RESEARCH CENTER

FIELD
Digital Health, Biology and Earth

Activity Report 2017

Section Highlights of the Team

COMPUTATIONAL BIOLOGY

COMPUTATIONAL NEUROSCIENCE AND MEDICINE

EARTH, ENVIRONMENTAL AND ENERGY SCIENCES

MODELING AND CONTROL FOR LIFE SCIENCES

ABS Project-Team (section vide)

AMIBIO Team (section vide)

<p style="text-align:center">**BEAGLE Project-Team**</p>

4. Highlights of the Year

4.1. ECAL Conference

In September 2017 Beagle organized the 14th European Conference on Artificial Life in Lyon (https://project.inria.fr/ecal2017/). ECAL is a biannual scientific meeting supported by the International Society for Artificial Life (ISAL). Carole Knibbe was scientific chair of the conference and Guillaume Beslon was local chair. We welcomed 200 researchers from various disciplines (computer science, biology, physics, humanities...) for 5 days of conferences (including 7 keynotes) in the domain of modelling and simulation of life. The scientific program was completed by an amazing social program (vineyard visits, old city visit, wine&cheese, banquet dinner, sport activities...). The proceedings of the conference have been published by MIT Press (http://cognet.mit.edu/journal/ecal2017).

4.1.1. Awards

Guillaume Beslon was awarded the 3rd price at the international innovation academy of the International conference on prevention and infection control. Geneva, Juin 2017. Project presented: ISEE-Resistance, using in silico experimental evolution to sensitize providers on antibiotic resistance [13].

BIGS Project-Team (section vide)

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

5. Highlights of the Year

5.1. Highlights of the Year

- Bonsai and close partners organized the French conference in bioinformatics, JOBIM, in Lille. More than 350 people attended to the conference.

- In the two last years, more than 2,000 samples of patients suffering leukaemia were analyzed with the Vidjil software developed in Bonsai with our partners. The VidjilNet consortium will be launched on January 1st 2018 within the Inria Foundation.

5.1.1. Awards

Pierre Pericard received the Best Oral Presentation Award from the SFBI for its talk on MATAM at the French bioinformatics conference JOBIM.

BEST PAPERS AWARDS :

[29] **JOBIM 2017 - Journées Ouvertes en Biologie, Informatique et Mathématiques**. P. PERICARD, Y. DUFRESNE, S. BLANQUART, H. TOUZET.

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

5. Highlights of the Year

5.1. Highlights of the Year

Following a collaboration with Emmanuel Levy at the Weizmann Institute, a manuscript on annotating protein quaternary structures using our Kpax software has been published in Nature Methods [16].

DYLISS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

The team received a best paper award at the conference ICFCA and a best student paper award at the conference LPNMR .

BEST PAPERS AWARDS :

[24] **International Conference on Formal Concept Analysis 2017**. L. BOURNEUF, J. NICOLAS.

[26] **14th International Conference on Logic Programming and Nonmonotonic Reasoning - LPNMR 2017**. C. FRIOUX, T. SCHAUB, S. SCHELLHORN, A. SIEGEL, P. WANKO.

ERABLE Project-Team (section vide)

5. Highlights of the Year

5.1. CAMI

GenScale participated to the international CAMI challenge. CAMI stands for Critical Assessment of Metagenome Interpretation. It is a community-led initiative designed to tackle the problem of recovering the complex information encoded in metagenomes by aiming for an independent, comprehensive and bias-free evaluation of methods. We contributed in the "Assembly" section with the Minia pipeline. Results of this competition, presented in the "Nature Methods" journal [20], highlight the good behaviour of our tool compared to other competitors.

4. Highlights of the Year

4.1. Highlights of the Year

Three new projects coordinated by IBIS started this year: the IPL COSY, the ADT CoSoft, and the ANR project Maximic (Section 8.2). A paper based on the PhD thesis of Manon Morin was published in *mBio* this year [20]. The techniques used for the analysis of flux data were presented at ISMB/ECCB 2017 and published in a special issue of *Bioinformatics* [17]. Hidde de Jong organized a workshop on growth control in microorganisms, as a side event of the yearly meeting of the special interest group in systems and synthetic biology GDR BioSynSys, in La Grande Motte.

LIFEWARE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- **Virtual Reality for Bacteria**

  Individual bacteria have been interfaced with a computer to build hybrid bio-digital circuits. Study published in Nature Communications [1].

- **Dynamical stabilization: real-time control allows maintaining cells in unstable configurations.**

  Using real-time control or periodic forcing one can drive cells towards a region of instability and dynamically maintain them there. Study published in Nature Communications [2].

- **Strong Turing Completeness of Continuous CRNs** solving a long standing open problem in CRN theory [8].

5.1.1. Awards

BEST PAPERS AWARDS :

[8] **CMSB 2017 - 15th International Conference on Computational Methods in Systems Biology**. F. FAGES, G. LE GULUDEC, O. BOURNEZ, A. POULY.

MORPHEME Project-Team (section vide)

PLEIADE Team (section vide)

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

5. Highlights of the Year

5.1. Highlights of the Year

The Serpico team will be the organizer of the 7th International Conference on "Quantitative BioImaging" (QBI) in January 2019 (300 attendees) in Rennes.

Juan Manual Perez Ru, Vincent Briane and Hoai-Nam Nguyeen defended their PhD thesis in December 2017.

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

Tristan Stérin won a best poster award at the conference DNA 23.

<p style="text-align:center">**VIRTUAL PLANTS Project-Team**</p>

4. Highlights of the Year

4.1. Highlights of the Year

- To obtain efficient data-structures from segmented images that can be used for later physical simulations, we developed a computational tool, DRACO-STEM, that interprets cell population images as 3D cell meshes. DRACO-STEM has been released as an independent package to enable biomechanical simulations on real-world data [33].

- *Modeling cell fate decisions during Acsidian embryo development*. Canalization of developmental processes ensures the reproducibility and robustness of embryogenesis within each species. In its extreme form, found in ascidians, early embryonic cell lineages are invariant between embryos within and between species, despite rapid genomic divergence. To resolve this paradox, we used live light-sheet imaging to quantify individual cell behaviors in digitalized embryos and explore the forces that canalize their development. This quantitative approach revealed that individual cell geometries and cell contacts are strongly constrained, and that these constraints are tightly linked to the control of fate specification by local cell inductions. While in vertebrates ligand concentration usually controls cell inductions, we found that this role is fulfilled in ascidians by the area of contacts between signaling and responding cells. We propose that the duality between geometric and genetic control of inductions contributes to the counterintuitive inverse correlation between geometric and genetic variability during embryogenesis [Submitted in Dec 2017].

ARAMIS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Anne Bertrand spent a year half-time within the ARAMIS team, thanks to an Inria-APHP interface contract (i.e., "poste d'accueil"), from november 2016 to november 2017. At the end of this contract, she was appointed as an Assistant Professor of Radiology at Sorbonne University, on september 2017, allowing her to continue working 40% of her time within the ARAMIS team.
- Fabrizio De Vico Fallani was named associate editor of the journal Brain Topography
- Stanley Durrleman was nominated coordinator of the ICM Center of Neuroinformatics, and scientific manager of the ICM iCONICS core-facility on bioinformatics.
- The team has been awarded the projects SEMAPHORE, ATTACK and PredictICD under the "Big Brain Theory" program (ICM)

5.1.1. Awards

- Jeremy Guillon was awarded the best lighting presentation at the international conference on complex networks

ASCLEPIOS Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

- Nina Miolane won the second prize of the competition "My thesis in 180 seconds" at the regional level, among 20 PhD students.

- Xavier Pennec was elected Fellow of the MICCAI scientific Society for "pioneering theoretical contributions grounding the field of computational anatomy, shape statistics and medical image computing".

- Sophie Giffard-Roisin won the best electrophysiology paper award at the Functional Imaging and Modelling of the Heart 2017 conference.

- Matthieu Lê receives the SGBM Research Award for his PhD Thesis.

- Nicholas Ayache was named Chevalier de l'Ordre des Palmes Académiques (Order of Academic Palms), promotion of July 2017.

- Nicholas Ayache was elected member of the Académie Nationale de chirurgie (National Academy of Surgery).

BEST PAPERS AWARDS :

[37] **Functional imaging and modelling of the heart 2017**. S. GIFFARD-ROISIN, H. DELINGETTE, T. JACKSON, L. FOVARGUE, J. LEE, A. RINALDI, N. AYACHE, R. RAZAVI, M. SERMESANT.

ATHENA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- D. Wassermann has been awarded an ERC Starting Grant from the European Research Council. NEUROLANG is a 5-years project about *Accelerating Neuroscience Research by Unifying Knowledge Representation and Analysis Through a Domain Specific Language.*. Since October, Demian Wassermann moved to Inria Saclay where he joined the PARIETAL project-team.
- B. Belaoucha has received the Best Student Paper Award at PRNI'17 and Medal of excellence from UCA for the paper [28].

BEST PAPERS AWARDS :

[28] **PRNI 2017 - 7th International Workshop on Pattern Recognition in NeuroImaging**. B. BELAOUCHA, T. PAPADOPOULO.

BIOVISION Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

The article "Bio-inspired computer vision: towards a synergistic approach of artificial and biological vision" (published in Computer Vision and Image Understanding in 2016 [10]) was selected as part of the 21st Annual Best of Computing.

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. Awards

A part of CAMIN team is in the process of creating a spin-off: Neurinnov which has been awarded with the i-Lab 2017 prize by the French Minister of Research and Innovation, that encourage the most innovative and promising startups in France.

GALEN Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

The work on dense registration of faces [22] was selected as demo at the IEEE Conference on Computer Vision and Pattern Recognition.

The work [26] received the best poster award at the BASP workshop 2017.

5.1.2. Others

Emilie Chouzenoux received an ANR JCJC grant, for her project MajIC:Majorization-Minimization algorithms for Image Computing.

Evangelia Zacharaki has defended her 'Habilitation à Diriger des Recherches' [3].

Emilie Chouzenoux has defended her 'Habilitation à Diriger des Recherches' [1].

MATHNEURO Team (section vide)

<p style="text-align:center">**MIMESIS Team**</p>

5. Highlights of the Year

5.1. Highlights of the Year

Prix de thèse 2016 en Génie Biologique et Médical attributed to Rosalie Plantefève for her thesis *Augmented Reality and Numerical Simulation for Resection of Hepatic Tumor*. The award is attributed by three scientific bodies: IEEE EMBS, Société Française de Génie Biologique et Médical, and Alliance pour le Génie Biologique et Médical. In this context, R. Plantefève was invited to submite a paper to the Journal on Innovation and Research in BioMedical Engineering and the manuscript was accepted for publication [17].

Runner up for the best poster award at the IEEE International Symposium on Mixed and Augmented Reality 2017 with the poster *Deformed Reality: Proof of concept and Preliminary Results* [32]. The poster introduced a new paradigm to interactively manipulate objects in a scene in a deformable manner. Using the core principle of augmented reality to estimate a rigid pose over time, the method enables the user to deform the targeted object while it is being rendered with its natural texture, giving the sense of a real-time object editing in the user environment. The results show that the method is capable of opening new ways of not only augmenting the scene but also to interact with it in real by imposing possibly non-linear transformations to selected entities.

The **physics-based image and video editing tool *Calipso* was resumed in *Two-minutes papers* on YouTube.** At the end of 2017, the video has more that 35k views. Calipso is an interactive method for editing images and videos in a physically-coherent manner. The main idea is to perform physics-based manipulations by running a full physics simulation on proxy geometries given by non-rigidly aligned CAD models. Running these simulations allows us to apply new, unseen forces to move or deform selected objects, change physical parameters such as mass or elasticity, or even add entire new objects that interact with the rest of the underlying scene.
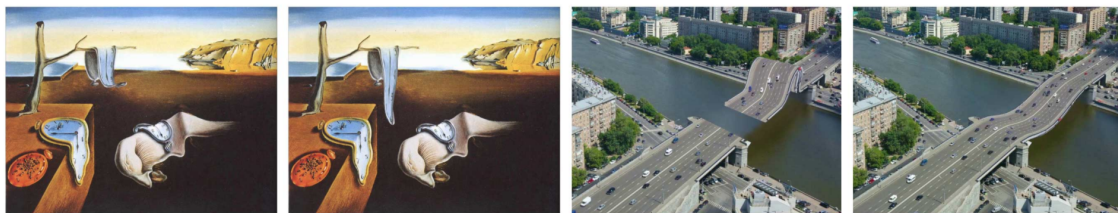
Figure 5. Illustration of Calipso deformed reality on two static images.

5. Highlights of the Year

5.1. Highlights of the Year

We published this year an important article [4] gathering 45 co-authors about the ReScience initiative which makes an important contribution that traditional scientific journals cannot offer. It provides a venue for publishing replication work, which traditional journals exclude for lack of novelty. Considering the ever increasing importance of computational methods in all scientific disciplines, we believe that our approach to replication is of interest to a broad audience of researchers.

NEUROSYS Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Laurent Bougrain is one of the three members of the committee, with Laurent Koessler and Stéphanie Caharel, that has successfully valued and amplified Neuroscience in Lorraine building a network of research in neuroscience at university of Lorraine. Neuroscience is currently being developed in different laboratories at the university of Lorraine in different institutes such as Inria, CNRS, INSERM, INRA and the university hospital of Nancy. The network will bring together more than 80 researchers in neuroscience to propose common researchers and to give national and international visibilities to neuroscience in Lorraine.

- Neurosys is the leader of the Brain-Computer Interface (BCI) for stroke platform in the Inria Project Lab BCI LIFT (see section 8.2). We developed Grasp'it, an innovative Brain-Computer Interface designed to enhance the motor rehabilitation of stroke patients with Stéphanie Fleck from Perseus lab at university of Lorraine [7], [11], [14]. Our system records users' cerebral activity during the kinesthetic motor imageries (KMI) execution using an electroencephalographic system and gives patients some visual feedback according to the accuracy of the performed imagined task. The graspIT platform was ranked second in the IHM2017 conference demonstrations and first in terms of utility. Grasp'it tends to become a serious game, whose aim is to support the learning and the practice of the KMI tasks in playful and motivating conditions. A French national (ANR) project has been submitted with two other Inria teams (Hybrid and Camin), three rehabilitation centers and an industrial partner, OpenEdge.

PARIETAL Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. ERC

Demian Wassermann obtained an ERC starting grant, Neurolang, *Accelerating Neuroscience Research by Unifying Knowledge Representation and Analysis Through a Domain Specific Language*.

Besides, Alexandre Gramfort joined Parietal just after the start of his ERC grant entitled SLAB, *Signal processing and Learning Applied to Brain data*.

VISAGES Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Recruitment

- Camille Maumet was recruited as Inria Researcher, starting from November 2017.

AIRSEA Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

M. Nodet and J. Erhel won the first prize of the second Imaginary Mathematics for Planet Earth competition with their web module entitled "Simulating the melting of ice caps" [26].

E. Arnaud was granted by a CRCT (Congé pour recherches ou conversions thématiques) by the CNU in 2016/2017.

ANGE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Human resources

A major event in the year was the merging with CLIME which induces the incorporation of several new researchers (1 Researcher, 1 engineer, 2 PhD). CLIME research is naturally complementary to ANGE works insofar as it provides high level tools to improve modelling and numerical results.

Another fact is J. Salomon's arrival as a Senior Researcher.

5.1.2. Scientific activities

There has been major achievements within the team in the framework of dispersive models. An increased research activity is carried out with spanish collaborators (Univ. Sevilla, Córdoba and Málaga) supported by several project call fundings. This lead to a main publication [30]. In the aftermath of N. Aïssiouene's PhD thesis, a new PhD has been hired to go further in the design of robust and efficient numerical algorithms.

As detailed in Section 10.1.1.1 , members of the team were involved in the organisation of a substantial number of scientific events, either in the framework of national initiatives (mainly funded by CNRS) or due to the expertise in the field. Members are is particularly involved in the mathematical community.

5.1.3. Awards

L. Boittin and F. Wahl were granted a SIAM Student Travel Award to attend SIAM GS 2017. F. Wahl also received a Young Researcher Scholarship to attend the 2017 SMAI conference.

CASTOR Project-Team

5. Highlights of the Year

5.1. Highlights

- Invited presentation at EPS Conference on Plasma Physics, 26 - 30 June 2017 Liu, F., Huijsmans, G.T., Alberto, L., Garofalo, A.M., Solomon, W.M., Nkonga, B., Hoelzl, M., Pamela, S., Becoulet, M., Orain, F. Non-linear MHD simulations of QH-mode and Type I ELMy H-mode DIII-D plasmas and implications for ITER high Q scenarios

- B. Nkonga, Elected member of the managing board, as treasurer, of the European Community on Computational Methods in Applied Sciences (ECCOMAS).

5.1.1. Awards

Jacques Blum has obtained the "Grand Prix de la ville de Nice" for 2017.

COFFEE Project-Team (section vide)

FLUMINANCE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

First prize of the second Mathematics of Planet Earth international competition. Module "Simulating the melting of ice caps", authors M. Nodet and J. Erhel.

BEST PAPERS AWARDS :

[] **Simulating the melting of ice caps**.

LEMON Team (section vide)

MAGIQUE-3D Project-Team (section vide)

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

5. Highlights of the Year

5.1. Highlights of the Year

The most important results of the ERC GATIPOR are now centralized in the ERC GATIPOR Gallery.

5.1.1. Awards

Laurent Monasse was awarded an ANR JCJC (young researcher) grant.

5. Highlights of the Year

5.1. Highlights of the Year

The STEEP research team has initiated in 2016 a series of conferences-debates entitled "Understanding & Acting" (« Comprendre et agir ») that examines sustainability issues in order to help researchers and citizens to increase their awareness of the various issues at stake in order to initiate relevant individual and collective actions. The presentations are captured on video and then made directly accessible on the YouTube Channel "Comprendre et Agir". At the end of 2017 the YouTube channel reached almost **45,000 views with a rate of integral viewings remaining at above 25%. This rate is quite important since the YouTube videos of the conferences last between 35 and 45 minutes.**

TONUS Team

5. Highlights of the Year

5.1. Highlights of the Year

We have developed [7] a new numerical method for solving any hyperbolic system of conservation laws (and among them the reduced plasma models). The method is based on a vectorial kinetic representation of the equations, an efficient transport solver (suc as DG or Semi-Lagrangian) and palindromic time integration. The resulting scheme is unconditionally stable, matrix-free and high order. We applied it successfully to the simulation of Rayleigh-Taylor instabilities and we are extending it to the simulation of MHD instabilities.

BIOCORE Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Determining ways of preventing the appearance of virulent pathogenic strains that are capable of infecting resistant plants is crucial to the durability of a resistant trait as a crop protection method. Genetic drift could be used in such a way by eliminating initially rare resistant breaking pathogens, but it is necessary to quantify this drift in the considered/developed plant strains to know if it can be of any help. In this work, we developed a method to disentangle the relative role of genetic drift and selection during within-host pathogen evolution, by the development and identification of the parameters of a Wright-Fisher model, based on time-series of the frequencies of the various pathogen variants [31].

- We have proposed a metabolic model [15] of the diauxic growth of microalgae on different substrates. The model, with 172 metabolic reactions is derived using the Drum approach [2]. This model was successfully validated for a broad variety of cases where algae grow under heterotrophic, autotrophic or mixotrophic conditions, and the transient accumulation of metabolites.

CARMEN Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. *Awards*

Michał Kania received a Gary and Bill Sanders poster award for his contribution "Prediction of the Exit Site of Ventricular Tachycardia Based on Different ECG Lead Systems" to the Computing in Cardiology meeting in Rennes, September 2017 .

5.1.2. *Inria domain evaluation*

In October the Carmen team participated in the evaluation of the Inria domain Life sciences, theme *Modeling and Control for Life Sciences*, during a 3-day seminar in Paris. The report was very positive about our work in general. The jury, composed of high-profile international scientists, noted especially the development of a bilayer model of the atria [56], [50] [15], the modified monodomain model which can reproduce much of the much more expensive bidomain model [49], and our contributions to electrocardiographic imaging [24], [17], [23], [27].

BEST PAPERS AWARDS :

[25] **Computing in Cardiology**. M. KANIA, Y. COUDIÈRE, H. COCHET, M. HAÏSSAGUERRE, P. JAÏS, M. POTSE.

DRACULA Project-Team (section vide)

M3DISIM Project-Team

5. Highlights of the Year

5.1. Highlights of the Year

- Promotion of Jean-Marc Allain as a professor at Polytechnique.

- Patent submitted and accepted on heart and vessels modelling with data interaction ([40]).

- Submission of a IHU proposal, of 3 ERC proposals, 1 associated team proposal with UT Southwestern Medical Center Dallas

- Contract of collaboration with UT Southwestern Medical Center Dallas (Profs. G. Greil and T. Hussain)

MAMBA Project-Team

4. Highlights of the Year

4.1. Highlights of the Year

4.1.1. *Awards*

Benoît Perthame has been elected member of the Académie des Sciences, in the section "Physique, mécanique, informatique".

4.1.2. *Personnel*

Marie Doumic has prolonged for one more year her sabbatical at WPI (Vienna, Austria, 2016-2018).

Diane Peurichard has been hired as Chargée de Recherche classe normale in Mamba, beginning in October 2017.

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

5. Highlights of the Year

5.1. Highlights of the Year

The team published in medical journals with strong impact factors like Cancer Research (*Mathematical modeling of tumor-tumor distant interactions supports a systemic anti-proliferative control of tumor growth* by S. Benzekry, *et al* for instance).

A new promising collaboration has started with the group of Yuval Shaked (double ERC laureate) at the Technion Israel Institute of Technology and first joint publication *Dose- and time-dependence of the host-mediated response to paclitaxel therapy: a mathematical modeling approach* by Benguigui *et al* will appear in Oncotarget, 2017.

Sébastien Benzekry received of the title of Assistant Associate Professor in the Department of Medical Biosciences of Iowa State University, reinforcing a starting collaboration with Jonathan Mochel about PK/PD modeling for comparative oncology.

Two former members of the team (Thierry Colin and Vivien Pianet) were hired by Sophia Genetics (http://www.sophiagenetics.com) to build its new imaging department and developed works initiated in Monc.

5. Highlights of the Year

5.1. Highlights of the Year

- We have completed in [17] our series of studies [8], [12], [6], [2], [4], [3] on the mathematical and numerical analysis of our multiscale model of structured cell populations in terminally developing ovarian follicles.
- We have completed in [19] our series of studies [27], [26], [35], [29], [32] on the mathematical and numerical analysis of our model of GnRH pulse and surge generator.

NUMED Project-Team (section vide)

<p style="text-align:center;color:red;font-weight:bold;">REO Project-Team</p>

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Mikel Landajuela Larma was awarded the 2017 SMAI-GAMNI PhD thesis prize by the French Society of Industrial and Applied Mathematics for his thesis supervised by Miguel Fernández.

<p style="text-align:center;color:red;font-weight:bold;">SISTM Project-Team</p>

5. Highlights of the Year

5.1. Highlights of the Year

Funding by PIA3 of the Bordeaux Graduate's School in Digital Public Health, headed by Rodolphe Thiébaut. This Master/PhD program is built with the expertise coming from the Inria Sistm project team and in collaboration with several other teams (MONC, CARMEN, PHOENIX).

Successful application of integrative analyses tools on high dimensional immunogenicity data from an Ebola vaccine trial with identification of early correlates of later antibody responses [30]

We published a milestone paper in Biometrics comparing descriptive models (Marginal structural models) and mechanistic models (Ordinary differential equations with mixed effect models on parameters). This is impactful as it shows that mechanistic models can adequately estimate a treatment effect in time-varying confounders settings as it is in observational studies. This opens the perspective of in silico trials based on predictions based on the analysis of available cohorts. [26]

We published a robust and powerful statistical method to analyzed longitudinal RNAseq data, largely outperforming state-of-the-art methods. With the surge in RNAseq data production, e.g. in system vaccinology, this principled methodology has a broad impact in deepening our understanding of underlying molecular mechanisms in various contexts, paving the way for further biological innovation. [16]

5.1.1. *Awards*

The University of Bordeaux Initiative of Excellence (IdEx) and Zellidja travel grants for a research PhD student visit of 3 months to the CSIRO's machine learning Data61 team, Canberra, Australia (Perrine Soret).

<p style="text-align:center;color:red;font-weight:bold;">XPOP Project-Team</p>

5. Highlights of the Year

5.1. Highlights of the Year

Eric Moulines was elected at the Académie des Sciences.

The ADT *SPIX* (Analysis of very high-resolution mass spectra) was selected. This project started in November 2017 for a period of one year.

The Math-AmSud project *SaSMoTiDep* (Statistical and Stochastic modeling for time-dependent data) was selected. It begins in January 2018 for a period of two years.