg participated in the activities of the Whisper team around the use of Coccinelle and research projects related to the Linux kernel, and he is a convinced ambassador of our research work.

Our work on Remote Core Locking (RCL) [10] was accepted in ACM Transaction in Computer Systems (TOCS) which is the most prestigious journal in systems. RCL is currently one of the most efficient locks for multicore architectures.

ALICE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Geometry Processing: New Algorithms / New Software

This year we developed a set of geometric algorithms to robustly manipulate 3D data and generate volumetric meshes from them, with a special focus on usability, efficiency and robustness. The pipeline that we developed includes a simple and scalable surface reconstruction algorithms, a compiler for generating C++ code for robust geometric predicates, an efficient implementation of 3D Delaunay triangulation, the first algorithm to compute optimal transport in 3D, and an algorithm to generate hexahedral-dominant meshes.

As a result of the VORPALINE ERC Proof of Concept project, we distribute most of these algorithms in our open-source low-level Geogram library and Graphite graphics user interface. Some algorithms are distributed in the commercial VORPALINE software (hex-dominant meshing), proposed to the sponsors of the GOCAD consortium. The Proof of Concept project made it possible to set up tools for software quality (continuous integration, non-regression testing, systematic Doxygen documentation of all classes/functions/parameters).

Fabrication

This year has seen some important advances regarding the objectives of the ERC ShapeForge, with the publications of two novel techniques for the synthesis of structures from examples [9], [12]. We have proposed to formulate a shape synthesis problem as an appearance synthesis problem under minimal rigidity constraints. This affords for the automatic synthesis of structurally sound objects under specific boundary conditions (attachments and loads), while producing objects that visually resemble an example pattern.

We have continued to include the results of our research into our additive manufacturing software IceSL, which has been augmented with a new user interface to make it more accessible.

This year we also gave a half-day course at ACM SIGGRAPH on fused filament deposition software in collaboration with Makerbot, one of the major manufacturer of consumer level 3D printers. The course is available online at http://webloria.loria.fr/~slefebvr/sig15fdm/.

ALPAGE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

In 2015, Alpage has obtained three new national fundings: the team is a partner of two new ANR projects (PARSEME-FR and SoSweet) and an industrial contract ("RAPID" project VeRDI).

5.1.1. Awards

Best Paper Award at the TALN 2015 conference .
BEST PAPERS AWARDS :
[22] **TALN 2015**. M. COAVOUX, B. CRABBÉ.

AVIZ Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

We had a number of highlights this year:

- Aviz researchers contributed 29 publications this year. Amongst these seven papers were presented at IEEE VIS, the largest international Visualizations and Visual Analytics conference. Four full papers were presented at CHI, the largest international conference on human computer interaction;
- Aviz researchers organized two workshops and one tutorial at international conferences (ACM ITS, and IEEE VIS);
- Eight awards were won by Aviz researchers for papers, service contributions, and PhD theses (see below);
- We welcomed three international researchers and students to our lab for research visits;
- Aviz researchers taught four lectures at various French and international universities.

Awards

- Samuel Huron won the best thesis award at the IEEE VGTC Vis Pioneer Group Best PhD Dissertation Award for his thesis "Constructive Visualization: A Token-based Paradigm Allowing to Assemble Dynamic Visual Representation for Non-experts" []
- Jeremy Boy got an honorable mention award at the IEEE VGTC Vis Pioneer Group Best PhD Dissertation Award for his thesis "Engaging the People to Look Beyond the Surface of Online Information Visualizations" [10]
- Jean-Daniel Fekete received an IEEE TVCG service award for organizing VIS'14 in Paris
- Petra Isenberg and Tobias Isenberg received a IEEE Computer Society Certificate of Appreciation for co-chairing the http://beliv-2014.cs.univie.ac.at/index.php2014 BELIV Workshop on "Beyond Time And Errors: Novel Evaluation Methods For Visualization"
- Wesley Willet, Tobias Isenberg, and Pierre Dragicevic received a best paper award from the ACM Conference on Human Factors in Computing Systems (CHI) for their paper "Lightweight Relief Shearing for Enhanced Terrain Perception on Interactive Maps" [33].
- Charles Perin, Jeremy Boy and Frédéric Vernier received an honorable Mention (2nd prize) for "Le Tour de France at a Glance" visualiation in the IEEE VGTC/VPG International Data Visualization Contest.
- Jeremy Boy won the World Statistics Day 2015 Data Visualization Contest with his "Is the World a Better Place Today" online visualization platform.

BEST PAPERS AWARDS :

[] **Constructive Visualization**.

[33] **Proceedings of the Conference on Human Factors in Computing Systems (CHI)**. W. WILLETT, B. JENNY, T. ISENBERG, P. DRAGICEVIC.

AYIN Team

5. Highlights of the Year

5.1. Highlights of the Year

- Yuliya Tarabalka (Inria junior researcher) and Emmanuel Maggiori (PhD student) moved from AYIN [https://team.inria.fr/ayin/] to TITANE [https://team.inria.fr/titane/] team in January.
- Josiane Zerubia was nominated in November IEEE Signal Processing Society (SPS) Distinguished Lecturer for a duration of 2 years [http://www.signalprocessingsociety.org/newsletter/2015/11/sps-announces-2016-class-of-distinguished-lecturers/].

Chroma Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Evolution of team

1. Creation of the team : March 2015.
2. Anne Spalanzani, Associate Professor at UPMF, joined the team on December 2015 (previously in Prima team).
3. Leaving of Dizan Vasquez, SRP Inria, for the Apple compagny, on January 2016.

5.1.2. Projects and results

1. Acceptation of the European H2020 Ecsel project "ENABLE" (European Initiative to Enable Validation for Highly Automated Safe and Secure Systems) (November 2015). Chroma is involved in the automated vehicles theme. Fundings for Chroma are 700K€, over 3 years.

DAHU Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Best student paper award for Nadime Francis [22] at the conference ICDT'15.

Luc Segoufin and Victor Vianu obtained the ACM Alberto O. Mendelzon PODS Test of Time Award in 2015.

DEFROST Team

5. Highlights of the Year

5.1. Highlights of the Year

Inverse deformable model in real-time by quadratic programming optimization

We have published the formulation of an inverse deformable model that we can compute in real time in the form of quadratic problem under equality and inequality constraints. After the projection of the deformable model in the reduced space of unknown parameters, we get an extremely compact formulation of the problem to be optimized. The quadratic formulation allows to write the problem with the conditions Karush-Kuhn-Tucker (KKT) and thus have certainties about the uniqueness and optimality of a solution. This formulation was used in image registration project for adaptive radiotherapy (study published in the International journal of computer assisted radiology and surgery) and also to calculate the inverse model of a deformable robot (study published in the conference ICRA 2015).

Deformable robots with vertebras

We proposed a for generic modeling method suitable for manipulator arm composed of a successive series of deformable portion (inter-vertebrae) and rigid (vertebrae). This method is very computationally efficient and compatible with real-time. These manipulators have a very large number of degrees of freedom. Our approach is to make a domain decomposition from a FEM model on inter-vertebrae and pre-compute a condensation of the model on the vertebrae to drastically reduce the complexity of the model used online. Condensed models are assembled for the global model of the robot. We have demonstrated in an article published in the ICRA 2015 conference that this model allowed to pilot the flexible robot CBHA developed by Festo. Furthermore, we have used this model to propose a new manipulator arm design called FETCH to the competition website Robotic Toolkits Harvard University. We had the 2nd place ex-aequo with 4 other teams.

SOFA

The work we have done and published around our simulation platform SOFA allowed us to get the price "Dirk Bartz Prize for Visual Computing in Medicine 2015," a biennial competition organized by the Eurographics conference. This award recognizes the significant contributions in computer graphics have an impact in the field of medicine. Parallel to that price, a consortium was created to SOFA (https://www.sofa-framework.org/sofa-consortium/) whose objective is to bring the academic community and users of industrial SOFA and also of guide future developments. Defrost is a member of this consortium.

Eurographics Dirk Bartz Prize for Visual Computing in Medicine.

DREAM Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The Dream project ended on the 31st of december 2015. A new EPI project, named Lacodam, is under way.

EX-SITU Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Michel Beaudouin-Lafon received the ACM SIGCHI Lifetime Service Award, which "goes to individuals who have contributed to the growth and success of SIGCHI in a variety of capacities. This award is for extended services to the community at large over a number of years" (http://www.sigchi.org/about/awards/2015-sigchi-awards).

Jérémie Garcia received the "Prix Jeune Chercheur Science et Musique", a best thesis award organized by IRISA (Rennes) and sponsored by the Association Française d'Informatique Musicale for his thesis *""Le papier interactif pour la composition musicale"*, supervised by Wendy Mackay, Theophannis Tsandilas and Carlos Agon (IRCAM) (http://jsm.irisa.fr/index.php/prix-jc.

Nolwenn Maudet received the "Prix Spécial du Jury du premier concours EDUCNUM Opération Vie privée", organized by CNIL (national commission for informatics and freedom), for her project *Data Fiction* with Thomas Thibault. This online game is designed to help teenagers better understand how their personal data can be exposed online and how to protect it.

ExSitu received three paper awards. One paper, *Webstrates* [18] received a best paper award at UIST 2015. Two other papers, *Color Portraits* [17] and *SketchSliders* [20], received Honorable Mention awards at CHI 2015 (at most 5% of CHI submissions receive an Honorable Mention).
BEST PAPERS AWARDS :
[18] **28th Annual ACM Symposium on User Interface Software and Technology (UIST'15)**. C. KLOKMOSE, J. EAGAN, S. BAADER, W. MACKAY, M. BEAUDOUIN-LAFON.

EXMO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Our work on alignment revision (§7.3.2) has been published in *Artificial intelligence* [7].

FLOWERS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Scientific Awards

Jonathan Grizou obtained the "Prix Le Monde de la recherche universitaire" for his thesis ([91]) and work on "Learning from unlabeled interaction" [30] [92]. This work allowed in particular to develop new algorithms for Brain-Computer Interfaces that remove the need for a phase of calibration and allow users to achieve sequential tasks. This work was achieved in collaboration with I. Iturrate and L. Montesano (Univ. Zaragoza, Spain), and the PhD was co-supervised by M. Lopes and PY. Oudeyer.

Matthieu Lapeyre obtained the "Second prix de thèse du GDR Robotique" for his thesis on the development of the open-source 3D printed Poppy Humanoid platform [102], now in use in various scientific, educational and artistic projects worldwide http://www.poppy-project.org. This work was achieved in collaboration with P. Rouanet and the PhD was supervised by PY Oudeyer.

Dissemination and transfer

In the context of the Poppy project, a contract was signed between Inria and the company Generation Robots agreeing on the worldwide reselling and distribution of the Poppy robotic kits, and in particular the Poppy Humanoid and Poppy Torso kits: http://www.generationrobots.com/.

The Flowers team made major achievements in diffusing science and technology towards the general public. The team developped the IniRobot pedagogical kit, for the discovery of computer science and robotics in primary schools. The kit was first developped and evaluated in schools, in collaboration with a group of teachers, and then in 2015 saw a large national dissemination, as it has been used by 8000 school children in 35 towns. 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. Also, in 2015 the team began a large scale transfer project called Poppy Education (Féder/Region Aquitaine/Inria co-finding) targeting to develop, evaluate and disseminate robotic pedagogical kits for teaching ICT in high-schools and university level courses.

GRAPHDECO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

This was the first year of existence of GRAPHDECO, which was officially created in July 2015. The group has advanced on its main research axes, that of Computer-Assisted Design with Heterogeneous Representations and Graphics with Uncertainty and Heterogeneous Content. Our most notable results are our ACM Transactions on Graphics papers on regularized curvature fields [7], multi-view intrinsic images and relighting [6] and finally computer-assisted crafting on wire-wrapping [8]. The ANR DRAO was completed in December with an excellent review result, and the EU project CR-PLAY was also evaluated with excellent results for it's 2nd year. Two Ph.D. students graduated this year (S. Duchêne [2] and E. Iarussi [3]) and A. Bousseau defended his Habilitation [1].

5.1.1. Awards

Kenneth Vanhoey received a thesis award from the University of Strasbourg, from which he graduated in 2014. Johanna Delanoy and Adrien Bousseau won second best paper award in the AFIG [5].

GRAPHIK Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Michel Chein was nominated at the **Academy of Science and Literature from Montpellier** (Académie des Sciences et des Lettres de Montpellier). It is the first nomination of a computer scientist in this academy.

  http://www.inria.fr/centre/sophia/actualites/michel-chein-elu-membre-de-l-academie-des-sciences-et-lettres-de-montpellier

- By joining the team, Meghyn Bienvenu (CR researcher) brings her deep expertise in description logics and complexity, in particular applied to ontology-based data access, a core focus in GraphIK. She was recently put forward by the national committee of the CNRS ("section 6 du comitée national", http://cn6.fr/) to receive the bronze medal of the CNRS.

HEPHAISTOS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Science

- strong advances on the analysis of cable-driven parallel robots (section 7.1.1)
- collaboration with lawyers on the ethical and legal aspects of robotics
- strong collaboration with the medical community on walking analysis and rehabilitation (section 7.1.2.2)

5.1.2. Experimentation

- start of an extensive test period for our walkers in clinical environment (section 7.1.2.2)
- start of the daily activities monitoring in our building (section 7.1.2.4)
- the workshop *Computer science for artists*

5.1.3. Transfer

- the contract with GénerationRobot for the development of a pedagogical cable-driven parallel robot

5.1.3.1. Awards

- J-P. Merlet has been nominated as IEEE Fellow and doctor honoris causae from University Innsbruck. He was also awarded a prize from Cote d'Azur University
- Y. Papegay was awarded the Wolfram Innovator Award

HYBRID Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Hybrid had 4 papers published at IEEE Virtual Reality Conference in 2015 : [19] [16] [18] [23].

Hybrid team was also strongly involved in IEEE Virtual Reality Conference, which took place for the first time in France in 2015 (Arles, March 23-27), with A. Lécuyer: Program Chair, F. Argelaguet and M. Marchal: Research Demos Chairs, F. Nouviale: Exhibit Chair, B. Arnaldi: Supporters Chair.

5.1.1. Awards

- Best PhD Thesis award from “Fondation Rennes 1” for former PhD student Fabien Danieau for his work "Contribution to the study of haptic feedback for improving the audiovisual experience" co-supervised with Technicolor company.
- Project PREVIZ received the “business” award in Trophies “Loading the future” (24/11, Nantes, Competitivity Cluster "Images et Réseaux").
- The algorithm developed by Lucas Royer (co-supervised by A. Krupa, M. Marchal and G. Dardenne) won the first place of the MICCAI Challenge on Liver Ultrasound Tracking.

ILDA Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- ACM CHI Honorable mention for **An Evaluation of Interactive Map Comparison Techniques** [4], awarded to the top 5% of all 2150 paper submissions.
- ACM CHI Honorable mention for **SketchSliders: Sketching Widgets for Visual Exploration on Wall Displays** [9], awarded to the top 5% of all 2150 paper submissions.

IMAGINE Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

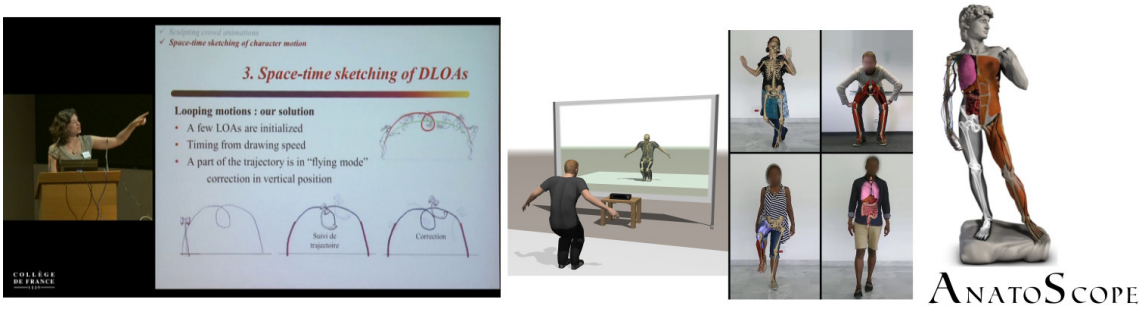

Figure 1. Left: Symposium organised by Marie-Paule Cani at Collège de France. Middle Demo of the Living Book of Anatomy presented in the Emergin Technologies at ACM SIGGRAPH Asia. Right: Creation of the startup Anatoscope by Francois Faure and Olivier Palombi.

- Marie-Paule Cani obtained the annual Chair of Informatics and Computational Sciences of the Collège de France in Paris. She organized a series of lectures about *Shaping Imaginary Content: from 3D Digital Design to Animated Virtual Worlds* and a symposium with 7 international invited speakers.
- Remi Ronfard organized the EG Workshop on Intelligent Cinematography and Editing which was for the first time an Eurographics Workshops.
- A demo of the Living Book of Anatomy (PhD work of Armelle Bauer) was presented in the Emerging Technologies exhibition at ACM SIGGRAPH Asia in November.
- François Faure and Olivier Palombi are creating a new startup Anatoscope since November 2015 on *Digital Anatomy for Personalized Healthcare*.
- We had 4 paper accepted to ACM SIGGRAPH [6], [8], [9], [15], and 2 accepted to ACM Transaction on Graphics (TOG) [10], [14], one has been presented at ACM SIGGRAPH Asia.

LAGADIC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- The work of Lucas Royer and Alexandre Krupa concerning non-rigid target tracking in ultrasound images [47] (see Section 7.6.1) was awarded by the organizers of the MICCAI CLUST'15 challenge (MICCAI Challenge on Liver Ultrasound Tracking) as being the best method for real-time and accurate target tracking in 3D ultrasound sequences.
- Paolo Robuffo Giordano has been awarded as Best Associate Editor of ICRA'2015.

LARSEN Team

5. Highlights of the Year

5.1. Highlights of the Year

Figure 1. Cover the Nature issue of the 28th of May, 2015, which features Larsen's work on trial-and-error learning for damage recovery (ResiBots project).

- Jean-Baptiste Mouret joined the team (CR1, HDR [8], on secondment from Pierre and Marie Curie University for 5 years);
- The ERC project ResiBots (PI: Jean-Baptiste Mouret) started on the 1st of May, 2015;
- The preliminary work on which the ERC project ResiBots is based made it to the cover of Nature (28th of May, 2015), see figure 1 . This work was covered by all the major media outlets and the associated videos total more than 400,000 views on YouTube.

LEAR Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- Cordelia Schmid received the Humbolt research award, Alexander von Humbolt Foundation, Germany, 2015, and gave the Karen Spärck Jones lecture, annual event of the British Computer Society that honours women in computing research, 2015.
- Cordelia Schmid was ranked among the Thomson Reuters Highly Cited Researcher, 2015.
- Yang Hua, Karteek Alahari and Cordelia Schmid won the VOT-TIR2015 challenge.
- G. Cinbis (PhD, 2014) was awarded the 2014 AFRIF thesis prize for his thesis entitled "Fisher kernel based models for image classification and object localization" at Orasis 2015. He was supervised by Jakob Verbeek and Cordelia Schmid.
- N. Dalal (PhD, 2006) together with his supervisor B. Triggs was awarded the Longuet-Higgins Prize 2015 for his PhD work, in particular the paper entitled "Histograms of Oriented Gradients for Human Detection" (CVPR 2005 paper).

LINKMEDIA Project-Team (section vide)

LINKS Team

5. Highlights of the Year

5.1. Highlights of the Year

SheX

SHEX SCHEMAS FOR RDF GRAPHS IN COOPERATION WITH THE W3C

I. Boneva and S. Staworko present the RDF schema language SheX [22] in cooperation with members of the W3C. The usual open world approach of RDF is schemaless in the alphabets of RDF data are left open, so that data from different sources and with different alphabets can be unified. This raises serious problems for query writing and thus linked data integration, since the same query may become invalid when the alphabet changes. A SheX schema allows express constraints on the alphabets, node labels and edge labels of RDF graphs, so that databases queries become safe with respect to future changes, without that the alphabets need to be closed. This work is highly relevant for the future on data integration for RDF data based on schema mappings.

IJCAI

REASONABLE HIGHLY EXPRESSIVE QUERY LANGUAGES

In his IJCAI paper [17] P. Bourhis develops a highly expressive Web query language of the Datalog family, for which static analysis problems such as query containment remain decidable. The relevance of this result is explained to non-experts in a popularization article: http://www.cnrs.fr/ins2i/spip.php?article1465

5.1.1. Awards

This paper obtained the honorable mention of IJCAI .

IJCAI-highlight

LEARNING JOIN QUERIES FROM EXAMPLES

Ciucanu, A. Boneva, and S. Staworko published an article at ACM TODS [7], where they show how to learn join queries for relational databases from examples. The learning algorithm they provide is shown to satisfy Gold's learning model. Previously this model got applied only to inference of automata rather than logical queries. Furthermore, this is the first query learning algorithm that relies on equalities of data values rather than on the structure of metadata.

BEST PAPERS AWARDS :

[17] **IJCAI**. P. BOURHIS, M. KRÖTZSCH, S. RUDOLPH.

MAGNET Team

5. Highlights of the Year

5.1. Highlights of the Year

We have published two papers at NIPS [3], [6], the leading conference in machine learning. The first paper presents novel results on large-scale learning with higher-order risk functionals, which has applications in link prediction, graph inference and metric learning (among others). The second paper proposes new gossip algorithms for decentralized estimation of pairwise statistics in networks.

We have published a paper at AAAI [4], one of the top conferences in Artificial Intelligence. The contribution is a new structured model for learning anaphoricity detection and coreference resolution, which achieved the best score to date on the popular CoNLL benchmark with gold mentions.

We have published a paper at EMNLP [2], a leading conference in Natural Language Processing. The work presents a detailed comparative framework for assessing the usefulness of popular unsupervised word representations for identifying so-called implicit discourse relations.

MAGRIT Project-Team (section vide)

MANAO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Our search of a better understanding of appearance have reached some great milestones this year. First, our studies have shown that Bidirectional Reflection Distribution Functions (BRDFs) exhibits some meaningful statistics [21]. They help designing intuitively MatCaps (a shorthand for "Material Capture") that are often used by artists as a simple and efficient way to design appearance [23]. Our studies have also shown that current BRDF models are limited [17]. We are exploring new models and parameterizations [20], [24]. It is worth noting that we are integrating all these researches into a common library named ALTA (http://alta.gforge.inria.fr/).

5.1.1. Awards

"Notable article in computing in 2014", from ACM ThinkLoud Computing Reviews http://www.computingreviews.com/recommend/bestof/notableitems.cfm?bestYear=2014 for our article on The Revealing Flashlight [7].

MAVERICK Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Three software platforms based on our research were released as open-source distributions in 2015. These platforms contain the result of several years of research, and have been supported by Inria through engineering support:

- Gratin, a node-based compositing software for creating, manipulating and animating 2D and 3D data. It uses an internal direct acyclic multi-graph and provides an intuitive user interface that allows to quickly design complex prototypes.
- Proland, a platform for real-time quality rendering and editing of large landscapes. All features can work with planet-sized terrains, for all viewpoints from ground to space.
- Gigavoxel, a software platform for real-time quality rendering of very large and very detailed scenes which couldn't fit memory. Performances permit showing details over deep zooms and walk through very crowded scenes (which are rigid, for the moment).

MIMETIC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

In March 2015, Ludovic Hoyet arrived in MimeTIC has full-time Inria CR2 researcher. It's an important event for the team as it will reinforce and push the Virtual Human simulation topic in the team. Ludovic has a unique expertise in both computer animation and perceptual studies which will enable us to tackle original problems, such as developping innovative animation methods while taking the perception of the user into account, contrary to classical approaches based on dynamic simulation.

Our work "Intuitive and Efficient Camera Control with the Toric Space", co-authored by Christophe Lino and Marc Christie has been selected at SIGGRAPH 2015, the premier and most selective computer graphics scientific event. The paper presents a novel representation to interactively and intuitively manipulate cameras, and to perform interpolations between camera keyframes while maintaining on-screen visual properties. Results of this paper, together with earlier work on automated viewpoint computation (Directors Lens patent), are now available as a plugin in Autodesk's Motion Builder. This technology is exploited by the french SME Solidanim http://www.solidanim.com through a technological transfer partnership.

Platforms in Immerstar project: Immerstar is the new name of our jointed platforms, namely Immersia on Inria campus and Immermove on ENS Campus. This year, we succeeded to end up the building of the first phase of Immermove platform. Associated with a sport area equipped with a high end motion capture system, an immersive setup has been installed. It is a L-shaped setup with 12m*4m front screen and floor. It allows to perform immersive interaction experiments between real and virtual human. To follow this first phase, and sustained by Inria and our academic institutions, we succeeded to the CPER call that will be implemented from 2016 to 2020. We will have the opportunity to invest and to improve the two immersive platforms (Immersia and Immermove) and their possibilities of distantly collaborate.

5.1.1. Awards

Caroline Martin won the "Jean Vives" Award for her work on the analysis of tennis serves. This price is discerned by the Académie nationale olympique française and given during the 40th congress of the Society of Biomechanics, 2015.

MINT Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Art/Science collaborations

4.1.1.1. Art paper and art show at SIGGRAPH ASIA (Kobe): Tools for digital anamorphoses: using raycasting techniques for creation anamorphoses

Anamorphoses have been know for centuries, as distorted images needing to be seen in a mirror from a special point of view in order to see the non-distorted image. During Renaissance, they have been associated to mathematical techniques for drawing such pictures efficiently, on specific mirror shapes (in the case of cylindrical or conical mirrors). We can expect in the next years a strong interest in such type of images, because of the emergence of various contexts and physical supports for image visualisation (soft or de-formable screens, lightmapping, projection of images on dynamic objects, etc...). Solving the numerical problem of anamorphosis in the general case belongs to the same class of problems as when the trend is to control image deformation as long as image is seen projected on, or reflected by, a non-planar surface, which can be of arbitrary shape. In this work, we show how raycasting technique, well-known in the computer graphics community , can be used to provide an efficient general framework for such rendering. We describe an effective procedure for building general anamorphoses. A generalisation of the method leads to the conception of three-dimensional anamorphic sculptures, usable for 3D printing anamorphic objects. We exhibit , through several artworks, tangible and virtual examples.
http://hal.univ-lille3.fr/hal-01258727v1

4.1.1.2. Presented at VISAP (IEEE InfoViz artTrack): "A main levée" Art Installation

Developed in collaboration with MINT, the "A main levée" art installation by Pauline de Chalendar was presented at VISAP, IEEE Infoviz ArtTrack, in August 2016. This immersive installation allows for free hand drawing using a virtual-reality headset. From this artwork (also presented at Panorama 2015 exposition),

4.1.2. Industrial collaboration: Hap2u

A license agreement has been signed with Hap2u, a new start-up which aims at designing new interaction devices, based on our patent on tactile rendering. Hap2u will industrialise commercial products, based on our patents. The beginning of the commercial activity might start in 2016.

4.1.3. MAuVE project

MAuve is a 4 Meuros project (2016-2020), which subject is ICT-based tools for mediation and access to knowledge. L. Grisoni is leading this project, along with S. Bartholeyns (historian, Lille 3) and S. Chaumier (sociologist, Univ. Artois).

Mjolnir Team

5. Highlights of the Year

5.1. Highlights of the Year

The team has strengthened its ties with leading research groups in Canada:

- Fanny Chevalier has been appointed at the rank of Assistant Professor (status only) by the Department of Computer Science of the University of Toronto.
- Stéphane Huot has been granted the "Collaborator" status by the Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT) of McGill University.
- Mitacs/Inria research awards allowed two of our Phd students to visit the University of Waterloo and McGill University. A third Mitacs award with Campus France will allow one PhD student from Carleton University to visit us in early 2016.
- Two other PhD students and three researchers from McGill University, the University of Waterloo and the University of Toronto visited us over the year.

Fanny Chevalier spent a week with the French news website Rue89 in October and one of their journalists (Benoît Le Corre) later spent one week at Inria Lille. Four articles published on Rue89 resulted from these visits, with over 40,000 views at the time of this writing.

MORPHEO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- The multi-camera platform Kinovis (http://kinovis.inrialpes.fr) was inaugurated on May 26th 2015. Kinovis is French *Equipement d'excellence* (Equipex project) that provides a unique acquisition platform with 68 color cameras and enables therefore high precision 4D modeling of dynamic scenes.
- The QuickCSG boolean mesh computation software developed within the context of the Kinovis platform was transferred in November of 2015, to a (contractually undisclosed) major industrial actor of the 3D business.

MULTISPEECH Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

We ranked 2nd among 9 teams for the ”Professionally produced music recordings” task of the 2015 Signal Separation Evaluation Campaign (SiSEC) [75].

We ranked 4th among 25 teams and as the best European team for the 3rd CHiME Speech Separation and Recognition Challenge [55].

5.1.1. Awards

Baldwin Dumortier received the best poster prize at EWEA 2015 (European Wind Energy Association 2015 Annual Event) [31].

Best paper award at SIIE 2015 (6th International Conference on Information Systems and Economic Intelligence) [34].
BEST PAPERS AWARDS :
[34] **IEEE International Conference on Information Systems and Economic Intelligence**. D. FOHR, I. ILLINA.

OAK Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

I. Manolescu and X. Tannier (LIMSI) have obtained a Google Computational Research Journalism Award on "Event Thread Extraction for Viewpoint Analysis". The team has also secured an ANR contract on content management techniques applied to computational fact-checking (coordonated by I. Manolescu, to start in 2016) and an ADT engineer has joined the team to work on the same topic.

The best publications of the year appeared in SIGMOD citecamachorodriguez:hal-01178490, PODS [16], PVLDB [29], [8], [26], ICDE [15], [14], and IEEE TKDE [3]. Other highly visible publications appeared in CIDR [9] and CIKM [28], [7].

5.1.2. Inria researcher recruited

M. Thomazo has joined the team as a junior researcher (Inria CR2).

ORPAILLEUR Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Aleksey Buzmakov was nominated at the 13th International Conference on Formal Concept Analysis (ICFCA, Nerja Málaga, Spain, June 23-26 2015) as the "best promising researcher in Formal Concept Analysis" and won the best student paper award [53].
- Two (very) young researchers have made a stay in the team, Artuur Leeuwenberg in Spring 2014 and Alibek Sailanbayev in Spring 2015. Both young researchers have done a very good work which was rewarded by two conference publications, [66] and [46]. The Orpailleur team is particularly proud of the very good results of these young researchers.
- Three PhD students, namely Alam Mehwish, Aleksey Buzmakov and Victor Codocedo, have joined their efforts in their last year of thesis preparation for working on a common topic, the completion of web of data. This very good and very uncommon research work was rewarded by a publication in the very highly selective IJCAI 2015 Conference [1].
- The paper "Miguel Couceiro, Lucien Haddad, Karsten Schölzel, Tamas Waldhauser. Relation graphs and partial clones on a 2-element set. 44th IEEE International Symposium on Multiple-Valued Logic (ISMVL 2014), IEEE Computer Society, 161-166." was awarded the "Outstanding Contributed Paper Award" at the conference ISMVL 2015 (IEEE Computer Society).
- The Taaable system won 3 of the 5 prizes of the 8th "Computer Cooking Contest", which was held during the International Conference on Case-Based Reasoning, in Bad Homburg, Germany (http://ccc2015.loria.fr/?id=rules): the prize of the best cocktail system according to the jury, based on the technical/scientific paper reviews and on the comparison of the results of the systems on a same set of queries, the prizes of the public for the cocktail and sandwich systems, based on the vote after tasting.

5.1.1. Awards

BEST PAPERS AWARDS :
[53] **International Conference in Formal Concept Analysis - ICFCA 2015**. A. BUZMAKOV, S. O. KUZNETSOV, A. NAPOLI.

PANAMA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Srdan Kitic won the CONEXANT award for best student paper on audio signal processing at LVA/ICA'2015 conference .

BEST PAPERS AWARDS :

[31] **LVA/ICA 2015 - The 12th International Conference on Latent Variable Analysis and Signal Separation**. S. KITIĆ, N. BERTIN, R. GRIBONVAL.

PERCEPTION Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Robotic Demonstration at ICMI'15. The PERCEPTION team was present at the ACM International Conference on Multimodal Interaction – ICMI'15 (November 2015,Seattle WA, USA) with the demonstration *A Distributed Architecture for Interacting with NAO* [27]. This software package enables robot programming using various languages, e.g. C, C++, Matlab, and Python. This distributed architecture is available under the NAOLab open-source software package. The development of NAOLab is part of PERCEPTION's participation in EU FP7 projects and is funded by STREP project *Embodied Audition for RobotS* (EARS) and ERC Advanced Grant *Vision and Hearing in Action* (VHIA).

The Xerox Foundation University Affairs Committee (UAC) awarded Radu Horaud and Florence Forbes (EPI MISTIS) with a three year grant *Advanced and Scalable Graph Signal Processing Techniques* (2015-2017). Collaboration with Arijit Biswas and Anirban Mondal, research scientists at Xerox Research Center India (XRCI), Bangalore. Information about these awards is available at page 9 of this document available online: http://www.xerox.com/downloads/usa/en/innovation/innovation_xig_brochure.pdf.

MOOC on Binaural Hearing for Robots. In May-June 2015 Radu Horaud taught a five hour MOOC dealing with the fundamental principles of robot hearing, from binaural signal processing to robotic implementations. MOOC content available at https://team.inria.fr/perception/mooc-bhr/ and at https://www.france-universite-numerique-mooc.fr/courses/inria/41004/session01/about.

4.1.1. Awards

- **Vincent Drouard** (PhD student) and his co-authors received the "Best Student Paper Award" (second place) at IEEE ICIP'15 for the paper *Head Pose Estimation via High-Dimensional Regression* . The conference took place in Quebec City, Canada, September 2015. There were five papers awarded, two "Best Paper" and three "Best Student Paper" out of a total of 1033 (oral and poster) papers presented at the conference. IEEE ICIP is the premier international image processing conference series held every year. The work is funded by the ERC Advanced Grant VHIA.
- **Dionyssos Kounades-Bastian** (PhD student) and his co-authors received the "Best Student Paper Award" at IEEE WASPAA'15 for the paper *A Variational EM Algorithm for the Separation of Moving Sound Sources* . The conference took place in New Paltz, NY, USA, October 2015. There were six papers nominated for the award, out of a total of 80 (oral and poster) papers presented at the workshop. The IEEE WASPAA workshop series is among the premier international forums in the field of audio and acoustic signal processing, held every other year. The work is funded by the EU STREP project EARS and the ERC Advanced Grant VHIA.

BEST PAPERS AWARDS :
[28] **IEEE International Conference on Image Processing**. V. DROUARD, S. BA, G. EVANGELIDIS, A. DELEFORGE, R. HORAUD.
[31] **IEEE Workshop on Applications of Signal Processing to Audio and Acoustics**. D. KOUNADES-BASTIAN, L. GIRIN, X. ALAMEDA-PINEDA, S. GANNOT, R. HORAUD.

POTIOC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Fabien Lotte obtained the ANR project REBEL (JCJC, acceptance rate 9.7%). More details in Section 9.2
- We have conceived a new system that aims at teaching Optics in an innovative way (Patent pending). This system mixes spatial augmented reality and tangible interaction. It is currently evaluated based on a panel of more than one hundred students. This work is conducted in collaboration with experts in Optics and Electronics (Univ. Bordeaux), and Education Sciences (Univ. Lorraine). More details in Section 7.6 .

5.1.1. Awards

IFRATH PhD Award, First Prize ex-aequo with J. Veytizou, Institut Fédératif de Recherche sur les Aides Techniques pour personnes Handicapées, June 2015 (Anke Brock)

BEST PAPERS AWARDS :

[39] **Colloque des Jeunes Chercheurs en Sciences Cognitives**. C. JEUNET.

[27] **PhyCS - International Conference on Physiological Computing Systems**. J. FREY.

PRIMA Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

The paper "The Grenoble System for the Social Touch Challenge at ICMI 2015" by Viet Cuong Ta, Wafa Johal, Maxime Portaz, Eric Castelli, Dominique Vaufreydaz has won the "ICMI 2015 Touch Challenge" at the ICMI 2015 conference".

4.1.2. Events

On 5 June 2015, members of PRIMA have organised the inauguration of the EquipEx platform Amiqual4Home.

RITS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Fawzi Nashashibi was awarded by the Higher Council for Innovation & Excellence in Palestine for his innovation research on intelligent transportation. The award was delivered by President Mahmoud ABBAS at the 1st HCIE National Forum for Innovators on innovation, September 12-13 2015, Ramallah, Palestine.

BEST PAPERS AWARDS :

[30] **ITS World Congress 2015**. A. DE LA FORTELLE, X. QIAN.

[35] **2015 IEEE International Conference on Vehicular Electronics and Safety**. R. LUIS, J. PÉREZ RASTELLI, D. GONZALEZ BAUTISTA, V. MILANÉS.

SEMAGRAMME Project-Team (section vide)

SIROCCO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- C. Guillemot has received a Google faculty research award
- T. Maugey has received an AIS grant ("Aide à installation scientitifique") from the region of Brittany.
- The papers [31], [28] have been recognized as “Top 10%” at the IEEE international conference ICIP 2015.

SMIS Project-Team (section vide)

STARS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

This year Stars has proposed new algorithms in the domains of perception for activity recognition and semantic activity recognition.

5.1.1. Perception for Activity Recognition

For perception, the main achievements are:

- A new Re-Identification algorithm which outperforms the State-of-the-art algorithms while being adapted to real-world applications (i.e. it does not require the use of heavy manual annotations which is typical of metric learning algorithms). The remaining challenge is to be able to distinguish people who have similar appearance.
- A new generic action recognition algorithm which outperforms the State-of-the-art algorithms. This algorithm uses new action descriptors that enable finer gesture classification. An open issue is to get a real-time implementation with good enough performance. An extension of this algorithm has been devised for RGB-D cameras, which has been demonstrated in a real-life application, where a robot has to recognize people taking their meal (e.g. eating, drinking).
- New generic tracking algorithms, which can optimize the on-line tuning of tracking parameters and can operate at different temporal scales to recover from lost tracklets. These tracking algorithms have been validated on real world videos lasting more than a week. The utilization of such sophisticated algorithms is still complex and requires some more researches for their deployment in a large variety of applications.

5.1.2. Semantic Activity Recognition

For activity recognition, the main advances on challenging topics are:

- New tools to help modeling human activities of daily living. These tools enable to evaluate and improve activity recognition algorithms on long videos depicting the performance of older people living in a nursing home in Nice. The utilization of these tools by clinicians and medical doctors is an ongoing task.
- A new algorithm to recognize human activities, that can benefit from the fusion of events coming from camera networks and heterogeneous sensors.
- A new algorithm to discover human activities of daily living by processing in an unsupervised manner a large collection of videos. The generation of the event models does not require the use of heavy manual annotations which is typical of supervised activity recognition algorithms. However this algorithm still need to have well tracked people to be able to understand their behaviors with sufficient precision.

TITANE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

Yuliya Tarabalka has joined our team since January 2015, making our initial objective to implement a synergy between geometry and image/vision more concrete.

On robust reconstruction of complex shapes and scenes we obtained a wide range of new results. One noticeable result is an approach for reconstruction of indoor scenes, which received the U. V. Helava Award Best Paper 2014. In our quest for semantized reconstruction we contributed an approach for reconstruction of levels of details of urban scenes, in accordance to the CityGML format. This work has been published in ACM Transactions on Graphics, and presented at ACM SIGGRAPH 2015. We also contributed a robust 3D reconstruction approach for underwater scenes, the latter exhibiting many new challenges in terms of data defect such as uncertainty and unprecedented level of outliers. Finally, we contributed a STAR (state of the art) report at the EUROGRAPHICS conference on 3D reconstruction from point clouds, which is being converted into a survey for the Computer Graphics Forum journal.

Our two-year efforts on the problem of isotopic shape approximation have turned into a new publication at the premier venue in Computer Graphics: the ACM SIGGRAPH conference 2015, and a patent. We derived a novel algorithm that generates a surface triangle mesh, given an input tolerance volume guaranteed to be within the tolerance, intersection free and topologically correct. Despite being a long standing problem, there was still no robust and practical solution to this enduring scientific challenge. This problem is both relevant to, and timely for, the increasing variety of industrial applications that involve raw geometric data.

The scientific impact of our contributions is illustrated by publications in premier journal and conference venues in our field, both in geometry processing and computer vision: ACM Transactions on Graphics and SIGGRAPH, Computer Graphics Forum, EUROGRAPHICS, IEEE Conference on Computer Vision and Pattern Recognition (CVPR), IJCV, IJRS/ISPRS. Note also that our work on underwater reconstruction has been published in the premier journal on robotic research.

Awards

Xavier Rolland-Nevière obtained the best student paper award for “track IFS” of ICASSP (IEEE International Conference on Acoustics, Speech and Signal Processing) .

Sven Oesau, Florent Lafarge and Pierre Alliez received the U.V. Helava Award Best Paper for year 2014: “Indoor Scene Reconstruction using Feature Sensitive Primitive Extraction and Graph-cut”. ISPRS Journal of Photogrammetry and Remote Sensing, 2014.

BEST PAPERS AWARDS :

[16] **IEEE International Conference on Acoustic, Speech Signal Processing (ICASSP)**. R.-N. XAVIER, G. DOËRR, P. ALLIEZ.

TYREX Project-Team (section vide)

WILLOW Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

J. Sivic has served as a Program Chair for International Conference on Computer Vision, Santiago, Chile, 2015

WIMMICS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Elena Cabrio successfully obtained an assistant professor position in Wimmics.
- Serena Villata successfully obtained a researcher position (CR1 CNRS) in Wimmics.
- Olivier Corby and Catherine Faron-Zucker received a medal from University Côte d'Azur on December 10th as a follow-up of their IC 2015 best paper award.
- HDR Defense of Freddy Lécué (Inria-IBM)
- Two successful MOOCs (HTML5, Semantic Web)
- Fabien Gandon was General Chair of ESWC 2015 and will be general co-chair of WWW 2018

5.1.1. Awards

BEST PAPERS AWARDS :

[39] **Journées francophones d'Ingénierie des Connaissances**. O. CORBY, C. FARON-ZUCKER.

ZENITH Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

The Pl@ntNet application, co-developed by Zenith, exceeded 1M downloads in October 2015.