Activity Report 2016

Section Highlights of the Team

AOSTE Project-Team (section vide)

AROMATH Project-Team (section vide)

DATASHAPE Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Jean-Daniel Boissonnat has been elected a professor at the Collège de France, on the Chair Informatics and Computational Sciences for the academic year 2016-2017.

5.1.2. Books

Publication of a book [29], providing a self-contained presentation of the theory of persistence modules over the real line, the objects that are at the heart of the field of TDA.

MARELLE Project-Team (section vide)

ACUMES Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- P. Goatin got the *Trophée des Femmes en Or* for the "Smart City" category.

APICS Project-Team (section vide)

ECUADOR Project-Team (section vide)

MCTAO Project-Team (section vide)

NACHOS Project-Team (section vide)

TOSCA Project-Team (section vide)

<p align="center" style="color:red">ABS Project-Team</p>

4. Highlights of the Year

4.1. Highlights of the Year

In 2016, several achievements are worth noticing in three realms, namely in computer science, computational structural biology, and software.

4.1.1. *Computer Science*

▶ **Optimal transportation problems with connectivity constraints**
Reference: [21]

In a nutshell: Optimal transportation theory provides a rich framework to compare *measures*, both in the continuous and discrete settings. In this work, we study generalization of discrete transportation problems, when the supply and demand nodes are endowed with a graph structure; due to these constraints, our study focuses on transport plans respecting selected connectivity constrains. Our contributions encompass a formalization of these problems, as well as hardness results and heuristic algorithms.

Assessment: To the best of our knowledge, this work is the first one focusing on transport plans with connectivity constraints. One of the key applications targeted is the comparison of potential energy landscapes (PEL) in biophysics. Our algorithms provide a novel way to compare PEL, a topic overlooked so far.

▶ **Clustering stability revealed by matchings between clusters of clusters**
Reference: [22]

In a nutshell: Clustering is a fundamental problem in data science, yet, the variety of clustering methods and their sensitivity to parameters make clustering hard. This work provides a new tier of methods to compare two clusterings, by computing meta-clusters within each clustering– a meta-cluster is a group of clusters, together with a matching between these.

Assessment: Our methods will help assess the coherence between two clusterings, in two respects: by stressing the (lack of) stability of clustering while varying the parameters of a given algorithm, and by allowing a detailed comparisons of various algorithms.

4.1.2. *Computational Structural Biology*

▶ **Novel structural parameters of Ig-Ag complexes yield a quantitative description of interaction specificity and binding affinity**
Reference: [23]

In a nutshell: Understanding the specificity of antibodies for the targeted antigens, and predicting the affinity an antibody - antigen complexes is a central question in structural immunology. Using novel parameters acting as proxys for important biophysical quantities, we obtained affinity predictions of unprecedented accuracy, and were able to provide a quantitative explanation for the specific role of so-called *complementarity determining regions* – in particular CDR3 of heavy chains. See details in section 6.1.2 .

Assessment: Our affinity predictions are the most accurate known to date, and show that for certain classes of IG - Ag complexes, the affinity prediction problem may be solved from databases of high resolution crystal structures.

▶ **Energy landscapes and persistent minima**
Reference: [15]

In a nutshell: Potential energy landscapes (PEL) of molecular systems are complex high-dimensional height functions. In this work, we introduced several tools from graph theory, optimization, and computational topology, so as to identify prominent features of PEL – prosaically distinguishing the signal from the noise. See details in section 6.3.1 .

Assessment: Our work calls for important developments in two directions. The first one is concerned with the *calibration / learning* of features of PEL. The second one is the systematic comparison of force fields used in biophysics, as from current knowledge, deciding which force field is best for a given task or system is an open issue.

▶ **Hybridizing rapidly growing random trees and basin hopping yields an improved exploration of energy landscapes**
Reference: [18]

In a nutshell: We developed a novel exploration algorithm for high-dimensional non convex (potential) energy functions used in biophysics. Our algorithm exploits the ability of *basin hopping* to locate low-lying local minima, and that of *rapidly exploring random tree* to foster the exploration of yet unexplored regions. See details in section 6.3.2 .

Assessment: Our exploration algorithm outperform the two classical algorithms it is derived from. To strike a major impact, though, our exploration strategy needs to be complemented by enhanced thermodynamic sampling algorithms, able to bridge the gap between structures on the one hand, and thermodynamics / dynamics on the other hand.

4.1.3. *Software*

▶ **The Structural Bioinformatics Library**
Reference: [20]

In a nutshell: The SBL was released in 2015. In 2016, two important milestones were achieved, with the addition of several important packages, notably geared towards the generation and the analysis of conformational ensembles, and the publication of [20]–to appear in Bioinformatics.

Assessment: As outlined by the reviewers of [20], the SBL is to the best of our knowledge the first library proposing a coherent framework, in terms of algorithms, data structures and biophysical models, to tackle the most important problems in structural bioinformatics. Our paper presenting the SBL being in press as of December 2016, statistics on users and downloads will be reported in the 2017 activity report.

ASCLEPIOS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

Marco Lorenzi has been recruited as Chargé de Recherche in the Asclepios team from December 2016.

4.1.1. Awards

- Nina Miolane received the l'Oréal-UNESCO Fellowship for Women In Science. She counts among the 30 awardees who have been selected by an independent jury to stress the excellence and originality of their scientific research and their dedication to share their knowledge in the broader society.

- Shuman Jia received the Best Challenge Paper Award during the 7th international workshop on Statistical Atlases and Computational Modeling of the Heart (STACOM), held in Conjunction with MICCAI 2016 in Athens, Greece.

BEST PAPERS AWARDS :

[39] **7th International Statistical Atlases and Computational Modeling of the Heart (STACOM) Workshop, Held in Conjunction with MICCAI 2016**. S. JIA, L. CADOUR, H. COCHET, M. SERMESANT.

ATHENA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. *Awards*

R. Deriche and the ATHENA team has been awarded by an ERC Advanced Grant from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (ERC AdG agreement No 694665 "Computational Brain Connectivity Mapping" started on Sept. 1st, 2016.)

Guillermo Guallardo, PhD has been awarded by a Merit Abstract Award by the 2016 OHBM Annual Meeting in Geneva, Switzerland for his work entitled *Efficient Population-Representative Whole-Cortex Parcellation Based on Tractography* [34].

5.1.2. *Press coverage*

Brain-Computer Interfaces developped in Athena attracted attention of the media, at regional and national levels: Nice Matin, Le Dauphiné Libéré and Le Figaro Santé have published articles about our translational research on the P300 speller. This system enables severely disabled patients, who are deprived of voluntary motor control, to communicate by using only their visual attention.

<p style="text-align: center; color: red;">**BIOCORE Project-Team**</p>

5. Highlights of the Year

5.1. Highlights of the Year

- The question of how many and how frequently natural enemies should be introduced into crops to most efficiently fight a pest species is an important issue of integrated pest management, which depends on the pest-natural enemies interaction. Since some natural enemies may exhibit positive predator density dependence in the predation interaction, we studied its impact on the optimal biological control introduction strategies [15].

- Optimal allocation of resources in a bacterium. We studied by techniques of optimal control the optimal allocation between metabolism and gene expression during growth of bacteria, in collaboration with Inria IBIS project-team. We showed that a good suboptimal control solution could be implemented in the cell by ppGpp (a small molecule involved in the regulation of ribosomes) [23].

BIOVISION Team (section vide)

<p style="text-align:center; color:red;">**CAMIN Team**</p>

5. Highlights of the Year

5.1. Highlights of the Year

International Functional Electrical Stimulation Society Conference organization

In 2016, CAMIN organized the 20th International Functional Electrical Stimulation Society Conference. 135 participants attended the event. Papers are referenced in Pubmed and published in European Journal of Translationnal Myology. A special issue with a selection of best articles will be published in 2017 in Artificial Organs Journal. http://ifess2016.inria.fr/

Figure 3. Flyer of IFESS 2016 conference

Participation into Cybathlon competition

We have participated in the first international competition Cybathlon held in Kloten, Switzerland in October 2016. After more than one year of physical and technical preparation, our team, Freewheels, was present with one complete paraplegic pilot in the FES cycling discipline. http://freewheels.inria.fr/
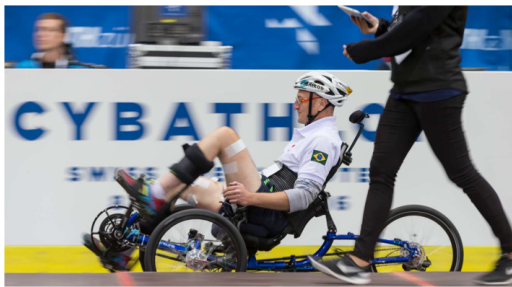
Figure 4. Freewheels team at Cybathlon 2016

CASTOR Project-Team (section vide)

COFFEE Project-Team (section vide)

5. Highlights of the Year

5.1. Highlights of the Year

- Antoine ROUSSEAU spent 9 months in the office of Inria Chile (Santiago, Chile) from February to October 2016 to collaborate on the new project on *Marine Energies Research International Center* (MERIC) in Chile. Antoine is the scientific coordinator of the research line "Advanced modeling for marine energy", and several members of LEMON, CARDAMOM and TOSCA research teams will be involved in this 8 years project in partnership with DCNS and Enel.

MATHNEURO Team (section vide)

MORPHEME Project-Team (section vide)

<div align="center" style="color:red">VIRTUAL PLANTS Project-Team</div>

4. Highlights of the Year

4.1. Highlights of the Year

- *Stochastic model of Phyllotaxis*: Exploration of developmental mechanisms classically relies on analysis of pattern regularities. Whether disorders induced by biological noise may carry information on building principles of developmental systems is an important debated question. In this work, we addressed theoretically this question using phyllotaxis, the geometric arrangement of plant aerial organs, as a model system. Phyllotaxis arises from reiterative organogenesis driven by lateral inhibitions at the shoot apex. Motivated by recurrent observations of disorders in phyllotaxis patterns, we revisited in depth the classical deterministic view of phyllotaxis. We developed a stochastic model of primordia initiation at the shoot apex, integrating locality and stochasticity in the patterning system. This stochastic model recapitulates phyllotactic patterns, both regular and irregular, and makes quantitative predictions on the nature of disorders arising from noise. Altogether, we show that disorders in phyllotaxis instruct us on the parameters governing phyllotaxis dynamics, and thus that disorders can reveal biological watermarks of developmental systems [27].

- *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 [18] and [25].

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

David Coudert and Nathann Cohen (LRI) won the Flinders Hamiltonian Cycle Problem (FHCP) Challenge 2016 (http://fhcp.edu.au/fhcpcs).

Fatima Zahra Moataz, former PhD student of COATI, is the recipient of an accessit to the PhD prize Graphes "Charles Delorme" 2016 for her PhD thesis entitled "Towards Efficient and Fault-Tolerant Optical Networks: Complexity and Algorithms".

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DIANA Project-Team

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4. Highlights of the Year

4.1. Highlights of the Year

The R^2lab testbed, part of the national FIT facility, was inaugurated on the SophiaTech campus this year. This new anechoic chamber can be used to remotely perform reproducible wireless network experimentation (5G/software-defined radio). The live public demonstration at the inauguration presented a 4G network being deployed remotely in merely three minutes. For more details see http://r2lab.inria.fr/news.md.

The soTweet project studying the impact Twitter on Media web sites popularity has triggered worldwide media coverage (*Washington Post, Les échos, Le Vif, El Diaro, BFM TV*, etc.) Details and links are in http://www-sop.inria.fr/members/Arnaud.Legout/Projects/sotweet.html. The results are published in [18].

This year witnessed the publication of three RFCs (7834 [36], 7835 [35] and 7927 [31]). These RFCs are the result of a long term contribution by Damien Saucez to the activities on the LISP protocol and in parallel on Information Centric Networking at the IETF and IRTF.

A third session of the Python MOOC by Arnaud Legout and Thierry Parmentelat has been programmed in 2016 and it was also a very big success: 12954 persons registered to the course, out of them 1603 qualified for the final attestation of achievement. This MOOC is adopted by several universities and engineering schools: UPMC L3 program (200 students), first year in CentralSupelec (529 students), SIO Master in CentralParis (16 students), first year of ESISAR school from the Institut Polytechnique de Grenoble group (67 students).

FOCUS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Valeria Vignudelli has won the "Outstanding Master Thesis Award", for best master thesis in logic in computer science. Awarded by the Vienna Center for Logic and Algorithms, as part of the VCLA International Student Awards (http://logic-cs.at/award/)

INDES Project-Team (section vide)

MAESTRO Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

The paper "Access-time Aware cache Algorithms" by Giovanni Neglia; Damiano Carra; Mingdong Feng; Vaishnav Janardhan; Pietro Michiardi and Dimitra Tsigkari got the Best Paper Award at ITC 28 in Würzburg.

The article "Sonorous Cartography for Sighted and Blind People" by Didier Josselin, Andelbery Saidi, Dorian Roussel, Said Boularouk, Olivier Bonin, Eitan Altman, Driss Matrouf got the Best Short Paper Award at the conference 19th AGILE International on Geographic Information Science, Helsinki, Finland, June 14-17, 2016.

S. Alouf has received a "Recognition of Service Award" from the ACM in September 2016.

BEST PAPERS AWARDS :

[46] **International Teletraffic Congress ITC-28**. G. NEGLIA, D. CARRA, M. FENG, V. JANARDHAN, P. MICHIARDI, D. TSIGKARI.

[40] **AGILE'2016 - 19th AGILE International Conference on Geographic Information Science**. D. JOSSELIN, D. ROUSSEL, S. BOULAROUK, A. SAIDI, D. MATROUF, O. BONIN, E. ALTMAN.

4. Highlights of the Year

4.1. Highlights of the Year

- Josiane Zerubia is IEEE Signal Processing Society Distinguished Lecturer for 2016 and 2017, see (http://signalprocessingsociety.org/newsletter/2015/11/sps-announces-2016-class-of-distinguished-lecturers/)

- Josiane Zerubia received the Excellency Prize of UCA (Université Cote d'Azur) for her outstanding research work in December 2016.

- Nazre Batool who was an Inria post-doc in AYIN till May 2015 received the IEEE R8 Women in Engineering Clementina Saduwa 2016 award, see (http://www.femmesetsciences.fr/actualites/nazre-batool-prix-clementina-saduwa-2016/)

- Josiane Zerubia, in collaboration with Gabriele Moser from University of Genoa (Italy), edited a book of more than 400 pages on mathematical models for remotely sensed image processing [11] which was submitted to Springer Verlag in December 2016 and will be published early 2017. They also contributed to two chapters of this book.

<div align="center" style="color:red">GRAPHDECO Project-Team</div>

4. Highlights of the Year

4.1. Highlights of the Year

In addition to publications in the leading conferences and journals in computer graphics (3 ACM Transactions on Graphics [5], [6], [8], 1 IEEE Virtual Reality), we made notable contributions to related fields such as human-computer interaction (1 ACM Conference on Human Factors in Computing Systems - CHI [9]) and computer vision (3 papers presented at the International Conference on 3DVision [13], [12], [10]). Several of these results were developed in the context of the CR-Play project, which was completed in November with excellent reviews.

4.1.1. Awards

Adrien Bousseau received a Young Researcher Award from the French National Research Agency (ANR) for the project ANR DRAO.

Adrien Bousseau obtained an ERC Starting Grant funding, the project will start in February 2017.

GRAPHIK Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

- M. Bienvenu was awarded the Bronze CNRS medal 2016 http://www.cnrs.fr/ins2i/spip. php?article2197. She was an invited speaker at IJCAI 2016 (International Joint Conference in Artificial Intelligence), Early Career Spotlight track http://ijcai-16.org/index.php/welcome/view/ early_career_spotlight

- Theoretical and algorithmic results on ontology-mediated query answering recognized at the best international level (10 articles in the major conferences in Artificial Intelligence and Knowledge Representation and Reasoning: IJCAI, AAAI, ECAI and KR)

- Sudoqual prototype for the evaluation of link quality in document bases considered to be used in production conditions by ABES (French Agency for Academic Libraries).

- CoGui-Capex prototype linking food descriptors to actions considered to be used in production conditions by Régilait in its milk powder factory in Macon.

4.1.1. Best papers

BEST PAPERS AWARDS :

[29] **10th International Conference on Web Reasoning and Rule Systems**. M. BIENVENU, M. THOMAZO.

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, rehabilitation (section 7.2.3) and activities detection (section 7.2.1)

5.1.2. Experimentation

- extensive test period for our walkers in clinical environment (section 7.2.3)
- start of the daily activities monitoring in a retirement house (section 7.2.1)

5.1.3. Transfer

- contract with Ellcie-Healthy for the evaluation of connected objects

5.1.3.1. Awards

- J-P. Merlet has been a finalist for the best paper award of the Eucomes conference and of the IROS conference

BEST PAPERS AWARDS :

[14] **Eucomes**. J.-P. MERLET.

[10] **IEEE Int. Conf. on Intelligent Robots and Systems (IROS)**. J.-P. MERLET.

LAGADIC Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Eric Marchand and Fabien Spindler co-authored with Prof. Hideaki Uchiyama (Kyushu Univ., Japan) a survey on pose estimation for augmented reality published in IEEE Trans. on Visualization and Computer Graphics [33].

- The second edition of the Springer Handbook of Robotics has been released this year. It contains an extended version of the chapter on visual servoing co-authored by François Chaumette, Prof. Seth Hutchinson (UIUC, Illinois) and Prof. Peter Corke (QUT, Brisbane, Australia) [77].

5.1.1. Awards

- The ANR project ENTRACTE, of which Julien Pettré is partner, has received the "ANR Grand Prix du Numérique 2016". The project is about anthropomorphic action planning and understanding: http://www.agence-nationale-recherche.fr/?Project=ANR-13-CORD-0002 (see also Section 9.2.3).

- Paper [71] has been selected has one of the five finalists for the ICARCV'2016 Best Paper Award.

- Lagadic is a member of the five finalist teams for the KUKA Innovation Award (https://www.kuka.com/en-de/press/events/kuka-innovation-award), together with the RIS group at LAAS (coordinator), the University of Siena, Italy, and the Seoul National University, South Korea. The goal is to address search and rescue operations in regions which are difficult to access or dangerous following disasters. For this, the team will explore the collaboration between a quadrotor UAV and a KUKA lightweight arm for cooperative transportation and manipulation of rigid objects (e.g., long bards), with a final peg-in-hole task to be demonstrated live at the Hannover fair during spring 2017.

STARS Project-Team (section vide)

<p style="text-align:center; color:red">TITANE Project-Team</p>

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

We obtained a Proof of Concept grant from the European Research Council, entitled TITANIUM (Software Components for Robust Geometry Processing). The TITANIUM project aims to develop a software demonstrator for geometry processing and 3D urban modeling, in order to facilitate the pre-commercialization of novel software components for the Computational Geometry Algorithms Library. The demonstrator will include novel approaches resulting from the ERC-funded IRON project.

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BEST PAPERS AWARDS :

[] **Computer Graphics Forum**. Z. SHI, P. ALLIEZ, M. DESBRUN, H. BAO, J. HUANG.

WIMMICS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards & Nominees

The Wimmics team received collectively the Université Côte d'Azur Award in recognition of the ISWC best demo.

Best demo award at ISWC for *Semantic Web Technologies for improving remote visits of museums, using a mobile robot* [32].

Best poster nominee at ISWC for *Materializing the Editing History of Wikipedia as Linked Data in DBpedia* [60].

Michel Buffa was finalist for the first-ever edX Prize for Exceptional Contributions in Online Teaching and Learning (11 teachers have been selected among 2500 others and 1200 online courses) for his MOOCs on HTML5.

Valerio Basile was awarded the first prize, granted by IBM, at the *Evaluation of NLP and Speech Tools for Italian (Evalita)* workshop.

<p style="text-align:center; color:red;">**ZENITH Project-Team**</p>

5. Highlights of the Year

5.1. Highlights of the Year

- The Pl@ntNet application, developed by Zenith and its partners, is enjoying a huge success: more than 2.7M downloads as in November 2016 in 150 countries; the number of users doubles every 6 months; tens of thousands of users each day, 12% being professionnals in agriculture or education.

- Alexis Joly and his collaborators of the Pl@ntNet project have been awarded the prize "La Recherche 2016" organized by the French magazine La Recherche for the article [2].