Activity Report 2018

Section Partnerships and Cooperations

ABS Project-Team

6. Partnerships and Cooperations

6.1. International Research Visitors

6.1.1. Visits of International Scientists

6.1.1.1. Internships

- Internship of Maria Guramare, Harvard University, Cambridge, Massachusetts. Supervision: Frédéric Cazals and Dorian Mazauric. *Shortest Paths under Constraints Problem with Application for Structural Alignments.*

- Internship of Xuchun Zhang, École Polytechnique de l'Université Nice Sophia Antipolis, filière Mathématiques Appliquées et Modélisation, year 4 (Master 1). Supervision: Jean-Baptiste Caillau (Inria project-team McTao), Enzo Giusti (startup Oui!Greens), Dorian Mazauric, and Joanna Moulierac (Inria/I3S project-team Coati). *Problèmes d'affectations d'annonces dans un réseau anti gaspillage !*

- Project of Ruiqing Chang and Xuchun Zhang, École Polytechnique de l'Université Nice Sophia Antipolis, Filière Mathématiques Appliquées et Modélisation, year 4 (Master 1). Supervision: Jean-Baptiste Caillau (Inria project-team McTao), Enzo Giusti (startup Oui!Greens), Dorian Mazauric, and Joanna Moulierac (Inria/I3S project-team Coati). *Problèmes d'affectations d'annonces dans un réseau anti gaspillage !*

- Internship of Nguyen Thi Viet Ha, Master 2 Fundamental Computer Science, École Normale Supérieure de Lyon. Supervision: Frédéric Havet (Inria/I3S project-team Coati), Dorian Mazauric, and Rémi Watrigant (École Normale Supérieure de Lyon and Université Claude Bernard Lyon 1). *Graph Algorithms for low resolution model of large protein assemblies.*

- Internship of Timothée O'Donnell, Master 2 University Paris Saclay, Master bioinformatique. *Structural modeling of FMRP dimers in solution*. Supervision: F. Cazals.

ACUMES Project-Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FK32

Title: Multi-agent Fokker-Planck Nash games

Programm: Bayerisch-Französische Hochschulzentrum / Centre de Coopération Univ. Franco-Bavarois (BFHZ-CCUFB)

Duration: January - December 2018

PIs: A. Borzi (Univ. Wuerzburg) and A. Habbal

The purpose of this project is the formulation and application of a new mathematical framework for modeling avoidance and/or meeting in multi-agents' motion in the framework of differential games with stochastic processes and related Fokker-Planck equations.

8.1.2. FP7 & H2020 Projects

8.1.2.1. TramOpt

Title: A Traffic Management Optimization platform for enhanced road network efficiency

Programm: H2020

Duration: Mai 2017 - Octobre 2018

Coordinator: Inria

Inria contact: Paola Goatin

Building on the advances of the ERC TRAM3 project, the TRAMOPT PoC project aims are twofold:

- developing a robust prototype to allow real-life testing and deployment of a novel traffic control Decision Support System (DSS) based on a software platform for road traffic management including variable speed limits, ramp-metering and re-routing policies. This DSS is intended for public and private traffic managers to increase freeway network performances (e.g. congestion and pollution reduction);
- assessing the exploitation perspectives through a dedicated market study evaluating the added value of TRAMOPT over existing solutions and identifying the best business approach to foster uptake and commercialization of our technology.

8.2. International Initiatives

8.2.1. NAMReD

Program: Program Hubert Curien PHC Utique (Tunisia)

Project acronym: NAMReD

Project title: Novel Algorithms and Models for Data Reconstruction

Duration: January 2018 - December 2020

Coordinator: A. Habbal and M. Kallel (Univ. Tunis al Manar)

Abstract: The project goal is the design of new and efficient algorithms tailored for data reconstruction involving ill-posed problems. We rely on an original use of game theory and p-Kirchhoff methods. We apply these approaches for missing data recovery and image restoration.

8.2.2. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

8.2.2.1. NOLOCO

Title: Efficient numerical schemes for non-local transport phenomena

International Partner (Institution - Laboratory - Researcher):

Universidad del Bio-Bio (Chile) - Department of Mathematics - Luis Miguel Villada Osorio

Start year: 2018

See also: https://team.inria.fr/acumes/assoc-team/noloco/

This project tackles theoretical and numerical issues arising in the mathematical study of conservation laws with non-local flux functions. These equations include in a variety of applications, ranging from traffic flows to industrial processes and biology, and are intended to model macroscopically the action of non-local interactions occurring at the microscopic level.

The team, bi-located in France and Chile, has complementary skills covering the analysis, numerical approximation and optimization of non-linear hyperbolic systems of conservation laws, and their application to the modeling of vehicular and pedestrian traffic flows, sedimentation and other industrial problems.

Based on the members' expertise and on the preliminary results obtained by the team, the project will focus on the following aspects: - The development of efficient, high-order finite volume numerical schemes for the computation of approximate solutions of non-local equations. - The sensitivity analysis of the solutions on model parameters or initial conditions

The impact of the project is therefore twofold: while addressing major mathematical advances in the theory and numerical approximation of highly non-standard problems, it puts the basis for innovative tools to handle modern applications in engineering sciences.

8.2.3. Inria International Partners

8.2.3.1. ORESTE

Title: Optimal REroute Strategies for Traffic managEment

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science (EECS) (EECS) - Alexandre M. Bayen

Duration: 2018 - 2022

Start year: 2018

See also: https://team.inria.fr/acumes/assoc-team/oreste

The rapidly changing transportation ecosystem opens new challenges in traffic modeling and optimization approaches. We will focus in particular on the two following aspects:

Route choice apps impact. The vast use of personal route choice systems through phone applications or other devices is modifying the traditional flow of networks, requiring new models for accounting of the guidance impact. Indeed, routing apps have changed traffic patterns in the US and Europe, leading to new congestion patterns where previously no traffic was observed. Over the last decade, GPS enabled smart phones and connected personal navigation devices have disrupted the mobility landscape. Initially, the availability of traffic information led to better guidance of a small portion of motorists in the system. But as the majority of the driving public started to use apps, the systematic broadcasting of "selfish" best routes led to the worsening of traffic in numerous places, ultimately leading to the first lawsuit against one specific company in particular (Waze) accused to be the cause of these problems. This is just the beginning of an evolution, which, if not controlled and regulated, will progressively asphyxiate urban landscapes (already nearly hundreds of occurrences of this phenomenon are noticed by the popular media, which indicates the presence of probably

thousands of such issues in the US alone). Traffic managers are typically not equipped to fix these problems, and typically do not fund this research, as in order to be able to regulate and fix the problem, fundamental science needs to be advanced, modeling and game theory in particular, so remediation can happen (for which the traffic managers are equipped). In this project, we will mainly focus on the development and study of new macroscopic dynamical models to describe the aforementioned phenomena, and we will explore control strategies to mitigate their impact.

Autonomous vehicles. Besides, the foreseen deployment of connected and autonomous vehicles (CAVs) opens new perspectives both in traffic modeling and control. Indeed, CAVs are expected to modify the classical macroscopic traffic dynamics due to their peculiar motion laws, which are more uniform than human drivers' and follow different rules. Besides, due to their extended information on neighboring traffic conditions, the resulting dynamics would have a non-local character, justifying the use of rapidly developing non-local models. In any case, the different behavior of autonomous vehicles requires the design of new multi-class models capable of accounting for different vehicle classes characteristics and mutual interactions. Moreover, CAVs could be used as endogenous variable speed limiters, thus providing new action points to control traffic flow. Preliminary results show that the presence of few controlled vehicles can positively affect traffic conditions. In this setting, the interaction of AVs with the surrounding traffic can be described by strongly coupled PDE-ODE systems, which have been largely studied by the ACUMES team. Yet, the study of CAVs impact in realistic situations requires further research, in particular towards model validation, for which the Berkeley team will provide the necessary data.

8.2.3.2. Informal International Partners

University of Brescia, Information Engineering (R.M. Colombo: http://rinaldo.unibs.it/)

University of Mannheim, Scientific Computing Research Group (SCICOM) (S. Göttlich: http://lpwima.math.uni-mannheim.de/de/team/prof-dr-simone-goettlich/)

University of Rutgers - Camden, Department of Mathematical Science (B. Piccoli: https://piccoli.camden.rutgers.edu/)

University of Texas Arlington (S. Roy, https://mentis.uta.edu/explore/profile/souvik-roy)

Technical University of Kaiserslautern - Department of mathematics (B. Simeon https://www.mathematik.uni-kl.de/en/das/people/head/simeon/)

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- M.D. Rosini (January 2018, Lublin University): co-direction of N. Dymski's PhD thesis.
- R.M. Colombo (July 2018, Brescia University): well-posedness of Initial Boundary Value Problems.
- L.M. Villada (September 2018, University of Bio-Bio): finite volume schemes for non-local systems of conservation laws.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

- N. Laurent-Brouty visited UC Berkeley (A. Bayen) for 1 month in April-May 2018.
- E. Rossi visited Mannheim University (S. Göttlich) for 1.5 months in September-October 2018.

AROMATH Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Our team AROMATH participates to the VADER project for VIRTUAL MODELING of RESPIRATION, UCA Jedi, axis "Modélisation, Physique et Mathématique du vivant". http://benjamin.mauroy.free.fr/VADER.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

Program: Marie Skłodowska-Curie ITN

Project acronym: ARCADES

Project title: Algebraic Representations in Computer-Aided Design for complEx Shapes

Duration: January 2016 - December 2019

Coordinator: I.Z. Emiris (NKUA, Athens, Greece, and ATHENA Research Innovation Center)

Scientist-in-charge at Inria: L. Busé

Other partners: U. Barcelona (Spain), Inria Sophia Antipolis (France), J. Kepler University, Linz (Austria), SINTEF Institute, Oslo (Norway), U. Strathclyde, Glascow (UK), Technische U. Wien (Austria), Evolute GmBH, Vienna (Austria).

Webpage: http://arcades-network.eu/

Abstract: ARCADES aims at disrupting the traditional paradigm in Computer-Aided Design (CAD) by exploiting cutting-edge research in mathematics and algorithm design. Geometry is now a critical tool in a large number of key applications; somewhat surprisingly, however, several approaches of the CAD industry are outdated, and 3D geometry processing is becoming increasingly the weak link. This is alarming in sectors where CAD faces new challenges arising from fast point acquisition, big data, and mobile computing, but also in robotics, simulation, animation, fabrication and manufacturing, where CAD strives to address crucial societal and market needs. The challenge taken up by ARCADES is to invert the trend of CAD industry lagging behind mathematical breakthroughs and to build the next generation of CAD software based on strong foundations from algebraic geometry, differential geometry, scientific computing, and algorithm design. Our game-changing methods lead to real-time modelers for architectural geometry and visualisation, to isogeometric and design-through-analysis software for shape optimisation, and marine design & hydrodynamics, and to tools for motion design, robot kinematics, path planning, and control of machining tools.

7.3. International Initiatives

7.3.1. Inria International Partners

NSFC collaboration project with Gang Xu, Hangzhou Dianzi University, China, "Research on theory and method of time-varying parameterization for dynamic isogeometric analysis", 2018-2021.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Aron Simis, University of Recife, Brazil, visited L. Busé for a week (October 8-12) to work on birationality of rational map by means of syzygy-based techniques.

Ibrahim Adamou, Univ. Dan Dicko Dankoulodo de Maradi, Niger, visited B. Mourrain (26 Nov.- 21 Dec.) to work on 3-dimensional VoronoïDiagrams of half-lines and medial axes of curve arcs.

7.4.1.1. Internships

Yairon Cid Ruiz, a PhD srudent at Barcelona in the Arcades network, visited L. Busé for 6 months (October 2017- March 2018) to work on birationality criteria for multi-graded rational maps with a view towards free form deformation problems.

Clément Laroche, a PhD student in Greece in the Arcades network, visited L. Busé and F. Yildirim for one month (October) for a collaboration on implicization matrices of rational curve in arbitrary dimension by means of quadratic relations.

Kim Perriguey, did a six months internship with L. Busé (December 2017-May 2018). She developed paramteric models for the human walk for the extraction of locomotive parameters. This work was done in collaboration with Pierre Alliez (EPI Titane) and the start-up Ekinnox (Sophia Antipolis).

7.4.2. Visits to International Teams

7.4.2.1. Research Stays Abroad

F. Yildirim was on secondment at MISSLER Topsolid (France), for 3 months (Mai-July).

From October 25th to November 25th, E. Hubert visited the Institute for Computational and Experimental Research in Mathematics (Providence USA) during the program *Nonlinear Algebra*.

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

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Université Côte d'Azur projects*

7.1.1.1. *Tech-ICOPA*

Participants: Maureen Clerc, Théodore Papadopoulo, Sofiane Guebba, Marie-Hélène Soriani [CHU Nice], Mariane Bruno [CHU Nice], Violaine Guy [CHU Nice].

Duration: 24 months

Improving autonomy is a main priority for people with disabilities. The goal of this project is to create a version usable by patients at their home of a brain-computer interface (BCI) research prototype system developped in our project-team. Making this technology actually usable in the context of pathology inducing severe disabilities such as ALS (Amyotrophic Lateral Sclerosis) is a challenge. Tackling this challenge would allow both to meet the expectations of dependent people and to envision a more widespread use of this technology. To reach this goal, several technological advances and industrial developments are needed : (i) developing a suitable ergonomic headset, wireless, functional, comfortable, incorporating a miniaturized amplifier (Nice University Hospital Center - ALS Center), (ii) reducing the number of electrodes while maintaining signal quality (Inria - UCA) and (iii) testing the prolonged use of dry electrodes. In addition to these technological advances, the Tech-ICOPA translational project aims at (1) improving the use of BCI in communication, in accessing the digital world, home automation and robotics and (2) enhancing the use of BCI in commercial applications.

7.1.1.2. *EPI-ANALYSE*

Participants: Fabrice Duprat [IPMC], Théodore Papadopoulo, Massimo Mantegazza [IPMC], Maureen Clerc.

Duration: 12 months

This project aims at developing two complementary analysis softwares dedicated to the detection of epileptic seizures in mice in order to study epileptogenesis and the consequences of spontaneous seizures. The first software will be the adaptation to the mouse EEG of a powerful algorithm based on a dictionary learning method developed by our project-team. We will use video-EEG recordings already made and analyzed at the IPMC to optimize and validate the new software. This will allow a detailed analysis of seizures and events occurring between seizures (e.g., interictal spikes). The second software deals with the analysis of video recordings of 3 models of mice not recordable until now with EEG. The implementation, recordings and the analysis of the 3 models will be carried out during this project. A prototype of this software already exists at IPMC (in Python, with OpenCV) but the analysis algorithm must be optimized. Semi-automatic video analysis will allow an easy identification of temporal segments corresponding to epileptic seizures. This will help the experimenter to classify the behavioral severity of seizures.

7.1.1.3. *MICADome*

Participants: Maureen Clerc, Michel Pascal [CNR Nice].

Duration: 24 months

The MICA-Dome project (MICA : Musique Interactive Côte d'Azur) initiates collaborative research between arts, science and humanities within a laboratory for exploring the sound spatialization in 3D, and its usage for an immersive music composition. For this MICADome will be equipped with a "Dome" of loudspeakers for 3D spatialization. Our team collaborates in MICADome in order to develop and anlyze EEG experiments to analyze the neural correlates of spatial auditory attention.

7.2. National Initiatives

7.2.1. *Inria Project Lab*

7.2.1.1. IPL BCI-LIFT

Participants: Maureen Clerc, Théodore Papadopoulo, Nathalie Gayraud, Federica Turi, Romain Lacroix.

Duration: *January 2015 to December 2018*

The Inria Project-Lab BCI-LIFT is an Inria-funded reasearch consortium to foster collaborative research on Brain-Computer Interfaces on the topic of Learning, Interaction, Feedback and Training. It is coordinated by Maureen Clerc. Its members are from 6 Inria teams: ATHENA, CAMIN, HYBRID, MJOLNIR, NEUROSYS, PO-TIOC, and from Dycog team from CRNL Lyon, and University of Rouen. The goal is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. For more information, refer to the BCI-LIFT website.

7.2.2. *ANR*

7.2.2.1. ANR NeuroRef

Participants: Demian Wassermann [Inria Parietal], Antonia Machlouziredes, Guillermo Gallardo Diez, Rachid Deriche.

Duration: *October 2016 to September 2019*
Call: *NSF-ANR Program Collaborative Research in Computational Neuroscience 2015*

This project is a collaboration with Pr. S. Bouix and his team at the Psychiatry NeuroImaging Lab, Dept of Radiology, Brigham and Women's Hospital, Harvard Medical School (USA) to build MRI reference atlases to analyze brain trauma and post-traumatic stress. The goal is to develop a robust framework to perform subject-specific neuroimaging analyses of Diffusion MRI (dMRI), as this modality has shown excellent sensitivity to brain injuries and can locate subtle brain abnormalities that are not detected using routine clinical neuroradiological readings.

7.2.2.2. ANR MOSIFAH

Participants: Rachid Deriche, Abib Olushola Yessouffou Alimi, Rutger Fick [TheraPanacea, Paris], Demian Wassermann [Inria Parietal], Théodore Papadopoulo.

Duration: *October 2013 to September 2018*
Call: *ANR Numerical Models 2013*

This ANR project is about multimodal and multiscale modelling and simulation of the fiber architecture of the human heart. It started on October 2013 and involves three partners: Creatis Team, INSA, Lyon (I. Magnin, Y. Zhu); TIMC-IMAG, CNRS, Grenoble (Y. Uson) and the ATHENA project team.

It consists in modelling and simulating the ex vivo and in vivo 3D fiber architectures at various scales using multiphysical data from different imaging modalities working at different spatial resolutions. To this end, the myocardium of the human heart will be imaged using respectively Polarized Light Imaging (PLI) and dMRI.

7.2.2.3. ANR VIBRATIONS

Participants: Théodore Papadopoulo, Maureen Clerc, Rachid Deriche, Demian Wassermann [Inria Parietal].

Duration: *February 2014 to February 2019*
Call:ANR Programme de Recherche Translationnelle en Santé (PRTS) 2013

The VIBRATIONS project proposes to simulate in a biologically realistic way MEG and EEG fields produced by different configurations of brain sources, which will differ in terms of spatial and dynamic characteristics. The research hypothesis is that computational and biophysical models can bring crucial information to clinically interpret the signals measured by MEG and EEG. In particular, they can help to efficiently address some complementary questions faced by epileptologists when analyzing electrophysiological data.

7.2.3. ADT

7.2.3.1. ADT BCI-Browser

Participants: Théodore Papadopoulo, Maureen Clerc.

Duration: 1 year

Most often, BCI techniques are demonstrated in simple toy applications made. The only "few" real BCI applications are specific developments and are not used much as they lack of functionality, maintenance, ... The goal of this development contract is to demonstrate a new approach to BCI, in which BCI interactions are integrated in existing applications. Ideally, the original software is not modified and not even recompiled. It is modified by providing either modified GUI libraries or providing extensions as plugins. As a proof of concept, we aim at modifying C++/Qt applications with a focus on web browsing, by redefining some of its basic interactions (mouse clicks, keyboard, ...) using some BCI components. In this manner, it might be possible to drive standard and state-of-the-art application using BCI and at a limited maintenance cost.

This contract is part of the AMDT initiative.

7.2.3.2. ADT BOLIS 2

Participants: Théodore Papadopoulo, Juliette Leblond [FACTAS project-team], Jean-Paul Marmorat [CMA Ecole des Mines Paritech].

Duration: *6 months.*

This contract is a follow-up of ADT BOLIS which aimed at building a sofware platform dedicated to inverse source localisation, building upon the elements of software found in FindSources3D. The platform is modular, ergonomic, accessible and interactive and offers a detailed visualisation of the processing steps and the results. Its goal is to provide a convenient graphical interface and a tool that can be easily distributed and used by professionals (target audience: clinicians and researchers). BOLIS 2 aims at simplifying some maintenance aspects of the software.

This contract is part of the AMDT initiative.

7.2.3.3. ADT OpenMEEG

Participants: Théodore Papadopoulo, Maureen Clerc, Kostiantyn Maksymenko, Alexandre Gramfort [PARIETAL], Joan Massich [PARIETAL].

Duration: *24 months.*

The OpenMEEG ADT aims at improving OpenMEEG along 3 main directions:

1. Offer a user interface for the creation and verification of head models most importantly for a simpler management of non-nested head models.

2. Improve the Python interface (extension and reliability). This will also be useful to develop new research axes (in connection with point 3).

3. Enrich the available operators and refactor the code to offer new possibilities in OpenMEEG and reduce the cost of maintenance.

In addition to the expected gains in code maintenance, these improvements will allow a number of new – more sophisticated – applications as well as open OpenMEEG to a larger audience with a simplified interface for classical use-cases.

This contract is part of the AMDT initiative.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. ERC AdG CoBCoM

Program: H2020-EU.1.1. (ERC-ADG-2015 - ERC Advanced Grant)

Project acronym: CoBCoM - **ID:** 694665

Project title: *Computational Brain Connectivity Mapping*

Start date: 2016-09-01, End date: 2021-08-31

P.I. : R. Deriche

Partners: ATHENA project-team

Abstract:

One third of the burden of all the diseases in Europe is due to problems caused by diseases affecting brain. Although exceptional progress has been obtained for exploring it during the past decades, **the brain is still terra-incognita** and calls for specific research efforts to better understand its architecture and functioning.

CoBCoM is our response to this great challenge of modern science with the overall goal to **develop a joint Dynamical Structural-Functional Brain Connectivity Network** (DSF-BCN) solidly grounded on advanced and integrated methods for diffusion Magnetic Resonance Imaging (dMRI) and Electro & Magneto-Encephalography (EEG & MEG).

To take up this grand challenge and achieve new frontiers for brain connectivity mapping, we will develop a new generation of computational models and methods for identifying and characterizing the structural and functional connectivities that will be at the heart of the DSF-BCN. Our strategy is to break with the tradition to incrementally and separately contributing to structure or function and develop **a global approach involving strong interactions between structural and functional connectivities.** To solve the limited view of the brain provided just by one imaging modality, our models will be developed under a rigorous computational framework integrating complementary non invasive imaging modalities: dMRI, EEG and MEG.

CoBCoM will push far forward the state-of-the-art in these modalities, developing **innovative models and ground-breaking processing tools** to provide in-fine a joint DSF-BCN solidly grounded on a detailed mapping of the brain connectivity, both in space and time.

Capitalizing on the strengths of dMRI, MEG & EEG methodologies and building on the **bio-physical and mathematical foundations** of our new generation of computational models, CoBCoM will be applied to high-impact diseases, and its **ground-breaking computational nature and added clinical value** will open new perspectives in neuroimaging.

7.3.1.2. ChildBrain ETN

ATHENA is an Associated Partner in the ChildBrain European Training Network: the team participates in training workshops and receive PhD students in secondments.

Program: European Training Network

Project acronym: ChildBrain

Project title: Advancing brain research in children's developmental neurocognitive disorders

Duration: March 2015 to March 2019

Coordinator: Prof. Paavo Leppänen, University of Jyváskylä, Finland

Other partners: University of Leuven (Belgium), University of Münster (Germany), Rabboud University (The Netherlands), Aston University (United Kingdom), IcoMetrix (Belgium), Elekta (Finland), BESA (Germany)

Abstract: The purpose of the ChildBrain ETN is to train young scientists, i.e. Early Stage Researchers (ESRs), to utilise evidence-based neuroscientific knowledge for helping children, especially those at high risk for dropout due to neurocognitive disorders, to meet future educational and societal demands.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Declared Inria International Partners

- Sherbrooke University, CA (M. Descoteaux)
- CMRR, University of Minnesota, USA (C. Lenglet)
- Verona University, It (G. Menegaz)
- Department of CISE, the University of Florida, Gainesville, USA (B. C. Vemuri)
- Centre for Medical Image Computing (CMIC), Dept. Computer Science, UCL, UK (D. Alexander)
- SBIA, University of Pennsylvania Medical School, USA (R. Verma).
- EEMagine company on EEG/MEG hardware.

7.4.1.2. Informal International Partners

- University Houari Boumedienne (USTHB, Algiers) (L. Boumghar) and University of Boumerdes, (D. Cherifi), Algeria.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Dr. Ragini Verma, Section of Biomedical Image Analysis, Center for Biomedical Image Computing and Analytics, Department of Radiology, University of Pennsylvania, USA (Oct 1st, 2018 - Dec 21st, 2018)
- Dr. Moo K. Chung, Waisman Laboratory for Brain Imaging and Behavior, University of Wisconsin-Madison, From Sept.10 to 14, 2018

7.5.1.1. Internships

- Rebecca Bonham-Carter - Queen's University, Kingston, Canada, From early May to late July, 2918.
- Max Amatsuji-Berry - Queen's University, Kingston, Canada, From early May to late July, 2918.
- Etienne Saint-Onge - Sherbrooke University, From Early Feb. to early June 2018.

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. National programmes

- **ANR-Phycover:** The overall objective of the PHYCOVER project (2014-2018) is to identify a modular wastewater treatment process for the production of biogas. The method combines three modules. First, a high-rate algal pond is dedicated to the treatment of municipal wastewater. Then, an anaerobic digester capable of co-digesting biomass products (and others organic matter resources) to significantly reduce biological and chemical contaminants while producing a sustainable energy as biogas is analysed. A final module transforms the residual carbon, nitrogen and phosphorus into high-value microalgae dedicated to aquaculture and green chemistry.

- **ITE-OPALE:** The goal of the Institut de la Transition Énergétique - OPALE project (2016-2019) is to increase the lipid content of microalgae by specific selection pressure. The project relies on the strain already selected during the Facteur 4 project, whose productivity was 4 times higher than the wild type. We expect to still increase strain performances up to 10 times the productivity of the wild type.

- **ANR-FunFit:** The objective of this project (2013-2018) is to develop a trait-based approach linking individual fitness of fungal plant pathogens to ecological strategies. The idea is to derive eco-epidemiological strategies from fitness optimization in colonized environments and during colonization, as well as understanding the coexistence of sibling species. This project is co-coordinated by F. Grognard.

- **ANR-TripTic:** The objective of this project (2014-2018) is to document the biological diversity in the genus of the minute wasps *Trichogramma*, and to study the behavioral and populational traits relevant to their use in biological control programs.

- **ANR-ICycle:** This project (2016-2020) aims at understanding the communication pathways between the cell division cycle and the circadian clock, using mathematical modeling and control theory to construct and implement two coupled synthetic biological oscillators. Project coordinated by M. Chaves.

- **ANR - Maximic:** The goal of the project (2017-2021) is to design and implement control strategies in a bacterium from producing at maximal rate a high value product. It is coordinated by H. de Jong (IBIS Grenoble), and involves members of Biocore and McTao.

- **Plan Cancer - Imodrez:** The objective of this project (2018-2021) is to understand cancer drug response heterogeneity using tumor single-cell dynamics and developing mathematical models and computational approaches. A project coordinated by J. Roux (IRCAN) and funded by Inserm - Plan Cancer.

- **SIGNALIFE:** Biocore is part of this Labex (scientific cluster of excellence) whose objective is to build a network for innovation on Signal Transduction Pathways in life Sciences, and is hosted by the University of Nice Sophia Antipolis.

- **UMT FIORIMED:** FioriMed is a Mixed Technology Unit created in January 2015 to strengthen the production and dissemination of innovation to the benefit of ornamental horticulture. Horticultural greenhouses are seen as a "laboratory" for the actual implementation of agroecology concepts with the possibility of generic outcomes being transfered to other production systems. The main partners of UMT FioriMed are ASTREDHOR (National Institute of Horticulture) and the ISA Joint Research Unit of INRA-CNRS-Univ. Nice.

- **ADEME Phytorecolt:** The goal of this project (2017-2019) is to develop an automated and optimized procedure for microalgae harvesting. A project coordinated by H. Bonnefond.

9.1.2. Inria funding

- **Inria Project Lab, Algae** *in silico***:** (2014-2018) The Algae in silico Inria Project Lab, funded by Inria and coordinated by O. Bernard, focuses on the expertise and knowledge of biologists, applied mathematicians and computer scientists to propose an innovative numerical model of microalgal culturing devices. The latest developments in metabolic modeling, hydrodynamic modeling and process control are joined to propose a new generation of advanced simulators in a realistic outdoor environment. The project gathers 5 Inria project teams and 3 external teams.

- **Inria Project Lab, Cosy:** (2017-...) This proposal aims at exploiting the potential of state-of-art biological modeling, control techniques, synthetic biology and experimental equipment to achieve a paradigm shift in control of microbial communities. We will investigate, design, build and apply an automated computer-driven feedback system for control of synthetic microbial communities, not just accounting for but rather leveraging population heterogeneity in the optimal accomplishment of a population-level task. The development of methodologies of general applicability will be driven by and applied to two different applications closely connected with real-world problems in the biomedical and biotechnological industry. The consortium is composed of the four Inria project-teams IBIS, BIOCORE, COMMANDS, NON-A, the Inria Action Exploratoire INBIO, as well as the external partners BIOP (Université Grenoble Alpes, including members of IBIS), MaIAge (INRA), and YoukLAB (TU Delft).

9.1.3. INRA funding

- **MoGeR:** "From knowledge to modeling: towards a user-friendly simulation tool to test crop resistance management scenarios in the Phoma-oilseed rape case study", INRA Metaprogramme SMaCH, 2017–2019. This is a follow-up of the K-Masstec project, which focused on sustainable strategies for the deployment of genetic resistance in the field, based on molecular knowledge on avirulence genes.

- **ABCD:** INRA SPE is funding the project ABCD "Augmentative Biological Control; optimizing natural ennemies Deployment" (2017-2019) in which Biocore is a partner with INRA Sophia Antipolis.

9.1.4. Networks

- **GDR Invasions Biologiques:** The objectives of this GDR are to encourage multidisciplinary research approaches on invasion biology. It has five different thematic axes: 1) invasion biology scenarios, 2) biological invasions and ecosystem functioning, 3) environmental impact of invasive species, 4) modeling biological invasions, 5) socio-economics of invasion biology. L. Mailleret is a member of the scientific comittee of the GDR .

- **ModStatSAP:** The objective of this INRA network is to federate researchers in applied mathematics and statistics and to promote mathematical and statistical modeling studies in crop and animal health. S. Touzeau is a member of the scientific committee.

- **Seminar:** BIOCORE organizes a regular seminar "Modeling and control of ecosystems" at the station zoologique of Villefranche-sur-Mer, at INRA-ISA or at Inria.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: **PHC-Pessoa** Partenariat Hubert Curien with Portugal, managed by Campus France

Project acronym: **LTSB**

Project title: Logic Tools for Systems Biology

Duration: 01/2018 - 12/2018

Coordinator: M. Chaves

Other partners: M.A. Martins, University of Aveiro

Abstract: This project aims at developing Boolean, piecewise linear and other hybrid tools for analysis of biological networks.

9.2.2. Collaborations with Major European Organizations

Imperial college, Department of Chemical engineering (UK),

Modeling and optimization of microalgal based processes.

University of Padova, Italy.

Modeling and control of microalgal production at industrial scale.

9.3. International Initiatives

9.3.1. Inria International Labs

Associate Team involved in the International Lab: **Inria Chile**

9.3.1.1. GREENCORE

Title: Modeling and control for energy producing bioprocesses

International Partners (Institution - Laboratory - Researcher):

PUCV (Chile) - Escuela de Ingenieria Bioquimica (EIB) - David Jeison

UTFSM (Chile) - Departamento de Matematica - Pedro Gajardo

Univ. Chile (Chile) - Centro de modelacion matematica - Hector Ramirez

Inria coordinator: O. Bernard

Start year: 2014

See also: https://team.inria.fr/eagreencore/

The worldwide increasing energy needs together with the ongoing demand for CO2 neutral fuels represent a renewed strong driving force for the production of energy derived from biological resources. In this scenario, the culture of oleaginous microalgae for biofuel and the anaerobic digestion to turn wastes into methane may offer an appealing solution. The main objective of our proposal is to join our expertise and tools, regarding these bioprocesses, in order to implement models and control strategies aiming to manage and finally optimize these key bioprocesses of industrial importance. By joining our expertise and experimental set-up, we want to demonstrate that closed loop control laws can significantly increase the productivity, ensure the bioprocess stability and decrease the environmental footprint of these systems. This project gathers experts in control theory and optimization (BIOCORE, UTFSM) together with experts in bioprocesses (PUCV and CMM) and software development.

Associate Team involved in the International Lab: **LIRIMA**, International Laboratory for Research in Computer Science and Applied Mathematics

9.3.1.2. EPITAG

Title: Epidemiological Modeling and Control for Tropical Agriculture

International Partner (Institution - Laboratory - Researcher):

Université de Douala (Cameroon) - Department of Mathematics and Computer Science - Samuel Bowong

Inria coordinator: S. Touzeau

Start year: 2017

See also: https://team.inria.fr/epitag/

EPITAG gathers French and Cameroonian researchers, with a background in dynamical systems and control and with an interest in crop diseases. Crop pests and pathogens are responsible for considerable yield losses. Their control is hence a major issue, especially in Cameroon, where agriculture is an important sector in terms of revenues and employment. To help design efficient strategies for integrated pest management, mathematical models are particularly relevant. Our main objective is to study the epidemiology and management of tropical crop diseases, with a focus on Cameroon and Sub-Saharan Africa. Our approach consists in developing and analysing dynamical models describing plant-parasite interactions, in order to better understand, predict and control the evolution of damages in crops. To ensure the relevance of our models, "end users" are closely associated. We focus on various pathosystems, such as cocoa plant mirids, coffee berry borers, coffee leaf rust and plantain plant-parasitic nematodes.

9.3.2. Inria International Partners

- NTNU (Norwegian University of Science and Technology), Trondheim, Norway. The project involves turning wastes into bioenergy with anaerobic digestion.
- University Ben Gurion : Microalgal Biotechnology Lab (Israel), Member of the ESSEM COST Action ES1408 European network for algal-bioproducts (EUALGAE). Modeling of photosynthesis.
- University of Manitoba: Department of Mathematics (Canada). Julien Arino hosted Nicolas Bajeux for 5 months. Invasion in metapopulations.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Luca Scardovi, University of Toronto, Canada, from Feb 2018 until June 2018. Long-term visit, to establish a new collaboration on the coupling and synchronization of biological oscillators.

Daniel Figueiredo, University of Aveiro, Portugal, 17-25 Oct 2018. Visit in the context of PHC-Pessoa project to work on the development of logical tools for systems biology.

Israël Tankam Chedjou, University of Yaoundé 1, Cameroon, April-August 2018. 5-month stay in the context of the EPITAG associate team.

Yves Fotso Fotso, University of Dschang, Cameroon, April-September 2018. 5-month stay in the context of the EPITAG associate team.

Clotilde Djuikem, University of Douala, Cameroon, May-July 2018. 3-month stay in the context of the EPITAG associate team.

9.4.2. Visits to International Teams

9.4.2.1. Sabbatical programme

O. Bernard is currently spending a one year sabbatical at NTNU (Norwegian University of Science and Technology), Trondheim, Norway. He works on a project to turn wastes into bioenergy with anaerobic digestion. Many challenges must be solved, from the theoretical stage up to the implementation.

9.5. Other Visits

Hussein Kanso, PhD student at INRA Avignon, a 2-week visit in the context of the work on modeling of sugar metabolism in peach fruit (collaboration with V. Baldazzi).

9.6. Project-team seminar

BIOCORE organized a 3-day seminar in September in Bauduen (Var). On this occasion, every member of the project-team presented his/her recent results and brainstorming sessions were organized.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Modélisation Théorique et Computationnelle en Neurosciences et Sciences Cognitives*

The Biovision team is a member of this "Axe Interdisciplinaire de Recherche de l'Université de Nice – Sophia Antipolis" and of the Institute Neuromod of neuroscience modelling . Biovision team has participated to the Rencontre C@UCA 2018 in Fréjus (June 2018). This axe is partly funding our work on retinal waves.

8.2. National Initiatives

8.2.1. *ANR*

8.2.1.1. *Trajectory*

Title: Encoding and predicting motion trajectories in early visual networks

Programme: ANR

Duration: October 2015 - September 2020

Coordinator: Invibe Team, Institut des Neurosciences de la Timone, Frédéric Chavane,

Partners:

Institut de Neurosciences de la Timone (CNRS and Aix-Marseille Université, France)

Institut de la Vision (Paris, France)

Universidad Tecnico Federico Santa María (Electronics Engineering Department, Valparaíso, Chile)

Inria contact: Bruno Cessac

Global motion processing is a major computational task of biological visual systems. When an object moves across the visual field, the sequence of visited positions is strongly correlated in space and time, forming a trajectory. These correlated images generate a sequence of local activation of the feed-forward stream. Local properties such as position, direction and orientation can be extracted at each time step by a feed-forward cascade of linear filters and static non-linearities. However such local, piecewise, analysis ignores the recent history of motion and faces several difficulties, such as systematic delays, ambiguous information processing (e.g., aperture and correspondence problems) high sensitivity to noise and segmentation problems when several objects are present. Indeed, two main aspects of visual processing have been largely ignored by the dominant, classical feed-forward scheme. First, natural inputs are often ambiguous, dynamic and non-stationary as, e.g., objects moving along complex trajectories. To process them, the visual system must segment them from the scene, estimate their position and direction over time and predict their future location and velocity. Second, each of these processing steps, from the retina to the highest cortical areas, is implemented by an intricate interplay of feed-forward, feedback and horizontal interactions. Thus, at each stage, a moving object will not only be processed locally, but also generate a lateral propagation of information. Despite decades of motion processing research, it is still unclear how the early visual system processes motion trajectories. We, among others, have proposed that anisotropic diffusion of motion information in retinotopic maps can contribute resolving many of these difficulties. Under this perspective, motion integration, anticipation and prediction would be jointly achieved through the interactions between feed-forward, lateral and feedback propagations within a common spatial reference frame, the retinotopic maps. Addressing this question is particularly challenging, as it requires to probe these sequences of events at multiple

scales (from individual cells to large networks) and multiple stages (retina, primary visual cortex (V1)). "TRAJECTORY" proposes such an integrated approach. Using state-of-the-art micro- and mesoscopic recording techniques combined with modeling approaches, we aim at dissecting, for the first time, the population responses at two key stages of visual motion encoding: the retina and V1. Preliminary experiments and previous computational studies demonstrate the feasibility of our work. We plan three coordinated physiology and modeling work-packages aimed to explore two crucial early visual stages in order to answer the following questions: How is a translating bar represented and encoded within a hierarchy of visual networks and for which condition does it elicit anticipatory responses? How is visual processing shaped by the recent history of motion along a more or less predictable trajectory? How much processing happens in V1 as opposed to simply reflecting transformations occurring already in the retina? The project is timely because partners master new tools such as multi-electrode arrays and voltage-sensitive dye imaging for investigating the dynamics of neuronal populations covering a large segment of the motion trajectory, both in retina and V1. Second, it is strategic: motion trajectories are a fundamental aspect of visual processing that is also a technological obstacle in computer vision and neuroprostheses design. Third, this project is unique by proposing to jointly investigate retinal and V1 levels within a single experimental and theoretical framework. Lastly, it is mature being grounded on (i) preliminary data paving the way of the three different aims and (ii) a history of strong interactions between the different groups that have decided to join their efforts.

8.3. European Initiatives

- Program: Leverhulme Trust

- Project acronym:

- Project title: A novel approach to functional classification of retinal ganglion cells

- Duration: 2017-2020

- Coordinator: Evelyne Sernagor, Institute of Neuroscience (ION, Newcastle, UK)

- Inria contact: Bruno Cessac

- Other partners:

    Melissa Bateson Institute of Neuroscience (ION, Newcastle, UK)

    Matthias Hennig Institute for Adaptive and Neural Computation (ANC, School of Informatics University of Edinburgh, UK)

- Abstract: Vision begins with photoreceptors converting light from different parts of the visual scene into electrical signals, compressing our visual world into a parsimonious code of impulses at the retinal output level, the retinal ganglion cells (RGCs). This information is sent to the brain via only $\approx$1m RGCs (45,000 in mouse). Amazingly, the brain can recreate images from interpreting these "barcodes" or trains of impulses. This ability is partly due to the astonishing functional diversity of RGCs, each interpreting a different feature of the visual scene. It is all these parallel streams of information that impart the complexity of visual scenes to our brain visual areas. At present, at least 30 RGC subtypes have been identified. Classification is typically based on common anatomical features, or on basic functions (e.g. whether cells respond to the onset or offset of the light, or whether they are sensitive to motion direction) and it has recently progressed to include molecular markers. Recent studies have successfully characterised common physiological properties between RGCs sharing gene expression, suggesting that their molecular signature may indeed be a good indicator of function. However, according to mouse genetics repositories (e.g., the Allen Brain Project) many genes are expressed in subpopulations of RGCs for which we have no phenotype yet. Genes that are expressed in most RGCs probably do not reflect specific functional populations, but some other genes are expressed only in sparse RGC groups. Each gene-specific class exhibits a distinct spatial mosaic pattern across the retina, suggesting that the cells belong to a common group. Many classes, even sparse, exhibit asymmetric distributions across the retina, e.g., with larger

numbers on the ventral or dorsal side, suggesting specific roles in ecological vision, e.g., specialised in detecting moving objects in the sky (ventral) or on the ground (dorsal).

We propose to develop a multidisciplinary approach to functionally phenotype "new" RGC subclasses sharing gene expression. Rather than inferring knowledge about the entire population from studying individual cells, we will take a global approach based on large-scale, high-density pan-retinal recordings, pharmacogenetics (allowing us to selectively silence defined cell populations at will) and high-resolution imaging combined with computational approaches and behaviour. This novel approach necessitates collaboration between retinal neurophysiologists, animal behaviour specialists (Newcastle) and modellers (Inria) who specialise in visual processing and have sophisticated mathematical tools and software to handle and interpret the encoding of visual information at the pan-retinal level.

8.4. International Initiatives

8.4.1. International Research Network to Study Predictive Coding in the Retina

Program: CHILEAN SUPPORT OF INTERNATIONAL NETWORKING BETWEEN RESEARCH CENTRES

Project title: International Research Network to Study Predictive Coding in the Retina

Duration: 2018-2020

Coordinator: Maria-José Escobar, Advanced Center for Electrical and Electronic Engineering, Universidad Técnica Federico Santa María, Chile

Other partners:

> Advanced Center for Electrical and Electronic Engineering (Valparaiso, Chili)
>
> Centro Interdisciplinario de Neurociencia de Valparaíso (CINV, Valparaíso, Chile)

Abstract: The retina, a well-structured multilayer neural system, encodes the visual information of the environment from an input of photon flux to a series of electrical pulses that are ultimately readout by the brain to create perception and program motor actions. The retina, from an engineering point of view, can be seen as a series of circuits computing visual features from the visual world in parallel encoding only informative inputs that are then sent to the brain. Regarding all the visual features that can be detected from the outer world, motion processing represents a fundamental visual computation ruling many visuomotor behaviours. Motion sensitive neurons have been early reported in the retina, but recently additional features have been added to the pool of capabilities present in this organ: especially motion direction selectivity and predictive coding. Motion processing presents predictive coding characteristics, in the sense that there is an anticipatory response of the visual system when an object in motion follows a trajectory in the visual field. Motion anticipation is fundamental for survival. Interestingly, this mechanism, observed in the visual cortex, has been also reported in the retina. Understanding how the visual system accumulates information along a certain trajectory raises fundamental questions about neural computation, its dynamics, and implementation. This understanding could be also extended to new algorithms to image/video processing, and also, autonomous navigation of robots.

In this project, we propose the formal establishment of a collaborative network between the AC3E Biomedical System group (AC3E-UTFSM), Centro Interdisciplinario de Neurociencia de Valparaíso (CINV -UV) and Biovision team (Inria Sophia-Antipolis Mediterranée), gathering together skills related with physiological recording in the retina, data analysis and theoretical tools to implement functional and biophysical models. This network aims to study the anticipatory response observed in the mammalian retina, characterizing its underlying mechanisms and the predictive coding capabilities present in this part of the nervous system.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

Institute of Neuroscience (ION, Newcastle, UK)

Institute for Adaptive and Neural Computation (ANC, School of Informatics University of Edinburgh, UK)

Universidad Tecnico Federico Santa María (Electronics Engineering Department, Valparaíso, Chile)

Centro Interdisciplinario de Neurociencia de Valparaíso (CINV, Valparaíso, Chile)

University of Genoa (DIBRIS, Genoa, Italy)

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Prof. Sarah Barman (School of Computer Science and Mathematics, Kingston University)

Dr Matteo Di Volo (Unité de Neurosciences Information et Complexité, Gif sur Yvette, France)

Dr Cyril Eleftheriou (IIT, Genova)

Dr Maria-José Escobar (Universidad Tecnico Federico Santa María (Electronics Engineering Department, Valparaíso, Chile))

8.5.1.1. Internships

Téva Andréoletti (Apr–Aug 2018)

Adrianna Janik (Oct 2017–Mar 2018)

Paula Pawlowski (Apr–Sept 2018)

CAMIN Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

We have obtained a financial support from Occitanie Region for the CIFRE PhD thesis (Xynue Lu) with NEURORESP Company "PILE CIFRE" BREATHLOOP.

8.2. National Initiatives

- Inria ADT STIMBIO

  Participants : Christine Azevedo, Daniel Simon, Ronan Le Guillou, Benoît Sijobert.

  A 1-year engineer (R. LeGuillou) was funded by Inria ADT on the development of an architecture dedicated to FES-cycling platform.

- I-SITE MUSE COMPANIES AND CAMPUS grant

  Collaboration with academic local partners (CHU, IES) and NEURINNOV company on the spinal stimulation for bladder and bowel functions restoration. This is linked to an ongoing collaboration with Oslo University (Norway).

- LABEX NUMEV MEDITAPARK

  Collaboration with Montpellier Hospital (Neurology service) and the Montpellier Mindfulness Center to analyze the impact of meditation on upper limb tremor.

- EDF Foundation

  Collaboration with La Châtaigneraie Hospital on FES-assisted cycling. Financial support for a study on FES-cycling training method and performance otimization on individuals with complete spinal cord injury.

- I-SITE MUSE - EXPLORE

  Support for the visit of Henrique Resende (UFMG, Brazil) and Emersion Fachin (UNB, Brazil) as guest researchers from December to February 2019. Completed with a LIRMM laboratory financial aid.

8.3. European Initiatives

Program: EIT Health

Project acronym: Agilis

Project title: Restoration of Hand Functions in Tetraplegia through Selective Neural Electrical Stimulation

Duration: Jan. 2019 - June 2020

Coordinator: Camin Inria

Other partners: APHP, Univ. Heidelberg, CRF La Châtaigneraie, Neurinnov.

Abstract: Complete tetraplegia leads to inability to move, thus use, both hands. To date, there is no solution to restore this absolutely needed function for very common daily activities such as social interactions, washing, eating or self catheterizing. We aim at an innovative implanted stimulation of only two nerves associated with an intuitive interface. It will provide functional grasping without a third person and thus will drastically increase the autonomy of such people for the rest of their life.

8.4. International Initiatives

8.4.1. Inria Associate Teams Not Involved in an Inria International Labs

8.4.1.1. CACAO

Title: Lower limb electrical stimulation for function restoration

International Partner (Institution - Laboratory - Researcher):

UNB Brasilia (Brazil), Physiotherapy department, Emerson Fachin Martins.

Start year: 2016

See also: https://team.inria.fr/cacao/

Electrical stimulation (ES) can activate paralyzed muscles to support rehabilitation. ES applied to fully or partially paralyzed muscles artificially induces muscle contraction substituting or completing the normal volitional control. In CACAO team we join our efforts and specific expertise to develop approaches of lower limb function restoration in spinal cord injured individuals. Two main applications have been addressed: 1) Functional Electrical Stimulation (FES) to assist SCI individuals to perform pivot transfers and 2) FES-assisted cycling. We aim at proposing solutions that can have an effect on patients' quality of life, thus our choices intend to be realistic form a practical point of view.

8.4.1.2. Informal International Partners

CAMIN collaborates with Dr JL Boulland (Norwegian Center for Stem Cell Research at Oslo University Hospital in Norway) on FES-assisted bladder and bowel functions restoration.

8.5. International Research Visitors

Henrique Resende (UFMG, Brazil) and Emerson Fachin (UNB, Brazil) will spend 3 months in CAMIN team from December 2018 to February 2019 to work on FES-cycling project.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Inria Project Lab: FRATRES (Fusion Reactors Research and Simulation)

- Participants : Inria project-teams : CASTOR, IPSO, TONUS,
- Partners : IRFM-CEA, Max Planck Institute-IPP Garching, LJLL-Jussieu, IMT-Toulouse

Controlled nuclear fusion can be considered as an example of grand challenge in many fields of computational sciences from physical modelling, mathematical and numerical analysis to algorithmics and software development and several Inria teams and their partners are developing mathematical and numerical tools in these areas.

Since january 2015, H. Guillard is coordinating the Inria Project Lab FRATRES (https://team.inria.fr/ipl-fratres/) to organize these developments on a collaborative basis in order to overcome the current limitations of today numerical methodologies. The ambition is to prepare the next generation of numerical modelling methodologies able to use in an optimal way the processing capabilities of modern massively parallel architectures. This objective requires close collaboration between a) applied mathematicians and physicists that develop and study mathematical models of PDE; b) numerical analysts developing approximation schemes; c) specialists of algorithmic proposing solvers and libraries using the many levels of parallelism offered by the modern architecture and d) computer scientists. This Inria Project Lab will contribute in close connection with National and European initiatives devoted to nuclear Fusion to the improvement and design of numerical simulation technologies applied to plasma physics and in particular to the ITER project for magnetic confinement fusion.

Contact : Hervé Guillard

8.1.2. Defi : Infiniti : INterFaces Interdisciplinaires NumérIque et ThéorIque

- Participants: HervéGuillard, AnnaDegioanni[LAMPEA Aix-en-Provence], SilvanaCondemi[ADES, Marseille], ZhenyuXu

In the framework of the "Defi : Infiniti : INterFaces Interdisciplinaires NumérIque et ThéorIque" of the "Mission pour l'Interdisciplinarité" of CNRS, this work has associated Hervé Guillard to Anna Degioanni of the Laboratory LAMPEA - Laboratoire Méditerranéen de Préhistoire Europe-Afrique of Aix-en-Provence and Silvana Condemi of the ADES (Anthropologie bio-culturelle, droit, éthique et santé - UMR 7268) laboratory in Marseille. The purpose of this work was to propose a numerical model and to realize a software allowing paleo-anthropologist and pre-historians to study numerically the propagation and diffusion of Homo Sapiens in Europe between 50 000 and 30 000 years BP. A 6 month internship of Ms Zhenyu Xu, 3rd year student at the polytech'Nice school of engineers has been devoted to this project and the results have been presented at the "Journée de restitution 2018 du Défi Infiniti", (http://www.cnrs.fr/mi/spip.php?article1440&lang=fr)

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

- Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)
- Commissariat A L Energie Atomique et Aux Energies Alternatives (France)
- Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)
- Consiglio Nazionale Delle Ricerche (Italy)
- The Cyprus Institute (Cyprus)
- Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)
- Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)
- Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)
- Forschungszentrum Julich (Germany)
- Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany)
- University of Bath (United Kingdom)
- Universite Libre de Bruxelles (Belgium)
- Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

The aim of the present proposal is to establish an Energy Oriented Centre of Excellence for computing applications, (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

EuroFusion Consortium

CASTOR participates to the following EuroFusion consortium projects :

Enabling research contract 2014-2018. (B. Nkonga, H. Guillard, A. Sangam) CfP-WP15-ENR-01/IPP-05, Grant agreement No 633053. «Global non-linear MHD modeling in toroidal X-point geometry of disruptions, edge localized modes, and techniques for their mitigation and suppression »

EUROfusion WPCD (Working Package Code Development):

- ACT1: Extended equilibrium and stability chain (participation)
- ACT2: Free boundary equilibrium and control (participation and coordination)

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- The team collaborates with TUC (Technical University of Crete, Prof. Argyris Delis) on extension of the shallow water model to turbulent flows. These common works overlap with the collaboration with Taiwan in the framework of the former AMOSS associate team.

- Collaboration with TIFR-Bangalore on MHD, one month invited at Bangalore (B. Nkonga and A. Bhole) C. Praveen will have 2months as invited professor at UCA in 2019.

8.3.2. Participation in Other International Programs

ITER Contracts (B. Nkonga):

- ITER IO/17/CT/4300001505: 2017-2019, "Non-linear MHD simulations for ITER QH-mode plasma with and without 3D magnetic field perturbations from in-vessel ELM control coils". (150KE)

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. COSIT, 2018-2019

Participants: Mohammed Amine Ait Ouahmed, Ali Al Zoobi, David Coudert, Nicolas Nisse.

Program: Innovation project, Centre de reference "Smart City" of IDEX UCA[JEDI].

Project acronym: COSIT

Project title: Convergent Service for Intermodal Transportation

Duration: February 2018 - January 2019

Coordinator: David Coudert

Other partners: UMR ESPACE (France) and SME Instant-System

Abstract: On-demand transportation is a highly flexible mode of transportation that aims at optimizing transit operator service by reducing operational cost while increasing the number of passengers per vehicles, and to increase customer satisfaction. We are considering a service where a fleet of vehicles (minibuses with a limited number of seats) is used to answer user requests. Vehicle trajectories need to be recalculated dynamically as new queries arrive. It is a complementary offer to existing public transport services (bus, tram, metro, etc.) and intermediate in terms of cost and quality of service between public transport and individual transport (taxi, VTC).

In the COSIT project, we studied different aspects of the problem including static and dynamic algorithms for the assignment of users to vehicles, the study of user flows in the city, and the prediction of users queries. We will developed a graphical interface to visualize the evolution of vehicle itineraries as the demands of users arrive.

8.1.2. SNIF, 2018-2021

Participants: David Coudert, Frédéric Giroire, Nicolas Nisse, Stéphane Pérennes.

Program: Innovation project of IDEX UCA[JEDI].

Project acronym: SNIF

Project title: Scientific Networks and IDEX Funding

Duration: September 2018 - August 2021

Coordinator: Patrick Musso

Other partners: GREDEG, SKEMA, I3S (SigNet) and Inria (COATI), all from UCA.

Abstract: Scientific collaboration networks play a crucial role in modern science. This simple idea underlies a variety of initiatives aiming to promote scientific collaborations between different research teams, universities, countries and disciplines. The recent French IDEX experience is one of them. By fostering competition between universities and granting few of them with a relatively small amount of additional resources (as compare to their global budget), public authorities aim to encourage them to deeply reshape the way academic activities are organized in order to significantly increase the quality of their research, educational programs and innovative activities. The development of new collaboration networks is one of the factors at the heart of this global reorganization. Promoting new international and/or interdisciplinary collaborations is supposed to increase researchers' productivity and industry partnerships. This project aims to question the validity of this line of thought.

8.2. National Initiatives

8.2.1. ANR-17-CE22-0016 MultiMod, 2018-2021

Participants: Mohammed Amine Ait Ouahmed, Ali Al Zoobi, David Coudert, Nicolas Nisse, Michel Syska.

Program: ANR

Project acronym: MultiMod

Project title: Scalable routing in Multi Modal transportation networks

Duration: January 2018 - December 2021

Coordinator: David Coudert

Other partners: Inria Paris, EP GANG; team CeP, I3S laboratory; SME Instant-System; SME Benomad

Abstract: The MultiMod project addresses key algorithmic challenges to enable the fast computation of personalized itineraries in large-scale multi-modal public transportation (PT) networks (bus, tram, metro, bicycle, etc.) combined with dynamic car-pooling. We will use real-time data to propose itineraries with close to real travel-time, and handle user-constraints to propose personalized itineraries. Our main challenge is to overcome the scalability of existing solutions in terms of query processing time and data-structures space requirements, while including unplanned transportation means (car-pooling), real-time data, and personalized user constraints. The combination of car-pooling and PT network will open-up areas with low PT coverage enable faster itineraries and so foster the adoption of car-pooling. We envision that the outcome of this project will dramatically enhanced the mobility and daily life of citizens in urban areas.

Web: https://project.inria.fr/multimod/

8.2.2. PEPS POCODIS

Program PEPS

Project Acronym: POCODIS

Project Title: POndérations et COlorations DIStinguantes de graphes

Duration: Février-Décembre 2018

Coordinator: Julien Bensmail

Others Partners: None

Abstract: This project is about two conjectures on *proper* weightings of a graph, namely the 1-2-3 conjecture and a conjecture about localy irregular decompositions. A weighting is proper whenever the coloring obtained by taking as color for a vertex v the sum of the weight in the neighbourhood of v is a proper coloring, more concisely adjacent vertices have different sums. The main objective of the project is to address several open questions around (i.e. motivated by) these conjectures since we believe that this could lead to significant progress toward the solution of the two main conjectures. To that aim we will make use of several recent and innovative tools and technique in the field, such as the probabilistic method and the polynomial method. In order to use and understand these techniques to their best we shall strengthen several international collaborations with experts from the field.

8.2.3. PICS DISCO

Program: PICS

Project acronym: DISCO

Project title: DIsjoint Structures and Coverings in Oriented graphs

Duration: January 2018 -December 2020.

Coordinator: Stéphane Bessy (LIRMM)

Other partners: organisme, labo (pays) CNRS LIRMM (Montpellier), Syddansk universitet (Odense, Danemark)

Abstract: Directed graphs (digraphs) are much less understood than undirected graphs. Many, seemingly very simple questions remain unsolved for digraphs while the analogous problem for undirected graphs is trivial. At the same time digraphs is a very important modelling tool for practical applications and so a better undestanding of their structure is important. The purpose of DISCO is to advance knowledge on fundamental problems on digraphs, including splitting a digraph into smaller pieces with given properties, problems regarding disjoint paths and trees, finding small certificates for given properties, such as strong spanning subdigraphs with few arcs. The later is important for speeding up certain algorithms.

Through a concerted effort we expect to obtain important results which will lead to a better undestanding of fundamental questions about the structure of digraphs. The participants will meet regularly both in France and in Denmark to work on carefully selected problems.

8.2.4. GDR Actions

8.2.4.1. GDR RSD, ongoing (since 2006)

Members of COATI are involved in the working group RESCOM (*Réseaux de communications*) of GDR RSD, CNRS (http://rescom.asr.cnrs.fr/). In particular, David Coudert is co-chair of this working group since 2017 and has organized its annual summer school, RESCOM'18. Christelle Caillouet was co-chair of the programme committee of the annual conference AlgoTel'18.

We are also involved in the working group "Energy" of GDR RSD. In particular, Frédéric Giroire is co-hair of this working group.

8.2.4.2. GDR IM, ongoing (since 2006)

Members of COATI are involved in the working group "Graphes" of GDR IM, CNRS. (http://gtgraphes.labri.fr/). In particular, Frédéric Havet is member of the steering committee.

8.2.4.3. GDR MADICS, ongoing (since 2017)

Members of COATI are involed in the working group GRAMINEES (GRaph data Mining in Natural, Ecological and Environnemental Sciences) of GDR MADICS (Masses de Données, Informations et Connaissances en Sciences). (http://www.madics.fr/actions/actions-en-cours/graminees/).

The annual summer school RESCOM'18 of GDR RSD has been co-organized with GDR MADICS.

8.3. International Initiatives

8.3.1. IFCAM Program, *Applications of Graph homomorphisms*

Program: IFCAM 2018-2020 (http://math.iisc.ac.in/~ifcam/)

Project acronym: –

Project title: Applications of graph homomorphisms on graph database

Duration: Janvier 2018 - Décembre 2020

Coordinator: Reza Naserasr (for France) - Sagnik Sen (for India)

Other partners: complete list of participants on the project website.

Abstract: In this project, we are going to study the graph homomorphism problems from a very general point of view. Apart from studying the usual graph homomorphism on undirected graphs, we will study it for different types of graphs such as, signed graphs, oriented graphs, edge-colored graphs, colored mixed graphs etc. We will apply the theories and techniques associated with graph homomorphism to solve practical problems. Our main application oriented work is studying graph homomorphism in the context of graph database, a type of database now a days used even by popular social medias. Graph homomorphism is equivalent to the query evaluation problem in graph

database, and thus have exciting intersection with the theory. In our group we have experts of graph homomorphisms as well as graph database making this project a potential case for Indo-French interdisciplinary collaboration. We want to organize a workshop by the end of this project. We also consider a few other application oriented topics as auxiliary research tracks inside this project.

8.3.2. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

8.3.2.1. ALDYNET

Title: distributed ALgorithms for DYnamic NETworks

International Partner (Institution - Laboratory - Researcher):

Universidad Adolfo Ibañez (Chile) - Facultad de Ingeniería y Ciencias - Karol SUCHAN

Start year: 2016

See also: https://team.inria.fr/coati/projects/aldynet/

This associated team would be the natural continuation of the fruitful EA AlDyNet (2013-2015, https://team.inria.fr/coati/projects/aldynet/)

The main goal of this Associate Team is to design and implement practical algorithms for computing graph structural properties. We will then use these algorithms on a concrete case of study which concerns the transportation network of the Santiago agglomeration. We are both interested in theoretical results concerning the feasibility of computing graph properties, and by their practical implementation (using Sagemath) for our application and their diffusion in the scientific community. There are three main objectives:

1) Design efficient algorithms to compute important graph properties (hyperbolicity, treelength, centrality, treewidth...) in real networks. We are not only interested by the worst-case time-complexity of these algorithms but by their performance in practice.

2) Implement and document our algorithms using the open-source framework SageMath. One advantage of using SageMath is that it has interfaces with other graph libraries (igraph, Boost...) and with Linear Programming solver (GLPK, Cplex...). Moreover, the success of SageMath (which has accumulated thousands of users over the last 10 years) will participate to the diffusion of our algorithms.

3) Apply our algorithms on the Santiago transportation network that have been collected by our Chilean partner during the last year of AlDyNet (2013-2015). Based on the results, propose tools for decision support in designing bus routes, timetables, etc. More precisely, we have collected information about the use of public transport (data of smart cards for automatic fare collection - BIP-, bus routes and bus schedules, etc.), urban infrastructure information, schools' addresses, and approximate locations where students live. We have started to clean and consolidate these data. We will then develop decision support tools, for example, for improving quality education accessibility.

8.3.3. Inria International Partners

8.3.3.1. Informal International Partners

Apart from formal collaboration COATI members maintain strong connections with the following international teams, with regular visits of both sides.

Universidade Federal do Ceará (Fortaleza, Brazil), ParGO team;

Universidade Estadual do Ceará (Fortaleza, Brazil), Prof. Leonardo Sampaio;

Univ. of Southern Denmark (Odense, Denmark), Prof. Jørgen Bang-Jensen;

RWTH Aachen Univ., Lehrstuhl II für Mathematik (Aachen, Germany), Prof. Arie M.C.A. Koster;

Concordia Univ. (Montréal, Québec, Canada), Prof. Brigitte Jaumard.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Jørgen Bang-Jensen

    University of Southern Denmark, Odense, Denmark. June 2018.

- Romuald Elie

    Paris-Est University. February 3 - March 2 2018.

- Gwenael Joret

    Université Libre de Bruxelles, Belgique. March 2018.

- Takako Kodate

    Tokyo's Woman's Christian University. December 15 2017 till March 31 2018.

- Kasper Szabo Lyngsie

    Technical University of Denmark, Lyngby, Denmark. June 27 - July 8.

- Joseph Peters

    Simon Fraser University, Vancouver, BC, Canada. October 1 2017 till March 31 2018.

- Tahiry Razafindralambo

    Université de la Réunion. July 8-28 2018.

- Leonardo Sampaio Rocha

    University Federal de Ceara, Fortaleza, Brazil. July 1 2018 till June 30 2019.

- Karol Suchan

    Universidad Adolfo Ibañez, Santiago, Chile. September 9-23 2018.

- Robert E. Tarjan

    Princetown University, Princetown, NJ, USA. July 2018.

- Min-Li (Joseph) Yu

    University of the Fraser Valley, Abbotsford, BC, Canada. March 1 till April 15 2018.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

- Julien Bensmail :

    Northwestern Polytechnical University, Xi'an, China. 22 Avril-13 Mai.

    LaBRI, Bordeaux, France. 23 Mai-12 Juin.

    Technical University of Denmark, Lyngby, Denmark. 22 Août-2 Septembre.

    AGH University, Krakow, Poland. 24 Novembre-2 Décembre.

- David Coudert :

    Universidad Adolfo Ibañez, Santiago, Chile, December 1-14, 2018.

- Frédéric Havet :

    University of Southern Denmark, Odense, Denmark. April 2018.

    Ecole Normale Supérieure de Lyon, France, January and September 2018.

- Nicolas Nisse :

    Xidian University, Xi'an, China, September 1-15, 2018

    Univ. Adolfo Ibañez, Santiago, Chile, December 1-15, 2018

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

The team is involved in the IDEX project UCA-JEDI.

- PhD of Laurence Beaude (october 2015 - december 2018) co-funded by BRGM and Region PACA and dealing with the simulation of geothermal systems, supervised by Roland Masson, Konstantin Brenner from LJAD-Inria and by Simon Lopez, Farid Smai from BRGM.

9.2. National Initiatives

9.2.1. ANR

- ANR CHARMS (Quantitative Reservoir Models for Complex Hydrothermal Systems), Roland Masson and Konstantin Brenner: december 2016 - december 2020, partners BRGM (leader), LJAD-Inria, Storengy, MdS, LJLL.
- ANR JCJC PRECIS (Effect of a shock wave on a structure with contact using mesh refinement and parallelism), Laurent Monasse: april 2018 - april 2021, partners Inria (leader), Ecole des Ponts, CEA, Université Paris-Est.

9.2.2. National and European networks

- GdR MANU.

  The research group MANU has activities centered around scientific computing, design of new numerical schemes and mathematical modelling (upscaling, homogenization, sensitivity studies, inverse problems,...). Its goal is to coordinate research in this area, as well as to promote the emergence of focused groups around specific projects

- S. Junca is involved in GdR 3437 DYNOLIN "Dynamique non linéaire" and GdR MecaWave.
- LJAD-Inria and BRGM are the French partners of the Norvergian, German French project InSPiRE "International Open Source Simulation Software Partnership in Research and Education" which has just been accepted by the Research Council of Norway with the code ComPASS as one of the softwares of this project together with Dune, Dumux and OPM.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Martin Gander (Genève), UCA invited professor 18/06 – 18/07, collaboration on reduced fracture models and DDM for coupling liquid gas Darcy and free gas flows. Co-organisation with Martin Gander, Stella Krell, Victorita Dolean, Roland Masson of the summer school on DDM: 19,20,21/06 https://math.unice.fr/~krell/ColloqueDD/index.php
- Felix Kwok (Hong Kong): 11/06 – 25/06 on nonlinear domain decomposition for the Richards equation.

DATASHAPE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR ASPAG
Participant: Marc Glisse.

- Acronym : ASPAG.

- Type : ANR blanc.

- Title : Analysis and Probabilistic Simulations of Geometric Algorithms.

- Coordinator : Olivier Devillers (équipe Inria Gamble).

- Duration : 4 years from January 2018 to December 2021.

- Others Partners: Inria Gamble, LPSM, LABRI, Université de Rouen, IECL, Université du Littoral Côte d'Opale, Telecom ParisTech, Université Paris X (Modal'X), LAMA, Université de Poitiers, Université de Bourgogne.

- Abstract:

The analysis and processing of geometric data has become routine in a variety of human activities ranging from computer-aided design in manufacturing to the tracking of animal trajectories in ecology or geographic information systems in GPS navigation devices. Geometric algorithms and probabilistic geometric models are crucial to the treatment of all this geometric data, yet the current available knowledge is in various ways much too limited: many models are far from matching real data, and the analyses are not always relevant in practical contexts. One of the reasons for this state of affairs is that the breadth of expertise required is spread among different scientific communities (computational geometry, analysis of algorithms and stochastic geometry) that historically had very little interaction. The Aspag project brings together experts of these communities to address the problem of geometric data. We will more specifically work on the following three interdependent directions.

(1) Dependent point sets: One of the main issues of most models is the core assumption that the data points are independent and follow the same underlying distribution. Although this may be relevant in some contexts, the independence assumption is too strong for many applications.

(2) Simulation of geometric structures: The phenomena studied in (1) involve intricate random geometric structures subject to new models or constraints. A natural first step would be to build up our understanding and identify plausible conjectures through simulation. Perhaps surprisingly, the tools for an effective simulation of such complex geometric systems still need to be developed.

(3) Understanding geometric algorithms: the analysis of algorithm is an essential step in assessing the strengths and weaknesses of algorithmic principles, and is crucial to guide the choices made when designing a complex data processing pipeline. Any analysis must strike a balance between realism and tractability; the current analyses of many geometric algorithms are notoriously unrealistic. Aside from the purely scientific objectives, one of the main goals of Aspag is to bring the communities closer in the long term. As a consequence, the funding of the project is crucial to ensure that the members of the consortium will be able to interact on a very regular basis, a necessary condition for significant progress on the above challenges.

- See also: https://members.loria.fr/Olivier.Devillers/aspag/

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. GUDHI

Title: Algorithmic Foundations of Geometry Understanding in Higher Dimensions

Programm: FP7

Type: ERC

Duration: February 2014 - January 2019

Coordinator: Inria

Inria contact: Jean-Daniel Boissonnat.

The central goal of this proposal is to settle the algorithmic foundations of geometry understanding in dimensions higher than 3. We coin the term geometry understanding to encompass a collection of tasks including the computer representation and the approximation of geometric structures, and the inference of geometric or topological properties of sampled shapes. The need to understand geometric structures is ubiquitous in science and has become an essential part of scientific computing and data analysis. Geometry understanding is by no means limited to three dimensions. Many applications in physics, biology, and engineering require a keen understanding of the geometry of a variety of higher dimensional spaces to capture concise information from the underlying often highly nonlinear structure of data. Our approach is complementary to manifold learning techniques and aims at developing an effective theory for geometric and topological data analysis. To reach these objectives, the guiding principle will be to foster a symbiotic relationship between theory and practice, and to address fundamental research issues along three parallel advancing fronts. We will simultaneously develop mathematical approaches providing theoretical guarantees, effective algorithms that are amenable to theoretical analysis and rigorous experimental validation, and perennial software development. We will undertake the development of a high-quality open source software platform to implement the most important geometric data structures and algorithms at the heart of geometry understanding in higher dimensions. The platform will be a unique vehicle towards researchers from other fields and will serve as a basis for groundbreaking advances in scientific computing and data analysis.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Wolfgang Polonik, UC Davis, California. Sept. and Oct. 2018. Statistical aspects of persistent homology.
- Arijit Ghosh, Indian Statistical Institute, Kolkata, India (December 2018)
- Ramsay Dyer, Berkeley Publishing (December 2018)

9.3.1.1. Internships

- Shreya Arya, BITS Pilani University, India, August-July 2018.

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

8. Partnerships and Cooperations

8.1. Inria internal funding

8.1.1. ADT ACQUA

Participants: Chadi Barakat.

In the context of the Inria ADT call, we have a funding for a two year engineering position on the ACQUA project for the 2015-2017 period. Thierry Spetebroot is hired on this position. In 2017, this ADT got extended by six months beyond the two years period to therefore end on March 2018.

8.1.2. IPL BetterNet

Participants: Chadi Barakat.

The DIANA team is part of the Inria Project Lab BetterNet (http://project.inria.fr/betternet/). Within this lab, Inria has funded two PhD students in 2017 co-supervised by Chadi Barakat from the DIANA project-team. The first PhD student is Thibaut Ehlinger hosted within the DIANA team and co-supervised by Vassilis Christophides from the MiMove team in Paris. The second PhD student is Imane Taibi hosted by the Dionysos team in Rennes and co-supervied by Gerardo Rubino and Yassine Hadjadj-Aoul. Both PhDs started on the 1st of November 2017. Further in 2018, Inria funded a PostDoc position to supervise the experiments planned within the IPL and develop the data analysis part. This PostDoc position is occupied by Giulio Grassi who is co-supervised by Chadi Barakat from the DIANA project-team and Renata Teixeira from the MiMove project-team. Giulio Grassi started on October 1st, 2018 and is currently located in Paris.

8.2. Regional Initiatives

8.2.1. ElectroSmart

Participants: Arnaud Legout, Mondi Ravi, David Migliacci, Abdelhakim Akodadi, Yanis Boussad.

The ElectroSmart project benefits form the following fundings:

- a 39 months engineering position from the UCN@Sophia Labex for the 2016-2019 period (Ravi Mondi is hired on this position)
- 30KEuros from Academy 1 of UCAJedi
- a two years engineering position from an Inria ADT for 2017/2019 (Abdelhakim Akodadi)
- a 18 months business developer from Inria ATT for june 2017-june 2019 (David Migliacci)
- a 3 years 2017/2020 Ph.D. thesis from Academy 1 of UCAJedi (Yanis Boussad)

8.2.2. D2D Indoor

Participants: Chadi Barakat, Zeineb Guizani.

This project is joint with the NFCOM startup in Nice, specialized in the development of new services for mobile phones. The project aims at leveraging mobile to mobile communications for offloading the cellular infrastructure, and will target a solution based on algorithms previously developed in the DIANA project-team (BitHoc and HBSD). The project got a funding for one year engineer from the Labex. Zeineb Guizani has been working on this project since July 2018.

8.3. National Initiatives

8.3.1. ANR

- **ANR JCJC DET4ALL** (2019-2021): Modern factories and industrial system massively rely on cyber physical systems with digital communications (e.g., to allow collaborative robots, for data analytics...). However, industrial networks are still mostly managed and conceived as collections of independent communicating units instead of one unified piece of software.

  The reason why the shift of paradigm did not occur yet to industrial digital communication networks is because industrial processes generally impose strong determinism and real-time constraints. As a result, industrial networks have a propensity of being physically segregated to contain potential malfunctions and simplify conception.

  With the DET4ALL project, we will apply the concept of network programmability to the world of industrial communicating systems. To that aim, we will construct and prove the essential building blocks that will allow to virtualise industrial networks:

  – algorithms to automatically provision the various components constituting industrial networks;

  – Domain Specific Languages (DSLs) to specify real-time communication schemes;

  – mechanisms to update on-the-fly the production infrastructures without service degradation.

  The impact of the DET4ALL project goes beyond technological advances; it will also bring a new vision on what production tools can become, namely agile systems in perpetual evolution.

- **ANR FIT** (2011-2019): FIT (Future Internet of Things) aims at developing an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's Equipements of Excellence (Equipex) research grant programme. The project will benefit from a 5.8 million euro grant from the French government. Other partners are UPMC, IT, Strasbourg University and CNRS. The project was extended for one year and will end in december 2019. See also http://fit-equipex.fr/.

- **ANR BottleNet** (2016-2019): BottleNet aims to deliver methods, algorithms, and software systems to measure Internet Quality of Experience (QoE) and diagnose the root cause of poor Internet QoE. This goal calls for tools that run directly at users' devices. The plan is to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. ANR BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

8.4. European Initiatives

8.4.1. FP7 & H2020 Projects

- Program: FP7 FIRE programme
- Project acronym: Fed4Fire+
- Project title: Federation for FIRE Plus

- Duration: January 2017 - December 2021
- Coordinator: iMinds (Belgium)
- Other partners: 20 european partners including IMEC (Belgium), UPMC (Fr), Fraunhofer (Germany), TUB (Germany), etc.
- Web site: http://www.fed4fire.eu/
- Abstract: The Fed4FIRE+ project has the objective to run and further improve Fed4FIRE as best-in-town federation of experimentation facilities for the Future Internet Research and Experimentation initiative. Federating a heterogeneous set of facilities covering technologies ranging from wireless, wired, cloud services and open flow, and making them accessible through common frameworks and tools suddenly opens new possibilities, supporting a broad range of experimenter communities covering a wide variety of Internet infrastructures, services and applications. Fed4FIRE+ will continuously upgrade and improve the facilities and include technical innovations, focused towards increased user satisfaction (user-friendly tools, privacy-oriented data management, testbed SLA and reputation, experiment reproducibility, service-level experiment orchestration, federation ontologies, etc.). It will open this federation to the whole FIRE community and beyond, for experimentation by industry and research organisations, through the organization of Open Calls and Open Access mechanisms. The project will also establish a flexible, demand-driven framework which allows test facilities to join during the course of its lifetime by defining a set of entry requirements for new facilities to join and to comply with the federation. FIRE Experimental Facilities generate an ever increasing amount of research data that provides the foundation for new knowledge and insight into the behaviour of FI systems. Fed4FIRE+ will participate in the Pilot on Open Research Data in Horizon 2020 to offer open access to its scientific results, to the relevant scientific data and to data generated throughout the project's lifetime. Fed4FIRE+ will finally build on the existing community of experimenters, testbeds and tool developers and bring them together regularly (two times a year) in engineering conferences to have maximal interaction between the different stakeholders involved.

8.5. International Initiatives

8.5.1. Inria Associate Teams Involved in an Inria International Lab

8.5.1.1. DrIVE

Title: DrIVE: Distributed Intelligent Vehicular Environment - Enabling ITS through programmable networks

Inria International Lab: **Inria@SiliconValley**

International Partner (Institution - Laboratory - Researcher):

Ericsson Research, Indaiatuba-SP, BRAZIL (Brazil) Mateus Augusto Silva Santos

Start year: 2018

See also: https://team.inria.fr/diana/drive-associated-team/

Abstract: Transportation systems are part of our society's critical infrastructure and are expected to experience transformative changes as the Internet revolution unfolds. The automotive industry is a notable example: it has been undergoing disruptive transformations as vehicles transition from traditional unassisted driving to fully automated driving, and eventually to the self-driving model. Communication technology advancements such as support for vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communication have been one of the key enablers of next generation transportation services, also known as Intelligent Transport Systems (ITS). However, ITS services and applications pose significant challenges to the underlying communication and network infrastructure due to their stringent low latency, reliability, scalability, and geographic decentralization requirements. The DrIVE associated team proposal aims at addressing such challenges by: (1) developing a programmable network control plane that will dynamically adjust to current environment conditions and network characteristics to support ITS' scalability, quality of service (QoS), and decentralization requirements, and (2) applying the proposed distributed network control plane framework to ITS applications, such as road hazard warning, autonomous- and self-driving vehicles, and passenger-centric services (e.g., infotainment and video streaming).

8.5.2. Inria Associate Teams Not Involved in an Inria International Labs

8.5.2.1. UHD-on-5G

Title: Ultra High Definition video streaming on future 5G networks

International Partner (Institution - Laboratory - Researcher):

National Institute of Information and Communications Technology (NICT) (Japan) - Hitoshi Asaeda

Start year: 2016

See also: https://team.inria.fr/diana/uhd-on-5g/

The aim of this collaboration is to design and develop efficient mechanisms for streaming UHD video on 5G networks and to evaluate them in a realistic and reproducible way by using novel experimental testbeds.

Our approach leverages and extends when necessary ICN and SDN technologies to allow very high quality video streaming at large scale. We also plan to use Virtual Network Functions (VNF) in order to place easily and dynamically different functions (e.g. transcoding, caching) at strategic locations within the network. Specifically, the placement of these functions will be decided by SDN controllers to optimize the quality of experience (QoE) of users. Moreover, we plan to integrate ICN functionalities (e.g., name-based forwarding and multipath transport using in-network caching) with SDN/NFV to provide better QoE and mobility services support to users than traditional IP architectures. Monitoring mechanisms such as the Contrace tool we developed in the SIMULBED associated team will be helpful to provide an accurate view of the network at the SDN controllers side. In addition, we will build a large-scale testbed to evaluate our solutions through reproducible experimentations based on two testbeds: the ICN wired CUTEi tesbed developed by NICT and the wireless R2lab testbed developed by Inria.

8.6. International Research Visitors

8.6.1. Visits of International Scientists

Katia Obraczka is Professor of Computer Engineering and Graduate Director at Department of Computer Engineering, UC Santa Cruz where she leads the Internetworking Research Group (i-NRG). She has visited us for four weeks in July 2018. The Labex UCN@Sophia has supported two one-month visits at the DIANA project-team, in July 2017 and during summer 2018 to work in particular on the decentralization of the SDN control plane applied to Intelligent Transport Systems (ITS). These two visits were very fruitful as they resulted in common publications [18], [17] and contributed to the start of the DrIVE Associated team.

8.6.2. Internships

Yevhenii Semenko and Alberto Zirondelli

Date: from from Apr 2018 until Sep 2018

Institution: Ubinet Master intern, University of Nice Sophia Antipolis

Supervisor: Damien Saucez

Subject: Privacy preserving taxi service with blockain

Laila Daanoun

Date: from Apr 2018 until Aug 2018

Institution: Ubinet Master intern, University of Nice Sophia Antipolis

Supervisor: Damien Saucez

Subject: The Network of the Future in Industry 4.0: Solving the Reachability problem

Gayatri Sivadoss

       Date: from Apr 2018 until Aug 2018

       Institution: Ubinet Master intern, University of Nice Sophia Antipolis

       Supervisor: Mohamed Naoufal Mahfoudi, Thierry Turletti and Walid Dabbous

       Subject: LoRa: Characterization and Range Extension in campus environment

Ohtmane Bensouda Korachi

       Date: from Apr 2018 until Aug 2018

       Institution: Ubinet Master intern, University of Nice Sophia Antipolis

       Supervisor: Mohamed Naoufal Mahfoudi, Thierry Turletti and Walid Dabbous

       Subject: Geolocation for LoRa Low Power Wide Area Network

Othmane Belmoukadam

       Date: from Mar 2018 until Aug 2018

       Institution: Ubinet Master intern, University of Nice Sophia Antipolis

       Supervisor: Chadi Barakat

       Subject: ACQUA - A data-driven approach for network and Quality of Experience monitoring

Yonathan Bleyfuesz

       Date: from Feb 2018 to Aug 2018

       Institution: International Master programme M1, University of Nice Sophia Antipolis

       Supervisor: Thierry Parmentelat

       Subject: Using `nepi-ng` to evaluate MANET routing protocols.

Indukala Naladala

       Date: from May 2018 until Jul 2018

       Institution: National Institute of Technology Karnataka, Surathkal, India

       Supervisor: Thierry Turletti and Walid Dabbous

       Subject: Integration of R2LAB with ns-3

Janati Idrissi

       Date: from Mar 2018 until Aug 2018

       Institution: Ubinet Master intern, University of Nice Sophia Antipolis

       Supervisor: Arnaud Legout

       Subject: Étude de la précision de la localisation dans ElectroSmart sous Android.

8.6.3. *Visits to International Teams*

Thierry Turletti visited NICT in Tokyo Japan in the context of the UHD-on-5G associated team in october 2018.

Thierry Turletti also visited UNICAMP in Campinas Bresil in the context of the UHD-on-5G associated team in october 2018.

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

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Inria International Labs

Ecuador participates in the Joint Laboratory for Exascale Computing (JLESC) together with colleagues at Argonne National Laboratory.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

- N. Ayache and P. Robert are principal investigators of the project MNC3 (Médecine Numérique, Cerveau, Cognition, Comportement) funded by Idex Jedi UCA (2017-2021, 450k€). M. Lorenzi (Inria) actively participates to the supervision of this project with the help of V. Manera (ICP).
- Hervé Delingette is the principal investigator of the LungMark project funded by Idex Jedi UCA (2018-2021).
- Hervé Delingette is the principal investigator of the CIMPLE project, funded by Idex Jedi UCA (2018-2021), the region PACA and Oticon Medical. The region PACA and Oticon Medical are co-funding the Phd of Zihao Wang.
- Marco Lorenzi is principal investigator of the project Big Data for Brain Research, funded during 2017-20 by the Départment des Alpes Maritimes.
- Marco Lorenzi is principal investigator of the project MetaImaGen, funded by Idex Jedi UCA (2018-2020, 37k€).
- Maxime Sermesant is principal investigator of the project "The Digital Heart" and the innovation action "Digital Heart Phantom" with General Electrics, funded by Idex UCA Jedi. These projects gather the local cardiac research in academia, clinics and industry.

8.2. National Initiatives

8.2.1. Consulting for Industry

- Nicholas Ayache is a scientific consultant for the company Mauna Kea Technologies (Paris).
- Marco Lorenzi is a scientific consultant for the company MyDataModels (Sophia Antipolis).
- Xavier Pennec is a scientific consultant for the company Median Technologies (Sophia Antipolis)
- Maxime Sermesant is a scientific consultant for the company inHEART (Bordeaux)

8.2.2. Collaboration with national hospitals

The Epione-project team collaborates with the following 3 French IHU (University Hospital Institute): the IHU-Strasbourg (Pr J. Marescaux and L. Soler) on image-guided surgery, the IHU-Bordeaux (Pr M. Haïssaguere and Pr P. Jaïs) on cardiac imaging and modeling and the IHU-Pitié Salpétrière (Dr. O. Colliot and S. Durrleman) on neuroimaging.

We also have long term collaborations with the CHU Nice and Centre Antoine Lacassagne in Nice.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ERC ECSTATIC

Title: Electrostructural Tomography – Towards Multiparametric Imaging of Cardiac Electrical Disorders

Programm: H2020

Type: ERC

Duration: 2017 - 2022

Coordinator: U. Bordeaux

Inria contact: Maxime Sermesant

Cardiac electrical diseases are directly responsible for sudden cardiac death, heart failure and stroke. They result from a complex interplay between myocardial electrical activation and structural heterogeneity. Current diagnostic strategy based on separate electrocardiographic and imaging assessment is unable to grasp both these aspects. Improvements in personalized diagnostics are urgently needed as existing curative or preventive therapies (catheter ablation, multisite pacing, and implantable defibrillators) cannot be offered until patients are correctly recognized.

ECSTATIC aims at achieving a major advance in the way cardiac electrical diseases are characterized and thus diagnosed and treated, through the development of a novel non-invasive modality (Electrostructural Tomography), combining magnetic resonance imaging (MRI) and non-invasive cardiac mapping (NIM) technologies.

The approach will consist of: (1) hybridising NIM and MRI technologies to enable the joint acquisition of magnetic resonance images of the heart and torso and of a large array of body surface potentials within a single environment; (2) personalising the inverse problem of electrocardiography based on MRI characteristics within the heart and torso, to enable accurate reconstruction of cardiac electrophysiological maps from body surface potentials within the 3D cardiac tissue; and (3) developing a novel disease characterisation framework based on registered non-invasive imaging and electrophysiological data, and propose novel diagnostic and prognostic markers.

This project will dramatically impact the tailored management of cardiac electrical disorders, with applications for diagnosis, risk stratification/patient selection and guidance of pacing and catheter ablation therapies. It will bridge two medical fields (cardiac electrophysiology and imaging), thereby creating a new research area and a novel semiology with the potential to modify the existing classification of cardiac electrical diseases.

8.3.1.2. ERC G-statistics

Title: Biophysical Modeling and Analysis of Dynamic Medical Images

Programme: FP7

Type: ERC

Period: 2018-2023

Coordinator: Inria

Inria contact: Xavier Pennec

G-Statistics aims at exploring the foundations of statistics on non-linear spaces with applications in the Life Siences. Invariance under gauge transformation groups provides the natural structure explaining the laws of physics. In life sciences, new mathematical tools are needed to estimate approximate invariance and establish general but approximate laws. Rephrasing Poincaré: a geometry cannot be more true than another, it may just be more convenient, and statisticians must find the most convenient one for their data. At the crossing of geometry and statistics, G-Statistics aims at grounding the mathematical foundations of geometric statistics and to exemplify their impact on selected applications in the life sciences.

So far, mainly Riemannian manifolds and negatively curved metric spaces have been studied. Other geometric structures like quotient spaces, stratified spaces or affine connection spaces naturally arise in applications. G-Statistics will explore ways to unify statistical estimation theories, explaining how the statistical estimations diverges from the Euclidean case in the presence of curvature, singularities, stratification. Beyond classical manifolds, particular emphasis will be put on flags of subspaces in manifolds as they appear to be natural mathematical object to encode hierarchically embedded approximation spaces.

In order to establish geometric statistics as an effective discipline, G-Statistics will propose new mathematical structures and characterizations of their properties. It will also implement novel generic algorithms and illustrate the impact of some of their efficient specializations on selected

applications in life sciences. Surveying the manifolds of anatomical shapes and forecasting their evolution from databases of medical images is a key problem in computational anatomy requiring dimension reduction in non-linear spaces and Lie groups. By inventing radically new principled estimations methods, we aim at illustrating the power of the methodology and strengthening the "unreasonable effectiveness of mathematics" for life sciences.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: ERA CoSysMed

Project acronym: SysAFib

Project title: Systems medicine for diagnosis and stratification of atrial fibrillation

Duration: Mai 2016 - Mai 2019

Coordinator: Simula, Norway

Inria contact: Maxime Sermesant

Other partners: Inria, Helmholtz Zentrum München, Oslo University Hospital, Maastricht University, CardioCentro Ticino/CCMC

Abstract: Atrial fibrillation (AF) sharply increases the risk of stroke and is associated with a number of other severe complications, including heart failure. The SysAFib project aims to combine advanced data analysis and computer simulations with classical clinical approaches to create a decision support tool for treating AF. Diverse data sources, such as the individual patient's medical history, clinical measurements and genetic data will be combined into a single tool for optimizing and personalizing AF therapy. SysAFib's ultimate goal is to deliver the right treatment to the right patient at the right time, stopping AF in its tracks and ending the need for repeat invasive procedures.

8.4. International Initiatives

8.4.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

8.4.1.1. GeomStats

Title: Geometric Statistics in Computational Anatomy: Non-linear Subspace Learning Beyond the Riemannian Structure

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Statistics - Susan Holmes

Start year: 2018

See also: http://www-sop.inria.fr/asclepios/projects/GeomStats/

The scientific goal of the associated team led by X. Pennec is to develop the field of geometric statistics with key applications in computational anatomy. Computational anatomy is an emerging discipline at the interface of geometry, statistics, image analysis and medicine that aims at analysing and modelling the biological variability of the organs shapes at the population level. An important application in neuroimaging is the spatial normalization of subjects that is necessary to compare anatomies and functions through images in populations with different clinical conditions. Following the developments of the last 3 years of the associated team GeomStat, the new research directions have been broken into three axes. The first axis aims at continuing the progresses in theoretical and applied Geometric statistics, with a first theme studying the impact of curvature on the estimation with a finite sample, and a second axis extending the current work on Barycentric Subspace Analysis (BSA), notably with algorithms. The second axis aims at developing a hierarchical atlas of the brain anatomy based on the stratification of the space of image orbits under diffeomorphisms. The third axis explores three important applications of low-dimensional subspace learning in manifolds using BSA in neuroscience: the approximation of EEG signals for brain-computer interfaces (BCI); the acceleration and robustification of Tensor Distribution Functions (TDF) estimation in diffusion images; and the efficient inference in spaces of rank-deficient symmetric matrices for imaging-genetics from multi-centric databases.

8.4.2. Inria Associate Teams Not Involved in an Inria International Labs

8.4.2.1. PersoCardioLearn

> Title: Personalization of Cardiac Models using Experimental Data and Machine Learning
>
> International Partner (Institution - Laboratory - Researcher):
>
>> University of Toronto (Canada) - Sunnybrook Research Institute - Mihaela Pop
>
> Start year: 2017
>
> See also: https://team.inria.fr/asclepios/research/associated-team-persocardiolearn/
>
> Multi-scale computer modelling is a powerful tool that could be used to simulate in silico cardiac electrical activity and biomechanical function of individual heart. Imaging and 3D heart models built from images can help us understand the basis of structurally-diseased hearts at organ level and to predict in silico the changes in electro-mechanical function as a consequence of muscle remodelling in pathologic state (e.g. chronic infarction, a major cause of death). We hypothesize that MRI-based predictive models can help us identify new opportunities to intervene or to predict the outcome of ablation therapy, which currently has low clinical success. However, these predictive models need to be validated and thoroughly tested in preclinical experiments prior to their integration into the clinical stage. Hence, the next logical step for our joint Inria-SB efforts is to expand our experimental-theoretical framework and to personalize fast 3D heart models from in vivo MR-EP data. This translational step involves numerous challenging tasks from the modelling perspective since the in vivo imaging and physiological signals are rather noisy and obtained at a poor spatial resolution, potentially leading to erroneous customization of mathematical model parameters. However, this collaboration employs a rare combination of experiments and modelling specialists. Moreover, the originality of the proposed approach is to build upon machine-learning techniques rather than on data assimilation methods that are more explored in the literature but have inherent limitations (robustness to noise, local minima. . .).

8.4.3. Inria International Partners

8.4.3.1. Informal International Partners

8.4.3.1.1. St Thomas' Hospital, King's College London, United Kingdom

Maxime Sermesant is a visiting lecturer in the Division of Imaging Sciences and Biomedical Engineering, St Thomas' Hospital, King's College London lead by Pr Reza Razavi. The XMR facility within this hospital is a unique opportunity to validate and exploit the cardiovascular modelling work.

8.4.3.1.2. Massachusetts General Hospital, Boston

A collaboration with Dr Jan Unklebach, Assistant Professor of Radiation Oncology and Dr Jayashree Kalpathy-Cramer, radiology instructor was initiated in 2013 around the topics of tumor growth modeling, radiotherapy planning and edema characterization from MRI.

8.4.3.1.3. University College London (UCL), London, UK

Marco Lorenzi is collaborator of the Translational Imaging Group of UCL, and with the UCL Institute od Ophtalmology. His collaboration is around the topic of spatio-temporal analysis of medical images, with special focus on brain imaging analysis and biomarker development. He is also collaborating with the "Progression Over Neurodegenerative Disorders" (POND) group (Prof. Daniel Alexander) for developing new computational models and techniques for learning characteristic patterns of disease progression using large longitudinal clinical data sets, with special focus on dementias.

8.4.3.1.4. Imaging Genetics Center (IGC), University of Southern California (USC), CA, USA

Marco Lorenzi is currently collaborator of IGC for the investigation of the complex relationship between brain atrophy and genetics in Alzheimer's disease, in particular for demonstrating the effectiveness of multivariate statistical models in providing a meaningful description of the relationship between genotype and brain phenotype.

8.4.3.1.5. Other International Hospitals

Collaborations with several other European hospitals have been established through the European projects VP2HF, MD PAEDIGREE and SysAFib.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Svenja Hüning, PhD student with Johannes Wallner at Graz University in Austria visited the Epione team in November 2018 to work with Xavier Pennec on subdivision schemes on manifolds.
- Santiago Smith Silva Rincon, Master student at the National University of Bogota (CO), visited the Epione team from May to October 2018 to work with Marco Lorenzi on distributed learning methods in imaging-genetics.

8. Partnerships and Cooperations

8.1. Regional Initiatives

- The team participates in the project WIMAG (Wave IMAGing) funded by the Idex UCA$^{\text{Jedi}}$. It aims at identifying and gathering the research and development by partners of UCA involved in wave imaging systems. Other partners are UNS and CNRS (GéoAzur, I3S, LEAT, LJAD), together with Orange Labs.

- The team co-advises a PhD (G. Bose) with the CMA team of LEAT (http://leat.unice.fr/pages/activites/cma.html) funded by the Labex UCN@Sophia on the co-conception of Antennas and Filters.

- The team participates in the transverse action C4PO funded by the Idex UCA$^{\text{Jedi}}$. This "Center for Planetary Origin" brings together scientists from various fields to advance and organize Planetary Science at the the University of Nice, and supports research and teaching initiatives within its framework, among which the workshop "Inverse problems and approximation techniques in planetary sciences" organized by members of Factas in May, about inverse problems in harmonic electromagnetism and approximation, with applications mainly dedicated to geomagnetism and paleomagnetism, see Section 9.1.1 .

- The team also participates in the project ToMaT, "Multiscale Tomography: imaging and modeling ancient materials, technical traditions and transfers", funded by the Idex UCA$^{\text{Jedi}}$ ("programme structurant Matière, Lumière, Interactions"). This project brings together researchers in archaeological, physical, and mathematical sciences, with the purpose of modeling and detecting low level signals in 3-D images of ancient potteries. The other concerned scientists are from CEPAM-CNRS-UCA (project coordinator: Didier Binder), Nice http://www.cepam.cnrs.fr, the team Morpheme, CNRS-I3S-Inria http://www.inria.fr/equipes/morpheme, and IPANEMA, CNRS, Ministère de la Culture et de la Communication, Université Versailles Saint Quentin http://ipanema.cnrs.fr/. Since March 2018, they co-advise together the post-doctoral research of Vanna Lisa Coli, see Section 6.5 .

8.2. National Initiatives

8.2.1. ANR MagLune

The ANR project MagLune (Magnétisme de la Lune) has been approved July 2014. It involves the Cerege (Centre de Recherche et d'Enseignement de Géosciences de l'Environnement, joint laboratory between Université Aix-Marseille, CNRS and IRD), the IPGP (Institut de Physique du Globe de Paris) and ISTerre (Institut des Sciences de la Terre). Associated with Cerege are Inria (Apics, then Factas team) and Irphe (Institut de Recherche sur les Phénomènes Hors Équilibre, joint laboratory between Université Aix-Marseille, CNRS and École Centrale de Marseille). The goal of this project (led by geologists) is to understand the past magnetic activity of the Moon, especially to answer the question whether it had a dynamo in the past and which mechanisms were at work to generate it. Factas participates in the project by providing mathematical tools and algorithms to recover the remanent magnetization of rock samples from the moon on the basis of measurements of the magnetic field it generates. The techniques described in Section 6.1 are instrumental for this purpose.

8.2.2. ANR Cocoram

The ANR (Astrid) project Cocoram (Co-design et co-intégration de réseaux d'antennes actives multi-bandes pour systèmes de radionavigation par satellite) started January 2014 and ended October 2018. We were associated with three other teams from XLIM (Limoges University), geared respectively towards filters, antennas and amplifiers design. The core idea of the project was to realize dual band reception an emission chains by co-conceiving the antenna, the filters, and the amplifier. A complete chain has been synthesized using matching filters placed after each of the accesses of a network of 4 bi-polarized antennas, resulting in a substantial gain in energy effectiveness of 30%. This communication chain has been manufactured by our partner XLIM, and presented to the final meeting of the ANR in October.

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Apics is part of the European Research Network on System Identification (ERNSI) since 1992.

System identification deals with the derivation, estimation and validation of mathematical models of dynamical phenomena from experimental data.

8.4. International Initiatives

8.4.1. Inria Associate Teams Not Involved in an Inria International Labs

8.4.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

International Partner (Institution - Laboratory - Researcher):

Massachusetts Institute of Technology (United States) - Department of Earth, Atmospheric and Planetary Sciences - Benjamin P. Weiss

Start year: 2016

See also: http://www-sop.inria.fr/apics/IMPINGE/

This proposal is concerned with the inverse problem of recovering a magnetization distribution from measurements of the magnetic field in a portion of space nearby. The application domain is to Earth and planetary sciences. Indeed, the remanent magnetization of rocks provides valuable information on their history. The proposal aims at renewing the existing "Équipe Associée" Impinge ending 2015, between Apics (now Factas) team at Inria and the Department of Earth, Atmospheric and Planetary Sciences at MIT (Cambridge, MA, USA), with the Department of Mathematics at Vanderbilt University (Nashville, TN, USA) as a secondary partner. Several research paths were broken towards magnetization recovery and promising numerical experiments have been conducted. This initial effort must be continued to achieve a reasonably complete methodology for reconstructing magnetizations and checking for hypotheses by geophysicists (e.g., unidirectionality of magnetization distributions).

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

MIT-France seed funding is a competitive collaborative research program ran by the Massachusetts Institute of Technology (Cambridge, Ma, USA). Together with E. Lima and B. Weiss from the Earth and Planetary Sciences dept. at MIT, Apics obtained two-years support from the above-mentioned program to run a project entitled: "Development of Ultra-high Sensitivity Magnetometry for Analyzing Ancient Rock Magnetism"

NSF Grant L. Baratchart, S. Chevillard and J. Leblond are external investigators in the NSF Grant 2015-2018, "Collaborative Research: Computational methods for ultra-high sensitivity magnetometry of geological samples" led by E. B. Saff (Vanderbilt Univ.) and B. Weiss (MIT).

8.5. International Research Visitors

8.5.1. *Visits of International Scientists*

- Axel Ringh (KTH Royal Institute of Technology, Stockholm, Sweden), June 11 -July 10.

- Elodie Pozzi (St Louis Univ., St. Louis, Missouri, USA), Brett Wick (Washington University, St. Louis, Missouri, USA), July 25.

- Cristobal Villalobos, Douglas Hardin, Edward Saff (Vanderbilt University, Nashville, Tennessee, USA), December, 6-19, 13-19, and 13-20 respectively.

- M. Olivi proposed with B. Hanzon and R. Peeters a Research in Pair event at CIRM « A state-space approach to parametrization of lossless and stable systems ». which was accepted and took place on August 27-31 https://conferences.cirm-math.fr/2126.html

8.6. List of international and industrial partners

- Collaboration under contract with Thales Alenia Space (Toulouse, Cannes, and Paris), CNES (Toulouse), XLIM (Limoges), LEAT (Sophia Antipolis), University of Bilbao (Universidad del País Vasco / Euskal Herriko Unibertsitatea, Spain), Flextronics.

- Regular contacts with research groups at UST (Villeneuve d'Asq), Universities of Bordeaux-I (Talence), Orléans (MAPMO), Aix-Marseille (CMI-LATP), Nice Sophia Antipolis (Lab. JAD), Grenoble (IJF and LJK), Paris 6 (P. et M. Curie, Lab. JLL), Inria Saclay (Lab. Poems, ENSTA), IMT Atlantique (Institut Mines-Télécom., Brest), Cerege-CNRS (Aix-en-Provence), CWI (the Netherlands), MIT (Boston, USA), Vanderbilt University (Nashville USA), Steklov Institute (Moscow), Michigan State University (East-Lansing, USA), Texas A&M University (College Station USA), Indiana University-Purdue University at Indianapolis, St Louis University and Washington University (St Louis, Missouri, USA), Cinvestav (Queretaro, Mexico), Politecnico di Milano (Milan, Italy), University of Trieste (Italy), RMC (Kingston, Canada), University of Leeds (UK), of Maastricht (the Netherlands), of Cork (Ireland), Vrije Universiteit Brussel (Belgium), TU-Wien and Universität Wien (Austria), TFH-Berlin and Technische Universität Bergakademie Freiberg (Germany), ENIT (Tunis), KTH (Stockholm), University of Cyprus (Nicosia, Cyprus), University of Macau (Macau, China), SIAE Microelettronica (Milano), Université Picardie Jules Verne (France), National and Kapodistrian University of Athens (Greece).

- The project is involved in the GDR-project AFHP (CNRS), in the ANR (Astrid program) project Cocoram (with XLIM, Limoges, and DGA), in the ANR (Défis de tous les savoirs program) project MagLune (with Cerege, IPGP, ISTerre, Irphe), in a MIT-France collaborative seed funding, in the Associate Inria Team IMPINGE (with MIT, Boston), and in a NSF grant (with Vanderbilt University and MIT).

<div align="center">

FOCUS Project-Team

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7. Partnerships and Cooperations

7.1. National Initiatives

- ELICA (Expanding Logical Ideas for Complexity Analysis) is an ANR project that started on October 2014 and that finished on September 2018. ELICA focused on methodologies for the static analysis of programs and their resource consumption. The project's aim was to further improve on logical methodologies for complexity analysis (type systems, rewriting, etc.). More specifically, one would like to have more powerful techniques with less false negatives, being able at the same time to deal with nonstandard programming paradigms (concurrent, probabilistic, etc.). Main persons involved: Avanzini, Dal Lago, Martini.

- REPAS (Reliable and Privacy-Aware Software Systems via Bisimulation Metrics) is an ANR Project that started on October 2016 and that will finish on October 2020. The project aims at investigating quantitative notions and tools for proving program correctness and protecting privacy. In particular, the focus will be put on bisimulation metrics, which are the natural extension of bisimulation to quantitative systems. As a key application, we will develop a mechanism to protect the privacy of users when their location traces are collected. Main persons involved: Dal Lago, Gavazzo, Sangiorgi.

- COCAHOLA (Cost models for Complexity Analyses of Higher-Order Languages) is an ANR Project that started on October 2016 and that will finish on October 2019. The project aims at developing complexity analyses of higher-order computations. The focus is not on analyzing fixed programs, but whole programming languages. The aim is the identification of adequate units of measurement for time and space, i.e. what are called *reasonable* cost models. Main persons involved: Dal Lago, Martini.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

- BEHAPI (Behavioural Application Program Interfaces) is an European Project H2020-MSCA-RISE-2017, running in the period March 2018 - February 2022. The topic of the project is behavioural types, as a suite of technologies that formalise the intended usage of API interfaces. Indeed, currently APIs are typically flat structures, i.e. sets of service/method signatures specifying the expected service parameters and the kind of results one should expect in return. However, correct API usage also requires the individual services to be invoked in a specific order. Despite its importance, the latter information is either often omitted, or stated informally via textual descriptions. The expected benefits of behavioural types include guarantees such as service compliance, deadlock freedom, dynamic adaptation in the presence of failure, load balancing etc. The proposed project aims to bring the existing prototype tools based on these technologies to mainstream programming languages and development frameworks used in industry.

7.2.2. Collaborations in European Programs, Except FP7 & H2020

- ICT COST Action IC1405 (Reversible computation - extending horizons of computing). Initiated at the end of April 2015 and with a 4-year duration, this COST Action studies reversible computation and its potential applications, which include circuits, low-power computing, simulation, biological modeling, reliability and debugging. Reversible computation is an emerging paradigm that extends the standard forwards-only mode of computation with the ability to execute in reverse, so that computation can run backwards as naturally as it can go forwards.

  Main persons involved: Lanese (vice-chair of the action).

- ICT COST Action IC1402 ARVI (Runtime Verification beyond Monitoring). Initiated in December 2014 and with a 4-year duration, this COST Action studies runtime verification, a computing analysis paradigm based on observing a system at runtime to check its expected behaviour.

  Main persons involved: Bravetti, Lanese.

7.2.3. Collaborations with Major European Organizations

We list here the cooperations and contacts with other groups, without repeating those already listed in previous sections.

- ENS Lyon (on concurrency models and resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi. Some visit exchanges during the year, in both directions. A joint PhD (Adrien Durier).

- University of Innsbruck (on termination and complexity analysis of probabilistic programs). Contact person(s) in Focus: Avanzini. Some short visits during the year.

- University of Southern Denmark (on service-oriented computing). Contact person(s) in Focus: Gabbrielli, Lanese, Zavattaro.

- Universitat Politecnica de Valencia, Spain (on reversibility for Erlang). Contact person(s) in Focus: Lanese. Some visit exchanges during the year, in both directions.

- Laboratoire d'Informatique, Université Paris Nord, Villetaneuse (on implicit computational complexity). Contact person(s) in Focus: Dal Lago, Martini.

- Institut de Mathématiques de Luminy, Marseille (on lambda-calculi, linear logic and semantics). Contact person(s) in Focus: Dal Lago, Martini.

- Team PPS, IRIF Lab, University of Paris-Diderot Paris 7 (on logics for processes, resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi. Some short visits in both directions during the year.

- IRILL Lab, Paris (on models for the representation of dependencies in distributed package based software distributions). Contact person(s) in Focus: Gabbrielli, Zavattaro. Some short visits in both directions during the year.

- IMDEA Software, Madrid (G. Barthe) (on implicit computational complexity for cryptography). Contact person(s) in Focus: Dal Lago. Some visits during the year.

- Facultad de Informatica, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project "Desarrollo y Análisis formal de sistemas complejos en contextos DistribuidOS: fundamentos, herramientas y aplicaciones (DArDOS)" (Development and formal analysis of complex systems in distributed contexts: foundations, tools and applications) January 2016 - December 2018, funded by the Spanish Ministerio de Economia y Competitividad.

7.3. International Initiatives

7.3.1. Inria Associate Teams Not Involved in an Inria International Labs

7.3.1.1. CRECOGI

Title: Concurrent, Resourceful and Effectful Computation by Geometry of Interaction

International Partner (Institution - Laboratory - Researcher):

Kyoto (Japan) - Research Institute for Mathematical Sciences - Naohiko Hoshino

Start year: 2018

See also: http://crecogi.cs.unibo.it

The field of denotational semantics has successfully produced useful compositional reasoning principles for program correctness, such as program logics, fixed-point induction, logical relations, etc. The limit of denotational semantics was however that it applies only to high-level languages and to extensional properties. The situation has changed after the introduction of game semantics and the geometry of interaction (GoI), in which the meaning of programs is formalized in terms of movements of tokens, through which programs "talk to" or "play against" each other, thus having an operational flavour which renders them suitable as target language for compilers. The majority of the literature on GoI and games only considers sequential functional languages. Moreover, computational effects (e.g. state or I/O) are rarely taken into account, meaning that they are far from being applicable to an industrial scenario. This project's objective is to develop a semantic framework for concurrent, resourceful, and effectful computation, with particular emphasis on probabilistic and quantum effects. This is justified by the greater and greater interest which is spreading around these two computation paradigms, motivated by applications to AI and by the efficiency quantum parallelism induces.

7.3.2. Participation in Other International Programs

Focus has taken part in the creation of the Microservices Community (http://microservices.sdu.dk/), an international community interested in the software paradigm of Microservices. Main aims of the community are: i) sharing knowledge and fostering collaborations about microservices among research institutions, private companies, universities, and public organisations (like municipalities); ii) discussing open issues and solutions from different points of view, to create foundations for both innovation and basic research.

U. Dal Lago is "Partner Investigator" in the project "Verification and analysis of quantum programs", whose Chief Investigator is Prof Yuan Feng, University of Technology Sydney. The project is funded by the Australian Research Council.

7.3.2.1. AYAME

CRECOGI

Title: Concurrent, Resourceful and Effectful Computation by Geometry of Interaction

International Partner (Institution - Laboratory - Researcher):

JSPS (Japan) - Kyoto University /Research Institute for Mathematical Sciences - Naohiko Hoshino

Duration: 2015 - 2020 The description of the project can be found in Section 7.3.1.1 .

7.4. International Research Visitors

7.4.1. Visits of International Scientists

The following researchers have visited Focus for short periods; we list them together with the title of the talk they have given during their stay, or the topic discussed during their stay.

- Filippo Bonchi (ENS Lyon and University of Pisa) "Sound up-to techniques and complete abstract domain".
- Luis Fernando Llana Díaz (Universidad Complutense de Madrid) "Probabilistic software product lines".
- Claudia Faggian (Université Paris-Diderot – Paris 7) : "Probabilistic Lambda Calculus – beyond deterministic evaluation"
- Nao Hirokawa (Japan Advanced Institute of Science and Technology): "Transformations for Lazy Evaluation and Theorem Proving".
- Guilhem Jaber (University of Nantes): "Game semantics for higher-order functions with state".
- Thomas Leventis (Institut de Mathematiques de Marseille): "Taylor Expansion of lambda terms and differential linear logic."
- Gabriel Scherer (Inria Parsifal). "Keep (re)playing until your get all the successes".
- Emilio Tuosto (University of Leicester): "On pomsets as models of asynchronous message-passing languages".
- Akihisa Yamada (NII Tokyo): "Mathematics for Complexity in Isabelle/HOL".

7.4.2. Visits to International Teams

- Francesco Gavazzo visited the Faculty of Mathematics and Physics (University of Ljubljana) hosted by Alex Simpson, from 02/10/2017 to 31/01/2018.
- U. Dal Lago has spent overall a few weeks in Japan (University of Kyoto and University of Tokyo), collaborations with Naohiko Hoshino and Naoki Kobayashi.

7.4.2.1. Sabbatical programme

Simone Martini is Fellow at the Collegium - Lyon Institute for Advanced Studies, since September 2018 and until June 2019 https://collegium.universite-lyon.fr.

GRAPHDECO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ADT PicPlay
Participants: Sebastien Bonopera, George Drettakis.

The Technology Development Action (ADT) PicPlay a technology tranfer pre-maturation project, supported by Inria and by UCA Jedi. The objective is to create a startup company based on image based rendering technologies, taking benefit from the team's research and experience over the last 8 years. At this early stage, we evaluated the market and produced several Proof-of-Concept demonstrations for potential clients. One of the demonstrations is our new asset streaming capability that allows the use for huge datasets. We also developed a new solution to improve rendering quality. This solution uses a 3D mesh for each view and refines it according to this view only, before blending each view. PicPlay involved the development of several tools for converting and processing datasets. During this year we established contacts with industrial partners in the automobile industry and in the construction/public works industry who expressed interest in using the technology in their projects for visualization and navigation of captured environments.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. ERC D3
Participants: Yulia Gryaditskaya, Tibor Stanko, Bastien Wailly, David Jourdan, Adrien Bousseau.

Designers draw extensively to externalize their ideas and communicate with others. However, drawings are currently not directly interpretable by computers. To test their ideas against physical reality, designers have to create 3D models suitable for simulation and 3D printing. However, the visceral and approximate nature of drawing clashes with the tediousness and rigidity of 3D modeling. As a result, designers only model finalized concepts, and have no feedback on feasibility during creative exploration. Our ambition is to bring the power of 3D engineering tools to the creative phase of design by automatically estimating 3D models from drawings. However, this problem is ill-posed: a point in the drawing can lie anywhere in depth. Existing solutions are limited to simple shapes, or require user input to "explain" to the computer how to interpret the drawing. Our originality is to exploit professional drawing techniques that designers developed to communicate shape most efficiently. Each technique provides geometric constraints that help viewers understand drawings, and that we shall leverage for 3D reconstruction.

Our first challenge is to formalize common drawing techniques and derive how they constrain 3D shape. Our second challenge is to identify which techniques are used in a drawing. We cast this problem as the joint optimization of discrete variables indicating which constraints apply, and continuous variables representing the 3D model that best satisfies these constraints. But evaluating all constraint configurations is impractical. To solve this inverse problem, we will first develop forward algorithms that synthesize drawings from 3D models. Our idea is to use this synthetic data to train machine learning algorithms that predict the likelihood that constraints apply in a given drawing. In addition to tackling the long-standing problem of single-image 3D reconstruction, our research will significantly tighten design and engineering for rapid prototyping.

8.2.1.2. ERC FunGraph
Participants: Sébastien Morgenthaler, George Drettakis, Rada Deeb, Diolatzis Stavros.

The ERC Advanced Grant FunGraph proposes a new methodology by introducing the concepts of rendering and input uncertainty. We define output or rendering uncertainty as the expected error of a rendering solution over the parameters and algorithmic components used with respect to an ideal image, and input uncertainty as the expected error of the content over the different parameters involved in its generation, compared to an ideal scene being represented. Here the ideal scene is a perfectly accurate model of the real world, i.e., its geometry, materials and lights; the ideal image is an infinite resolution, high-dynamic range image of this scene.

By introducing methods to estimate rendering uncertainty we will quantify the expected error of previously incompatible rendering components with a unique methodology for accurate, approximate and image-based renderers. This will allow FunGraph to define unified rendering algorithms that can exploit the advantages of these very different approaches in a single algorithmic framework, providing a fundamentally different approach to rendering. A key component of these solutions is the use of captured content: we will develop methods to estimate input uncertainty and to propagate it to the unified rendering algorithms, allowing this content to be exploited by all rendering approaches.

The goal of FunGraph is to fundamentally transform computer graphics rendering, by providing a solid theoretical framework based on uncertainty to develop a new generation of rendering algorithms. These algorithms will fully exploit the spectacular – but previously disparate and disjoint – advances in rendering, and benefit from the enormous wealth offered by constantly improving captured input content.

8.2.1.3. Emotive

Participants: Julien Philip, Sebastiàn Vizcay, George Drettakis.

https://emotiveproject.eu/

Type: COOPERATION (ICT)

Instrument: Reseach Innovation Action

Objectif: Virtual Heritage

Duration: November 2016 - October 2019

Coordinator: EXUS SA (UK)

Partner: Diginext (FR), ATHENA (GR), Noho (IRL), U Glasgow (UK), U York (UK)

Inria contact: George Drettakis

Abstract: Storytelling applies to nearly everything we do. Everybody uses stories, from educators to marketers and from politicians to journalists to inform, persuade, entertain, motivate or inspire. In the cultural heritage sector, however, narrative tends to be used narrowly, as a method to communicate to the public the findings and research conducted by the domain experts of a cultural site or collection. The principal objective of the EMOTIVE project is to research, design, develop and evaluate methods and tools that can support the cultural and creative industries in creating Virtual Museums which draw on the power of 'emotive storytelling'. This means storytelling that can engage visitors, trigger their emotions, connect them to other people around the world, and enhance their understanding, imagination and, ultimately, their experience of cultural sites and content. EMOTIVE will do this by providing the means to authors of cultural products to create high-quality, interactive, personalized digital stories.

GRAPHDECO contributes by developing novel image-based rendering techniques to help museum curators and archeologists provide more engaging experiences. In 2018, we developed a mixed reality plugin for Unity that allows the use of IBR in a VR experience used in one of the EMOTIVE user experiences using a VIVE HMD.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

We maintain close collaborations with international experts, including

- University College London (G. Brostow, P. Hedman)
- UC Berkeley (A. Efros)
- Purdue University (D. Aliaga)
- George Mason University (Y. Gingold)
- Tu Delft (M. Sypesteyn, J. W. Hoftijzer and S. Pont)

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Carol O'Sullivan, Trinity College Dublin, visited the group for one week in August.
- Peter Hedman, University College London, visited us for a few days in July.
- Miika Aittala, MIT, visited the group for one month in July.
- Yotam Gingold, George Mason University, visited the group for one month in June.

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Several students and postdocs visited our international collaborators:

- Yulia Gryaditskaya and Valentin Deschaintre visited the research group of Fredo Durand at MIT for two weeks. They presented their work to several groups (HCI, geometry, computer graphics).
- Tibor Stanko spent two weeks at RWTH Aachen University, Germany, to collaborate with David Bommes.
- Johanna Delanoy did a 3-months internship at Adobe Research (San Francisco) to collaborate with Aaron Hertzmann.
- Julien Philip spent a week at University College London to visit Gabriel Brostow and five weeks at University of California, Berkeley, to visit Alexei A. Efros. During this visit, he presented his work to the computer graphics groups of Stanford and UC Berkeley.

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. CQFD (ANR PRC, Jan. 2019-Dec. 2022)

Participants: Jean-François Baget, Michel Leclère, Marie-Laure Mugnier, Federico Ulliana.

CQFD (Complex ontological Queries over Federated heterogeneous Data), coordinated by Federico Ulliana (GraphIK), involves participants from Inria Saclay (CEDAR team), Inria Paris (VALDA team), Inria Nord Europe (SPIRALS team), IRISA, LIG, LTCI, and LaBRI. The aim of this project is tackle two crucial challenges in OMQA (Ontology Mediated Query Answering), namely, heterogeneity, that is, the possibility to deal with multiple types of data-sources and database management systems, and federation, that is, the possibility of cross-querying a collection of heterogeneous datasources. By featuring 8 different partners in France, this project aims at consolidating a national community of researchers around the OMQA issue.

8.1.2. ICODA (Inria Project Lab, 2017-2021)

Participants: Jean-François Baget, Michel Chein, Marie-Laure Mugnier.

The iCODA project (Knowledge-mediated Content and Data Interactive Analytics—The case of data journalism), coordinated by Guillaume Gravier and Laurent Amsaleg (LINKMEDIA), takes together four Inria teams: LINKMEDIA, CEDAR, ILDA and GraphIK, as well as three press partners: Ouest France, Le Monde (les décodeurs) and AFP.

Taking data journalism as an emblematic use-case, the goal of the project is to develop the scientific and technological foundations for knowledge-mediated user-in-the-loop big data analytics jointly exploiting data and content, and to demonstrate the effectiveness of the approach in realistic, high-visibility use-cases. https://project.inria.fr/icoda/

8.1.3. Docamex (CASDAR project, 2017-2020)

Participants: Patrice Buche, Madalina Croitoru, Jérôme Fortin, Clément Sipieter.

DOCaMEx (Développement de prOgiciels de Capitalisation et de Mobilisation du savoir-faire et de l'Expérience fromagers en filière valorisant leur terroir), let by CFTC (centre technique des fromages de Franche-Comté) involves 7 research units (including IATE and LIRMM), 8 technical centers and 3 dairy product schools. It represents five cheese-making chains (Comté, Reblochon, Emmental de Savoie, Salers, Cantal).

Traditional cheese making requires a lot of knowledge, expertise, and experience, which is usually acquired over a long time. This knowledge is today mainly transmitted by apprenticeship and a concrete risk of knowledge forgetting is raised by the evolution of practices in the sector. Using new methods for expert knowledge capitalization the main goal of the project is to develop a new approach for expert knowledge elicitation and a dedicated software for decision making. The novel part of the decision making tool will consist in the representation power and reasoning efficiency in the context of the logic used to describe the domain knowledge. http://www.rmtfromagesdeterroirs.com/projets-de-r-et-d/docamex/

8.1.4. Convergence Institute #DigitAg (2017-2023)

Participants: Patrice Buche, Madalina Croitoru, Marie-Laure Mugnier, Rallou Thomopoulos, Federico Ulliana.

Located in Montpellier, #DigitAg (for Digital Agriculture) gathers 17 founding members: research institutes, including Inria, the University of Montpellier and higher-education institutes in agronomy, transfer structures and companies. Its objective is to support the development of digital agriculture. GraphIK is involved in this project on the issues of designing data and knowledge management systems adapted to agricultural information systems, and of developing methods for integrating different types of information and knowledge (generated from data, experts, models). A collaboration is starting with the research laboratory UMR SYSTEM (Tropical and mediterranean cropping system functioning and management) on knowledge representation and reasoning for agro-ecological systems.

https://www.hdigitag.fr/en/

8.1.5. *Informal National Partners*

We continue to work informally with the following partners:

- Michael Thomazo (VALDA Inria team) on Ontology-Mediated Query Answering [37], [27].
- Jérôme Bonnet and Sarah Gouiziou, from the Center for Structural Biochemistry of Montpellier (CBS), on the encoding of Boolean functions in biological systems [15].
- Jean-Claude Léon (IMAGINE Inria team) on the developement of an ontology-mediated query answering system applied to the field of CAD (Computer Aided Design).
- Srdjan Vesic (CRIL) on logical argumentation systems [35], [28], [30], [31], [32] . In particular, Srdjan Vesic is a co-supervisor of Bruno Yun PhD thesis, started in Sept 2016.

8.2. European Initiatives

8.2.1. *NoAW (H2020, Oct. 2016-Sept. 2020)*

Participants: Patrice Buche, Pierre Bisquert, Madalina Croitoru, Nikolaos Karanikolas, Rallou Thomopoulos.

NoAW (No Agricultural Waste) is led by INRA-IATE. Driven by a "near zero-waste" society requirement, the goal of NoAW project is to generate innovative efficient approaches to convert growing agricultural waste issues into eco-efficient bio-based products opportunities with direct benefits for both environment, economy and EU consumer. To achieve this goal, the NoAW concept relies on developing holistic life cycle thinking able to support environmentally responsible R&D innovations on agro-waste conversion at different TRLs, in the light of regional and seasonal specificities, not forgetting risks emerging from circular management of agro-wastes (e.g. contaminants accumulation). GraphIK contributes on two aspects. On the one hand we participate in the annotation effort of knowledge bases (using the @Web tool). On the other hand we further investigate the interplay of argumentation with logically instantiated frameworks and its relation with social choice in the context of decision making.

http://cordis.europa.eu/project/rcn/203384_en.html

8.2.2. *GLOPACK (H2020, June. 2018- July. 2022)*

Participants: Patrice Buche, Pierre Bisquert, Madalina Croitoru.

GLOPACK is also led by INRA-IATE. It proposes a cutting-edge strategy addressing the technical and societal barriers to spread in our social system, innovative eco-efficient packaging able to reduce food environmental footprint. Focusing on accelerating the transition to a circular economy concept, GLOPACK aims to support users and consumers' access to innovative packaging solutions enabling the reduction and circular management of agro-food, including packaging, wastes. Validation of the solutions including compliance with legal requirements, economic feasibility and environmental impact will push forward the technologies tested and the related decision-making tool to TRL 7 for a rapid and easy market uptake contributing therefore to strengthen European companies' competitiveness in an always more globalised and connected world.

https://glopack2020.eu/.

8.2.3. FoodMC (European COST action, 2016-2020)

Participants: Patrice Buche, Madalina Croitoru, Rallou Thomopoulos.

COST actions aim to develop European cooperation in science and technology. FoodMC (CA 15118) is a cost action on Mathematical and Computer Science Methods for Food Science and Industry. Rallou Thomopoulos is co-leader of this action for France, and member of the action Management Committee, and other members of GraphIK (Patrice Buche, Madalina Croitoru) are participants. The action is organised in four working groups, dealing respectively with the modelling of food products and food processes, modelling for eco-design of food processes, software tools for the food industry, and dissemination and knowledge transfer. http://www6.inra.fr/foodmc

8.2.4. Informal International Partners

- University of Toronto (Canada): collaboration with Sheila McIlraith and her research group on temporal logics [22].
- Birkbeck College, University of London (UK): collaboration with Michael Zacharyaschev, Roman Kontchakov, and Stanislav Kikot on the complexity of ontology-mediated query answering [14].
- Patras University (Greece): collaboration with Nikolaos Karanikolas (formerly postdoc in the team) [16].

8.2.5. International Research Visitors

- David Carral (postdoc, TU Dresden, Germany) visited the group between 19-21 Dec. 2018.
- Joshua Sohn (PhD, DTU, Denmark) visited the group for a month in October 2018.
- Prof. Guillermo Simari (U. Nacional del Sur, Argentina) visited the group for a week in July 2018.

8.2.6. Visits to International Teams

- One-year stay (academic year 2017-2018) of Meghyn Bienvenu at University of Toronto, Computer Science Department, collaboration with Sheila McIlraith and KR group, focusing mainly on program synthesis with linear temporal logic (LTL) specifications, in particular, taking into account environment assumptions and user preferences.
- Marie-Laure Mugnier visited the Knowledge-Based Systems research group at TU Dresden (Markus Kroetzsch), mid July 2018.

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HEPHAISTOS Project-Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

- the HEPHAISTOS and CHORALE teams together with I3S have organized the 2-days workshop *Robopaca* supported by Inria and UCA. The purpose was to organize a meeting between academics, industry and end-users to examine together the possibility of structuring the robotic activities in PACA

9.2. National Initiatives

- the project **Craft** on collaborative cable-driven parallel robot has been funded by ANR. It involves LS2N (Nantes) and the Cetim. This project will start in 2019

9.2.1. FHU

- the team has been involved for the FHU *INOVPAIN : Innovative Solutions in Refractory Chronic Pain* that has been labeled in December 2016

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

We have numerous international collaborations but we mention here only the one with activities that go beyond joint theoretical or experimental works:

- University of Bologna: 2 joint PhD student, publications
- University Innsbruck: joint conference organization
- Fraunhofer IPA, Stuttgart: joint conference organization
- Duisburg-Essen University: joint conference organization
- University of New-Brunswick: 1 joint PhD student
- University Laval, Québec: joint book
- University of Tokyo: joint conference organization
- Tianjin University, China: joint book

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

7. Partnerships and Cooperations

7.1. Inria internal funding

7.1.1. IPL SPAI

SPAI (Security Program Analyses for the IoT) is an IPL (Inria Project Lab), with a duration of 4 years, started on April 2018. Members of the Antique, Celtique, Indes,Kairos, and Privatics Inria teams are involved in the SPAI IPL.

SPAI is concerned with the design of program analyses for a multitier language for the Internet of Things (IoT). The programming abstractions will allow us to reason about IoT systems from microcontrollers to the cloud. Relying on the Inria multitier language Hop.js semantics and the current Coq formalizations of JavaScript semantics, we plan to certify these analyses in order to guarantee the impossibility of security properties violations and implement security properties' enforcements by compilation.

Tamara Rezk coordinates this project.

7.1.2. ADT FingerKit

In the context of the Inria ADT call, we are involved in a *FingerKit: a Cloud Platform to Study Browser Fingerprints at Large*, lead by Walter Rudametkin from the Spirals project-team. The funding for a two year engineering position for the 2018-2020 period was obtained and an engineer is hired in Spirals project-team. Nataliia Bielova from INDES team is part of this project.

7.2. National Initiatives

7.2.1. ANR AJACS

The AJACS project (Analyses of JavaScript Applications: Certification & Security) is funded by the ANR for 42 months, starting December 2014. The goal of the AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts. The Indes members Tamara Rezk and Nataliia Bielova are involved in the tasks WP2 Certified Analyses and WP3 Security of JavaScript Applications. The partners of this project include Inria teams Celtique (coordinator), Toccata, and Prosecco.

7.2.2. ANR CISC

The CISC project (Certified IoT Secure Compilation) is funded by the ANR for 42 months, starting in April 2018. The goal of the CISC project is to provide strong security and privacy guarantees for IoT applications by means of a language to orchestrate IoT applicatoins from the microcontroller to the cloud. Tamara Rezk coordinates this project, and Manuel Serrano, Ilaria Castellani and Nataliia Bielova participate in the project. The partners of this project are Inria teams Celtique, Indes and Privatics, and Collège de France.

7.2.3. ANR PrivaWeb

The PrivaWeb project (Privacy Protection and ePrivacy Compliance for Web Users) is funded by the ANR JCJC program for 42 months, starting in December 2018. PrivaWeb aims at developing new methods for detection of new Web tracking technologies and new tools to integrate in existing Web applications that seamlessly protect privacy of users. Nataliia Bielova coordinates this project.

7.2.4. FUI UCF

The 3 years long UCF project aims at developing a reactive Web platforms for delivering multimedia contents. The partners of the project are the startups Alterway, OCamlPro, and XWiki, and the academic research laboratories of University Pierre et Marie Curie, and Denis Diderot. Manuel Serrano participates in this project.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, Except FP7 & H2020

7.3.1.1. ICT Cost Action IC1405 on Reversible Computation

Program: ICT COST Action IC1405

Project title: Reversible computation - extending horizons of computing

Duration: November 2014 - April 2019

Coordinator: Irek Ulidowski, University of Leicester

Other partners: several research groups, belonging to 23 European countries.

Abstract: Reversible computation is an emerging paradigm that extends the standard mode of computation with the ability to execute in reverse. It aims to deliver novel computing devices and software, and to enhance traditional systems. The potential benefits include the design of reversible logic gates and circuits - leading to low-power computing and innovative hardware for green ICT, new conceptual frameworks and language abstractions, and software tools for reliable and recovery-oriented distributed systems. This is the first European network of excellence aimed at coordinating research on reversible computation.

7.3.1.2. Bilateral PICS project SuCCeSS

Program: CNRS Bilaterial PICS project

Project acronym: SuCCeSS

Project title: Security, Adaptability and time in Communication Centric Software Systems

Duration: June 2016 - June 2019

Coordinator: Cinzia Di Giusto, I3S, Sophia Antipolis

Partners: I3S, Inria, University of Groningen

Abstract: The project SuCCeSS is a CNRS-funded "Projet coopératif" (PICS 07313), involving two French teams in Sophia Antipolis (the MDSC team at the laboratory I3S, acting as coordinator, and the INDES team) and one Dutch team at the University of Groningen. The project started in June 2016 and is due to end in June 2019. The objective of the project is to study formal models for reliable distributed communication-centric software systems. The project focusses on analysis and validation techniques based on behavioural types, aimed at enforcing various properties (safety, liveness, security) of structured communications.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

- We are initiating a new collaboration with Prof. Robby Findler and his group from Northwestern University of Chicago. We are studying reactive synchronous programming languages and their applications.

- We are pursuing our collaboration on session types with Prof. Mariangiola Dezani Ciancaglini from the University of Torino and Prof. Paola Giannini from the University of Piemonte Orientale. We also continue to collaborate with Dr. Jorge Pérez and his PhD student Mauricio Cano, from the University of Groningen, on the integration of session types with synchronous reactive programming.

- We are initiating a new collaboration with Professor of Law, Frederik Zuiderveen Borgesius from the Radbound University Nijmegen and Amsterdam Law School (double affiliation). We are studying General Data Protection Regulation (GDPR) and ePrivacy Regulation and their application to Web tracking technologies.

- We have been collaborating with Prof. Alejandro Russo from Chalmers University of Technology and Prof. Cormac Flanagan from University of California Santa Cruz, that resulted in a joint publication at WWW conference [15].
- We have been collaborating with Prof. Benoit Baudry from KTH Royal Institute of Technology, Sweden on the survey of browser fingerprinting technologies.

7.4.2. Participation in Other International Programs

7.4.2.1. International Initiatives

DAJA

Title: Detection strategies based on Software Metrics for Multitier JavaScript

International Partners (Institution - Laboratory - Researcher):

Universidad de Chile (Chile), DDC Alexandre Bergel

Universidad Nacional del Centro de la Provincia de Buenos Aires (Argentina) - ISISTAN Research Insitute - Santiago Vidal

Duration: 2018 - 2019

Start year: 2018

See also: https://daja-sticamsud.github.io/

JavaScript is the most popular object scripting programming language. It is extensively used conceived only for scripting, it is frequently used in large applications. The rapid adoption of JavaScript has outpaced the Software Engineering community to propose solutions to ensure a satisfactory code quality production. This situation has favored the production of poor quality JavaScript applications: we have found across JavaScript applications a large presence of dead-code (i.e., source code portion that is never used) and code duplications. These symptoms are known to lead to maintenance and performance degradation. Moreover, we have previously analyzed potential security threats to JavaScript applications produced by bad coding practices.

The DAJA project will provide methodologies, techniques, and tools to ease the maintenance of software applications written in JavaScript while improving its security.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- We are collaborating with Prof. Marc Feeley from University of Montréal. For the second consecutive year, M. Feeley has visited us for studying implementation of dynamic languages.
- As part of our ongoing collaboration on session types, Prof. Paola Giannini from the University of Piemonte Orientale visited our team for two weeks, funded by the COST Action on Reversibility.
- Our team, together with Cinzia Di Giusto's team at I3S, hosted Mauricio Cano, a PhD student from the University of Groningen, for a 2-month visit. This was part of our collaboration with the University of Groningen within the project PICS SuCCeSS. The visit was funded for the most part by Academy 1 of Université Côte d'Azur.

7.5.1.1. Internships

- Tamara Rezk supervised the intern Sadry Fievet for 6 months
- Tamara Rezk supervised - as "tuteur" - the internship of El Mehdi Regragui for 6 months
- Bertrand Petit and Manuel Serrano supervised the internship of Thibaud Ardoin who studied and implemented the Skini distributed sequencer.

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KAIROS Team

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9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Université Côte d'Azur Academy 1*

In the context of the UCA Jedi IDEX, associated with the UCA ComUE, we have applied to a number of funding initiatives. The project Smart IoT for Mobility has been funded for three years by the Academy RISE. This project is lead by the LEAT and Kairos is building a formal language for the design of smart contracts in the context of a mobility project with Renault Software Labs. The smart contracts are persisted in a secured distributed ledgers (through blockchain technology). The SyMag company, a subsidiary of BNP Paribas, is providing the technology to access block chain with a ledger-agnostic API. A PhD (at LEAT) and a Post-doc (within Kairos) positions are funded by this project. A complementary funding has been asked to the ANR with the generic call 2019.

9.2. National Initiatives

9.2.1. *Investissements d'Avenir: PIA Clarity*
Participants: Julien Deantoni, Robert de Simone, Amin Oueslati, Frédéric Mallet, Marie-Agnès Peraldi-Frati.

This project was funded by the LEOC Call (*Logiciel Embarqué et Objets Connectés*) of the national support programme *Investissements d'Avenir*. It ended in January 2018. Partners were: Thales (several divisions), Airbus, Areva, Altran, All4Tec, Artal, the Eclipse Fondation, Scilab Enterprises, CESAMES, U. Rennes, and Inria. The purpose of the project is to develop and promote an open-source version of the ARCADIA Melody system design environment from Thales, renamed CAPPELLA for that purpose. In this project we investigated extensions of Capella to enable simulation and analysis of mode automata in the context of model based system engineering.

9.2.2. *CNRS GDRs*

We are registered members of three GDR funded by CNRS : SoC^2, on topics of Hardware-software codesign and Non-Functional Property modeling for co-simulation; LTP, on verification and language design for reactive CPS systems; GPL,con Programming and Software Engineering (LaHMA group), LTP, Langages, Types et Preuves.

9.3. International Initiatives

9.3.1. *Inria International Labs*

The SACCADES LIAMA project came to a conclusion with the ending of the related Associated Team with ECNU Shanghai. We are actively working on a renewal of this colaboration, integrating the new generation of Professors there.

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

- Luigi Liquori has a steady collaboration with researchers from University of Udine, and Turin, Italy.
- We collaborate with the University of Verona on topics of CPS co-simulation. This partly funds a support engineer on their side.
- M.A Peraldi-Frati participates in an international cooperation between University Côte d'Azur, University of Danang (Vietnam) and AUF. This collaboration crystallized through the DNIIT excellence initiative between Univ of Danang and UCA. M.A Peraldi-Frati is involved in the SLEGO project (Specific domain Language for Experience Global Orchestration)[22].

9.3.2.2. TuMuLT

Title: Trustworthy Modeling using Logical Time

International Partner (Institution - Laboratory - Researcher):

ECNU (China) - Software Engineering Institute - Min Zhang

Duration: 2018 - 2022

Start year: 2018

See also: https://team.inria.fr/tumult/

We have four main research directions:

- Modeling the Uncertain Environments of Cyber-Physical Systems (CPS): Logical Time was one of the main scientific foundations of the AOSTE Team. From the background in theory of concurrency, we are used to consider mainly discrete control systems that can guarantee a functional determinism independently of any implementation-specific timing variation. Addressing CPS means widening those assumptions to consider the external environment as part of the design. The environment obeys the law of physics that usually depend on physical time consideration with models that are approximation of the reality and that necessarily introduce a wide uncertainty on the behavior. This task explores the definition of sound extensions to logical time to capture both the physical continuous behavior and make an abstract characterization as a statistical approximation [25].
- SMT For Logical Time: While synchronous systems usually focus on finite state-based control systems, our abstraction of logical time relies on both Boolean algebra (for synchronous operations) and integer arithmetic, Solving a system of logical-time constraints is NP-complete but we strive to find efficient algorithms to solve sub-classes of well defined systems. In that context, SMT is a promising solution to combine and solve systems that combine several theories. We had first results on this aspect [8] but we still need to increase the subset of constraints that can be addressed efficiently as well as the performances of the solving tools.
- Spatio-Temporal Specification for Trustworthy Intelligent Transportation Systems: Focusing on Intelligent Transportation Systems as a subset of Cyber-Physical Systems, we encounter specific problems. In addition to the temporal factor omni-present in real-time and embedded systems, a physical location plays also a central role. Functions of the system (like a train) must be done both at the right time AND at the right location. This task focuses on extensions of our framework for a spatio-temporal logics based on logical time. This means a description of the location of infrastructures as well as the ability to build constraints that depend both on time (logic or physical) and locations (logical or physical).
- Open pNets: Methods for analyzing and guaranteeing the properties of critical and complex systems, including their data and time depend aspects, have strongly evolved with the emergence of efficient satisfiability checking engines (SAT and SMT). We are working on novel methods combining classical verification paradigms (state-space construction and minimization, model-checking) with SMT approaches to create symbolic and compositional verification methods and tool platforms. We have interesting preliminary results [26], and collaborate actively on both fundamental results and prototype development.

9.3.3. Participation in Other International Programs

- PHC Xu Quangqi funded by ANR for International collaborations with China in 2008.
  - PI: Frédéric Mallet (France) and Zhang Min (China)
  - Title: SMT FOR LOGICAL TIME
  - Description: The main goal of the project was to build an efficient encoding of logical time in SMT solvers. This goal has been achieved (see New Result in Section 7.1).

9.4. International Research Visitors

- Xue-Yang ZHU, assistant research professor at Institute of Software, Chinese Academy of Science, Beijing.
- Zhang Min, Assistant Professor, ECNU Shanghai, 2 weeks in August 2018,
- Changbo Wang, Professor, Dean of Computer Science Department, ECNU Shanghai, 2 weeks in August 2018.

9.4.1. Internships

Zechen HOU benefited from an Inria International Internship Grant.

9.4.2. Visits to International Teams

9.4.2.1. Explorer programme

Julien Deantoni has spent one week visiting the Modelling, Simulation and Design Lab (MSDL) in Antwerp, funded by the MPM4CPS European cost action.

9.4.2.2. Research Stays Abroad

Eric Madelaine has spent 1 month visiting the Software engineering and computer Science department at ECNU Shanghai (2 weeks in May, 2 week in October).

LEMON Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

Cart'Eaux project (European Regional Development Fund (ERDF)): in partnership with colleagues of LIRMM and HSM (Montpellier) and with Berger-Levrault company, Carole Delenne and Benjamin COMMANDRE are developing a methodology that will collect and merge multi-sources data in the aim of mapping urban drainage networks for hydraulic modeling purpose. This chain of treatment includes: i) detection of manhole covers from remote sensing data (aerial images, numerical elevation models...), 2) development of an algorithm to retrieve the network from the detected points and other information such as roads or topography, 3) data manning to extract useful characteristics for the hydraulic model, from various databases available or from documents automatically gathered from the web. A confidence index will be given to each characteristic assessed and a sensitivity analysis will enable the software to propose a hydraulic model together with an associated uncertainty.

The GeRIMU project (Gestion du Risque d'Inondation en Milieu Urbain) will be based on the SW2D computational code. The purpose is to optimize and implement the commercial version of the code into a complete software chain for the forecasting and scenario appraisal for rainfall-generated urban floods on the scale of the urban area. The test and application site is the entire urban area of Montpellier.

9.2. National Initiatives

Antoine Rousseau is member of the ANR project ANSWER (PI Céline Casenave), 2016-2019

Gwladys Toulemonde is head of a project (2016-2018) funded by INSU via the action MANU (MAthematical and NUmerical methods) of the LEFE program. This project, called Cerise, aims to propose methods for simulating scenarii integrating spatio-temporal extremes fields with eventual asymptotic independence for impact studies in environmental sciences. Fatima PALACIOS-RODRIGUEZ is also a member of this project.

9.3. International Initiatives

9.3.1. Inria International Labs

Antoine Rousseau collaborates with Inria Chile through the partnership with MERIC in Chile. Two visits every year.

9.3.1.1. Associated team NEMOLOCO

Title: NEw MOdeLing tOols for Coastal Oceanography

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (Chile) - CIGIDEN - Rodrigo Cienfuegos

Start year: 2017

See also: https://team.inria.fr/LEMON/en/

The NEMOLOCO project targets the improvement of models in the coastal zone. Expected contributions concern: - design and implementation of domain decomposition and coupling techniques for coastal modeling - high resolution ocean simulation (including nesting) thanks to the software ROMS-CROCO, applied to biological tracers tracking.

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

In 2015, the *Marine Energies Research International Center* (MERIC) was launched in Chile by CORFO. Antoine Rousseau is the scientific coordinator for Inria, and several members of LEMON, CARDAMOM and TOSCA research teams will be involved in this 8 years project driven by DCNS. Antoine Rousseau is involved in the research line *advanced modeling for marine energy*.

9.3.2.2. Informal International Partners

Vincent Guinot collaborates with B.F. Sanders (University of California Irvine, USA)

Carole Delenne and Vincent Guinot collaborate with S. Soares-Frazao (Unité de Génie Civil, Université catholique de Louvain, Belgium)

Gwladys Toulemonde collaborates with C. Gaetan (Università Ca' Foscari - Venezia)

9.3.3. Participation in Other International Programs

Antoine Rousseauwas member of a successfull application to the REDES (Conicyt, Chile) program with H. Ramirez (CMM, Santiago) and P. Gajardo (UTFSM, Valparaiso).

9.4. International Research Visitors

Rodrigo Cienfuegos (PUC Santiago, Chile) visited Paris for two weeks in June (collaboration around TsunamiLab).

MARELLE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

We are currently members of four projects funded by the French national agency for research funding.

- TECAP "Analyse de protocoles, Unir les outils existants", starting on October 1st, 20117, for 60 months, with a grant of 89 kEuros. Other partners are Inria teams PESTO (Inria Nancy grand-est), Ecole Polytechnique, ENS Cachan, IRISA Rennes, and CNRS. The corresponding researcher for this contract is Benjamin Grégoire.
- SafeTLS "La sécurisation de l'Internet du futur avec TLS 1.3" started on October 1st, 2016, for 60 months, with a grant of 147kEuros. Other partners are Université de Rennes 1, and secrétariat Général de la Défense et de la Sécurité Nationale. The corresponding researcher for this contract is Benjamin Grégoire.
- BRUTUS "Chiffrements authentifiés et résistants aux attaques par canaux auxiliaires", started on October 1st, 2014, for 60 months, with a grant of 41 kEuros for Marelle. Other partners are Université de Rennes 1, CNRS, secrétariat Général de la défense et de la sécurité nationale, and Université des Sciences et Technologies de Lille 1. The corresponding researcher for this contract is Benjamin Grégoire.
- FastRelax, "Fast and Reliable Approximations", started on October 1st, 2014, for 60 months, with a grant of 75 kEuros for Marelle. Other partners are Inria Grenoble (ARIC project-team), LAAS-CNRS (Toulouse), Inria Saclay (Toccata and Specfun project-teams), and LIP6-CNRS (Paris). The corresponding researcher for this contract is Laurence Rideau.

8.1.2. FUI

The acronym *FUI* stands for "fonds unique interministériel" and is aimed at research and development projects in pre-industrial phase. The Marelle team is part of one such project.

- VERISICC (formal verification for masking techniques for security against side-channel attacks), This contracts concerns 5 partners: CRYPTOEXPERTS a company from the Paris region (île de France), ANSSI (Agence Nationale de Sécurité des Systèmes d'Information), Oberthur Technologies, University of Luxembourg, and Marelle. A sixth company (Ninjalabs) acts as a sub-contractant. The financial grant for Marelle is 391 kEuros, including 111kEuros that are reserved for the sub-contractant. This project started in October 2018 for a duration of 4 years. The corresponding researcher for this contract is Benjamin Grégoire.

8.2. International Research Visitors

8.2.1. *Visits of International Scientists*

8.2.1.1. *Internships*

Joshua Gansher from Cornell and Sunjay Cauligi from the University of California at San Diego visited for three months, as part of their PhD training.

Vincent Laporte from IMDEA Madrid visited for 9 months.

Benoît Viguier from Radboud University, Nijmegen visited for 1 month.

8.2.2. *Visits to International Teams*

Yves Bertot visited AIST in February in Tsukuba, Japan, ITU Copenhagen in April in Copenhagen, Denmark, and the DeepSpec Summer School in July at Princeton University.

MATHNEURO Team

5. Partnerships and Cooperations

5.1. European Initiatives

5.1.1. FP7 Projects

5.1.1.1. HBP

Title: The Human Brain Project

Program: FP7

Duration: October 2013 - March 2016 (first part), then : April 2016 - March 2018 (second part) and then : April 2018 - March 2020 (third part)

Coordinator: EPFL

Partners:
see the webpage of the project.

Olivier Faugeras is leading the task T4.1.3 entitled "Meanfield and population models" of the Worpackage W4.1 "Bridging Scales".

Inria contact: Olivier Faugeras (first part) and then : Romain Veltz (second and third part)

Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight. The goal of the Human Brain Project, part of the FET Flagship Programme, is to translate this vision into reality, using ICT as a catalyst for a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. The Human Brain Project will last ten years and will consist of a ramp-up phase (from month 1 to month 36) and subsequent operational phases.
This Grant Agreement covers the ramp-up phase. During this phase the strategic goals of the project will be to design, develop and deploy the first versions of six ICT platforms dedicated to Neuroinformatics, Brain Simulation, High Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics, and create a user community of research groups from within and outside the HBP, set up a European Institute for Theoretical Neuroscience, complete a set of pilot projects providing a first demonstration of the scientific value of the platforms and the Institute, develop the scientific and technological capabilities required by future versions of the platforms, implement a policy of Responsible Innovation, and a programme of transdisciplinary education, and develop a framework for collaboration that links the partners under strong scientific leadership and professional project management, providing a coherent European approach and ensuring effective alignment of regional, national and European research and programmes. The project work plan is organized in the form of thirteen subprojects, each dedicated to a specific area of activity.
A significant part of the budget will be used for competitive calls to complement the collective skills of the Consortium with additional expertise.

5.2. International Research Visitors

5.2.1. *Visits of International Scientists*

Invitation of Andrey Shilnikov, Georgia State University (USA), January 2018

Invitation of Jean-Pierre Françoise, Sorbonne Université (Paris), April 2018

Invitation of Vivien Kirk, University of Auckland (New Zealand), May 2018

Invitation of Peter De Maesschalck, University of Hasselt (Belgium), June 2018

5.2.2. Visits to International Teams

Visit of Mathieu Desroches to Jean-Pierre Françoise (LJLL, Sorbonne Université, Paris) in October 2018

5.2.2.1. Research Stays Abroad

One-month research stay of Mathieu Desroches at BCAM (Bilbao, Spain) on an invited professor scholarship to work with Serafim Rodrigues, June 2018

<p align="center">**MCTAO Project-Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

Sub-Riemannian Geometry and Interactions (SRGI). Started 2015 (decision ANR-15-CE40-0018), duration: 4 years. L. Rifford is a member.

Intéractions Systèmes Dynamiques Équations d'Évolution et Contrôle (ISDEEC). Started 2016 (decision ANR-16-CE40-0013), duration: 4 years. L. Rifford is a member.

Maximic: optimal control of microbial cells by natural and synthetic strategies. Started 2017, duration: 4 years. J.-B. Caillau, L. Giraldi, J.-B. Pomet are members.

9.1.2. Others

Défi InfIniti CNRS project, Control and Optimality of Magnetic Microrobots, (PI L. Giraldi). Started 2017, duration: 1 years. This project involves colleagues from Paris Sorbonne Université (around S. Régnier's team) and from University of Strasbourg (around C. Prud'Homme's team).

PGMO grant (2016-2018) on "Metric approximation of minimizing trajectories and applications" (PI J.-B. Caillau). This project involved colleagues from Université Paris Dauphine and has funding for two year (originally one, extended), including one intership (M2 level).

PGMO grant (2017-2019) on "Algebro-geometric techniques with applications to global optimal control for Magnetic Resonance Imaging (MRI)". B. Bonnard, A. Nolot and J. Rouot participate in this project, the PI is O. Cots, from ENSEIHHT, Toulouse.

The McTAO team participates in the GdR MOA, a CNRS network on Mathematics of Optimization and Applications.

J.-B. Caillau is associate researcher of the CNRS team Parallel Algorithms & Optimization at ENSEEIHT, Univ. Toulouse.

P. Lissy was the PI of a PEPS project JCJC (young researchers).

9.2. European Initiatives

9.2.1. Bilateral program with Portugal

Program: FCT (Fundação para a Ciência e a Tecnologia)

Grant no. : PTDC/MAT-CAL/4334/2014

Project title: "Extremal spectral quantities and related problems"

Duration: 05/2016-05/2019

Coordinator: P. Freitas (Univ. Lisbon)

Team member involved: J.-B. Caillau

Other partners: Univ. Lisbon, Univ. Luxembourg, Czech Nuclear Physics Institute, Univ. Bern

Link: https://team.inria.fr/mctao/fct-project-extremal-spectral-quantities-and-related-problems-2016-2019

9.2.2. Bilateral ANR-DFG program with Germany

Program: Projets de recherche collaborative-internationale ANR-DFG (Germany)

Grant no. : ANR-14-CE35-0013-01; DFG-Gl 203/9-1

Project title: "**Exploring the physical limits of spin systems (Explosys).**"

Duration: 11/2014-10/2018

Coordinator: D. Sugny (Univ. de Bourgogne) for France, Glaser (TU München) for Germany.

Team member involved: Bernard Bonnard.

Other partners: TU München, Univ. de Bourgogne (IMB and UCB).

This project involves specialists in physics and control theory in order to make important progresses in the use of spin dynamics, in particular for Magnetic Resonance Medical Imaging.

Link: http://www.agence-nationale-recherche.fr/fileadmin/aap/2014/selection/pa-2014-selection-franco-allemand-dfg.pdf

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Zhen Chen, Technion. Two day visit in July, 2018. Gave a talk "Shortest Dubins Paths through Three Points" at McTAO seminar.

9.3.2. Visits to International Teams

Lamberto Dell'Elce visited Department of Aerospace Engineering at Technion (Haifa, Israel) for a week in July, 2018.

Pierre Lissy was invited one month at Fudan University (China) in March and June, 2018.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Labex Signalife

The MORPHEME team is member of the SIGNALIFE Laboratory of Excellence.

Florence Besse and Xavier Descombes are members of the Scientific Committee.

8.1.2. Idex UCA Jedi

Florence Besse is a member of the scientific council of the IDEX JEDI Academy 2.

Laure Blanc-Féraud is chair of the scientific council of Academy 1 of Idex UCA JEDI.

A number of projects has been partially funded by the Idex.

- Artificial intelligence application to the identification of functional traits of zooplankton from high-resolution images (ARTIFACTZ) collaboration with Laval University, Québec / UCA Coll. with : F. Maps (ULaval), D. Laurandeau (ULaval),L. Guidi (LOV), S. Ayata (LOV), J.-O. Irisson (LOV) Participants : E. Debreuve

- Biological Image Super-resolution Enhanced with Tensor (Biset) supported by Académie 1 RISE Coll. with G. Favier (I3S), G. Sandoz (iBV) Participants : E. Debreuve, L. Blanc-Féraud, S. Schaub

- Quantitative analysis of exovesicle transport dynamics in the zebrafish Left/Right organizer. supported by Academy 2 "Complex Systems" Coll. with M. Furthauer (PI, iBV), T. Juan (iBV) Participants: R. Pages, X. Descombes

- Study of a complex biological system pf prostate organoid: applications in biomedical research. supported by Academy 2 "Complex Systems" Coll. with F. Bost (PI, C3M), S. Clavel (C3M), R.F. Roustan (C3M), S. Torrino (C3M). Participants: C. Girard-Ribouleau, X. Descombes

- Imaging analysis for mitochondrial network tracking and recgnition. supported by Academy 1 "Living Sciences" Coll. with M. Chami (IPMC), C. Badot (IPMC), F. Bost (C3M), S. Clavel (C3M), A. Charezac (C3M) Participants: G. Lavisse, X. Descombes.

8.1.3. 3AI Côte d'Azur

Laure Blanc-Féraud is a member of the scientific committee of the 3IA proposal of Nice.

8.2. National Initiatives

8.2.1. ANR RNAGRIMP

Participants: Florence Besse [PI], Fabienne de Graeve, Xavier Descombes, Eric Debreuve.

Here, we propose to study the molecular bases underlying the assembly and regulation of RNA granules, using the highly conserved IMP-containing granules as a paradigm. Specifically, we propose to perform an unbiased genome-wide RNAi screen on Drosophila cultured cells to identify mutant conditions in which the organization and/or distribution of IMP-containing granules is altered. To quantitatively and statistically analyze mutant conditions, and to define precise and coherent classes of mutants, we will combine high throughput microscopy with the development of a computational pipeline optimized for automatic analysis and classification of images. The function of positive hits isolated in the screen will then be validated in vivo in Drosophila neurons using fly genetics and imaging techniques, and characterized at the molecular and cellular levels using biochemical assays, in vitro phase transition experiments and live-imaging. Finally, the functional conservation of identified regulators will be tested in zebrafish embryos combining gene inactivation and live-imaging techniques. This integrative study will provide the first comprehensive analysis of the functional network that regulates the properties of the conserved IMP RNA granules. Our characterization of the identified regulators in vivo in neuronal cells will be of particular significance in the light of recent evidence linking the progression of several degenerative human diseases to the accumulation of non-functional RNA/protein aggregates.

This 4-years project started january, 2016 and is leaded by F. Besse (iBV, Nice). Participants are iBV, institut de biologie Paris Seine (IBPS, Paris), and Morpheme.

8.2.2. ANR HMOVE

Participants: Xavier Descombes, Eric Debreuve.

Among the signaling molecules involved in animal morphogenesis are the Hedgehog (Hh) family proteins which act at distance to direct cell fate decisions in invertebrate and vertebrate tissues. To study the underlying process we will develop accurate tracking algorithm to compare trajectories of different Hh pools transportation in live animals. This will allow us to analyze the contribution of the different carriers in the establishment of the Hh gradient. Moreover, we will develop new methods to modify the spatio-temporal and dynamical properties of the extra-cellular Hh gradient and separate the contribution of the apical versus basal Hh pools. We will complete this study with a genome-wide screen to identify genes and related cellular processes responsible for Hh release. The particular interest of this collaboration lies in the combination of development of tracking algorithm to analyze Hh distribution and trajectories with extremely powerful genetics, ease of in vivo manipulation and lack of genetic redundancy of Drosophila.

This 4-years project started january, 2016 and is leaded by P. Thérond (iBV, Nice). Participants are iBV and Morpheme.

8.2.3. ANR DIG-EM

Participants: Grégoire Malandain, Xavier Descombes, Gaël Michelin.

Morphogenesis controls the proper spatial organization of the various cell types. While the comparatively simple process of patterning and cell differentiation has received considerable attention, the genetic and evolutionary drivers of morphogenesis are much less understood. In particular, we very poorly understand why some morphogenetic processes evolve very rapidly, while others show remarkable evolutionary stability.

This research program aims at developing a high-throughput computational framework to analyze and formalize high-throughput 4D imaging data, in order to quantify and formally represent with cellular resolution the average development of an organism and its variations within and between species. In addition to its biological interest, a major output of the project will thus be the development of robust general computational methods for the analysis, visualization and representation of massive high-throughput light-sheet data sets.

This 4-years project started october the 1st, 2014 and is leaded by P. Lemaire (CRBM, Montpellier). Participants are the CRBM, and two Inria project-team, Morpheme and Virtual Plants.

8.2.4. ANR PhaseQuant

Participants: Grégoire Malandain, Eric Debreuve, Kevin Giulietti, Sarah Laroui.

The PhaseQuantHD project aims at developing a high-content imaging system using quadriwave lateral shearing interferometry as a quantitative phase imaging modality. Automated analysis methods will be developed and optimized for this modality. Finally an open biological study question will be treated with the system.

This 3-years project started october the 1st, 2014 and is leaded by B. Wattelier (Phasics, Palaiseau). Participants are Phasics, and three academic teams TIRO (UNS/CEA/CAL), Nice, Mediacoding (I3S, Sophia-Antipolis), and Morpheme.

8.2.5. *Inria Large-scale initiative Naviscope*

Participant: Grégoire Malandain.

This action gathers the expertise of seven Inria research teams (Aviz, Beagle, Hybrid, Morpheme, Parietal, Serpico and Mosaic) and other groups (MaIAGE, INRA, Jouy-en-Josas and UMR 144, Institut Curie Paris) and aimed at developing original and cutting-edge visualization and navigation methods to assist scientists, enabling semi-automatic analysis, manipulation, and investigation of temporal series of multi-valued volumetric images, with a strong focus on live cell imaging and microscopy application domains. More precisely, the three following challenges will be addressed:

- Novel machine learning methods able to detect the main regions of interest, and automatic quantification of sparse sets of molecular interactions and cell processes during navigation to save memory and computational resources.

- Novel visualization methods able to encode 3D motion/deformation vectors and dynamics features with color/texture-based and non-sub-resolved representations, abstractions, and discretization, as used to show 2D motion and deformation vectors and patterns.

- Effective machine learning-driven navigation and interaction techniques for complex functional 3D+Time data enabling the analysis of sparse sets of localized intra-cellular events and cell processes (migration, division, etc.).

8.2.6. *Octopus Project*

Participant: Eric Debreuve.

The Octopus project deals with automatic classification of images of zooplankton. It is conducted in collaboration with the Laboratoire d'Océanographie de Villefranche-sur-mer (LOV) et l'ENSTA Paris. The kickoff meeting took place in May 2015 and a 3-day *brainstorming* meeting on Deep Learning took place in December 2015. Participants are I3S (Frédéric Precioso and Mélanie Ducoffe), LOV (Marc Picheral and Jean-Olivier Irisson), and ENSTA Paris (Antoine Manzanera).

NACHOS Project-Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Program: H2020

See also: https://www.eocoe.eu

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center (Spain)

CEA (France)

CERFACS (France)

CNR (Italy)

The Cyprus Institute (Cyprus)

ENEA (Italy)

Fraunhofer–Gesellschaft (Germany)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Forschungszentrum Julich (Germany)

Max-Planck-Gesellschaft (Germany)

University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

The aim of the present proposal is to establish an Energy Oriented Centre of Excellence for computing applications, (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

8.1.1.2. PRACE 5IP

Title: PRACE Fifth Implementation Phase (PRACE-5IP) project

See also: http://www.prace-ri.eu/prace-5ip

Duration: January 2017 - April 2019

Partners: see http://www.prace-ri.eu/member-systems

Inria contact: Stéphane Lanteri

The mission of PRACE (Partnership for Advanced Computing in Europe) is to enable high-impact scientific discovery and engineering research and development across all disciplines to enhance European competitiveness for the benefit of society. PRACE seeks to realise this mission by offering world class computing and data management resources and services through a peer review process. PRACE also seeks to strengthen the European users of HPC in industry through various initiatives. PRACE has a strong interest in improving energy efficiency of computing systems and reducing their environmental impact. The objectives of PRACE-5IP are to build on and seamlessly continue the successes of PRACE and start new innovative and collaborative activities proposed by the consortium. These include: assisting the transition to PRACE2 including ananalysis of TransNational Access; strengthening the internationally recognised PRACE brand; continuing and extend advanced training which so far provided more than 18 800 persontraining days; preparing strategies and best practices towards Exascale computing; coordinating and enhancing the operation of the multi-tier HPC systems and services; supporting users to exploit massively parallel systems and novel architectures.

8.1.1.3. EPEEC

Title: European joint effort toward a highly productive programming environment for heterogeneous exascale computing

Program: H2020

See also: https://epeec-project.eu

Duration: October 2018 - September 2021

Coordinator: Barcelona Supercomputing Center

Partner: Barcelona Supercomputing Center (Spain)

Coordinator: CEA

Partners:

Fraunhofer–Gesellschaft (Germany)

CINECA (Italy)

IMEC (Blegium)

INESC ID (Portugal)

Appentra Solutions (Spain)

Eta Scale (Sweden)

Uppsala University (Sweden)

Inria (France)

Cerfacs (France)

Inria contact: Stéphane Lanteri

EPEEC's main goal is to develop and deploy a production-ready parallel programming environment that turns upcoming overwhelmingly-heterogeneous exascale supercomputers into manageable platforms for domain application developers. The consortium will significantly advance and integrate existing state-of-the-art components based on European technology (programming models, runtime systems, and tools) with key features enabling 3 overarching objectives: high coding productivity, high performance, and energy awareness. An automatic generator of compiler directives will provide outstanding coding productivity from the very beginning of the application developing/porting process. Developers will be able to leverage either shared memory or distributed-shared memory programming flavours, and code in their preferred language: C, Fortran, or C++. EPEEC will ensure the composability and interoperability of its programming models and runtimes, which will incorporate specific features to handle data-intensive and extreme-data applications. Enhanced leading-edge performance tools will offer integral profiling, performance prediction, and visualisation of traces. Five applications representative of different relevant scientific domains will serve as part of a strong inter-disciplinary co-design approach and as technology demonstrators. EPEEC exploits results from past FET projects that led to the cutting-edge software components it builds upon, and pursues influencing the most relevant parallel programming standardisation bodies.

8.2. International Initiatives

8.2.1. Participation in Other International Programs

8.2.1.1. International Initiatives

PHOTOM

Title: PHOTOvoltaic solar devices in Multiscale computational simulations

International Partners:

Center for Research in Mathematical Engineering, Universidad de Concepcion (Chile), Rodolfo Araya

Laboratório Nacional de Computação Científica (Brazil), Frédéric Valentin

Instituto de Matemáticas, PUCV (Chile), Diego Paredes

Duration: 2018 - 2019

Start year: 2018

See also: http://www.photom.lncc.br

The work consists of devising, analyzing and implementing new multiscale finite element methods, called Multiscale Hybrid-Mixed (MHM) method, for the Helmholtz and the Maxwell equations in the frequency domain. The physical coefficients involved in the models contain highly heterogeneous and/or high contrast features. The goal is to propose numerical algorithms to simulate wave propagation in complex geometries as found in photovoltaic devices, which are naturally prompt to be used in massively parallel computers. We demonstrate the well-posedness and establish the optimal convergence of the MHM methods. Also, the MHM methods are shown to induce a new face-based a posteriori error estimator to drive space adaptivity. An efficient parallel implementation of the new multiscale algorithm assesses theoretical results and is shown to scale on a petaflop parallel computer through academic and realistic two and three-dimensional solar cells problems.

8.2.2. Inria International Partners

8.2.2.1. Informal International Partners

Prof. Kurt Busch, Humboldt-Universität zu Berlin, Institut für Physik, Theoretical Optics & Photonics

Prof. Martijn Wubs, Technical University of Denmark (DTU), Structured Electromagnetic Materials Theory group

Dr. Urs Aeberhard and Dr. Markus Ermes, Theory and Multiscale Simulation, IEK-5 Photovoltaik, Forschungszentrum Jülich, Germany

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Prof. Liang Li, School of Mathematical Sciences, University of Electronic Science and Technology of China, Chengdu. From July to August 2018.

Stéphane Lanteri and Théophile Chaumont-Frelet at LNCC, Petropolis, Brazil, March 12-16, 2018.

Stéphane Lanteri and Claire Scheid at UAM and CSIC, Spain, May 29-30, 2018.

Stéphane Lanteri and Claire Scheid at Humboldt-Universität zu Berlin, Berlin, Germany, July 12-13, 2018.

Stéphane Lanteri at Barcelona Supercomputing Center, Barcelona, Spain, July 23-24, 2018.

Neo Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

MYDATA   (Sept. 2018 - Nov. 2020) This is a research project in cooperation with two other labs (LJAD and GREDEG) from Univ. Côte d'Azur to study how to achieve privacy through obfuscation. The project is funded by IDEX UCA$^{\text{JEDI}}$ Academy 1 on "Networks, Information and Digital society."

9.2. National Initiatives

9.2.1. PIA ANSWER

Participants: Konstantin Avrachenkov, Abhishek Bose.

Project Acronym: ANSWER

Project Title: Advanced aNd Secured Web Experience and seaRch

Coordinator: QWANT

Duration: 15 November 2017 – 31 December 2020

Others Partners: Inria Project-Teams WIMMICS, INDES, COFFEE

Abstract: ANSWER is a joint project between QWANT and Inria, funded by the French Government's initiative PIA "Programme d'Investissement d'Avenir".

The aim of the ANSWER project is to develop the new version of the search engine http://www.qwant.com by introducing radical innovations in terms of search criteria as well as indexed content and security. This initiative is a part of the Big Data Big Digital Challenges field, since a Web search engine deals with large volumes of heterogeneous and dynamic data.

Of the five characteristics of big data, the ANSWER project will focus more particularly on the aspects of Velocity in terms of near real-time processing of results, and Variety for the integration of new indicators (emotions, sociality, etc.) and meta-data. The Volume, Value and Veracity aspects will necessarily be addressed jointly with these first ones and will also be the subject of locks, especially on the topics of crawling and indexing.

This registration of the search engine in the Big Data domain will only be reinforced by developments in the Web such as the Web of data, and generally by the current trend to integrate the Web of increasingly diverse, rich and complex resources.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Participant: Konstantin Avrachenkov.

Program: EU COST

Project acronym: COSTNET

Project title: European Cooperation for Statistics of Network Data Science

Duration: May 2016 - April 2020

Coordinator: Ernst Wit (NL), Gesine Reinert (UK)

Other partners: see http://www.cost.eu/COST_Actions/ca/CA15109

Abstract: A major challenge in many modern economic, epidemiological, ecological and biological questions is to understand the randomness in the network structure of the entities they study: for example, the SARS epidemic showed how preventing epidemics relies on a keen understanding of random interactions in social networks, whereas progress in curing complex diseases is aided by a robust data-driven network approach to biology.

Although analysis of data on networks goes back to at least the 1930s, the importance of statistical network modelling for many areas of substantial science has only been recognized in the past decade. The USA is at the forefront of institutionalizing this field of science through various interdisciplinary projects and networks. Also in Europe there are excellent statistical network scientists, but until now cross-disciplinary collaboration has been slow.

This Action aims to facilitate interaction and collaboration between diverse groups of statistical network modellers, establishing a large and vibrant interconnected and inclusive community of network scientists. The aim of this interdisciplinary Action is two-fold. On the scientific level, the aim is to critically assess commonalities and opportunities for cross-fertilization of statistical network models in various applications, with a particular attention to scalability in the face of Big Data. On a meta-level, the aim is to create a broad community which includes researchers across the whole of Europe and at every stage in their scientific career and to facilitate contact with stakeholders.

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. MALENA

Title: Machine Learning for Network Analytics

International Partner (Institution - Laboratory - Researcher):

Indian Institute of Technology Bombay (India) - Electrical Communication Engineering - Vivek Borkar

Start year: 2017

See also: http://www-sop.inria.fr/members/Konstantin.Avratchenkov/MALENA.html

In the past couple of decades network science has seen an explosive growth, enough to be identified as a discipline of its own, overlapping with engineering, physics, biology, economics and social sciences. Much effort has gone into modelling, performance measures, classification of emergent features and phenomena, etc, particularly in natural and social sciences. The algorithmic side, all important to engineers, has been recognised as a thrust area (e.g., two recent Nevanlinna Prize (J. Kleinberg 2006 and D. Spielman 2010) went to prominent researchers in the area of network analytics). Still, in our opinion the area is yet to mature and has a lot of uncharted territory. This is because networks provide a highly varied landscape, each flavour demanding different considerations (e.g., sparse vs dense graphs, Erdös-Rényi vs planted partition graphs, standard graphs vs hypergraphs, etc). Even adopting existing methodologies to these novel situations is often a nontrivial exercise, not to mention many problems that cry out for entirely new algorithmic paradigms. It is in this context that we propose this project of developing algorithmic tools, drawing not only upon established as well as novel methodologies in machine learning and big data analytics, but going well beyond, e.g., into statistical physics tools.

9.4.1.2. THANES

Title: THeory and Application of NEtwork Science

International Partner (Institution - Laboratory - Researcher):

Universidade Federal do Rio de Janeiro (Brazil) - Department of Computer and Systems Engineering (PESC/COPPE) - Daniel Ratton Figueiredo, Edmundo De Souza e Silva

Universidade Federal do Rio de Janeiro (Brazil) - Math institute - Giulio Iacobelli

Purdue Univ. (USA) - Computer Science Department - Bruno Ribeiro

Start year: 2017

See also: https://team.inria.fr/thanes/

We plan move beyond the study of a single network and focus on multiplex networks, i.e. multiple interacting networks. Multiplex networks have recently raised as "one of the newest and hottest themes in the statistical physics of complex networks." They originate from the observation that many complex systems, ranging from living organisms to critical infrastructures, operate through multiple layers of distinct interactions among their constituents. In particular we plan to work on the co-evolution of the different layers of a multiplex network and on how epidemics spread in such setting.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

NEO has continued collaborations with researchers from GERAD, Univ. Montreal (Canada), Flinders Univ. (Australia), Univ. of South Australia (Australia), National Univ. of Rosario (Argentina), Technion - Israel Institute of Technology (Israel), Univ. of Arizona (USA), Univ. of Illinois at Urbana-Champaign (USA), Univ. of Liverpool (UK), Univ. of Massachusetts at Amherst (USA), Univ. of Florence (Italy), Univ. of Palermo (Italy), Univ. of Twente (The Netherlands), Saint Petersburg State Univ. (Russia), Petrozavodsk State Univ. (Russia) and Ghent Univ. (Belgium).

9.4.3. Participation in Other International Programs

9.4.3.1. Indo-French Center of Applied Mathematics (IFCAM)

NEO is involved in the IFCAM with the MALENA project. See §9.4.1.1 .

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Professors/Researchers

Damiano Carra,   Date: 23-27 April, Institution: Univ. of Verona (Italy)

Daniel Figueiredo,   Date: 9-13 July, Institution: UFRJ (Brazil)

Giulio Iacobelli,   Date: 9-13 July, Institution: UFRJ (Brazil)

Nikhil Karamchandani,   Date: 11-15 June, Institution: IIT Bombay (India)

Nelly Litvak,   Date: 2-14 July, Institution: Univ. of Twente (Netherlands)

Vladimir Mazalov,   Date: 16-17 July, Institution: Petrozavodsk State Univ. (Russia)

Daniel Sadoc Menasché,   Date: 31 August - 6 September, Date: 8-12 December, Institution: UFRJ (Brazil)

Bruno Ribeiro,   Date: 9-18 July, Institution: Purdue Univ. (USA)

Vikas Vikram Singh,   Date: 1-8 June, Institution: IIT Delhi (India)

Rajesh Sundaresan,   Date: 15-26 January, Institution: IISc Bangalore (India)

9.5.1.2. Postdoc/PhD Students

Víctor Bucarey López,   Date: 18-19 October, Institution: Université Libre de Bruxelles (Belgium)

Yuzhou Chen,   Date: 7 June - 6 September, Institution: Southern Methodist Univ. (USA)

Eduardo Hargreaves,   Date: 31 August - 6 September, Institution: UFRJ (Brazil)

Mayank Kakodkar,   Date: 9-13 July, Institution: Purdue Univ. (USA)

Mikhail Kamalov,   Date: 1 September - 30 November, Institution: Univ. St. Petersburg (Russia)

Maria Kleshnina,   Date: 2-8 July, Institution: Queensland Univ. (Australia)

Suhail Mohmad Shah,   Date: 18 June - 14 August, Institution: IIT Bombay (India)

9.5.2. Internships

Note: UNS is the Univ. Nice Sophia-Antipolis.

Nour Elhouda Ayari, Date: 4 April - 8 October, Institution: Tunis SUP'COM, Supervisors: E. Altman and M. Haddad (UAPV), Subject: Speed Estimation in Mobile Networks

Gianmarco Calbi, Date: 15 March - 31 August, Institution: Master RIF, UNS, Supervisor: G. Neglia, Subject: Asynchronous Approximate Distributed Computation for Machine Learning

Yu-Zhen Chen, Date: 1 June - 31 July, Institution: The Chinese Univ. of Hong Kong, Supervisor: K. Avrachenkov, Subject: Application of deep learning for graphlet statistics estimation

Kostantinos Dermentzis, Date: 20 November 2017 - 19 May 2018, Institution: National Technical Univ. of Athens (Greece), Supervisor: G. Neglia, Subject: Caching Policies with Partial Future Knowledge: the case of Spark

Vladyslav Fedchenko, Date: 1 March - 31 August, Institution: Master IFI Ubinet, UNS, Supervisor: G. Neglia, Subject: Estimating Content Popularity in Cache Networks

Pulkit Goel, Date: 15 May - 31 July, Institution: IIT New Delhi (India), Supervisor: K. Avrachenkov, Subject: Application of Deep Learning for Recovering Graph Motifs

Nisha Mishra, Date: 5 February - 20 July, Institution: ENSIMAG, Supervisor: E. Altman and C. Touati, Subject: Routing Games

Utsav Sen, Date: 15 May - 31 July, Institution: IIT New Delhi (India), Supervisor: K. Avrachenkov, Subject: Asynchronously distributed and randomized methods for computing network centralities

Adeel Siddiqui, Date: 1 October 2018 - 30 September 2019, Institution: Univ. Côte d'Azur, Supervisor: G. Neglia, Subject: Achieve Web Privacy by Obfuscation

Xing Yafei, Date: 1 March - 31 August, Institution: Master IFI Ubinet, UNS, Supervisor: K. Avrachenkov, Subject: Distributed Approaches for Graph-based Unsupervised Learning

Xiawen Zhu, Date: 1 March - 31 August, Institution: Master IFI Ubinet, UNS, Supervisor: K. Avrachenkov, Subject: Distributed Approaches for Graph-based Unsupervised Learning

9.5.3. Visits to International Teams

9.5.3.1. Research Stays Abroad

Eitan Altman
- Date: 1-8 March, Institution: Technion (Israel)
- Date: 12-23 April, Institution: Technion and Univ. Tel-Aviv (Israel)
- Date: 10-21 December, Institution: IIT Bombay (India)

Konstantin Avrachenkov
- Date: 29 January - 2 February, Institution: Univ. Liverpool (United Kingdom)
- Date: 21-22 May, Institution: Saint Petersburg State Univ. (Russia)
- Date: 17-18 September, Institution: Univ. Leiden (The Netherlands)
- Date: 19-23 September, Institution: Univ. Twente (The Netherlands)
- Date: 15-18 October, Institution: IIT Bombay (India)

Abhishek Bose
- Date: 19-23 November, Institution: IIT Bombay (India)

Swapnil Dhamal
- Date: 17-18 September, Institution: IISc Bangalore (India)
- Date: 19 September, Company: IBM Research Labs Bangalore (India)

Alain Jean-Marie
   Date: 24 September - 14 October, Institution: Univ. of Montreal (Canada)
   Date: 2-27 November, Institution: National Univ. of Rosario (Argentina)

Giovanni Neglia
- Date: 11-16 November, Institution: Purdue Univ. (USA)
- Date: 3-8 November, Institution: IIT Bombay (India)

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

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ENVISION

Program: ANR JCJC

Project acronym: ENVISION

Project title: Computer Vision for Automated Holistic Analysis of Humans

Duration: October 2017-September 2020.

Coordinator: Antitza Dantcheva (STARS)

Abstract: The main objective of ENVISION is to develop the computer vision and theoretical foundations of efficient biometric systems that analyze appearance and dynamics of both face and body, towards recognition of identity, gender, age, as well as mental and social states of humans in the presence of operational randomness and data uncertainty. Such dynamics - which will include facial expressions, visual focus of attention, hand and body movement, and others, constitute a new class of tools that have the potential to allow for successful holistic analysis of humans, beneficial in two key settings: (a) biometric identification in the presence of difficult operational settings that cause traditional traits to fail, (b) early detection of frailty symptoms for health care.

9.1.2. FUI

9.1.2.1. Visionum

Program: FUI

Project acronym: Visionum

Project title: Visonium.

Duration: January 2015- December 2018.

Coordinator: Groupe Genious

Other partners: Inria(Stars), StreetLab, Fondation Ophtalmologique Rothschild, Fondation Hospitalière Sainte-Marie.

Abstract: This French project from Industry Minister aims at designing a platform to re-educate at home people with visual impairment.

9.1.2.2. StoreConnect

Program: FUI

Project acronym: StoreConect.

Project title: StoreConnect.

Duration: September 2016 - September 2018.

Coordinator: Ubudu (Paris).

Other partners: Inria(Stars), STIME (groupe Les Mousquetaires (Paris)), Smile (Paris), Thevolys (Dijon).

Abstract: StoreConnect is an FUI project started in 2016 and will end in 2018. The goal is to improve the shopping experience for customers inside supermarkets by adding new sensors such as cameras, beacons and RFID. By gathering data from all the sensors and combining them, it is possible to improve the way to communicate between shops and customers in a personalized way. StoreConnect acts as a middleware platform between the sensors and the shops to process the data and extract interesting knowledge organized via ontologies.

9.1.2.3. ReMinAry

Program: FUI

Project acronym: ReMinAry.

Project title: ReMinAry.

Duration: September 2016 - September 2019.

Coordinator: GENIOUS Systèmes,

Other partners: Inria(Stars), MENSIA technologies, Institut du Cerveau et de la Moelle épinière, la Pitié-Salpêtrière hospital.

Abstract:This project is based on the use of motor imagery (MI), a cognitive process consisting of the mental representation of an action without concomitant movement production. This technique consists in imagining a movement without realizing it, which entails an activation of the brain circuits identical to those activated during the real movement. By starting rehabilitation before the end of immobilization, a patient operated on after a trauma will gain rehabilitation time and function after immobilization is over. The project therefore consists in designing therapeutic video games to encourage the patient to re-educate in a playful, autonomous and active way in a phase where the patient is usually passive. The objective will be to measure the usability and the efficiency of the reeducative approach, through clinical trials centered on two pathologies with immobilization: post-traumatic (surgery of the shoulder) and neurodegenerative (amyotrophic lateral sclerosis).

9.2. International Initiatives

9.2.1. International Initiatives

FER4HM

Title: Facial expression recognition with application in health monitoring

International Partner (Institution - Laboratory - Researcher):

Chinese Academy of Sciences (China) Institute of Computing Technology - Hu HAN

Duration: 2017 - 2019

Start year: 2017

See also: https://project.inria.fr/fer4hm/

The proposed research aims to provide computer vision methods for facial expression recognition in patients with Alzheimer's disease. Most importantly though, the work seeks to be part of a paradigm shift in current healthcare, in efficiently and cost effectively finding objective measures to (a) assess different therapy treatments, as well as to (b) enable automated human-computer interaction in remote large-scale healthcare- frameworks. Recognizing expressions in severely demented Alzheimer's disease (AD) patients is essential, since such patients have lost a substantial amount of their cognitive capacity [1-3], and some even their verbal communication ability (e.g., aphasia)2. This leaves patients dependent on clinical staff to assess their verbal and non-verbal language, in order to communicate important messages, as of discomfort associated to potential complications of the AD [9, 10]. Such assessment classically requires the patients' presence in a clinic, and time consuming examination involving medical personnel. Thus, expression monitoring is costly and logistically inconvenient for patients and clinical staff, which hinders among others large-scale monitoring. Approaches need to cater to the challenging settings of current medical recordings,

STARS

which include continuous pose variations, occlusions, camera-movements, camera-artifacts, as well as changing illumination. Additionally and importantly, the (elderly) patients exhibit generally less profound facial activities and expressions in a range of intensities and predominantly occurring in combinations (e.g., talking and smiling). Both, Inria-STARS and CAS-ICT have already initiated research activities related to the here proposed topic. While both sides have studied facial expression recognition, CAS-ICT has explored additionally the use of heart rate monitoring sensed from a webcam in this context.

 SafEE

Title: Safe Easy Environment

International Partner (Institution - Laboratory - Researcher):

Duration: 2018 - 2020

Start year: 2018

SafEE (Safe Easy Environment) investigates technologies for the evaluation, stimulation and intervention for Alzheimer patients. The SafEE project aims at improving the safety, autonomy and quality of life of older people at risk or suffering from Alzheimer's disease and related disorders. More specifically the SafEE project : 1) focuses on specific clinical targets in three domains: behavior, motricity and cognition 2) merges assessment and non pharmacological help/intervention and 3) proposes easy ICT device solutions for the end users. In this project, experimental studies will be conducted both in France (at Hospital and Nursery Home) and in Taiwan.

9.3. International Research Visitors

9.3.1. Visits to International Teams

Antitza Dantcheva visited Wael Abd-Almageed's laboratory at the Information Sciences Institute of the University of Southern California Viterbi School of Engineering in August 2018.

Antitza Dantcheva, Abhijit Das and Yaohui Wang visited the Institute of Computing Technology (ICT) at the Chinese Academy of Sciences (CAS) in August 2018.

<h1 style="text-align:center; color:red">TITANE Project-Team</h1>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. PISCO: Perceptual Levels of Detail for Interactive and Immersive Remote Visualization of Complex 3D Scenes
Participants: Pierre Alliez [contact], Flora Quilichini, Florent Lafarge.

The way of consuming and visualizing this 3D content is evolving from standard screens to Virtual and Mixed Reality (VR/MR). Our objective is to devise novel algorithms and tools allowing interactive visualization, in these constrained contexts (Virtual and Mixed reality, with local/remote 3D content), with a high quality of user experience. Partners: Inria, LIRIS INSA Lyon Institut National des Sciences Appiquées (coordinator), Laboratoire d'Informatique en Images et Systèmes d'Information LS2N Nantes University. Total budget 550 KE, 121 KE for TITANE. The project started in January 2018, for a total duration of 4 years.

9.1.1.2. LOCA-3D: Localization Orientation and 3D CArtography
Participants: Fernando Ireta Munoz, Florent Lafarge, Pierre Alliez [contact].

This project is part of the ANR Challenge MALIN LOCA-3D (Localization, orientation and 3D cartography). The challenge is to develop and experiment accurate location solutions for emergency intervention officers and security forces. These solutions must be efficient inside buildings and in conditions where satellite positioning systems do not work satisfactorily. Our solution is based on an advanced inertial system, where part of the inertial sensor drift is compensated by a vision system. Partners: SME INNODURA TB (coordinator), IBISC laboratory (Evry university) and Inria. Total budget: 700 KE, 157 KE for TITANE. The project started in January 2018, for a total duration of 4 years.

9.1.1.3. EPITOME: efficient representation to structure large-scale satellite images
Participants: Nicolas Girard, Yuliya Tarabalka [PI].

The goal of this young researcher project is to devise an efficient multi-scale vectorial representation, which would structure the content of large-scale satellite images. More specifically, we seek for a novel effective representation for large-scale satellite images, that would be generic, i.e., applicable for images worldwide and for a wide range of applications, and structure-preserving, i.e. best representing the meaningful objects in the image scene. To address this challenge, we plan to bridge the gap between advanced machine learning and geometric modeling tools to devise a multi-resolution vector-based representation, together with the methods for its effective generation and manipulation. Total budget: 225 KE for TITANE. The project started in October 2017, for a total duration of 4 years.

9.1.1.4. Faults_R_GEMS: Properties of FAULTS, a key to Realistic Generic Earthquake Modeling and hazard Simulation
Participants: Lionel Matteo, Yuliya Tarabalka.

The goal of the project is to study the properties of seismic faults, using advanced math tools including learning approaches. The project is in collaboration with Geoazur lab (coordinator), Arizona State University, CALTECH, Ecole Centrale Paris, ENS Paris, ETH Zurich, Geosciences Montpellier, IFSTTAR, IPGP Paris, IRSN Fontenay-aux-Roses, LJAD Nice, UNAVCO Colorado and Pisa University. The project started in October 2017, for a total duration of 4 years.

9.1.1.5. BIOM: Building Indoor and Outdoor Modeling
Participants: Muxingzi Li, Pierre Alliez, Florent Lafarge.

The BIOM project aims at automatic, simultaneous indoor and outdoor modelling of buildings from images and dense point clouds. We want to achieve a complete, geometrically accurate, semantically annotated but nonetheless lean 3D CAD representation of buildings and objects they contain in the form of a Building Information Models (BIM) that will help manage buildings in all their life cycle (renovation, simulation, deconstruction). The project is in collaboration with IGN (coordinator), Ecole des Ponts Paristech, CSTB and INSA-ICube. Total budget: 723 KE, 150 KE for TITANE. The project started in February 2018, for a total duration of 4 years.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. TITANIUM - Software Components for Robust Geometry Processing

ERC Proof of concept grant TITANIUM "Software Components for Robust Geometry Processing" (2017-2018), total 150 KE. Principal investigator: Pierre Alliez. Partner: Inria Spin-off Geometry Factory. Participants: Florent Lafarge, Dmitry Anisimov, Simon Giraudot and Andreas Fabri. We developed a software demonstrator for geometry processing and 3D urban modeling, in order to facilitate the pre-commercialization of novel software components for the CGAL Library. The outcome of TITANIUM is a versatile method for semantic classification of 3D point clouds and for semantic-aware reconstruction of urban scenes (in preparation).

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

We collaborated with Mathieu Desbrun from Caltech, David Bommes from Bern University (Switzerland), Gianmarco Cherchi and Riccardo Scateni from University of Cagliary (Sardinia).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Mathieu Desbrun, Professor at Caltech, visited us from September to mid November.
- Michael Hemmer, research engineer at Google, visited us in December.
- Jorg Peters, Professor at University of Florida, visited us in October.

9.4.1.1. Internships

- Tong Zhao (Ecole des ponts ParisTech): geometric descriptors and robust principal component analysis. In collaboration with Mathieu Desbrun from Caltech.
- Vasudha Varadarajan (Birla Institute of Technology and Science, India): shape reconstruction using binary programming.
- Andrew Khalel (Cairo University, Egypt): Multi-task deep learning for simultaneous satellite image segmentation and pan-sharpening. In collaboration with Guillaume Charpiat.
- Andrii Zhygallo (TUM, Germany): Using deep learning for change detection from remote sensing images.

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

7. Partnerships and Cooperations

7.1. Regional Initiatives

- A. Lejay is a member of the Executive board of LUE Impact digistrust on citizens' trust in the digital world (grant of the i-site, U. Lorraine), since 2018.

7.2. National Initiatives

7.2.1. ANR

N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, 2014–2018) coordinated by F. Hamel (Univ. Aix-Marseille).

7.2.2. GDR

A. Lejay is leader of the GdR Project TRAG on rough path. This project has been accepted in October and should start on January 1st, 2019.

7.2.3. ITMO project

N. Champagnat, C. Fritsch and D. Villemonais are involved in an ITMO Cancer project (INSERM funding) on "Modeling ctDNA dynamics for detecting targeted therapy resistance" (2017-2020), involving researchers from IECL (Institut Elie Cartan de Lorraine), the Inria teams BIGS and TOSCA, ICL (Institut de Cancérologie de Lorraine), CRAN (Centre de Recherche en Automatique de Nancy) and CHRU Strasbourg (Centre Hospitalier Régional Universitaire). This project is coordinated by N. Champagnat.

7.2.4. PEPS

D. Villemonais has obtained a "PEPS jeune chercheur" grant.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

- Mireille Bossy is involved in the VIMMP H2020 project, started in January 2018, as responsible for the partner Inria. VIMMP is a four years development for a software platform and simulation market place on the topic of complex multiscale CFD simulations.

7.4. International Initiatives

7.4.1. Participation in Other International Programs

7.4.1.1. International Initiatives

Discrelongmem (C15E05)

Title: On discretization procedures in Non-Gaussian long memory processes with applications in non parametric statistics and time series analysis (C15E05)

International Partner (Institution - Laboratory - Researcher):

Universidad de Valparaiso (Chile) - CIMFAV – Facultad de Ingenieria

PI: E. Tanré (France), S. Torrès (Chile)

Duration: 2016 - 2018

Start year: 2016

Keywords: Approximations of non-Gaussian long-memory processes. Fractional Poisson processes (fPp). Skew Fractional Process (SfP).

BRN

Title: Biostochastic Research Network

International Partner (Institution - Laboratory - Researcher):

> Universidad de Valparaiso (Chile) - CIMFAV – Facultad de Ingenieria - Soledad Torres, Rolando Rebolledo

> CNRS, Inria & IECL - Institut Élie Cartan de Lorraine (France) - N. Champagnat, A. Lejay, D. Villemonnais, R. Schott.

Duration: 2018 - 2022

Start year: 2018

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- A. Kohatsu-Higa (Ritsumeikan University, Japan) - 1 month, with an invited professor position.

7.5.1.1. Internships

- Walid El Wahabi

    subject: processus de fragmentation pour les avalanches

    date: sept. 2018 - june. 2019

    institution: École des Mines de Nancy

- Vincent Hass

    Subject: Modèles de diffusion et estimation des dynamiques d'ADN tumoral circulant pour la détection d'une résistance à une thérapie ciblée

    Date: April 2018 - Sept. 2018

    Institution: Université Paris Sud

- Azer Mimouni

    subject: Méthodes de signature en apprentissage statistique

    date: sept. 2018 - june. 2019

    institution: École des Mines de Nancy

7.5.1.2. Sabbatical programme

D. Villemonais has obtained a *délégation CNRS* starting in September.

WIMMICS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. ALDRAI UCA Project

At the center of the project, there is a triple ambition. The first is methodological and epistemological: it is a question of contributing to the development of the field of computational humanities via new tools of exploration of corpora, beyond the lexical approach (without excluding it, obviously, but in complementing) - it is a question of learning how to mobilize Artificial Intelligence to locate arguments, ideas and not simply terms, uses of terms, semantic fields. The second ambition is academic and transdisciplinary: the field studied in the project - administrative law from 1799 to today - concerns several disciplines (the history of law, administrative law, modern and contemporary history, philosophy, political science, administrative science) and the development of digital technology will make it possible to considerably widen the sources available for its study, both from the point of view of their analysis (thanks to the exploratory tools mentioned in the previous point) and from the point of view of their nature. The third ambition is professional: practitioners already use the available databases (such as ArianeWeb [0] - for administrative case law) but they need to be able to question them more finely, in relation to the theoretical questions they ask themselves. This need is all the stronger as the so-called *digital transformation of justice* is developing in the sense of automating decision-making processes, based on the disputes already settled through the implementation of systematic line of all court decisions (pursuant to the law of 7 October 2016 on the Digital Republic). Magistrates as lawyers therefore need new digital tools to work and several start-ups have appeared in the sector called Legal Tech.

Partners: UNS (faculté de lettres and faculté de droit), Inria, UCA, École Pratique des Hautes Études [0] and Institut des Systèmes Complexes de Paris IDF [0], duration: 2018-2019.

9.1.2. IADB UCA Project

IADB, *Integration and Learning on Biomedical Data*[0], is a project funded by UCA JEDI Labex (Université Côte d'Azur). The goal of the project is to leverage medical prognosis and decision making in the clinical domain with big data analysis techniques, Natural Language Processing and Machine Learning. The partners are: I3S, Wimmics, CHU Nice and BCL (Bases, Corpus, Language) Laboratory.

9.1.3. INCERTIMMO UCA Project

INCERTIMMO, *Uncertainty in Real Estate Spatial Modeling in the City*[0], is a research and development partnership funded by UCA and Kinaxia [0] company. UCA partners are: I3S, ESPACE [0], and IMREDD [0].

9.2. National Initiatives

9.2.1. PIA GDN ANSWER

Participants: Fabien Gandon, Hai Huang, Vorakit Vorakitphan, Serena Villata, Elena Cabrio.

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[0]http://arianeinternet.conseil-etat.fr/arianeinternet/
[0]https://www.ephe.fr/
[0]https://iscpif.fr/
[0]*Intégration et Apprentissage sur les Données Biomédicales*
[0]*Prise en compte de l'Incertitude pour une Modélisation Spatiale des Valeurs Immobilières dans la Ville*
[0]http://www.kinaxia.fr/
[0]http://univ-cotedazur.fr/laboratoires_old/espace
[0]http://imredd.fr/

ANSWER stands for Advanced aNd Secured Web Experience and seaRch [0]. It is a GDN project (Grands Défis du Numérique) from the PIA program (Programme d'Investissements d'Avenir) on Big Data. The project is between four Inria research teams and the Qwant company.

The aim of the ANSWER project is to develop the new version of the Qwant [0] search engine by introducing radical innovations in terms of search criteria as well as indexed content and users' privacy.

The purpose is to strengthen everyone's confidence in the search engine and increase the effectiveness of Web search. Building trust in the search engine is based on innovations in (1) Security: computer security, privacy; (2) Completeness: completeness and heterogeneity of (re)sources; and (3) Neutrality: analysis, extraction, indexing, and classification of data.

Increasing the effectiveness of Web-based research relies on innovations related to (1) Relevance: variety and value of content taken into account, measurement of emotions carried by query results; (2) Interaction with the user: adaptation of the interfaces to the types of research; and (3) Performance: perceived relevance of results and response time.

The proposed innovations include:

- Design and develop models and tools for the detection of emotions in query results:
  - Ontology, thesaurus, linguistic resources
  - Metrics, indicators, classification of emotions
- Design and develop new crawling algorithms:
  - Dynamic crawling strategies
  - Crawlers and indexes for linked open data
- Ensure respect for privacy:
  - Detection of Internet tracking
  - Preventive display of tracing techniques
  - Certified security of automatic adaptation of ads to keywords entered by the user

9.2.2. DGA CONFIRMA

Participants: Elena Cabrio, Serena Villata.

The theme of this new project with DGA is counter argumentation against fake news. Its duration is 2018-2020.

9.2.3. Ministry of Culture: MonaLIA 1.0

Participants: Anna Bobasheva, Fabien Gandon.

The MonaLIA 1.0 project is a preliminary study on the coupling of learning methods (Deep Neural Networks) and knowledge-based methods (Semantic Web) for image recognition and the enhancement of descriptive documentary records. The approach is applied and evaluated on the collection and data in the Joconde database in order to identify the possibilities and challenges offered by this coupling in assisting in the creation and maintenance of such an annotated collection.

9.2.4. ANR WASABI

Participants: Michel Buffa, Elena Cabrio, Catherine Faron Zucker.

The ANR project WASABI started in January 2017 with IRCAM, Deezer, Radio France and the SME Parisson, consists in building a 2 million songs knowledge base of commercial popular music (rock, pop, etc.) Its originality is the joint use of audio-based music information extraction algorithms, song lyrics analysis algorithms (natural language processing), and the use of the Semantic Web. Web Audio technologies then explore these bases of musical knowledge and provide innovative applications for composers, musicologists, music schools and sound engineers, music broadcasters and journalists.

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[0] https://project.inria.fr/answer/
[0] http://www.qwant.com

9.2.5. ANR SIDES 3.0

Participants: Catherine Faron Zucker, Olivier Corby, Fabien Gandon, Alain Giboin, Andrea Tettamanzi.

Partners: Université Grenoble Alpes, Inria, Ecole Normale Supérieure de Lyon, Viseo, Theia.

SIDES 3.0 is an ANR project (2017-2020) which started in fall 2017. It is led by Université Grenoble Alpes (UGA) and its general objective is to introduce semantics within the existing SIDES educational platform [0] for medicine students, in order to provide them with added value educational services.

Web site: https://www.uness.fr/anr/projets/dune/sides3.0

9.2.6. DBpedia.fr

Participants: Elmahdi Korfed, Fabien Gandon.

The DBpedia.fr project proposes the creation of a French chapter of the DBpedia database. This project was the first project of the Semanticpedia convention signed by the Ministry of Culture, the Wikimedia foundation and Inria.

Web site: http://dbpedia.fr

9.2.7. Convention between Inria and the Ministry of Culture

Participant: Fabien Gandon.

We supervise the research convention with the Ministry of Culture to foster research and development at the crossroad of culture and digital sciences. This convention signed between Inria and the Ministry of Culture provides a framework to support projects at the cross-road of the cultural domain and the digital sciences.

9.2.8. Qwant-Inria Joint Laboratory

Participants: Fabien Gandon, Alain Giboin.

We supervise the Qwant-Inria Joint Laboratory where joint teams are created and funded to contribute to the search engine research and development. The motto of the joint lab is Smart Search and Privacy with five research directions:

- Crawling, Indexing, Searching
- Execution platform, privacy by design, security, ethics
- Maps and navigation
- Augmented interaction, connected objects, chatbots, personnal assistants
- Education technologies (EdTech)

We identify possibilities of exploiting the Qwant search engine to improve the search for information in the digital cultural resources of the French Ministry of Culture. At the end of the project, some possibilities will be selected and will be the subject of research actions in the context a long-term project.

9.2.9. Inria Federated Query Scaler

Participant: Olivier Corby.

Federated Query Scaler is an Exploratory Research Project (PRE) funded by Inria, together with the Dyliss team at Inria Rennes. The topic of this project is the study of distributed SPARQL queries in the context of bioinformatics.

9.2.10. GDRI Zoomathia

Participants: Catherine Faron Zucker, Franck Michel, Andrea Tettamanzi.

Wimmics is a partner of the International Research Group (GDRI) Zoomathia funded by two CNRS institutes: INEE and INSHS. This group aims at studying transmission of zoological knowledge from Antiquity to Middle-Age through material resources (bio residues, artefacts), iconography and texts.

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[0]http://side-sante.org/

As a continuation of the work initiated with the *Muséum National d'Histoire Naturelle* (MNHN) during the last three years, the TAXREF-LD linked data dataset, that we produced jointly with the MNHN, now appears in the Linked Open Data cloud [0] and is published on AgroPortal [0]. Relatedly, we have reflected on modelling principles for biodiversity Linked Data [45].

Web site: http://www.cepam.cnrs.fr/zoomathia/

9.3. European Initiatives

9.3.1. CREEP EIT Project

The CREEP project (Cyberbulling Effects Prevention) aims at identifying and preventing the possible negative impacts of cyberbullying on young people. It seeks to realize advanced technologies for the early detection of cyberbullying phenomena through the monitoring of social media and the communication of preventive advices and personalized recommendations tailored to teenagers' needs through a virtual coaching system (chatbot). Partners: University of Trento, Fondazione Bruno Kessler, Inria, ExpertSystem, NeuroNation; duration: 2018-2020.

Web site: http://creep-project.eu/.

9.3.2. MIREL

MIREL, MIning and REasoning with legal text, is a Research and Innovation Staff Exchange (RISE) project, funded by Marie Skłodowska-Curie grant, duration: 2016-2019

The coordinator is Leendert van der Torre, University of Luxembourg

Other partners are: University of Bologna (Italy), University of Torino (Italy), University of Huddersfield (UK), Inria (France), APIS (Bulgaria), Nomotika s.r.l. (Italy), DLVSystem s.r.l. (Italy), Zhejiang University (China), Research Organization of Information and Systems (Japan), University of Cape Town (South Africa), National University of La Plata (Argentina), National University of Córdoba (Argentina), Universidad Nacional del Sur in Bahía Blanca (Argentina), National ICT Australia Ltd (Australia), Stanford University (USA).

The MIREL project will create an international and inter-sectorial network to define a formal framework and to develop tools for MIning and REasoning with Legal texts, with the aim of translating these legal texts into formal representations that can be used for querying norms, compliance checking, and decision support. MIREL addresses both conceptual challenges, such as the role of legal interpretation in mining and reasoning, and computational challenges, such as the handling of big legal data, and the complexity of regulatory compliance. It bridges the gap between the community working on legal ontologies and NLP parsers and the community working on reasoning methods and formal logic. Moreover, it is the first project of its kind to involve industrial partners in the future development of innovative products and services in legal reasoning and their deployment in the market. MIREL promotes mobility and staff exchange between SMEs to academies in order to create an inter-continental interdisciplinary consortium in Law and Artificial Intelligence areas including Natural Language Processing, Computational Ontologies, Argumentation, and Logic & Reasoning.

Web site: http://www.mirelproject.eu/

9.4. International Initiatives

9.4.1. *Inria Associate Teams Not Involved in an Inria International Labs*

MoReWAIS
MoReWAIS stands for Mobile Read Write Access and Intermittent to Semantic Web.

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[0] http://lod-cloud.net/
[0] http://agroportal.lirmm.fr/ontologies/TAXREF-LD/

Partners: UGB (Senegal) - LANI - Moussa Lo; start year: 2016.

MoReWAIS proposes to explore the specificities (advantages and constraints) of mobile knowledge sharing. The mobile application targeted in MoReWAIS must allow communities and their users to enrich and access more easily the knowledge base using the user's context with its richness (e.g. location, other users close-by) and addressing its limitations (e.g. intermittent access, limited resources).

Web site: https://project.inria.fr/morewais/.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Christian Cardellino: PhD, Universidad de Córdoba, Argentina, May and July.
Andrei Ciortea: PostDoc, University of Saint Gallen, Switzerland, Labex UCN@Sophia grant, November-December.
Kaladzavi Guidedi: PostDoc CEA-MITIC University of Maroua, Cameroon, MoreWAIS grant, November-December.
Phan Hieu Ho: PhD, Polytechnic Institute, Danang, Vietnam, April-July.
Milagro Teruel: PhD, Universidad de Córdoba, Argentina, May-June.
Thuy Trieu: PhD, University of Timisoara, Romania, March-July.

9.5.2. *Research Stays Abroad*

- Fabien Gandon visited CSIRO, Brisbane, Australia from July to August 2018. In the context of the project MIREL he worked on the problem of aligning semantic Web schemas (argumentation and generic schemas) to support interoperable and linked arguments on the Web as an extension of Web annotation and Web provenance.

- Raphaël Gazzotti visited the Natural Language Processing research group of the Universidad Nacional de Córdoba, Argentina, for two months as a secondment of the MIREL H2020 Project, March-April. We carried out information retrieval of medical test results within free text in french Electronic Medical Records by a symbolic approach. In a future step, we could annotate automatically free texts with this method then train a machine learning algorithm in order to have a better generalization of this extraction process. We also worked on a sequential machine learning modelization suited to Electronic Medical Records. This model exploits the potential of Conditional Random Fields and consequently allows us to interpret the decision made by the algorithm across all the different consultations of a patient, moreover, all medical test results can be considered with this modelization.

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

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Labex NUMEV, Montpellier*

URL: http://www.lirmm.fr/numev

We participate in the Laboratory of Excellence (labex) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences) headed by University of Montpellier in partnership with CNRS, and Inria. NUMEV seeks to harmonize the approaches of hard sciences and life and environmental sciences in order to pave the way for an emerging interdisciplinary group with an international profile. The project is decomposed in four complementary research themes: Modeling, Algorithms and computation, Scientific data (processing, integration, security), Model-Systems and measurements.

9.1.2. *Institute of Computational Biology (IBC), Montpellier*

URL: http://www.ibc-montpellier.fr

IBC is a 6 year project (2012-2018) with a funding of 2Meuros by the MENRT (PIA program) to develop innovative methods and software to integrate and analyze biological data at large scale in health, agronomy and environment. Patrick Valduriez heads the workpackage on integration of biological data and knowledge.

9.2. National Initiatives

9.2.1. *Institut de Convergence Agriculture numérique #DigitAg, (2017-2023), 275Keuro.*

Participants: Florent Masseglia, Esther Pacitti, Christophe Pradal, Patrick Valduriez.

#DigitAg brings together in a partnership of seventeen actors (public research and teaching organizations, transfer actors and companies) with the objective of accelerating and supporting the development of agriculture companies in France and in southern countries based on new tools, services and uses. Based in Montpellier with an office in Toulouse and Rennes and led by Irstea, #DigitAg's ambition is to become a world reference for digital agriculture. In this project, Zenith is involved in the analysis of big data from agronomy, in particular, plant phenotyping.

9.2.2. *PIA (Projets Investissements d'Avenir) Floris'Tic (2015-2018), 430Keuro.*

Participants: Antoine Affouard, Jean-Christophe Lombardo, Hervé Goëau, Alexis Joly.

Floris'tic aims at promoting the scientific and technical culture of plant sciences through innovative pedagogic methods, including participatory initiatives and the use of IT tools such as the one built within the Pl@ntNet project. A. Joly heads the work package on the development of the IT tools. This is a joint project with the AMAP laboratory, the TelaBotanica social network and the Agropolis foundation.

9.2.3. *ANR WeedElec (2018-2021), 106 Keuro.*

Participants: Jean-Christophe Lombardo, Hervé Goëau, Alexis Joly.

The WeedElec project offers an alternative to global chemical weed control. It combines an aerial means of weed detection by drone coupled to an ECOROBOTIX delta arm robot equipped with a high voltage electrical weeding tool. WeedElec's objective is to remove the major related scientific obstacles, in particular the weed detection/identification, using hyperspectral and colour imaging, and associated chemometric and deep learning techniques.

9.2.4. Others

9.2.4.1. INRA/Inria PhD program, 100Keuros
Participant: Alexis Joly.

This contract between INRA and Inria allows funding a 3-years PhD student (Christophe Botella). The addressed challenge is the large-scale analysis of Pl@ntNet data with the objective to model species distribution (a big data approach to species distribution modeling). The PhD student is supervised by Alexis Joly with François Munoz (ecologist, IRD) and Pascal Monestiez (statistician, INRA).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. CloudDBAppliance
Participants: Reza Akbarinia, Boyan Kolev, Florent Masseglia, Esther Pacitti, Patrick Valduriez.

Project title: CloudDBAppliance
Instrument: H2020
Duration: 2016 - 2019
Total funding: 5 Meuros (Zenith: 500Keuros)
Coordinator: Bull/Atos, France
Partner: Europe: Inria Zenith, U. Madrid, INESC and the companies LeanXcale, QuartetFS, Nordea, BTO, H3G, IKEA, CloudBiz, and Singular Logic.
Inria contact: Florent Masseglia, Patrick Valduriez

The project aims at producing a European Cloud Database Appliance for providing a Database as a Service able to match the predictable performance, robustness and trustworthiness of on premise architectures such as those based on mainframes. The cloud database appliance features: (i) a scalable operational database able to process high update workloads such as the ones processed by banks or telcos, combined with a fast analytical engine able to answer analytical queries in an online manner; (ii) an operational Hadoop data lake that integrates an operational database with Hadoop, so operational data is stored in Hadoop that will cover the needs from companies on big data; (iii) a cloud hardware appliance leveraging the next generation of hardware to be produced by Bull, the main European hardware provider. This hardware is a scale-up hardware similar to the one of mainframes but with a more modern architecture. Both the operational database and the in-memory analytics engine will be optimized to fully exploit this hardware and deliver predictable performance. Additionally, CloudDBAppliance will tolerate catastrophic cloud data centres failures (e.g. a fire or natural disaster) providing data redundancy across cloud data centres. In this project, Zenith is in charge of designing and implementing the components for analytics and parallel query processing.

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. SciDISC

Title: Scientific data analysis using Data-Intensive Scalable Computing

International Partner (Institution - Laboratory - Researcher):

Universidade Federal do Rio de Janeiro (Brazil) - Computer Laboratory - Marta Mattoso

Start year: 2017

See also: https://team.inria.fr/zenith/scidisc/

Data-intensive science requires the integration of two fairly different paradigms: high-performance computing (HPC) and data-intensive scalable computing (DISC). Spurred by the growing need to analyze big scientific data, the convergence between HPC and DISC has been a recent topic of interest [[Coutinho 2014, Valduriez 2015]. This project will address the grand challenge of scientific data analysis using DISC (SciDISC), by developing architectures and methods to combine simulation and data analysis. The expected results of the project are: new data analysis methods for SciDISC systems; the integration of these methods as software libraries in popular DISC systems, such as Apache Spark; and extensive validation on real scientific applications, by working with our scientific partners such as INRA and IRD in France and Petrobras and the National Research Institute (INCT) on e-medicine (MACC) in Brazil.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

We have regular scientific relationships with research laboratories in

- North America: Univ. of Waterloo (Tamer Özsu), UCSB Santa Barbara (Divy Agrawal and Amr El Abbadi), Northwestern Univ. (Chicago), university of Florida (Pamela Soltis), Vikram Salatore (Manager of Artificial Intelligence Products Group at Intel Corporation).

- Asia: National Univ. of Singapore (Beng Chin Ooi, Stéphane Bressan), Wonkwang University, Korea (Kwangjin Park), Kyoto University (Japan)

- Europe: Univ. of Madrid (Ricardo Jiménez-Periz), UPC Barcelona (Josep Lluis Larriba Pey), HES-SO (Henning Müller), University of Catania (Concetto Spampinatto), Cork School of Music (Ireland), RWTH (Aachen, Germany), Chemnitz technical university (Stefan Kahl), Berlin Museum für Naturkunde (Mario Lasseck), Stefanos Vrochidis (Greece, ITI)

- Africa: Univ. of Tunis (Sadok Ben-Yahia), IMSP, Bénin (Jules Deliga)

- Australia: Australian National University (Peter Christen)

- Central America: Technologico de Costa-Rica (Erick Mata, former director of the US initiative Encyclopedia of Life)

9.4.3. Participation in Other International Programs

BD-FARM

Title: Big Data Management and Analytics for Agriculture and Farming

International Partner (Institution - Laboratory - Researcher):

> Chubu University - International Digital Earth Applied Science Research Center (IDEAS), Kiyoshi Honda

Duration: 2016 - 2018

Start year: 2016

See also: https://team.inria.fr/zenith/bdfarm-2016-2018-stic-asia/

World population is still growing and people are living longer and older. World demand for food rises sharply and current growth rates in agriculture are clearly not sufficient. But extreme flood, drought, typhoon etc, caused by climate change, give severe damages on traditional agriculture. Today, an urgent and deep redesign of agriculture is crucial in order to increase production and to reduce environmental impact. In this context, collecting, managing and analyzing dedicated, large, complex, and various datasets (Big Data) will allow improving the understanding of complex mechanisms behind adaptive, yield and crop improvement. Moreover, sustainability will require detailed studies such as the relationships between genotype, phenotype and environment. In other words, data science and ICT for agriculture must help improving production. Moreover, it has to be done while getting properly adapted to soil, climatic and agronomic constraints as well as taking into account the genetic specificities of plants.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Several international scientists visited the team and gave seminars

- Vitor Silva (COPPE/UFRJ,Brazil): "A methodology for capturing and analyzing dataflow paths in computational simulations" on January 31.

- Dennis Shasha (NYU): "Reducing Errors by Refusing to Guess (Occasionally)" on June 1.

- Daniel de Oliveira (UFF, Brazil): "Parameter and Data Recommendation in Scientific Workflows based on Provenance" on June 5.

- Eduardo Ogasawara, (CEFET-RJ, Brazil): "Comparing Motif Discovery Techniques with Sequence Mining in the Context of Space-Time Series" on November 26.