

*Inria*

RESEARCH CENTER

FIELD

**Applied Mathematics, Computation  
and Simulation**

Activity Report 2019

# Section Highlights of the Team

Edition: 2020-03-21



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

## **CAGIRE Project-Team**

### **5. Highlights of the Year**

#### **5.1. Highlights of the Year**

##### ***5.1.1. R. Manceau, new Cagire team leader***

After having taken over the responsibility of the team since its creation, Pascal Bruel, 59, has decided this year to hand over the reins! After consultation, Inria's management has appointed Remi Manceau as the new head of the Cagire team as of 18 November 2019.

## CARDAMOM Project-Team

### 5. Highlights of the Year

#### 5.1. Highlights of the Year

- In September 2019 Martin Parisot, previously CR in the ANGE team, has joined CARDAMOM;
- In September 2019 Nicolas Barral, previously post-doc in the Computational Geoscience and Energy division of the Department of Earth Science and Engineering at Imperial College London, has joined CARDAMOM
- H. Beaugendre has contributed to the organization of Inria's Autumn school, November 4-8 2019, Inria Bordeaux Sud-Ouest.

School's objective: The school will aim at simulating a physical problem, from its modeling to its implementation in a high performance computing (HPC) framework. The school will offer both plenary courses and hands-on sessions. The physical problem considered will be the harmonic wave propagation.

The first day will be dedicated to the modeling of the problem and its discretization using a Discontinuous Galerkin scheme. The following two days will be dedicated to linear algebra for solving large sparse systems. Background on direct, iterative and hybrid methods for sparse linear systems will be discussed. Hands-on on related parallel solvers will then be proposed. Will follow a session dedicated to advanced parallel schemes using task-based paradigms, including a hands-on with the starpu runtime system. The ultimate hands-on session will be devoted to the use of parallel profiling tools. The school will be closed with plenary talks illustrating the usage of such a workflow in an industrial context.

38 participants, mostly PhD students and Post-docs.

This school received support from cea, Inria, prace and sysnum.

##### 5.1.1. Awards

In November 2019 M. Ricchiuto has been granted the honorary appointment of Adjunct Professor at the Civil and Environmental Engineering department of Duke University in North Carolina (USA).

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



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

## ELAN Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

### 5.1.1. *Creation of Graphyz, a new graphics-physics workshop*

- F. Bertails-Descoubes, together with B. Audoly (École Polytechnique), has founded, chaired and organized the first graphics-physics workshop, **Graphyz**, held at Inria Montbonnot on October 24-25 2019. An outstanding **scientific program**, gathering 15 international experts from both Computer Graphics and Physics, originally combined talks from both communities around various topics ranging from viscous thread coiling to snow avalanches. The workshop was entirely funded by the ERC GEM. Being a high success, it will be organized again in 2021, in Paris.

### 5.1.2. *Keynote at Eurographics 2019*

- Florence Bertails-Descoubes was a **Keynote speaker** at **Eurographics 2019** held in May 2019 in Genova, Italy.

### 5.1.3. *Awards*

BEST PAPERS AWARDS :

[7]

R. CHARRONDIÈRE, F. BERTAILS-DESCOUBES, S. NEUKIRCH, V. ROMERO. *Modélisation numérique de rubans en éléments de haut degré*, in "JF.IG.RV 2019 - Journées Françaises d'Informatique Graphique et de Réalité Virtuelle", Marseille, France, November 2019, p. 1-7, <https://hal.archives-ouvertes.fr/hal-02384170>

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

## **MATERIALS Project-Team**

### **4. Highlights of the Year**

#### **4.1. Highlights of the Year**

##### **4.1.1. Grants**

- Eric Cancès, Laura Grigori (ALPINES, Inria Paris), Yvon Maday (Sorbonne Université), and Jean-Philip Piquemal (Sorbonne Université) are the PIs of the ERC Synergy project EMC2 (Extreme-scale Mathematically-based Computational Chemistry) launched in September 2019 (grant agreement No 810367).
- Virginie Ehrlacher is the PI of the ANR JCJC COMODO (CrOss-diffusion systems on MOving DOmains) project, to start in January 2020.

##### **4.1.2. Awards**

- C. Le Bris was a plenary speaker at ICIAM 2019, July 2019, Valencia, Spain.
- T. Lelièvre has received a Visiting professorship from the Leverhulme Trust, for his sabbatical leave at Imperial College London (Sep 2019-Jul 2020).

## MEMPHIS Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

### 5.1.1. 3D Numerical Model of a Zebra Fish Larva

The full reconstruction of a 3D larval zebrafish (5 days post fertilization) was realized using a serial-section electron microscopy data set combined with the technique of level-set and optimal transportation for shape interpolation. From an experimental video of zebrafish escape swimming, the kinematics of the swimming is extracted removing both translational and rotating displacements. Based on this video-extracted body deformation, 3D zebrafish snapshots of the body surface were generated deforming the 3D model according to the midline motion. The escape response of the zebrafish larva has been simulated using the NaSCar solver. The numerical simulation of the hydrodynamic zebrafish-locomotion provides a full range of the energetic performance performed by the larva during an escape response that are used by the MRGM biology lab in Bordeaux for toxicology evaluations. See figures 6 and 7 .

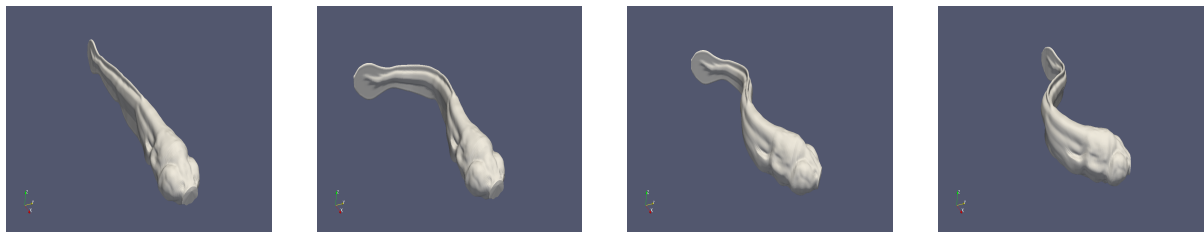


Figure 6. Snapshots from left to right: reconstruction from electron microscopy and experimental video provided by MRGM Bordeaux of a zebra fish larva swimming movement.

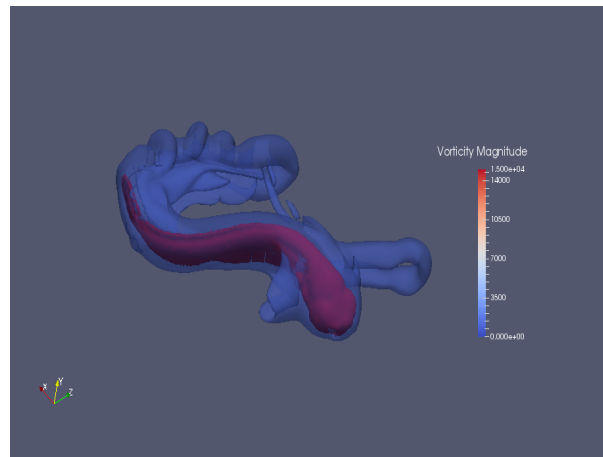


Figure 7. Numerical simulation of the swimming displacement of a zebra fish larva.

## **MEPHYSTO Team**

### **4. Highlights of the Year**

#### **4.1. Highlights of the Year**

The team has almost completed the process of creation of a new project-team named *Paradyse* (for *PAR*ticles *ANd* *DY*namical *SY*stEms), between Inria and the Laboratoire Paul Painlevé of the Université de Lille in 2019.

In 2019, the Mephysto team has been granted an Action de Développement Technologique (ADT) by Inria. This allowed the team to hire Alexandre Roget as an engineer for 2 years. The goal of this ADT is to develop software using mathematical techniques developed in the team, to be used by theoretical and experimental physics communities.

In 2019, the team also had individual successes that can be highlighted. Amongst others, M. Simon submitted an ERC Starting Grant project which was ranked A, and S. De Bièvre became Associate Editor of the Journal of Mathematical Physics.

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



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

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

## NANO-D Team

### 4. Highlights of the Year

#### 4.1. Highlights of the Year

- The work on first-principle simulation has been completed. The aim was to use the restrained dynamical model ARPS previously developed by the team to speed-up dynamical simulations using a first-principle interaction model. We have chosen Orbital-Free Density Functional Theory (OF-DFT), a fast scheme of DFT, as interaction model. We have developed a new OF-DFT code adapted to restrained particle simulations and have compared the accuracy and speed of our method to the state of the art OF-DFT code, PROFESS. The results were published in the Journal of Computational Chemistry [11] and the code is available in SAMSON. The thesis at the origin of this research has been defended in October.
- The proof-of-concept orientation-dependent potential for small molecules was developed and tested.
- With the advance of experimental procedures, obtaining sparse experimental data of proteins in solution (chemical crosslinking and small-angle scattering) is becoming a fast and routine practice. These can greatly enhance the accuracy of protein structure modeling. We participated in reviewing the current state of the art in modeling protein structures with the assistance of experimentally determined chemical crosslinks and small-angle scattering profiles within the framework of the 13th meeting of Critical Assessment of Structure Prediction approaches [2], [4].

## **POEMS Project-Team**

### **4. Highlights of the Year**

#### **4.1. Highlights of the Year**

- The POEMS EPI has been officially renewed by Inria on the 1st November 2019.
- Two permanent members of the team, S. Chaillat and S. Fliss, have successfully defended their habilitation theses.
- SACHEMS project led by CEA (where POEMS is involved) has been retained in the call of Ile-de-France Region SESAME 2019. Its purpose is to federate the research in the region in the field of SHM (Structural Health Monitoring), which consists of developing intelligent sensors aimed at detecting and characterizing directly defects in a structure (crack, corrosion, etc.). The SACHEMS project is part of a strategy for pooling equipment with the objective of creating an innovation platform for SHM methods.

## RAPSODI Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

In 2019, RAPSODI members have been the laureates of several calls for projects.

- T. Rey has been awarded an ERC Generator grant (116 545 euros) from I-SITE Université Lille - Nord Europe for his project MANAKINEQ0 (R-ERCGEN-19-007-REY). Upon the next two years, T. Rey aims at investigating mathematical properties, as well as developing efficient numerical schemes, for multiscale collisional kinetic equations of the Boltzmann type. A 20-months post-doc will be funded using this grant, as well as an international conference. Following this ERC Generator grant, T. Rey will apply for an ERC Consolidator grant.
- S. Lemaire is the PI of the ADT project ParaSkel++, which is one of the funded Actions of Technological Development of the Inria Lille - Nord Europe 2019 campaign. The aim of the project is to develop an optimized C++ platform for the arbitrary-order numerical approximation of PDEs by skeletal methods on general 2D/3D meshes, with a particular emphasis on the implementation of HPC facilities. L. Beaudé has been hired as a development engineer for this project. She will start in February 2020.
- C. Cancès, C. Chainais-Hillairet and B. Merlet are involved in the H2020 project EURAD (European Joint Programme on RADioactive Waste Management). The aim of their project inside EURAD is to establish an energetic formulation of the Diffusion Poisson Coupled Model leading to new large-time robust numerical methods for the simulation of the corrosion processes in an underground repository. C. Cancès is the leader of the task “Numerical methods for high-performance computing of coupled processes” within the EURAD project.

One can also mention the obtention by T. Rey of a Young Researcher PEPS grant from CNRS’s INSMI (3 500 euros, from March to November 2019). The granted project aimed at investigating high-order (in time and velocity) numerical methods for approximating the solutions to the granular gases equation.

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

## **COMMANDS Project-Team**

# **5. Highlights of the Year**

## **5.1. Highlights of the Year**

We have now a strong involvement in the study of mean-field games (MFG) and their application to distributed energy production problems. In the paper [3] we study MFG equilibria with coupling of the agents through a price function (see more in the 'New Results' section). In the framework of the PhD of Pierre Lavigne we currently study discrete-time models with risk-averse agents. Both directions take advantage of the recent recruitment of Laurent Pfeiffer as "chargé de recherche", and of a starting collaboration with Jameson Graber (Baylor University, Texas).

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



## FACTAS Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

### 5.1.1. *Robotic tuning: a nice outcome of our long lasting experience in the field of computer assisted tuning for microwave devices*

A contract was signed with the French small and midsize business (SMB) Inoveos for the realization of a robotic prototype for the mass tuning of microwave devices. In addition to Inria, this project includes the university of Limoges Xlim and the engineering center Cisteme <https://cisteme.net>. Our team will be responsible of the driving software of the robot based on our long lasting experience in circuit extraction methods and in connection with our tools Presto-HF and Dedale-HF. Among the technical and scientific challenges for us on this project we can list:

- Improvement of the computational efficiency of our circuit methods in order to be compatible with real-time measurements techniques of filter. Typically a circuit extraction needs to be performed in less than 1 second when dealing with a filter of order 10.
- Handling the ambiguity resulting from the use of multiple solutions coupling topologies yielding several equivalent circuits for a single DUT (device under tuning).

## **I4S Project-Team**

# **4. Highlights of the Year**

## **4.1. Highlights of the Year**

### **4.1.1. Awards**

- Our former PhD student Nicolas Le Touz received the Abertis Prize France for his thesis “Design and study of positive energy transport infrastructure: from thermomechanical modelling to the optimisation of such energy systems“, defended in November 2018. The Abertis Prize is awarded for research in transport infrastructure management.
- Nassif Berrabah, industrial PhD student of the I4S Team in collaboration with EDF, has defended his thesis on “Inverse problems for diagnosis of electric cables from reflectometry measurements” in November 2017. The research work of his thesis received the award of Scientific Prize from EDF R&D.

## **MCTAO Project-Team**

### **5. Highlights of the Year**

#### **5.1. Highlights of the Year**

##### ***5.1.1. Awards***

Laetita Giraldi has been awarded the price "My Innovation is" by SATT Sud & Corse for her research project on the control of swimming microbots.

## **NECS Team**

# **5. Highlights of the Year**

## **5.1. Highlights of the Year**

- C. Canudas-de-Wit was the General Chair of IEEE Conference on Decision and Control 2019 (CDC) in Nice (11-13 Dec. 2019).
- H. Fourati was elected as member of CNU61 (Conseil national des universités, Génie informatique, Automatique et Traitement du Signal), 2020-2023.
- H. Fourati has co-edited the book “Cooperative Localization and Navigation: Theory, Research and Practice”, by Taylor and Francis Group LLC.

## QUANTIC Project-Team

### 5. Highlights of the Year

#### 5.1. Highlights of the Year

- Zaki Leghtas has obtained an ERC starting grant in pannel PE3 entitled ECLIPSE (Exotic superconducting CIrcuits to probe and protect quantum States of light and mattEr).
- Our team (Zaki Leghtas and Mazyar Mirrahimi) has obtained a european QUANTERA grant entitled QuCOS (Quantum Computation with Schrödinger cat states).
- Philippe Campagne-Ibarcq was hired as a CRCN Inria in the QUANTIC team.
- Zaki Leghtas was an invited speaker of American Physical Society March Meeting in Boston, USA.
- Pierre Rouchon was a semi-plenary speaker at the IFAC Mechatronics and NOLCOS conference, September 4-6, Vienna, Austria.
- Successful PhD defense of Gerardo Cardona, under the direction of P. Rouchon and A. Sarlette.
- Successful PhD defense of Lucas Verney, under the direction of M. Mirrahimi and Z. Leghtas.
- Successful PhD defense of Zhifei Zhang, under the direction of A. Sarlette at Ghent University.

## **SPHINX Project-Team**

# **5. Highlights of the Year**

## **5.1. Highlights of the Year**

Four members of the team are involved in the scientific project ODISSE funded by the ANR (october 2019-october 2023). The goal of this project, which gathers researchers from communities of automatic control and applied mathematics, is to investigate inverse problems using observer techniques.

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

## TROPICAL Project-Team

### 5. Highlights of the Year

#### 5.1. Highlights of the Year

##### 5.1.1. Notable article

The results of the article [45], providing an unexpected counter example to the “continuous analogue of the Hirsch conjecture”, showing that log-barrier interior point methods are not strongly polynomial, have been discussed by Jesus De Loera in his survey of recent advances on Linear Programming, “**Algebraic and Topological Tools in Linear Optimization**”, Notices de l’AMS (volume 66, number 7, 2019, especially pp. 1028-1032.

##### 5.1.2. Awards

Maxime Grangereau (PhD student) has been laureate of the programme “Siebel Scholar 2020”, <https://twitter.com/polytechnique/status/1177111371835695104>



## **VALSE Project-Team**

### **5. Highlights of the Year**

#### **5.1. Highlights of the Year**

- This year Valse published 6 papers in Automatica and 4 in IEEE Transaction on Automatic Control (the top journals in the domain of control theory).
- A. Polyakov wrote a book **Generalized Homogeneity in Systems and Control**.

## BONUS Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

### 5.1.1. Awards

- + The paper [30] was nominated for the *Best Student Workshop Paper Award* at the 28<sup>th</sup> ACM (Companion) Genetic and Evolutionary Computation Conference (GECCO 2019).
- + *USA Patent* with Beckman & Coulter on the optimization of large medical laboratories (Prof. E-G. Talbi, S. Faramarzi Oghani, M. Bué), 2019.
- + The paper [29] has received the *Best Student Paper Award* at the 10<sup>th</sup> International Conference on Evolutionary Multi-Criterion Optimization (EMO 2019).

BEST PAPERS AWARDS :

[29]

Y. MARCA, H. AGUIRRE, S. Z. MARTINEZ, A. LIEFOOGHE, B. DERBEL, S. VEREL, K. TANAKA. *Approximating Pareto Set Topology by Cubic Interpolation on Bi-objective Problems*, in "EMO 2019 - International Conference on Evolutionary Multi-Criterion Optimization", East Lansing, Michigan, United States, February 2019, p. 386-398 [DOI : 10.1007/978-3-030-12598-1\_31], <https://hal.archives-ouvertes.fr/hal-02064548>

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

## **GEOSTAT Project-Team**

### **5. Highlights of the Year**

#### **5.1. Highlights of the Year**

- Inria's exploratory action "TRACME" led by N. Brodu, starting October 2019.

## **INOCS Project-Team**

# **5. Highlights of the Year**

## **5.1. Highlights of the Year**

### **5.1.1. Awards**

- Martine Labbé received the EURO Gold Medal in June 2019. This is the highest distinction in Operations Research in Europe.

## MISTIS Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

### New appointments:

- Florence Forbes has been appointed as a member of the advisory committee of the Helmholtz AI Cooperation Unit <https://helmholtz.ai/>.

### Data Challenges

- Pixyl winner of the Société Française de Radiologie Data Challenge 2019

Pixyl, a Grenoble-based start-up originating in the team and Inserm, accompanied by a team of neuroradiologists and academics, distinguished itself in the AI challenge held during the 2019 edition of the Journées Francophone de Radiologie, which took place from 11 to 14 October in Paris. The Challenge was about prediction of multiple sclerosis patient disability from a single MRI image

### 5.1.1. Awards

- Meryem Bousebata received the second best presentation award at the “10th conference of the international society for Integrated Disaster Risk Management (IDRiM)” organized by CNRS-University of Nice and AFPCN and held from 16 to 18 October 2019 in Nice.
- Mariia Vladimirova received the best poster award for her work [45] at the “12th Conference on Bayesian Nonparametrics”, Oxford University, UK, June 24-28, 2019.

### BEST PAPERS AWARDS :

[52]

M. BOUSEBATA, G. ENJOLRAS, S. GIRARD. *Bayesian estimation of natural extreme risk measures. Application to agricultural insurance*, in "IDRiM 2019 - 10th conference of the international society for Integrated Disaster Risk Management", Nice, France, October 2019, <https://hal.archives-ouvertes.fr/hal-02276292>

## MODAL Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

- Benjamin Guedj gave (with John Shawe-Taylor) a plenary tutorial of 2 hours for opening the ICML 2019 (Longbeach, California, USA – June 2019).
- Official creation in July 2019 of a startup DiagRAMS using MODAL's technology (MixtComp software) for predictive maintenance.
- Benjamin Guedj has received two best reviewer awards (top 5% of reviewers) for ICML 2019 and NeurIPS 2019, the flagship conferences in machine learning. Pascal Germain received the best reviewer award (top 5% of reviewers) for NeurIPS 2019.

### 5.1.1. More relevant results in 2019.

While Section 7 contains a complete list of results for 2019, the important results which were published in peer-reviewed international conferences/journals are described in Sections [7.2](#) , [7.3](#) , [7.13](#) , [7.16](#) , [7.17](#) , [7.18](#) , [7.19](#) , [7.21](#) , [7.22](#) , [7.27](#) , [7.28](#) , [7.32](#) , [7.37](#) , [7.43](#) and [7.47](#) .

## RANDOPT Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

### 5.1.1. Awards

- Cheikh Touré received the 2nd prize for the student best paper award at the conference EMO 2019 for the paper “On Bi-Objective convex-quadratic problems” by Cheikh Touré, Anne Auger, Dimo Brockhoff, Nikolaus Hansen
- Nikolaus Hansen received the ENUM best paper award at the ACM-GECCO 2019 conference (see <https://gecco-2019.sigev.org/index.html/Best+Paper+Awards>) for the paper “A global Surrogate Assisted CMA-ES”

BEST PAPERS AWARDS :

[6]

C. TOURÉ, A. AUGER, D. BROCKHOFF, N. HANSEN. *On Bi-Objective convex-quadratic problems*, in "10th International Conference on Evolutionary Multi-Criterion Optimization", East Lansing, Michigan, United States, March 2019, <https://arxiv.org/abs/1812.00289> , <https://hal.inria.fr/hal-01942159>

[5]

N. HANSEN. *A Global Surrogate Assisted CMA-ES*, in "GECCO 2019 - The Genetic and Evolutionary Computation Conference", Prague, Czech Republic, ACM, 2019, p. 664-672 [DOI : 10.1145/3321707.3321842], <https://hal.inria.fr/hal-02143961>



## **REALOPT Project-Team**

# **5. Highlights of the Year**

## **5.1. Highlights of the Year**

The team has recruited Aurélien Froger as assistant professor.

Ruslan Sadykov has defended his habilitation (HDR) [2].

A paper [8] was accepted in conference IPCO, which is the most prestigious conference in the field.

## SEQUEL Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

- Organization of the 1st Reinforcement Learning Summer School: 2 weeks of lectures, keynotes, and practical sessions fully dedicated to bandits and reinforcement learning. We received about 300 applications from all around the world and selected 110 participants.
- Julien Seznec and Michal Valko have obtained an oral at AI&Stats (2,5% acceptance rate) [32].
- This is the ultimate SEQUEL highlight: after 12 years, following Inria's policy, SEQUEL comes to an end. We have designed a new team-project which will be named SCOOOL.

### 5.1.1. Awards

BEST PAPERS AWARDS :

[16]

M. ASADI, M. S. TALEBI, H. BOUREL, O.-A. MAILLARD. *Model-Based Reinforcement Learning Exploiting State-Action Equivalence*, in "ACML 2019, Proceedings of Machine Learning Research", Nagoya, Japan, 2019, vol. 101, p. 204 - 219, <https://hal.archives-ouvertes.fr/hal-02378887>

## **SIERRA Project-Team**

# **5. Highlights of the Year**

## **5.1. Highlights of the Year**

### **5.1.1. Awards**

- Damien Scieur, Prix de thèse PSL-ADELI
- Francis Bach, Prix Jean-Jacques Moreau

## TAU Project-Team

# 5. Highlights of the Year

## 5.1. Highlights of the Year

### 5.1.1. Awards

- Best Paper Award in Machine Learning at ECML-PKDD 2019 in Würzburg to Guillaume Doquet and Michèle Sebag for their paper *Agnostic feature selection*. See Guillaume's PhD [13] for more details.
- Nacim Belkhir, Winner ACM-GECCO 2019 **BBComp single-objective**, **BBComp two-objective** and **three-objective** tracks. The winning program is a slightly modified version of the one Nacim wrote during his PhD in TAU in 2017 [71], co-supervised by Marc Schoenauer, Johann Dréo and Pierre Savéant (Thalès TRT).

### 5.1.2. Visibility

- Marc Schoenauer, expert seconding Guillaume Klossa, special advisor to European Vice-President Ansip, for the **report *Toward European Media Sovereignty*** giving strategic advice on the opportunities and challenges related to the use artificial intelligence, with a focus on the media sector.

BEST PAPERS AWARDS :

[32]

G. F. DOQUET, M. SEBAG. *Agnostic feature selection*, in "ECML PKDD 2019 - European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases", Würzburg, Germany, September 2019, <https://hal.archives-ouvertes.fr/hal-02436824>

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

## **MATHRISK Project-Team**

### **5. Highlights of the Year**

#### **5.1. Highlights of the Year**

##### **5.1.1. Awards**

Aurélien Alfonsi : Award for the Best Young Researcher in Finance and Insurance, Europlace Institute of Finance and SCOR Corporate Foundation.

##### **5.1.2. Publications**

B. Øksendal and A. Sulem. *Applied Stochastic Control of Jump Diffusions*. 3rd edition (436 pages) 2019, Universitext, Springer Verlag, Berlin, Heidelberg, New York [23].

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

**TOSCA Team (section vide)**