



RESEARCH CENTER

FIELD

Digital Health, Biology and Earth

Activity Report 2014

Section Highlights of the Team

Edition: 2015-06-01

COMPUTATIONAL BIOLOGY

1. ABS Project-Team	5
2. AMIB Project-Team (section vide)	6
3. BAMBOO Project-Team (section vide)	7
4. BEAGLE Project-Team	8
5. BIGS Project-Team (section vide)	9
6. BONSAI Project-Team	10
7. DYLISS Project-Team	11
8. GENSCALE Project-Team	12
9. IBIS Project-Team	13
10. LIFEWARE Team (section vide)	14
11. MAGNOME Project-Team	15
12. MORPHEME Project-Team	16
13. SERPICO Project-Team (section vide)	17
14. VIRTUAL PLANTS Project-Team	18

COMPUTATIONAL NEUROSCIENCE AND MEDECINE

15. ARAMIS Project-Team	19
16. ASCLEPIOS Project-Team	20
17. ATHENA Project-Team	21
18. DEMAR Project-Team (section vide)	22
19. GALEN Project-Team	23
20. MNEMOSYNE Project-Team (section vide)	24
21. NEUROMATHCOMP Project-Team	25
22. NEUROSYS Team	26
23. PARIETAL Project-Team	27
24. POPIX Team	28
25. SHACRA Project-Team	29
26. SISTM Team	31
27. VISAGES Project-Team	32

EARTH, ENVIRONMENTAL AND ENERGY SCIENCES

28. ANGE Project-Team	33
29. CASTOR Project-Team (section vide)	34
30. CLIME Project-Team	35
31. COFFEE Project-Team (section vide)	36
32. FLUMINANCE Project-Team	37
33. KALIFFE Project-Team (section vide)	38
34. LEMON Team	39
35. MAGIQUE-3D Project-Team (section vide)	40
36. MOISE Project-Team (section vide)	41
37. POMDAPI Project-Team (section vide)	42
38. SAGE Project-Team	43

39. STEEP Team	44
40. TONUS Team	45
MODELING AND CONTROL FOR LIFE SCIENCES	
41. BIOCORE Project-Team	46
42. CARMEN Team	47
43. DRACULA Project-Team	48
44. M3DISIM Team	49
45. MAMBA Team	50
46. MASAIE Project-Team	51
47. MODEMIC Project-Team	52
48. MYCENAE Project-Team	53
49. NUMED Project-Team	54
50. REO Project-Team	55
51. SISYPHE Project-Team (section vide)	56

ABS Project-Team

5.1. Highlights of the Year

In 2014, two achievements are worth noticing:

Analysis of large assemblies using native mass spectrometry data. Native mass spectrometry is about to revolutionize structural biology, since such experiments give access to the composition in terms of subunits of large macro-molecular assemblies, usually beyond reach for classical experimental techniques. In this context, we designed an algorithm to infer pairwise contacts within subunits of large macro-molecular assemblies – see section 5.3.1 . To the best of our knowledge, our algorithm is the only one whose performances can be precisely analyzed, the contenders being of heuristic nature.

Analysis and comparison of conformational ensembles and sampled energy landscapes. A key property governing the behavior of many biophysical systems is the classical enthalpy - entropy balance, which is the root of thermodynamics. Therefore, studying the way a protein folds or the way two proteins assemble requires unveiling properties of ensembles of conformations of the system scrutinized. In this context, we designed novel methods to analyze and compare collections of conformations and the associated energy landscape – see section 5.4.1 . The algorithms are based on state-of-the-art techniques from computational topology (Morse theory, Morse homology), and optimal transportation.

AMIB Project-Team (section vide)

BAMBOO Project-Team (section vide)

BEAGLE Project-Team

5.1. Highlights of the Year

We organized two satellite workshops of international conferences:

- The Aevol tutorial during ALife 2014 (July 30 - August 2, New York) <http://www.aevol.fr/alifeTutorial>
- The "Computational Methods and Modeling of Astrocyte Physiology and Neuron-Glia Interactions" workshop during the Computational NeuroScience 2014 conference (July 26 - 31, Quebec City, Canada)

These highlight our active presence in the scientific life of our two sub-domains in major conferences.

BIGS Project-Team (section vide)

BONSAI Project-Team

6.1. Highlights of the Year

- Amandine Perrin received the best paper award and the best oral presentation at the ISCB-LA 2014 international conference for the work on reconstruction of ancestral gene orders.
- H el ene Touzet was invited as a keynote speaker at the ALGO 2014 international conference. The topic of the talk was RNA bioinformatics.

BEST PAPERS AWARDS :

[7] **ISCB-Latin America**. A. PERRIN, J.-S. VARR E, S. BLANQUART, A. OUANGRAOUA.

DYLISS Project-Team

6.1. Highlights of the Year

Four PhD theses were defended this year. They evidenced that ASP-technologies are now mature enough to perform data integration of large-scale bio-molecular datasets: classification of families of proteins [10], reconstruction of regulatory networks [13], reconstruction of metabolic network [11], and modelling of the discrete dynamics of a signalling or a regulatory network [12]. Importantly, symbolic classification technics have been adapted to exhibit relevant biological features: we used both formal concept analysis and semantic-based analysis for sequence and network analysis.

GENSCALE Project-Team

6.1. Highlights of the Year

discoSnp published in NAR. The publication presents a wide range of discoSnp applications that highlight the advantages and the drawbacks of predicting SNPs when no reference genomes are available. The publication witnesses the enthusiasm of users regarding both reference-free methods and the quality of the method. [20]

IBIS Project-Team

5.1. Highlights of the Year

A paper based on the PhD thesis of Diana Stefan was accepted for *PLoS Computational Biology* this year [7].

LIFEWARE Team (section vide)

MAGNOME Project-Team

6.1. Highlights of the Year

In collaboration with colleagues from the Institut du Vigne et du Vin (ISVV), Bordeaux and the Universidade Nova de Lisboa, Lisbon we used a population genomics approach to investigate the global phylogeography and domestication fingerprints of winemaking yeasts, using a collection of isolates obtained from fermented beverages and from natural environments on five continents. These results appeared in *Nature Communications* [11].

MORPHEME Project-Team

5.1. Highlights of the Year

- Laure Blanc-Féraud was General Program chair of the conference IEEE ISBI 2014 in Beijing.

SERPICO Project-Team (section vide)

VIRTUAL PLANTS Project-Team

5.1. Highlights of the Year

- Publication of a joint work with RDP at ENS-Lyon in the journal 'Nature'. In December 2013, a joint work on phyllotaxy with the RDP lab from ENS-Lyon was published online in the journal Nature [2]. This paper obtained the 2014 prize "la Recherche" in the biology category <http://www.leprixlarecherche.com>. Based on the analysis of phyllotaxis perturbations in mutants, this study sheds a new light on our interpretation of phyllotaxis, revisiting the standard model and suggesting that several fields based on auxin and cytokinin with different properties are required to provide robustness to phyllotaxis.
- To study and model morphogenesis, the team has been working in the last 8 years on modeling mechanical forces and deformations in tissues in collaboration with the UMR RDP at ENS-Lyon. This work has given rise to the development of a 3D computational framework to model the mechanics of 3D plant tissues during growth at cellular resolution and has been finalized this year with a publication in PLoS Comp. Biology (to appear in 2015). This framework makes it possible to construct models of meristem development, showing how the regulation of regional identities can lead to realistic shape development by dynamically modulating the mechanical properties of cells. It has been used also to study the influence of a specific signalling cascade (the ABP1-Kat1 signalling pathway) and its putative mechanical consequences on primordium initiation [25]. The expertise gained by our groups on physical models of plant tissue development has been wrapped up in a review paper [12].

ARAMIS Project-Team

6.1. Highlights of the Year

ARAMIS has contributed to the special issue on "Complex network theory and the brain" in the prestigious journal of Philosophical Transactions of the Royal Society, Series B. This work was featured by the ICM (<http://icm-institute.org/en/news/complex-network-theory-and-the-brain?lang=en>) and Inria (<http://www.inria.fr/en/centre/paris-rocquencourt/news/complex-network-theory-and-the-brain>).

ASCLEPIOS Project-Team

5.1. Highlights of the Year

- Nicholas Ayache was elected a **member of the Académie des sciences** on 18th Nov. 2014.
- Nicholas Ayache received the “Grand Prix Inria – Académie des sciences 2014“ for his major contributions to Informatics and Computational Sciences at Inria.
- Nicholas Ayache taught the **"Personalized Digital Patient" course at the Collège de France** on the annual chair "Informatics and Computational Sciences".
- Hervé Lombaert was awarded and ranked 1st in computer science at the highly selective NSERC Postdoctoral Fellowship (Top funding agency in Canada).
- Nina Miolane and Bishesh Khanal won the first prize in the “Popular Vote Awards” at the MIC-CAI 2014 Educational Challenge for their video on “Statistics on Lie groups for Computational Anatomy“.

BEST PAPER AWARD :

[12] **MICCAI Workshop on Abdominal Imaging – Computational and Clinical Applications.** C. AUDIGIER, T. MANSI, H. DELINGETTE, S. RAPAKA, V. MIHALEF, D. CARNEGIE, E. BOCTOR, M. CHOTI, A. KAMEN, D. COMANICIU, N. AYACHE.

ATHENA Project-Team

6.1. Highlights of the Year

Maureen Clerc was awarded the PIERRE FAURRE Prize by the French Academy of Sciences. This award recognizes her outstanding contributions to the modelling and interpretation of electrical signals in the brain. The ceremony took place at the Institut de France on October 14th, 2013.

Emmanuel Caruyer was awarded the AFRIF Best PhD thesis award 2013 for his work “Q-space diffusion MRI: Acquisition and Signal Processing” performed under the direction of Rachid Deriche. He received the award thesis AFRIF 2013 during RFIA Conference held from June 30 to July 4, 2014 in Rouen.

Rachid Deriche was awarded the title of Honorary Doctor (honoris causa) from the University of Sherbrooke, Canada. This award recognises his achievements and contributions to image processing, computer vision and computational brain imaging. The title was awarded at the academic conferment ceremony held on September 20th, 2014 at the University of Sherbrooke.

Théo Papadopoulos has been promoted to the position of Research Director Class 2, starting from October 1st, 2014.

DEMAR Project-Team (section vide)

GALEN Project-Team

6.1. Highlights of the Year

- Handbook of Biomedical Imaging: Methodologies and Clinical Research [38] - co-edited from Nikos Paragios, James Duncan and Nicholas Ayache - has been published from Springer Publishing house.
- Nikos Paragios was admitted as a senior fellow at the Insitut Universitaire de France and has been awarded an IBM Faculty award. He has also been one of the plenary invited lecturers at the IARP International Conference in Pattern Recognition (ICPR'2015, Stockholm).

BEST PAPER AWARD :

[26] **Sparsity Techniques in Medical Imaging (STMI)**. M. MISYRLIS, A. KONOVA, M. BLASCHKO, J. HONORIO, N. ALIA-KLEIN, R. GOLDSTEIN, D. SAMARAS.

MNEMOSYNE Project-Team (section vide)

NEUROMATHCOMP Project-Team

5.1. Highlights of the Year

Olivier Faugeras received the **Okawa prize** for his pioneering contributions for computer vision and for computational neuroscience. The ceremony will be held in Tokyo in March 2015.

NEUROSYS Team

6.1. Highlights of the Year

Microscopic action affects mesoscopic and macroscopic action in neural systems. In the context of general anaesthesia, it is not understood how single neuron properties, such as ion-channel conductivities or anesthetic action on neuron receptors, translate to population dynamics and consequently to behavior. The work of Laure Buhry and Axel Hutt [4] proposes a modelling approach how to bridge the microscopic and the mesoscopic scale. The most interesting aspect is that this model bridge allows to extend standard neural field theory on the mesoscopic scale instead of introducing a new model.

In addition, we have developed strong collaborations with medical doctors. First, we have established a collaboration with Dr. Denis Schmartz and Dr. Claude Meistelmann at the *CHU Nancy* to plan and perform well-controlled resting state experiments under propofol anaesthesia. Second, we are in close contact to Jean-Luc Schaff at the *CHU Nancy* (together with Laurent Koessler at *CRAN*) in the context of sleep monitoring. Dr. Schaff has provided us polysomnographic data measured during sleep of insomnia patients.

PARIETAL Project-Team

6.1. Highlights of the Year

- Congratulations also to Alex and Daniel Strohmeier for their best paper award at the PRNI 2014 conference: “Improved MEG/EEG source localization with reweighted mixed-norms“.
- Elvis Dohmatob got a honorable mention for the student paper award at PRNI 2014 for the work “Benchmarking solvers for TV-l1 least-squares and logistic regression in brain imaging”

POPIX Team

6.1. Highlights of the Year

Marc Lavielle published the book, *Mixed Effects Models for the Population Approach: Models, Tasks, Methods and Tools* (Chapman & Hall/CRC), which presents a rigorous framework for describing, implementing, and using mixed effects models. With these models, readers can perform parameter estimation and modeling across a whole population of individuals at the same time.

SHACRA Project-Team

5.1. Highlights of the Year

5.1.1. Intra-operative guidance

Each year in Europe 50,000 new liver cancer cases are diagnosed for which hepatic surgery combined to chemotherapy is the most common treatment. In particular the number of laparoscopic liver surgeries has increased significantly over the past years. Minimally invasive procedures are challenging for the surgeons due to the limited field of view.

Providing new solutions to assist surgeons during the procedure is of primary interest. This year, the team developed an innovative system for augmented reality in the scope of minimally invasive hepatic surgery. The first issue is to align preoperative data with the intra-operative images. We first proposed a semi-automatic approach [28] for solving the ill-posed problem of initial alignment for augmented reality systems during liver surgery. Our registration method relies on anatomical landmarks extracted from both the laparoscopic images and a three-dimensional model, using an image-based soft-tissue reconstruction technique and an atlas-based approach, respectively.

Second, we introduced a method for tracking the internal structures of the liver during robot-assisted procedures [25]. Vascular network, tumors and cut planes, computed from pre-operative data, can be overlaid onto the laparoscopic view for image-guidance, even in the case of large motion or deformation of the organ. This is made possible by relying on a fast yet accurate 3D biomechanical model of the liver combined with a robust visual tracking approach designed to properly constrain the model. Our augmented reality proved to be accurate and extremely promising on in-vivo sequences of a human liver during robotic surgery.

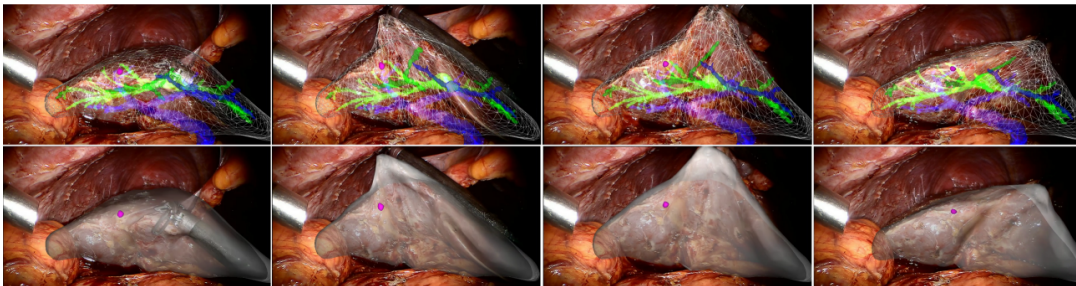


Figure 4. Augmented reality on the liver with 3D visualization of the blood vessels

5.1.2. Ph.D. defenses

The year 2014 was also special since many PhDs have been defended. Four PhD defenses took place with:

- Ahmed Yureidini's defense about *Robust blood vessel surface reconstruction for interactive simulations from patient data* [15] in May 2014,
- Guillaume Kazmitcheff's defense about *Minimal invasive robotics dedicated to otological surgery* [13] in June 2014,
- Hugo Talbot's defense about *Interactive patient-specific simulation of cardiac electrophysiology* [14] in July 2014,
- Alexandre Bilger's defense about *Patient-specific biomechanical simulation for deep brain stimulation* [12] in December 2014.

5.1.3. Organization of ISBMS 2014

The team co-organized the 6th International Symposium on Biomedical Simulation (ISBMS) 2014, which was held in Strasbourg (France) on October 16 – 17, 2014. The ISBMS conference is a well-established scientific meeting that provides an international forum for researchers interested in using biomedical simulation technology for the improvement of patient care and patient safety. The SiMMS group from Imperial College London and IHU-Strasbourg were the two other co-organizers. The event was hosted at IRCAD, a center of excellence in surgical training. The ISBMS chairs were:

- Stéphane Cotin (Inria),
- Fernando Bello (Imperial College London),
- Jérémie Dequidt (Univ. Lille),
- Igor Peterlik (IHU Strasbourg & Masaryk Univ.).

The whole team was involved in the organization of the event. About 65 participants joined the conference. Regarding their feedback, the conference was a real success. For more information about ISBMS, refer to the official website <http://www.isbms.org>.

Finally, a day dedicated to our software SOFA ("SOFA Day") was organized the day after the ISBMS conference. This was the opportunity to introduce SOFA to the ISBMS community and to share with the SOFA users.



(a) Setup of our demo



(b) With Genevieve Fioraso

Figure 5. Presentation of our work at the French National Assembly. Genevieve Fioraso is the French national research secretary

5.1.4. Demonstration at the French National Assembly

On Tuesday 21st January 2014, the team SHACRA presented its work during the "Internet et société numérique" working group. This was a joint event between Inria and the French National Assembly (Assemblée Nationale). On this special occasion, we made a demonstration of our simulations and the CEO from Inria Michel Cosnard also presented more globally the role of Inria in healthcare but also education, cloud computing, big data.

SISTM Team

6.1. Highlights of the Year

A work (described below), in collaboration with M. Davis and R. Tibshirani from Stanford University, has been published in the "Proceedings of the National Academy of Sciences" : [8].

Females have generally more robust immune responses than males for reasons that are not well-understood. Here we used a systems analysis to investigate these differences by analyzing the neutralizing antibody response to a trivalent inactivated seasonal influenza vaccine (TIV) and a large number of immune system components, including serum cytokines and chemokines, blood cell subset frequencies, genome-wide gene expression, and cellular responses to diverse in vitro stimuli, in 53 females and 34 males of different ages. We found elevated antibody responses to TIV and expression of inflammatory cytokines in the serum of females compared with males regardless of age. This inflammatory profile correlated with the levels of phosphorylated STAT3 proteins in monocytes but not with the serological response to the vaccine. In contrast, using a machine learning approach, we identified a cluster of genes involved in lipid biosynthesis and previously shown to be up-regulated by testosterone that correlated with poor virus-neutralizing activity in men. Moreover, men with elevated serum testosterone levels and associated gene signatures exhibited the lowest antibody responses to TIV. These results demonstrate a strong association between androgens and genes involved in lipid metabolism, suggesting that these could be important drivers of the differences in immune responses between males and females.

VISAGES Project-Team

6.1. Highlights of the Year

Dr Camille Maumet was awarded by the French Society of Magnetic Resonance in Biology and Medicine (SFRMBM) for her PhD Thesis on analysis of neuroimaging data including images from functional Magnetic Resonance Imaging (fMRI) and Arterial Spin Labeling <http://www2.warwick.ac.uk/fac/sci/wmg/idh/idhnews/?tag=Neural+Engineering>.

Dr Americ Stamm was awarded by the Univ. of Rennes I foundation as the best PhD thesis in Math, Computer Sciences and Electrical Engineering. This award is dedicated for the PhDs having the highest potential for innovation and technological transfer
;ses-de-la-fondation<https://fondation.univ-rennes1.fr/les-prix-de-thèses-de-la-fondation>.

ANGE Project-Team

6.1. Highlights of the Year

In 2014, ANGE status turned from Inria team to Inria project-team. Afterwards, M. Parisot was recruited by Inria as a junior researcher.

CASTOR Project-Team (section vide)

CLIME Project-Team

6.1. Highlights of the Year

BEST PAPER AWARD :

[20] **VISAPP - International Conference on Computer Vision Theory and Applications.** D. BÉRÉZIAT, I. HERLIN.

COFFEE Project-Team (section vide)

FLUMINANCE Project-Team

6.1. Highlights of the Year

6.1.1. Stochastic fluid flow dynamics under uncertainty

We have proposed the basis of a formalism allowing to built large scale stochastic representation of fluid flows dynamics [17]. This formalism relies on a location uncertainty principle which separates the flow in terms of a resolved large scale component and a highly oscillating random component. The dynamics is built in a similar way as in the deterministic case through a stochastic representation of the Reynolds transport theorem. This principle paves a new way for the construction of subgrid models from the uncertainties we have on the flow. The associated subgrid tensor provides a clear interaction between small scale data and large scale resolved quantities. This characteristic opens new directions for the devising of methods for the numerical simulation of large scale components of the flow. It allows also deriving large-scale models that takes into account explicitly the inherent errors to a particular geophysical dynamics representation.

KALIFFE Project-Team (section vide)

LEMON Team

6.1. Highlights of the Year

Antoine ROUSSEAU and 5 co-authors released in 2014 the book *Brèves de Maths* [16]. This work (in french) selected more than 100 posts from the [blog breves-de-maths.fr](http://blog.breves-de-maths.fr), in the framework of the international initiative “Mathematics of the Planet Earth”. In this book (see cover 5), no complicated numbers, no weird equation, but short and clear sentences together with nice drawings to illustrate everyday life topics on our planet with the beauty of mathematics.



Figure 5. *Brèves de Maths*. Ed. Nouveau Monde, 2014

MAGIQUE-3D Project-Team (section vide)

MOISE Project-Team (section vide)

POMDAPI Project-Team (section vide)

SAGE Project-Team

6.1. Highlights of the Year

Lionel Lenôtre and his co-authors revisited in a very efficient way the Hastings-Metropolis Algorithm on Markov Chains for Small-Probability Estimation.

STEPP Team

6.1. Highlights of the Year

This year has seen a number of major advances in the team research projects, on several fronts. The first one concerns the most important and time consuming project, namely integrated land use, activity and transport modelling (LUTI modelling). In this respect, the results described in 6.8 below constitute probably the first set of works contributing sophisticated numerical procedures to the calibration and validation of the TRANUS LUTI model.

The second significant breakthrough concerns the completion of a downscaling method for Material Flow Analysis (MFA), a key aspect in the characterization and understanding of territorial metabolism for decision-help purposes (section 6.2).

Finally, the modelling effort on land use change for the ESNET project has now been mostly completed, and an operational LUCC model has been calibrated and validated for this project (section 6.3).

TONUS Team

6.1. Highlights of the Year

We have implemented an OpenCL task graph version of our Discontinuous Galerkin solver that allows to overlap GPU computations and MPI communications. With this optimizations, we were recently able to achieve a 14 GFLOPS simulation with 8 GPUs on an electromagnetic test case. These results are included in the PhD of Thomas Strub (defence planned in March 2015) under the supervision of Philippe Helluy.

BIOCORE Project-Team

6.1. Highlights of the Year

- We reanalyzed the so-called Marginal Value Theorem (MVT), first published in 1976, in a paper published in Ecology Letters [23]. This theorem, also used in human behavior and economics, establishes how individuals should behave to optimize resource exploitation. Despite the thousands of papers written on the subject, we obtained the first mathematical characterization of how habitat characteristics affect the optimal foraging strategy. Mathematical foundations for this work were given in [24].
- The analysis of metabolic networks is generally made under the assumption (so called "balanced growth") that there is no internal accumulation of metabolites. However, this hypothesis is clearly wrong for microalgae, which store lipids and carbohydrates during the day and consume it during the night. A new formalism, called DRUM (Dynamic Reduction of Unbalanced Metabolism) was developed [16], assuming that the balanced growth is valid only in subnetworks, but that there can be accumulation between these modules (which often represent spatial distribution in the cell). This approach was successfully used to represent the dynamics of carbon accumulation in the microalgae *Tisochrysis lutea* under light/dark cycles, or in response to a nitrogen starvation. It also well described the diauxic heterotrophic growth of *Chlorella pyrenoidosa* [11].

CARMEN Team

6.1. Highlights of the Year

- New associated team EPICARD (principal investigator N. zemzemi, Y. Coudière and J. Henry). The aim of of this associated team for the first year is to overcome the technical difficulties that we pointed out during the year 2014 in inverse problem for the heart.
- June 2014: Based on a peer-reviewed proposal, the Grand équipement national de calcul intensif (GENCI) has attributed us 3 million core-hours on the national high-performance computing system Turing, to be used in the year 2014.
- December 2014: Based on a peer-reviewed proposal, the Grand équipement national de calcul intensif (GENCI) has attributed us 3.5 million core-hours on the national high-performance computing machines Turing, Curie, and Occigen, to be used in the year 2015.
- LIRYC will fund a 2-year postdoctoral position on simulation of Brugada syndrome, a rare ECG anomaly predictive of sudden cardiac death in young, apparently healthy subjects. This work will be performed in tight collaboration with clinicians at the Haut-Lévêque hospital

DRACULA Project-Team

6.1. Highlights of the Year

- Marine Jacquier and Fabien Crauste (in collaboration with C.O. Soulage and H.A. Soul) published a paper ([18], see also § 6.7) in PLoS ONE 2014.
- Sotiris Prokopiou, Loic Barbarroux, Samuel Bernard, Olivier Gandrillon and Fabien Crauste (in collaboration with J. Mafille, Y. Leverrier, C. Arpin and J. Marvel) published a paper ([21], see also § 6.2) in Computation 2014.
- We organized a session "Deterministic and stochastic models in biology and medicine" at 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Madrid (Spain), 7 - 11 July 2014 <http://www.aimsociences.org/conferences/2014/>.
- Our project entitled "Prion and Alzheimer: mathematical modeling and experiments dealing with a dangerous liaison" has been granted by the French Association France Alzheimer, and has been selected with 3 other projects amongst 14 supported works to be part of a scientific popularizing broadcasting campaign through a short scientific cartoon <http://www.francealzheimer.org/projets-soutenus-cette-ann%C3%A9e/lab-alz-comprendre-enjeux-recherche/964> and <https://www.youtube.com/watch?v=X0mLf8IJhV4&list=PLCq-e7n2r6Wgo3kaseDHetNAPAG7y9B-d>.

M3DISIM Team

6.1. Highlights of the Year

- Radomir Chabiniok recruited in starting research position (start Febr 2015);
- PhD Defense of Annabelle Collin;
- “Usine Nouvelle” article.

MAMBA Team

6.1. Highlights of the Year

Benoît Perthame was invited as plenary speaker for the International Congress of Mathematicians ICM 2014 (Seoul, <http://www.icm2014.org>), that attracted more than 5000 participants. This is the first time that a mathematician working in mathematics applied to biology was invited at ICM, which is the most prestigious conference for mathematicians of all fields. This represents a consecration both for Benoît Perthame's work and for the MAMBA team, and more generally for the whole domain of mathematics applied to biology.

Marie Doumic was a plenary speaker at the ECMTB 2014 (Göteborg, <http://ecmtb2014.org/> 600 participants).

Dirk Drasdo was invited speaker at the Systems Biology of Human Diseases conference (Harvard University, <http://www.csb2.org/events/sbhd-2014>).

Five articles are noteworthy in terms of bibliometry:

- (*Impact factor 11.2*) F. SCHLISS, S. HOEHME, S. HENKEL, A. GHALLAB, D. DRIESCH, J. BÖTTGER, R. GUTHKE, M. PFAFF, J. HENGSTLER, R. GEBHARDT, D. HÄUSSINGER, D. DRASDO, S. ZELLMER. Integrated metabolic spatial-temporal model for the prediction of ammonia detoxification during liver damage and regeneration, *Hepatology*, Dec. 2014, vol. 60, no 6, pp. 2040-2051, <https://hal.inria.fr/hal-01110646> [17]
- (*Impact factor 10.4*) D. DRASDO, S. HOEHME, J. G. HENGSTLER. How predictive quantitative modeling of tissue organization can inform liver disease pathogenesis, *Journal of Hepatology*, Oct. 2014, vol. 61, no 4, pp. 951-956 [DOI : 10.1016/J.JHEP.2014.06.013], <https://hal.inria.fr/hal-01110644> [7]
- (*Impact factor 10.7*) S.R.K. VEDULA, G. PEYRET, I. CHEDDADI, T. CHEN, A. BRUGUÉS, H. HIRATA, H. LOPEZ-MENENDEZ, Y. TOYAMA, L. NEVES DE ALMEIDA, X. TREPAT, C.T. LIM, B. LADOUX. Mechanics of epithelial closure over non-adherent environments, *Nature Communications*, Jan. 2015, vol. 6, art. number 6111 [DOI : 10.1038/ncomms7111], <http://www.nature.com/ncomms/2015/150122/ncomms7111/abs/ncomms7111.html> (open access)
- (*Impact factor 7.5*) L. ROBERT, M. HOFFMANN, N. KRELL, S. AYMERICH, J. ROBERT, M. DOUMIC. Division in *Escherichia coli* is triggered by a size-sensing rather than a timing mechanism, in "BMC Biology", 2014, vol. 12, no 1, 17 p. [DOI : 10.1186/1741-7007-12-17], <https://hal.inria.fr/hal-00981312> [16]
- (*Impact factor 9.3*) R. H. CHISHOLM, T. LORENZI, A. LORZ, A. K. LARSEN, L. ALMEIDA, A. ESCARGUEIL, J. CLAIRAMBAULT. Emergence of drug tolerance in cancer cell populations: an evolutionary outcome of selection, nongenetic instability and stress-induced adaptation, *Cancer Research* (Mathematical oncology), 10p.+suppl. mat., in press, Jan. 2015, <https://hal.archives-ouvertes.fr/hal-0111271> [33]

MASAIE Project-Team

5.1. Highlights of the Year

The estimation of sequestered parasite population has been a challenge for the biologist and modeler, with many authors having studied this problem. The difficulty is that the infected erythrocyte leaves the circulating peripheral blood and binds to the endothelium in the microvasculature of various organs. A measurement of *Plasmodium falciparum* parasitaemia taken from a blood smear therefore samples young parasites only and there is no clinical methods to measure the sequestered parasites. We have developed a simple tool to estimate the sequestered parasites and hence the total parasite burden for *Plasmodium falciparum* malaria patients. We have also given a method to estimate a crucial parameter in the model of infection. This parameter β can be thought as the "transmission/invading" factor between merozoites and erythrocytes. This work [9] has been published in "Mathematical Biosciences and Engineering".

MODEMIC Project-Team

6.1. Highlights of the Year

Yeasts play a central role in the wine making process. To study the yeasts in a stable environment and physiological state, a Multi-Stage Continuous Fermentor (MSCF) has been designed by the research Unit SPO (Sciences For Oenology). This device mimics the steps of the batch fermentation process. In this paper, the problem of the control of the sugar concentrations in each of the four reactors of the MSCF is considered. The cascade structure of the device leads to a constraint on the input flow rates (the control variables). A control strategy based on a linearizing control law coupled with a state observer and an anti windup component is proposed and finally implemented on the experimental process (see also 6.3.2).

BEST PAPER AWARD :

[41] **19th IFAC World Congress 2014**. C. CASENAVE, D. DOCHAIN, J. HARMAND, M. PEREZ, A. RAPAPORT, J.-M. SABLAYROLLES.

MYCENAE Project-Team

6.1. Highlights of the Year

- Picture of the Conference poster of the **2014 SIAM annual meeting** (July 7-11, Chicago, USA), adapted from [7]
- Invitation to organize the mini symposium “The stochastic brain” at the **Stochastic Processes and Applications Conference** (Jul 28-Aug1, Buenos-Aires, Argentina)
- Selection of the NeuroMathMod project in the framework of the Sorbonne Université **Emergence 2014 call**

NUMED Project-Team

5.1. Highlights of the Year

Vincent Calvez has been awarded an ERC Grant and the prestigious Bronze medal CNRS.

REO Project-Team

6.1. Highlights of the Year

- Jimmy Mullaert was awarded the best poster prize at the conference Canum 2014.
- Jessica Oakes was awarded a University of California Presidential Postdoctoral Fellowship.
- Jessica Oakes won a young investigator award at the “4th International Conference on Engineering Frontiers in Pediatric and Congenital Heart Disease”.

SISYPHE Project-Team (section vide)