

**RESEARCH CENTER** 

FIELD Perception, Cognition and Interaction

# Activity Report 2017

# Section Partnerships and Cooperations

Edition: 2018-02-19

DATA AND KNOWLEDGE REPRESENTATION AND PROCESSING
1. CEDAR Team
2. GRAPHIK Project-Team
3. LACODAM Project-Team 11
4. LINKS Project-Team
5. MAGNET Project-Team
6. MOEX Project-Team
7. ORPAILLEUR Project-Team
8. PETRUS Project-Team
9. TYREX Project-Team
10. Valda Team
11. WIMMICS Project-Team
12. ZENITH Project-Team
INTERACTION AND VISUALIZATION
13. ALICE Project-Team
14. AVIZ Project-Team
15. EX-SITU Project-Team
16. GRAPHDECO Project-Team
17. HYBRID Project-Team
18. ILDA Project-Team
19. IMAGINE Project-Team
20. MANAO Project-Team
21. MAVERICK Project-Team
22. MIMETIC Project-Team
23. MINT2 Team
24. Mjolnir Team
25. POTIOC Project-Team
26. TITANE Project-Team
LANGUAGE, SPEECH AND AUDIO
27. ALMANACH Team
28. COML Team
29. MULTISPEECH Project-Team
30. PANAMA Project-Team
31. SEMAGRAMME Project-Team
ROBOTICS AND SMART ENVIRONMENTS
32. CHROMA Project-Team
33. DEFROST Project-Team
34. FLOWERS Project-Team
35. HEPHAISTOS Project-Team
36. LAGADIC Project-Team 109
37. LARSEN Project-Team

38. PERVASIVE INTERACTION Project-Team	19
39. RITS Project-Team	22
VISION, PERCEPTION AND MULTIMEDIA INTERPRETATION	
40. LINKMEDIA Project-Team12	26
41. MAGRIT Project-Team	30
42. MORPHEO Project-Team    13	32
43. PERCEPTION Project-Team13	34
44. SIROCCO Project-Team	35
45. STARS Project-Team	37
46. THOTH Project-Team	42
47. WILLOW Project-Team	45

## **CEDAR Team**

## 8. Partnerships and Cooperations

## 8.1. National Initiatives

## 8.1.1. ANR

- AIDE ("A New Database Service for Interactive Exploration on Big Data") is an ANR "Young Researcher" project led by Y. Diao, started at the end of 2016.
- CBOD ("Cloud-Based Organizational Design") is a 4-year ANR started in 2014, coordinated by prof. Ahmed Bounfour from UPS. Its goal is to study and model the ways in which cloud computing impacts the behavior and operation of companies and organizations, with a particular focus on the cloud-based management of data, a crucial asset in many companies.
- ContentCheck (2015-2018) is an ANR project in collaboration with U. Rennes 1 (F. Goasdoué), INSA Lyon (P. Lamarre), the LIMSI lab from U. Paris Sud, and the Le Monde newspaper, in particular their fact-checking team Les Décodeurs. Its aim is to investigate content management models and tools for journalistic fact-checking.

## 8.1.2. LabEx, IdEx

• CloudSelect is a three-years project started in October 2015. It is financed by the *Institut de la Société Numérique* (ISN) of the IDEX Paris-Saclay; it funds the PhD scholarship of S. Cebiric. The project is a collaboration with A. Bounfour from the economics department of Université Paris Sud. The project aims at exploring technical and business-oriented aspects of data mobility across cloud services, and from the cloud to outside the cloud.

#### 8.1.3. Others

- ODIN is a four-year project started in 2014, funded by the Direction Générale de l'Armement, between the SemSoft company, IRISA Rennes and Cedar. The project aims to develop a complete framework for analytics on Web data, in particular taking into account uncertainty, based on Semantic Web technologies such as RDF.
- The goal of the iCODA project is to develop the scientific and technological foundations for knowledge- mediated user-in-the-loop collaborative data analytics on heterogenous information sources, and to demonstrate the effectiveness of the approach in realistic, high-visibility use-cases. The project stands at the crossroad of multiple research fields—content analysis, data management, knowledge represen- tation, visualization—that span multiple Inria themes, and counts on a club of major press partners to define usage scenarios, provide data and demonstrate achievements. This is a project funded directly by Inria ("Inria Project Lab"), and is in collaboration with GraphIK, ILDA, LINKMEDIA (coordinator), as well as the press partners AFP, Le Monde (Les Décodeurs) and Ouest-France.

## 8.2. International Initiatives

## 8.2.1. Inria Associate Teams Not Involved in an Inria International Labs

## 8.2.1.1. WebClaimExplain

Title: Mining for explanations to claims published on the Web International Partner (Institution - Laboratory - Researcher): AIST (Japan) - Julien Leblay Start year: 2017 See also: https://team.inria.fr/cedar/projects/webclaimexplain/

The goal of this research is to create tools to find explanations for facts and verify claims made online. While this process cannot be fully automated, the main focus of our work will be explanation finding via trusted sources, based on the observation that one can only trust a statement if he/she can explain it through rules and proofs that can themselves be trusted.

## **8.3. International Research Visitors**

## 8.3.1. Visits of International Scientists

#### 8.3.1.1. Internships

Lars Kegel, a PhD student at the university of Dresden, is visiting the team since September 2017. He is working on the systematic description of time series with features that capture the global, structural characteristics of a series in a lower dimensional space.

## **GRAPHIK Project-Team**

## 9. Partnerships and Cooperations

## 9.1. National Initiatives

## 9.1.1. ANR Projects

9.1.1.1. ASPIQ (ANR white, Jan. 2013-July 2017) **Participants:** Jean-François Baget, Madalina Croitoru, Marie-Laure Mugnier.

ASPIQ (ASP technologIes for Querying large scale multisource heterogeneous web information), coordinated by Odile Papini (LSIS), involves other participants from CRIL, LERIA and LSIS. http://aspiq.lsis.org/

The aim of this project is to propose:

- extensions of standard ASP for representing OWL2 tractable sublanguages;
- new operations for merging conflicting information in this extended ASP;
- the identification of subclasses of this extended ASP allowing for efficient query answering mechanisms;
- an implementation of a prototype reasoning system.
- See Section 7.1 for this year's results. An international workshop (WASPIQ 2017) associated with the conference IEA/AIE 2017 was also organized (see Section 10.1.1)

#### 9.1.1.2. Pagoda (ANR JCJC, Jan. 2013-Dec. 2017)

Participants: Jean-François Baget, Meghyn Bienvenu, Marie-Laure Mugnier, Federico Ulliana.

Pagoda (Practical Algorithms for Ontology-based Data Access), coordinated by Meghyn Bienvenu, involves participants from IRISA, LIX, LIG, and the Anatomy Laboratory of Grenoble. http://pagoda.lri.fr/

The primary aim of this project is to address challenges brought by scalability and the handling of data inconsistencies by developing novel OBDA (Ontology Based Data Access) query answering algorithms and practical methods for handling inconsistent data.

• See Section 7.1 for this year's results.

#### 9.1.1.3. Dur-Dur (ANR ALID, March 2014-Feb. 2017)

**Participants:** Pierre Bisquert, Patrice Buche, Madalina Croitoru, Jérôme Fortin, Abdelraouf Hecham, Rallou Thomopoulos.

Dur-Dur (Innovations agronomiques, techniques et organisationnelles pour accroître la DURabilité de la filière blé DUR), coordinated by Bernard Cuq (IATE), involves participants from 6 agronomy research units (including IATE), and 4 technical / professional partners. http://umr-iate.cirad.fr/projets/dur-dur

The Dur-Dur project develops a systematic approach to investigate the questions related to the management of the nitrogen, energy and contaminants, to guarantee a global quality of products throughout the production and the processing chain. The knowledge representation task of Dur-Dur proposes to map the stakeholders' objectives into a multicriteria cartography, as well as possible means to reach them, and computes the compatibility / incompatibility of these objectives on the basis of argumentation methods. The research methods used are qualitative and based both on argumentation theory and on Social Multi- Criteria Evaluation (SMCE) theory. They will be extended and adapted to the needs of the project to provide a formal framework of assessment of the various orientations considered for the durum wheat chain.

• See Section 7.2 for this year's results.

#### 9.1.2. Other projects

#### 9.1.2.1. 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 (with being the project leaders), 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.

#### 9.1.2.2. Docamex (CASDAR project, 2017-2020)

Participants: Patrice Buche, Madalina Croitoru, Jérôme Fortin, Clement Sipietier.

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 evolutions of practices in the sector. Using new methods for expert capitalization and numeric representation, the main goal of the project is to develop a new approach for expert knowledge explicitation and representation and the development of a software dedicated to their manipulation. With this software, cheese makers will be able to easily access to these knowledge for decision making assistance, and more generally any learner in cheese making process will be able to use it to complete its knowledge. His sustainability will be assured by possibility of enrichment with new knowledge and experience feedback. The software will be delivered with a tool-box including a methodological guide and a software package to be informed to assured its usability. IATE, Heudyasic and Graphik will design the new version of CoGui-Capex software tool (based on Cogui) in this project. The original part of the reasoning tool will consist in representing and computing the efficiency and the reliability of actions undertaken to maintain a food quality descriptor. This new tool will be able to enrich information with new experiences.

9.1.2.3. 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).

9.1.2.4. Pack4Fresh (GloFoodS INRA-Cirad metaprogram, sept. 2015-sept 2017) Participants: Pierre Bisquert, Patrice Buche, Madalina Croitoru, Bruno Yun.

Pack4Fresh is funded by the multi-year metaprogramme GloFoodS (Transitions to global food security), which is dedicated to the investigation of pathways to worldwide food security in a context of competition for land and natural resources, and is jointly conducted by INRA and Cirad. Involving research on crop yield and livestock systems, land use changes, food processing and waste, nutrition and governance, GloFoodS aims at articulating global modeling of food supply and demand, with local issues of production and access to food.

In this context, Pack4Fresh focuses on the big fragility of fresh foods which generates enormous post-harvest wastes, short shelf-life, and constitutes a major lock to their consumption and health benefit. This project aims at initiating an eco-design approach of the post-harvest phase of fresh foods working on the interdependency relation between environmental impact (1) positive for waste reduction, et (2) negative for technologies, which aims at reducing the waste, in order to minimize the ratio between those two parameters.

• See Section 7.2 for this year's results.

## 9.1.3. Informal National Partners

- A new collaboration started this year with Pierre Bourhis (SPIRALS Inria team, UMR CRIStAL) and Sophie Tison (LINKS Inria team, UMR CRIStAL) on the OMQA issue for the case of Key-Value stores [21].
- The team continues the collaboration with Michael Thomazo (CEDAR Inria team) on Ontology-Mediated Query Answering. This year we worked on extensions of conjunctive queries that enable regular path expressions [20].
- We continued our collaboration with Florence Dupin de Saint-Cyr (Paul Sabatier University, Toulouse) [15], since 2014.
- We continued our collaboration with Srdjan Vesic, Researcher (CNRS CRIL), Lens, France, since 2016 [13].
- This year we started a collaboration with the Center for Structural Biochemistry of Montpellier (CBS), with Jérôme Bonnet and Sarah Gouiziou, on the encoding of Boolean functions in biological systems [42].
- A new collaboration started with Reza Akbarinia (ZENITH Inria team) on parallel query rewriting for OMQA [31].
- We collaborated with Marianne Huchard (MAREL team, LIRMM) on the combined application of our techniques to generate text under constraints [27].
- We continued our collaboration with Jéan-Claude Léon (IMAGINE Inria team), since 2014 [36].

## 9.2. European Initiatives

## 9.2.1. FP7 & H2020 Projects

## 9.2.1.1. 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 will contribute on two aspects. On one hand we will participate in the annotation effort of knowledge bases (using the @Web tool). On the other hand we will 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

## 9.2.2. Collaborations in European Programs, Except FP7 & H2020

## 9.2.2.1. 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 several 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 ecodesign of food processes, software tools for the food industry, and dissemination and knowledge transfer. http://www6.inra.fr/foodmc

## 9.3. International Initiatives

## 9.3.1. Informal International Partners

- Laval University (Quebec city, Canada): since 2012 we collaborate with Bernard Moulin on combined argumentation and simulation for decision support, and with Irène Abi-Zeid on Argumentation and multicriteria decision [33], [34].
- Birmingham University (UK), we continued our collaboration with Serafim Bakalis on decision support in agronomy [32].
- University of Toronto (Canada): this year a new collaboration started with Sheila McIlraith and her research group.
- Birkbeck College, University of London (UK): ongoing work with Michael Zacharyschev, Roman Kontchakov, and Stanislav Kikot on the OMQA issue.
- Sapienza University (Rome, Italy): collaboration with Riccardo Rosati, since 2012 [45].
- University of Bremen (Germany): collaboration with Carsten Lutz, since 2009 [44], [43].
- University of Liverpool (UK): collaboration with Frank Wolter, since 2009 [43], [44].
- Patras University (Greece): collaboration with Nikolaos Karanikolas, since 2017 (formerly postdoc in the team) [41], [25].

## 9.4. International Research Visitors

## 9.4.1. Visits to International Teams

- Meghyn Bienvenu visited the Birkbeck College, University of London for 1 week during February 2017 as for her collaboration with Michael Zacharyschev, Roman Kontchakov, Stanislav Kikot. She also visited the
- Rallou Thomopoulos visited the team of Alexandros Koulouris and Maria Papageorgiou atATEI Thessaloniki, Greece (November 2017). He gave also the talk "Science for Food and Bioproduct Engineering at INRA: a knowledge engineering perspective".

## 9.4.1.1. Research Stays Abroad

• Meghyn Bienvenu will be visiting the Department of Computer Science of the University of Toronto from early August 2017 for nearly 12 months. She will collaborate with Sheila McIlraith and the rest of the Knowledge Representation group.

## **LACODAM Project-Team**

## 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

#### 9.1.1. SePaDec: Declarative approaches for Sequential Pattern mining

Participants: Benjamin Negrevergne, Thomas Guyet, Ahmed Samet, Alexandre Termier.

The SEPADEC project is funded by the Region Bretagne. During the execution of this project we explored the application of declarative pattern mining (specifically ASP) in the field of care pathway analysis. The goal was to model domain knowledge to enrich raw data with medical expert knowledge and to develop a toolbox that smoothly integrates both expert knowledge and declarative pattern mining.

We developed a new approach for mining rare sequential mining with ASP [20] and we also proposed a general framework based on ASP for flexibly mine care pathways [12].

## 9.2. National Initiatives

## 9.2.1. ANR

#### 9.2.1.1. #DigitAg: Digital agriculture

Participants: Alexandre Termier, Véronique Masson, Christine Largouët, Anne-Isabelle Graux.

#DigitAg is a "Convergence Institute" dedicated to the increasing importance of digital techniques in agriculture. Its goal is twofold: First, make innovative research on the use of digital techniques in agriculture in order to improve competitiveness, preserve the environment, and offer correct living conditions to farmers. Second, prepare future farmers and agricultural policy makers to successfully exploit such technologies.

While #DigitAg is based on Montpellier, Rennes is a satellite of the institute focused on cattle farming. LACODAM is involved in the "data mining" challenge of the institute, that A. Termier co-leads. He is also the representative of Inria in the steering comittee of the institute.

The interest for the team is to design novel methods to analyze and represent agricultural data, which are challenging because they are both heterogeneous and multi-scale (both spatial and temporal).

#### 9.2.2. National Platforms

#### 9.2.2.1. PEPS: Pharmaco-epidemiology for Health Products

Participants: Yann Dauxais, Thomas Guyet, Véronique Masson, René Quiniou, Ahmed Samet.

The PEPS project (Pharmaco-epidemiology des Produits de Santé) is funded by the ANSM (National Agency for Health Security). The project leader is E. Oger from the clinical investigation center CIC-1414 INSERM/CHU Rennes. The other partners located in Rennes are the Institute of Research and Technology (IRT), B<>Com, EHESP and the LTSI. The project started in January 2015 and is funded for 4 years.

The PEPS project consists of two parts: a set of clinical studies and a research program dedicated to the development of innovative tools for pharmaco-epidemiological studies with medico-administrative databases.

Our contribution to this project will be to propose pattern mining algorithms and reasoning techniques to analyse the typical care pathways of specific groups of insured patients. This year we worked on the design and development of the DCM algorithm [8], [7] to mine patterns on care pathways.

## 9.3. International Research Visitors

## 9.3.1. Internships

This year, we hosted Scarlett Kelly, a student of Dalhousie University (Canada) from May to the end of August. Her internship was funded by a joint Mitacs Globalink (Canada) / Inria grant. Scarlett Kelly is a student of social sciences, thus she has a different profile that the computer science students who usually do internships at LACODAM. We were interested in such profile in order to gain a critical view on the current approaches of *interactive data mining*. Scarlett quickly picked up the literature of the domain, and could write a report and make interesting propositions that were unexpected from a computer science point of view, i.e., introduce a specially trained "data liaison" person between practitioners and data scientists. Her proposition led to a paper [14] accepted at the HICSS conference (an IT conference ranked "A" at CORE2017).

## **LINKS Project-Team**

## 8. Partnerships and Cooperations

## 8.1. National Initiatives

ANR Aggreg (2014-19): Aggregated Queries.

- Particpants: J. Niehren [correspondent], P. Bourhis, A. Lemay, A. Boiret
- The coordinator is J. Niehren and the parteners are the University Paris 7 (A. Durand) including members of the Inria project DAHU (L. Ségoufin), the University of Marseille (N. Creignou) and University of Caen (E. Grandjean).
- Objective: the main goal of the Aggreg project is to develop efficient algorithms and to study the complexity of answering aggregate queries for databases and data streams of various kinds.

ANR Colis (2015-20): Correctness of Linux Scripts.

- Participants: J. Niehren [correspondent], A. Lemay, S. Tison, A. Boiret, V. Hugot, N. Bacquey, P. Gallot, S. Salvati.
- The coordinator is R. Treinen from the University of Paris 7 and the other partner is the Tocata project of Inria Saclay (C. Marché).
- Objective: This project aims at verifying the correctness of transformations on data trees defined by shell scripts for Linux software installation. The data trees here are the instance of the file system which are changed by installation scripts.

**ANR DataCert** (2015-20):

- Participants: I. Boneva [correspondent], S. Tison, J. Lozano.
- Partners: The coordinator is E. Contejean from the University of Paris Sud and the other partner is the University of Lyon.
- Objective: the main goals of the Datacert project are to provide deep specification in Coq of algorithms for data integration and exchange and of algorithms for enforcing security policies, as well as to design data integration methods for data models beyond the relational data model.

ANR Headwork (2016-21):

- Participants: P. Bourhis [correspondant], J. Niehren, M. Sakho.
- Scientific partners: The coordinateur is D. Gross-Amblard from the Druid Team (Rennes 1). Other partners include the Dahu team (Inria Saclay) and Sumo (Inria Bretagne)
- Industrial partners: Spipoll, and Foulefactory.
- Objective: The main object is to develop data-centric workflows for programming crowd sourcing systems in flexible declarative manner. The problem of crowd sourcing systems is to fill a database with knowledge gathered by thousands or more human participants. A particular focus is to be put on the aspects of data uncertainty and for the representation of user expertise.

ANR Delta (2016-21):

- Participants: J. Niehren, P. Bourhis [correspondent], S. Salvati, N. Bacquey, D. Gallois.
- Partners: The coordinator is M. Zeitoun from LaBRI, other partners are LIF (Marseille) and IRIF (Paris-Diderot).
- Objective: Delta is focused on the study of logic, transducers and automata. In particular, it aims at extending classical framework to handle input/output, quantities and data.

**ANR Bravas** (2017-22):

- Participants: S. Salvati [correspondent]
- Scientific Partners: The coordinator is Jérôme Leroux from LaBRI, University of Bordeaux. The other partner is LSV, ENS Cachan.
- Objective: The goal of the BraVAS project is to develop a new and powerful approach to decide the reachability problems for Vector Addition Systems (VAS) extensions and to analyze their complexity. The ambition here is to crack with a single hammer (ideals over well-orders) several long-lasting open problems that have all been identified as a barrier in different areas, but that are in fact closely related when seen as reachability.

## 8.2. European Initiatives

Edinburgh-Links exchange projet funded by the University of Lille. The coordiator is Slawek Staworko. Lille-Oxford cooperation project funded by the University of Lille. Links' contact is Pierre Bourhis.

## 8.3. International Initiatives

## 8.3.1. Inria International Partners

Niehren and Bourhis continue to cooperate with Domagoy Vrgoc from the University of Satiago di Chile, also after the end of the AMSud project.

## **MAGNET Project-Team**

## 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

We strengthen our partnership with the linguistic laboratory STL in Lille university. We welcome Bert Cappelle for a stay (delegation) in the group. The topic of this collaboration is to study modal verbs and the translation of the notion of compositionality when applied to vectorial representation of words.

We also participate to the *Data Advanced data science and technologies* project (CPER Data). This project is organized following three axes: internet of things, data science, high performance computing. MAGNET is involved in the data science axis to develop machine learning algorithms for big data, structured data and heterogeneous data. The project MyLocalInfo is an open API for privacy-friendly collaborative computing in the internet of things.

## 9.2. National Initiatives

#### 9.2.1. ANR Pamela (2016-2020)

Participants: MARC TOMMASI [correspondent], AURÉLIEN BELLET, RÉMI GILLERON, FABIO VITALE

The Pamela project aims at developing machine learning theories and algorithms in order to learn local and personalized models from data distributed over networked infrastructures. Our project seeks to provide first answers to modern information systems built by interconnecting many personal devices holding private user data in the search of personalized suggestions and recommendations. More precisely, we will focus on learning in a collaborative way with the help of neighbors in a network. We aim to lay the first blocks of a scientific foundation for these new types of systems, in effect moving from graphs of data to graphs of data and learned models. We argue that this shift is necessary in order to address the new constraints arising from the decentralization of information that is inherent to the emergence of big data. We will in particular focus on the question of learning under communication and privacy constraints. A significant asset of the project is the quality of its industrial partners, Snips and Mediego, who bring in their expertise in privacy protection and distributed computing as well as use cases and datasets. They will contribute to translate this fundamental research effort into concrete outcomes by developing personalized and privacy-aware assistants able to provide contextualized recommendations on small devices and smartphones. https://project.inria.fr/pamela/.

## 9.2.2. ANR JCJC GRASP (2016-2020)

Participants: PASCAL DENIS [correspondent], AURÉLIEN BELLET, RÉMI GILLERON, MIKAELA KELLER, MARC TOMMASI

The GRASP project aims at designing new graph-based Machine Learning algorithms that are better tailored to Natural Language Processing structured output problems. Focusing on semi-supervised learning scenarios, we will extend current graph-based learning approaches along two main directions: (i) the use of structured outputs during inference, and (ii) a graph construction mechanism that is more dependent on the task objective and more closely related to label inference. Combined, these two research strands will provide an important step towards delivering more adaptive (to new domains and languages), more accurate, and ultimately more useful language technologies. We will target semantic and pragmatic tasks such as coreference resolution, temporal chronology prediction, and discourse parsing for which proper Machine Learning solutions are still lacking. https://project.inria.fr/grasp/.

### 9.2.3. ANR-NFS REM (2016-2020)

With colleagues from the linguistics departments at Lille 3 and Neuchâtel (Switzerland), PASCAL DENIS is a member of another ANR project (REM), funded through the bilateral ANR-NFS Scheme. This project, co-headed by I. Depreatere (Lille 3) and M. Hilpert (Neufchâtel), proposes to reconsider the analysis of English modal constructions from a multidisciplinary perspective, combining insights from theoretical, psycho-linguistic, and computational approaches.

#### 9.2.4. EFL (2010-2020)

PASCAL DENIS is an associate member of the Laboratoire d'Excellence *Empirical Foundations of Linguistics* (EFL), http://www.labex-efl.org/.

## 9.3. European Initiatives

#### 9.3.1. FP7 & H2020 Projects

ERC-PoC 713626 SOM "Statistical modeling for Optimization Mobility": This project aims at bringing to practice results from the project ERC-StG 240186 MiGraNT in the domain of mobility and mobile devices. In particular, a proof of concept will be made of graph mining approaches to learn predictive models and/or recommendation systems from collections of data distributed over a large number of devices (cars, smartphones, ...) while caring about privacy-friendliness.

### 9.3.2. Collaborations in European Programs, Except FP7 & H2020

#### 9.3.2.1. Sci-GENERATION (2013-2017)

Program: COST

Project acronym: Sci-GENERATION

Project title: Next Generation of Young Scientist: Towards a Contemporary Spirit of R&I.

Duration: 2013-2017

Coordinator: JAN RAMON is an MC member for belgium and a core group member

Other partners: More information on http://scigeneration.eu/en/participants.html

Abstract: Sci-Generation is a COST targeted network that addresses the challenges faced by next generation of researchers in Europe. We aim to improve the visibility, inclusion and success of excellent young researchers and research teams in European science and policy-making. We study and deliberate how changes in research funding opportunities and career perspectives can facilitate these improvements. We wish to promote new and emergent research topics, methods and management organizations. We are developing recommendations for EU science policy that will foster transformations at national and regional levels to promote scientific excellence and to establish a true European research area. (See http://scigeneration.eu).

#### 9.3.2.2. TextLink (2014-2018)

Program: COST Action

Project acronym: TextLink

Project title: Structuring Discourse in Multilingual Europe

Duration: Apr. 2014 - Apr. 2018

Coordinator: Prof. Liesbeth Degand, Université Catholique de Louvain, Belgium. PASCAL DENIS is member of the Tools group.

Other partners: 26 EU countries and 3 international partner countries (Argentina, Brazil, Canada)

Abstract: Effective discourse in any language is characterized by clear relations between sentences and coherent structure. But languages vary in how relations and structure are signaled. While monolingual dictionaries and grammars can characterize the words and sentences of a language and bilingual dictionaries can do the same between languages, there is nothing similar for discourse. For discourse, however, discourse-annotated corpora are becoming available in individual languages. The Action will facilitate European multilingualism by (1) identifying and creating a portal into such resources within Europe - including annotation tools, search tools, and discourse-annotated corpora; (2) delineating the dimensions and properties of discourse annotation across corpora; (3) organizing these properties into a sharable taxonomy; (4) encouraging the use of this taxonomy in subsequent discourse; and (5) promoting use of the portal, its resources and sharable taxonomy. With partners from across Europe, TextLink will unify numerous but scattered linguistic resources on discourse structure. With its resources searchable by form and/or meaning and a source of valuable correspondences, TextLink will enhance the experience and performance of human translators, lexicographers, language technology and language learners alike.

## 9.4. International Initiatives

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

9.4.1.1. RSS

Program: Inria North-European Labs

Project title: Rankings and Similarities in Signed graphs

Duration: late 2015 to late 2017

Partners: Aristides Gionis (Data Mining Group, Aalto University, Finland) and Mark Herbster (Centre for Computational Statistics and Machine Learning, University College London, UK) Abstract: The project focuses on predictive analysis of networked data represented as signed graphs, where connections can carry either a positive or a negative semantic. The goal of this associate team is to devise novel formal methods and machine learning algorithms towards link classification and link ranking in signed graphs and assess their performance in both theoretical and practical terms.

## 9.4.1.2. LEGO

Title: LEarning GOod representations for natural language processing

International Partner (Institution - Laboratory - Researcher):

University of Southern California (United States) - Department of Computer Science - Fei Sha

Start year: 2016

#### See also: https://team.inria.fr/lego/

LEGO lies in the intersection of Machine Learning and Natural Language Processing (NLP). Its goal is to address the following challenges: what are the right representations for structured data and how to learn them automatically, and how to apply such representations to complex and structured prediction tasks in NLP? In recent years, continuous vectorial embeddings learned from massive unannotated corpora have been increasingly popular, but they remain far too limited to capture the complexity of text data as they are task-agnostic and fall short of modeling complex structures in languages. LEGO strongly relies on the complementary expertise of the two partners in areas such as representation/similarity learning, structured prediction, graph-based learning, and statistical NLP to offer a novel alternative to existing techniques. Specifically, we will investigate the following three research directions: (a) optimize the embeddings based on annotations so as to minimize structured prediction errors, (b) generate embeddings from rich language contexts represented as graphs, and (c) automatically adapt the context graph to the task/dataset of interest by learning a similarity between nodes to appropriately weigh the edges of the graph. By exploring these complementary research strands, we intend to push the state-of-the-art in several core NLP problems, such as dependency parsing, coreference resolution and discourse parsing.

## 9.5. International Research Visitors

#### 9.5.1. Visits of International Scientists

- PETER KLING The objective of the visit of PETER KLING was centered around Learning in Distributed Environments. This initiative contributes to the recent effort of Magnet towards decentralized learning also supported for instance by the Pamela project (Personalized and decentrAlized MachinE Learning under constrAints). Peter Kling's background in distributed computing, combinatorial optimization, online algorithms, and stochastic processes is a good opportunity to investigate new machine learning approaches in this area. In this first of one month, we have started to study Population and Spreading Processes. Two other topics on distributed load balancing and energyaware algorithms will be the investigated in a second visit in 2018.
- VALENTINA ZANTEDESCHI During her one month stay, VALENTINA ZANTEDESCHI has collaborated with AURÉLIEN BELLET and MARC TOMMASI on decentralized learning. A paper on collaborative and decentralized boosting will be submitted in 2018.
- ISABEL VALERA visited MAGNET for 3 days to collaborate with AURÉLIEN BELLET on fairness in machine learning.
- CLEMENT WEISBECKER visited MAGNET for 1 week to collaborate with AURÉLIEN BELLET on large-scale kernel methods using block low-rank approximations.
- WILHELMIINA HAMALAINEN visited MAGNET for 2 weeks to collaborate with JAN RAMON. In particular, they worked on multiple hypothesis tests for regression and discretization problems.
- BERT CAPPELLE visited MAGNET for a semester, as part of his "delegation", to collaborate with PASCAL DENIS and MIKAELA KELLER on compositional distributional semantics, and more specifically on the distributional analysis of so-called privative adjectives. A collaborative paper on this work will be submitted in 2018.

Several international researchers have also been invited to give a talk at the MAGNET seminar:

- R. Babbar (Max Planck Institute): Algorithms for Extreme Multi-Class and Multi-Label Classification
- M. Chehreghani (Xerox Research): Unsupervised Learning over Graphs: Distances, Algorithms, and an Information-Theoretic Model Validation Principle
- G. Boleda (University Pompeu Fabra): Instances and Concepts in Distributional Space
- M. Blondel (NTT): A Regularized Framework for Sparse and Structured Neural Attention
- L. Wehenkel (University of Liège): Probabilistic Reliability Management of the European Electric Power System
- A. Herbelot (University Pompeu Fabra): A Formal Distributional Semantics for Cognitively-Plausible Reference Acts
- H. Ivey-Law (Data61/CSIRO): Private Federated Learning on Vertically Partitioned Data via Entity Resolution and Additively Homomorphic Encryption

#### 9.5.1.1. Internships

- Juhi Tandon worked on developing re-ranking parsing models that exploit and compare various tree kernels in the context of semi-supervised graph-based multilingual dependency parsing.
- Quentin Tremouille worked on applications of the Hypernode graphs model [39] in the context of (movie) recommendation based on reviews in natural language.
- Hippolyte Bourel worked on the application of the decentralized learning algorithms [15] for mobility data.
- Rumei Li worked on a Yanakakis style algorithm for computing the effective sample size of a set of dependent training examples.

## 9.5.2. Visits to International Teams

#### 9.5.2.1. Research Stays Abroad

- MATHIEU DEHOUCK visited USC during one month. He worked with pairs of 8 main and auxiliary NLP tasks. More specifically, he looked at transfer learning from low-level tasks (such as part-of-speech tagging, named entity recognition, chunking, word polarity classification) to high-level tasks (e.g., semantic relatedness, textual entailment, sentiment analysis). In contrast to a common belief in the NLP community that transfer learning between these tasks should be possible, we discovered that the widely-used technique in which word representations act as a medium of transfer only leads to limited improvements. These results were presented by Fei Sha at the Inria SiliconValley workshop (BIS'2017), and a paper is in preparation for 2018.
- AURÉLIEN BELLET visited École Polytechnique Fédérale de Lausanne (EPFL) during 1 week. He worked with the distributed computing group of Rachid Guerraoui on decentralized and privacy-preserving machine learning, leading to some joint papers [18], [16].
- AURÉLIEN BELLET and PASCAL DENIS visited USC during two weeks in December 2017. In collaboration with MELISSA AILEM, recently recruited as a post-doc on the LEGO project, they worked on developing a new algorithm for joint learning of word and image embeddings inspired on the Skip-Gram word2vec model. In addition, they furthered the work initiated with MATHIEU DEHOUCK along with USC colleagues on multi-task learning by proposing a new encoder-decoder model that integrates task and domain embeddings.

## **MOEX Project-Team**

## 5. Partnerships and Cooperations

## 5.1. National Initiatives

## 5.1.1. ANR Elker

Program: ANR-PRC

Project acronym: ELKER

Project title: Extending link keys: extraction and reasoning

Duration: October 2017 - September 2021

Coordinator: LIG/Manuel Atencia

Participants: Manuel Atencia Arcas, Jérôme David, Jérôme Euzenat

Other partners: Inria Lorraine, Université de Vincennes

Abstract: The goal of ELKER is to extend the foundations and algorithms of link keys (see §3.3) in two complementary ways: extracting link keys automatically from datasets and reasoning with link keys.

## 5.1.2. Framework agreement Ministère de la culture et de la communication

Program: Framework agreement Inria-Ministère de la culture et de la communication

Project acronym: GINCO V3

Project title: Outil d'aide à l'alignement pour l'élaboration du graphe culture

Duration: November 2017 - December 2018

Coordinator: Jérôme David

Participants: Jérôme David, Jérôme Euzenat, Manuel Atencia Arcas

Abstract: The GINCO V3 project aims at extending the GINCO tool with ontology alignment capabilities.

Program: Framework agreement Inria-Ministère de la culture et de la communication

Project acronym: FNE

Project title: Algorithmes d'aide à la définition de clés de liage et d'alignement d'autorités

Duration: November 2017 - December 2018

Coordinator: Jérôme David

Participants: Jérôme David, Manuel Atencia Arcas, Jérôme Euzenat

Other partners: Bibliothèque nationale de France

Abstract: The goal of the FNE cooperation is to evaluate the suitability of link key extraction algorithms to matching authorities from BnF, ABES and the ministry of Culture and to improve such algorithms if necessary.

## 5.2. International Initiatives

#### 5.2.1. Participation in Other International Programs

Jérôme Euzenat has benefited from a special visiting researcher grant from the Brazilian Ciência sem Fronteiras program on "Methodology and algorithms for ontology refinement and matching" (2015-2017). He works with the team of Fernanda Baião and Kate Revoredo at the Universidade Federal do Estado do Rio de Janeiro (UNIRIO). Together, they investigate methods for evolving ontologies and alignments which involve users and agents. The goal of the project is to design methods and algorithms using theory revision to deal with knowledge evolution in a reliable manner and obtaining better quality alignments.

## **5.3. International Research Visitors**

## 5.3.1. Visits of International Scientists

• Kate Revoredo (UNIRIO) visited mOeX in May 2017.

## 5.3.2. Visits to International Teams

• Jérôme Euzenat visited the Universidade Federal do Estado do Rio de Janeiro (UNIRIO) for one month in November-December 2017 (see §5.2.1).

## **ORPAILLEUR Project-Team**

## 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

## 8.1.1. Hydreos

Participant: Jean-François Mari.

Hydreos is a state organization -a so-called "Pôle de compétitivité" – aimed at evaluating the delivering and the quality of water (http://www.hydreos.fr/fr). Actually, data about water resources rely on many agronomic variables, including land use successions. The data to be analyzed are obtained by surveys or by satellite images and describe the land use at the level of the agricultural parcel. Then there is a search for detecting changes in land use and for correlating these changes to groundwater quality. Accordingly, one main challenge in our participation in Hydreos is to process and analyze space-time data for reaching a better understanding of the changes in the organization of a territory. The systems ARPEnTAge and CarottAge are used in this context, especially by agronomists of INRA (ASTER Mirecourt http://www6.nancy.inra.fr/sad-aster).

#### 8.1.2. The Smart Knowledge Discovery Project

Participants: Jérémie Nevin, Amedeo Napoli, Chedy Raïssi.

The SKD project for "Smart Knowledge Discovery" aims at analyzing complex industrial data for troubleshooting and decision making, and is funded by "Grand Est Region". We are working with the Vize company –which is based in Nancy and specialized in visualization-based data mining– on exploratory knowledge discovery. The data which are under study are provided by the Arcelor-Mittal Steel Company and are related to the monitoring of rolling mills. Data are complex time series and the problem can be set as follows: problem statement, data access and preparation, design of adapted knowledge discovery methods based on symbolic and numerical methods, interaction with analysts, tests and validation. For the Orpailleur team, one main objective of SKD is to combine sequence mining and visualization tools for recognizing and then preventing the occurrences of defects in the outputs of the rolling mills.

## 8.2. National Initiatives

## 8.2.1. ANR

#### 8.2.1.1. Elker (2017-2020)

Participants: Miguel Couceiro, Esther Catherine Galbrun, Amedeo Napoli, Chedy Raïssi.

The objectives of the new ELKER ANR Research Project is to study, formalize and implement the search for link keys in RDF data. Link keys generalize database keys in two independent directions, i.e. they deal with RDF data and they apply across two datasets. The goal of ELKER is to study the automatic discovery of link keys and reasoning with link keys, especially in taking an FCA point of view. One main idea is to rely on the competencies of Orpailleur in FCA for solving the problem using FCA and pattern structures algorithms, especially those related to the discovery of functional dependencies. This project involves the EPI Orpailleur at Inria Nancy Grand Est, the EPI MOEX at Inria Rhône Alpes, and LIASD at Université Paris 8.

#### 8.2.1.2. ISTEX (2014-2017)

Participant: Yannick Toussaint.

ISTEX is a so-called "Initiative d'excellence" managed by CNRS and DIST ("Direction de l'Information Scientifique et Technique"). ISTEX aims at providing the research and teaching community an on-line access to scientific publications in all domains (http://www.istex.fr/istex-excellence-initiative-of-scientific-and-technical-information/). In this way, ISTEX requires a massive acquisition of documents such as journals, proceedings, corpora, and databases. The Orpailleur team was especially involved in the development of facilities for querying full-text documentation, analyzing content and extracting information. The project was carried out in collaboration with the ATILF laboratory and the INIST Institute (both located in Nancy).

#### 8.2.1.3. PractiKPharma (2016-2020)

**Participants:** Adrien Coulet, Joël Legrand, Pierre Monnin, Amedeo Napoli, Malika Smaïl-Tabbone, Yannick Toussaint.

PractiKPharma for "Practice-based evidences for actioning Knowledge in Pharmacogenomics" is an ANR research project (http://practikpharma.loria.fr/) about the validation of domain knowledge in pharmacogenomics. Pharmacogenomics is interested in understanding how genomic variations related to patients have an impact on drug responses. Most of the available knowledge in pharmacogenomics (state of the art) lies in biomedical literature, with various levels of validation. An originality of PractiKPharma is to use Electronic Health Records (EHRs) to constitute cohorts of patients. These cohorts are then mined for extracting potential pharmacogenomics patterns to be then validated w.r.t. literature knowledge for becoming actionable knowledge units. More precisely, firstly we should extract pharmacogenomic patterns from the literature and secondly we should confirm or moderate the interpretation and validation of these units by mining EHRs. Comparing knowledge patterns extracted from the literature with facts extracted from EHRs is a complex task depending on the EHR language –literature is in English whereas EHRs are in French– and on knowledge level, as EHRs represent observations at the patient level whereas literature is related to sets of patients. The PractiKPharma involves three other laboratories, namely LIRMM in Montpellier, SSPIM in St-Etienne and CRC in Paris.

#### 8.2.2. CNRS PEPS and Mastodons projects

8.2.2.1. Mastodons Projects: from HyQual to HyQualiBio (2016–2018)

**Participants:** Miguel Couceiro, Esther Catherine Galbrun, Tatiana Makhalova, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

The HyQual project was proposed in 2016 in response to the Mastodons CNRS Call about data quality in data mining (see http://www.cnrs.fr/mi/spip.php?article819&lang=fr). This project is interested in the mining of nutritional data for discovering predictive biomarkers of diabetes and metabolic syndrome in elder populations. The considered data mining methods are hybrid, and they combine symbolic and numerical methods for mining complex and noisy metabolic data [80]. Regarding the mining process, we are interested in the quality of the data at hand and in the discovered patterns. In particular, we check the incompleteness of the data, the quality of the extracted rules and the possible existence of redescriptions.

Initially, the project involved researchers from the EPI Orpailleur, with researchers from LIRIS Lyon, ICube Strasbourg, and INRA Clermont-Ferrand. This year, we were merged with another Mastodons project, namely QualiBioConsensus, about the "ranking of biological data using consensus ranking techniques". The joint Mastodons project is now called "HyQualiBio". The topics of interest for the participants are the mining of complex biological data, rankings and ties in rankings, and the search of dependencies in the web of data.

#### 8.2.2.2. PEPS Decade

**Participants:** Miguel Couceiro, Esther Catherine Galbrun, Nyoman Juniarta, Amedeo Napoli, Justine Reynaud, Chedy Raïssi.

Decade stands for "Découverte et exploitation des connaissances pour l'aide à la décision en chimie thérapeutique". The objective of the CNRS PEPS Decade project is to study the basis of knowledge system for analyzing the so-called PAINS ("Pan Assay Interference Compounds") in chemistry. The system should rely on the knowledge possibly discovered in the data and domain knowledge and expertise. The members of the projects are interested in data mining techniques guided by constraints and preferences, "instant data mining", subgroup discovery and exceptional model mining. All these topics were already of interest in the PEPS Prefute (2015-2016) which was about interaction and iteration in the knowledge discovery process.

The members of the Decade project are from Greyc Caen, LIFO Orléans LIRIS Lyon, Université de Tours-Blois, EPI Lacodam in Rennes and EPI Orpailleur (in association with chemists based in Caen and Orléans)

## 8.3. European Initiatives

#### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. CrossCult (H2020 Project, 2016-2020)

Participants: Miguel Couceiro, Nyoman Juniarta, Amedeo Napoli, Chedy Raïssi.

CrossCult (http://www.crosscult.eu/) aims to make reflective history a reality in the European cultural context, by enabling the re-interpretation of European (hi)stories through cross-border interconnections among cultural digital resources, citizen viewpoints and physical venues. The project has two main goals. The first goal is to lower cultural EU barriers and create unique cross-border perspectives, by connecting existing digital historical resources and by creating new ones through the participation of the public. The second goal is to provide long-lasting experiences of social learning and entertainment that will help for achieving a better understanding and re-interpretation of European history. To achieve these goals, CrossCult will use cutting-edge technology to connect existing digital cultural assets and to combine them with interactive experiences that all together are intended to increase retention, stimulate reflection and help European citizens appreciate their past and present in a holistic manner. CrossCult will be implemented on four real-world flagship pilots involving a total of 8 sites across Europe.

The role of the Orpailleur Team (in conjunction with the LORIA Kiwi Team) is to work on knowledge discovery and recommendation. The focus is on the mining of visitor trajectories for analysis purposes, and on the definition of a visitor profile in connection with domain knowledge for recommendation.

The numerous partners of the Orpailleur team in the CrossCult project are: Luxembourg Institute for Science and Technology and Centre Virtuel de la Connaissance sur l'Europe (Luxembourg, leader of the project), University College London (England), University of Malta (Malta), University of Peloponnese and Technological Educational Institute of Athens (Greece), Università degli Studi di Padova (Italy), University of Vigo (Spain), National Gallery (London, England), and GVAM Guìas Interactivas (Spain).

## 8.4. International Initiatives

## 8.4.1. Inria Associate Teams Not Involved in an Inria International Lab

8.4.1.1. Snowball

Title: Discovering knowledge on drug response variablity by mining electronic health records

International Partner (Institution - Laboratory - Researcher):

Stanford (United States) - Department of Medicine, Stanford Center for Biomedical Informatics Research (BMIR) - Nigam Shah

Start year: 2017

See also: http://snowball.loria.fr/

Snowball (2017-2019) is an Inria Associate Team and the continuation of the preceding Associate Team called Snowflake (2014-2016). The objective of Snowball is to study drug response variability through the lens of Electronic Health Records (EHRs) data. This is motivated by the fact that many factors, genetic as well as environmental, imply different responses from people to the same drug. The mining of EHRs can bring substantial elements for understanding and explaining drug response variability.

Accordingly the objectives of Snowball are to identify in EHR repositories groups of patients which are responding differently to similar treatments, and then to characterize these groups and predict patient drug sensitivity. These objectives are complementary to those of the PractikPharma ANR project. Moreover, it should be noticed that Adrien Coulet has started a one-year sabbatical stay in the lab of Nigam Shah at Stanford University since September 2017.

#### 8.4.2. Participation in International Programs

#### 8.4.2.1. A stay at NASA Frontier Development Lab

In July 2017, Chedy Raïssi visited NASA Ames and SETI Institute as part of the Frontier Development Lab. He worked on mentoring teams and developing meaningful research opportunities, as well as supporting the work of the planetary defense community and showing the potential of this kind of applied research methodology to deliver breakthrough of significant value.

Delay-Doppler radar imaging is a powerful technique to characterize the trajectories, shapes, and spin states of near-Earth asteroids and has yielded detailed models of dozens of objects. Since the 1990s, delay-Doppler data has been analyzed using the SHAPE software developed originally by Steven J. Ostro. SHAPE performs sequential single-parameter fitting, and requires considerable computation runtime and human intervention. Recently, multiple-parameter fitting algorithms have been shown to more efficiently invert delay-Doppler datasets thus decreasing runtime while improving accuracy. However, reconstructing asteroid shapes and spins from delay-Doppler data is, like many inverse problems, computationally intensive and requires extensive human oversight of the shape modeling process.

Thus we have explored two new techniques to better automate delay-Doppler shape modeling: Bayesian optimization and deep generative models. Firstly we have implemented a Bayesian optimization routine that uses SHAPE to autonomously search the space of spin-state parameters. Bayesian optimization yielded similar spin state constraints with computer runtime reduced by a factor of 3. Secondly, the shape modeling process could be further accelerated using a deep "generative model" to replace or complete iterative fitting. Accordingly, we have implemented and trained a deep generative model based on different architectures of deep convolutional networks. Results are currently under analysis and future publications are in preparation.

#### 8.4.2.2. LEA STRUCO

#### Participant: Jean-Sébastien Sereni.

LEA STRUCO is an "Associated International Laboratory" of CNRS between IÚUK, Prague, and LIAFA, Paris. It focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work. Jean-Sébastien Sereni is the founder and previous director of LEA STRUCO, which was initiated when Jean-Sébastien was a member of LIAFA, and he is now a member of its scientific committee.

#### 8.4.2.3. Research Collaboration with HSE Moscow

**Participants:** Miguel Couceiro, Adrien Coulet, Tatiana Makhalova, Amedeo Napoli, Chedy Raïssi, Justine Reynaud.

An on-going collaboration involves the Orpailleur team and Sergei O. Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory several times while Sergei O. Kuznetsov visits Inria Nancy Grand Est every year. The collaboration is materialized by the joint supervision of students (such as the thesis of Aleksey Buzmakov defended in 2015 and the on-going thesis of Tatiana Makhalova), and the the organization of scientific events, as the workshop FCA4AI with five editions between 2012 and 2016 (see http://www.fca4ai.hse.ru).

This year, we participated in the organization of two main events: a special session about Knowledge Discovery and Formal Concept Analysis at the ISMIS Conference in Warsaw (Poland) in June 2017 (http://ismis2017. ii.pw.edu.pl/s\_kd\_fca.php), and the chairing of the track "General Topics of Data Analysis" at the AIST Conference in Moscow in July 2017 (6th International Conference on Analysis of Images, Social Networks, and Texts http://aistconf.org/). Finally a next edition of the seventh edition of the FCA4AI workshop is planned in July 2018 at the ECAI-IJCAI Conference to be held in Stockholm Sweden.

## **PETRUS Project-Team**

## 8. Partnerships and Cooperations

## 8.1. National Initiatives

#### 8.1.1. ANR PerSoCloud (Jan 2017 - Jan 2020)

Partners: Orange Labs (coordinator), PETRUS (Inria-UVSQ), Cozy Cloud, U. of Versailles.

PETRUS funding: 170k€. The objective of PerSoCloud is to design, implement and validate a full†'fledged Privacy-by-Design Personal Cloud Sharing Platform. One of the major difficulties linked to the concept of personal cloud lies in organizing and enforcing the security of the data sharing while the data is no longer under the control of a central server. We identify three dimensions to this problem. Devices-sharing: assuming that the primary copy of user U1's personal data is hosted in a secure place, how to share and synchronize it with U1's multiple (mobile) devices without compromising security? Peers-sharing: how user U1 could exchange a subset of his-her data with an identified user U2 while providing to U1 tangible guarantees about the usage made by U2 of this data? Community-sharing: how user U1 could exchange a subset of his-her data with a large community of users and contribute to personal big data analytics while providing to U1 tangible guarantees about the preservation of his-her anonymity? In addition to tackling these three scientific and technical issues, a legal analysis will guarantee compliance of this platform with the security and privacy French and UE regulation, which firmly promotes the Privacy by Design principle, including the current reforms of personal data regulation.

#### 8.1.2. PIA - PDP SECSi (May 2016 - Dec 2017)

Partners: Cozy Cloud (coordinator), Qwant, Inria (Inria-UVSQ), FING.

SMIS funding:  $149k\in$ . The objective of this PIA-PDP (Programme Investissement d'Avenir - Protection des Données Personnelles) SECSi project is to build a concrete Personal Cloud platform which can support a large scale deployment of Self Data services. Three major difficulties are identified and will be tackled in this project: (1) how to implement and enforce a fine control of the data flow when personal data are exploited by third party applications, (2) how to protect these same applications when processing is delegated to the personal cloud platform itself and (3) how to implement personalized search on the web without hurting user's privacy.

## 8.1.3. CityLab@Inria, Inria Project Lab (May 2014 -).

Inria Partners: ARLES-MIMOVE, CLIME, DICE, FUN, MYRIADS, OAK, PETRUS, URBANET, WILLOW. External partners: UC Berkeley.

Funding: not associated to individual project teams. CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. SMIS contributes to Privacy-by-Design architectures for trusted smart objects so as to ensure privacy to citizens, which is critical for ensuring that urbanscale sensing contributes to social sustainability and does not become a threat. The PhD Thesis of Dimitris Tsoulovos, co-directed by MIMOVE and PETRUS, is funded by CityLab. http://citylab.inria.fr/

## **TYREX Project-Team**

## 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

AGIR

Title: Data-CILE

Call: Appel à projet Grenoble Innovation Recherche (AGIR-Pole)

Duration: 2016-2018

Coordinator: Nabil Layaïda

Abstract: The goal of this project is to contribute to foundational and algorithmic challenges introduced by increasingly popular data-centric paradigms for programming on distributed architectures such as spark and the massive production of big linked open data. The focus of the project is on building robust and more efficient workflows of transformations of rich web data. We will investigate effective programming models and compilation techniques for producing specialised language runtimes. We will focus on high-level specifications of pipelines of data transformations and extraction for producing valuable knowledge from rich web data. We will study how to synthesise code which is correct and optimised for execution on distributed platforms. The overall expected outcome is to make the development of rich-data-intensive applications less error-prone and more efficient.

## 8.2. National Initiatives

## 8.2.1. ANR

CLEAR

Title: Compilation of intermediate Languages into Efficient big dAta Runtimes

Call: Appel à projets générique 2016 défi 'Société de l'information et de la communication' - JCJC

Duration: October 2016 - September 2020

Coordinator: Pierre Genevès

See also: http://tyrex.inria.fr/clear

Abstract: This project addresses one fundamental challenge of our time: the construction of effective programming models and compilation techniques for the correct and efficient exploitation of big and linked data. We study high-level specifications of pipelines of data transformations and extraction for producing valuable knowledge from rich and heterogeneous data. We investigate how to synthesize code which is correct and optimized for execution on distributed infrastructures.

#### 8.2.2. PERSYVAL-lab LabEx

Title: Mobile Augmented Reality Applications for Smart Cities

Call: Persyval Labex ("Laboratoire d'excellence").

Duration: 2014 - 2017

Coordinators: Pierre Genevès and Nabil Layaïda

Others partners: NeCS team at GIPSA-Lab laboratory.

Abstract: The goal of this project is to increase the relevance and reliability of augmented reality (AR) applications, through three main objectives:

- 1. Finding and developing appropriate representations for describing the physical world (3D maps, indoor buildings, ways...), integrated advanced media types (3D, 3D audio, precisely geo-tagged pictures with lat., long. and orientation, video...)
- 2. Integrating the different abstraction levels of these data streams (ranging from sensors data to high level rich content such as 3D maps) and bridging the gap with Open Linked Data (the semantic World). This includes opening the way to query the environment (filtering), and adapt AR browsers to users' capabilities (e.g. blind people). The objective here is to provide an open and scalable platform for mobile-based AR systems (just like the web represents).
- 3. Increasing the reliability and accuracy of localization technologies. Robust and highaccuracy localization technologies play a key role in AR applications. Combined with geographical data, they can also be used to identify user-activity patterns, such as walking, running or being in an elevator. The interpretation of sensor values, coupled with different walking models, allows one to ensure the continuity of the localization, both indoor and outdoor. However, dead reckoning based on Inertial Navigation Systems (INS) or Stepand-Heading Systems (SHS) is subject to cumulative errors due to many factors (sensor drift (accelerometers, gyroscopes, etc.), missed steps, bad estimation of the length of each stride, etc.). One objective is to reduce such errors by merging and mixing these approaches with various external signals such as GPS and Wi-Fi or relying on the analyses of user trajectories with the help of a structured map of the environment. Some filtering methods (Kalman Filter, observer, etc.) will be useful to achieve this task.

## Valda Team

## 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

Valda has obtained a  $10k \in$  budget from ENS in 2017, as a start-up grant from the team (*Action Concertée Incitative*).

Inria established a bilateral contract with the Centre – Val de Loire region, for the expertise and audit of a research project by Pierre Senellart. Because of delays due to the company being audited, the expertise is still in progress.

## 7.2. National Initiatives

## 7.2.1. ANR

Valda has been part of one ANR project in 2017 (Headwork, budget managed by Inria), together with IRISA (DRUID team, coordinator), Inria Lille (LINKS & SPIRAL), and Inria Rennes (SUMO), and two application partners: MNHN (Cesco) and FouleFactory. The topic is workflows for crowdsourcing. See http://headwork.gforge.inria.fr/.

In addition, another project (BioQOP, budget managed by ENS) will start in January 2018, with Morpho and GREYC, on the optimization of queries for privacy-aware biometric data management

## 7.3. International Initiatives

## 7.3.1. Informal International Partners

Valda has strong collaborations with the following international groups:
Univ. Edinburgh, United Kingdom: Peter Buneman and Leonid Libkin
Univ. Oxford, United Kingdom: Michael Benedikt, Evgeny Kharlamov, and Georg Gottlob
Dortmund University, Germany: Thomas Schwentick
Warsaw University, Poland: Mikołaj Bojańczyk and Szymon Toruńczyk
Tel Aviv University, Israel: Daniel Deutch and Tova Milo
Drexel University, USA: Julia Stoyanovich
Univ. California San Diego, USA: Victor Vianu
National University of Singapore: Stéphane Bressan

## 7.4. International Research Visitors

## 7.4.1. Visits of International Scientists

Victor Vianu, Professor at UC San Diego and holder of an Inria international chair, spent 6 months within Valda: three months employed by Inria and three months as an ENS invited professor.

#### 7.4.1.1. Internships

Deabrota Basu, PhD student at National University of Singapore, stayed 2.5 months within Valda, to work with Pierre Senellart.

#### 7.4.2. Visits to International Teams

#### 7.4.2.1. Research Stays Abroad

- Pierre Senellart has spent around two months at the University of Edinburgh, collaborating with Peter Buneman and Leonid Libkin.
- Pierre Senellart has spent a cumulated time of more than one month at National University of Singapore, co-advising Debabrota Basu, PhD student working under the co-supervision of Stéphane Bressan.

## WIMMICS Project-Team

## 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

## 9.1.1. SPARKS Team (I3S)

Wimmics is member of the I3S SPARKS team (Scalable and Pervasive softwARe and Knowledge Systems) led by Andrea Tettamanzi, with Johan Montagnat (CNRS, I3S). It is structured according to three axes: FORUM, ELK and S3.

#### 9.1.1.1. SPARKS FORUM Axis

Wimmics contributes to the SPARKS FORUM research axis (FORmalizing with Users and Models). Catherine Faron Zucker and Alain Giboin are co-animators of FORUM.

#### 9.1.1.2. SPARKS S3 Axis

Wimmics contributes to the SPARKS S3 research group (Scalable Software Systems). Olivier Corby contributes with federated distributed query processing in Corese with Johan Montagnat and Abdoul Macina. Catherine Faron Zucker and Franck Michel contribute on it with Johan Montagnat on heterogeneous data integration.

#### 9.1.1.3. SPARKS ELK Axis

The ELK activity is about Extracting and Learning Knowledge. Andrea Tettamanzi is a co-animator of ELK with Frédéric Precioso (I3S, UNS).

## 9.2. National Initiatives

#### 9.2.1. NiceCampus Research Lab

Participant: Nhan Le Thanh.

NiceCampus Research Lab (from training to/and through research to a Joint International Laboratory) is a framework for cooperation for research training. This framework is proposed by the University of Nice Sophia Antipolis to support the 911 Vietnamese research training program that aims to support the development of Vietnamese universities. The NiceCampus Lab Project was a winner of the AUF Call for Proposals 2016-2017. In this context, the MIRE (Maison de l'innovation et de la recherche NiceCampus) was created at University of Da Nang (Vietnam).

## 9.2.2. DILPROSPECT

#### Participant: Andrea Tettamanzi.

We participated in the interdisciplinary DILPROSPECT CNRS Project, with researchers of many other research units, including the UMR 7300 ESPACE and INRA on the study of the interface between constructed and natural land on the French Riviera.

## 9.2.3. AZKAR

Participants: Alain Giboin, Thierry Bergeron, Michel Buffa, Catherine Faron Zucker.

The AZKAR research project <sup>0</sup>, funded by the BPI, started in 2014, ended in September 2017. This project brings together the world of robotics assistance and the Web of linked data. Its goal was to experiment P2P remote control of a mobile robot using only Web technologies, as well as using artificial intelligence supported by semantic Web formalisms, schemas and datasets in the context of museum visits. Many experiments took place at the Museum of the Great War of Meaux and at the Cité des Sciences de la Villette. The places thus visited at a distance, the spaces and the elements they contain are described with the help of an ontology of the scenes, objects, observation points and paths specific to the museum. Geography and collections are captured using linked data and integrated with Web resources external to the museum to enrich the scenes and objects observed. On this basis, we have designed a demonstrator to offer external media based on visited museum scenes, implementing SPARQL queries on a previously populated triplestore.

## 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 will then explore these bases of musical knowledge by providing innovative applications for composers, musicologists, music schools and sound engineers, music broadcasters and journalists.

## 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 <sup>0</sup> for medicine students, in order to provide them with added value educational services.

Web site: https://www.uness.fr/projets/sides

## 9.2.6. Ministry of Culture: DBpedia.fr

Participants: Elmahdi Korfed, Fabien Gandon.

This 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

Participant: Fabien Gandon.

<sup>0</sup>http://www.azkar.fr <sup>0</sup>http://side-sante.org/

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
- Eductation technologies (EdTech)

#### 9.2.9. GDRI Zoomathia

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

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

One of the goals of the project is to design a thesaurus and semantically annotate resources, capturing different types of knowledge: zoonyme, historical period, zoological speciality (ethology, anatomy, physiology, psychology, zootechnique, etc.), litterary genre or iconography.

This year, as a continuation of the work initiated with the *Muséum National d'Histoire Naturelle* of Paris during the last two years, we have proposed a model to represent taxonomic and nomenclatural information as Linked Data, and we published the french taxonomic register on the Web along this model.

On another note, we worked with researchers from CEPAM on the applying plagiarism detection methods in the analysis of manuscript transmission.

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

## 9.2.10. FUI PadDOC

Participants: Patrice Pena, Alain Giboin.

PadDOC goal is to contribute to accelerating the digital transition of citizen, local and regional authorities, administrations and enterprises, by : (1) developing an open standard and innovative software and hardware resources to facilitate nearby or distant administrative formalities and procedures; (2) improving the security of the holder's personal data by putting these data under the exclusive control of the holder; (3) by exploiting unmarked communicating supports (such as smartphones or tablets) for all chain actors. PadDOC partners are: Docapost BPO, Anyces, ABC SmartCard and the teams Rainbow, Media-Coding and Wimmics. Started in November 2014, the project ended this year (June 2017). Wimmics contributed to the analysis, design and evaluation of the PadDOC security-oriented user interfaces

## 9.3. European Initiatives

## **Program: CHIST-ERA**

#### **Project acronym: ALOOF**

Project title: Autonomous Learning of the Meaning of Objects

Duration: 2013-2017

Coordinator: University of Rome La Sapienza (Italy)

Other partners: University of Birmingham (United Kingdom), Technische Universität Wien (Austria), Inria Sophia Antipolis Méditerranée (France).

Abstract: The goal of ALOOF is to significantly advance the ability of today's autonomous systems to adapt to ever changing, dynamic real world environments by enabling them to learn about the meaning of objects from resources accessible through the Web. In ALOOF we focus on objects and the knowledge gaps a service robot will encounter about them. The fundamental contribution is to enable robots to translate between the representations they use in their situated experience and those on the Web.

# Program: Research and Innovation Staff Exchange (RISE) project, funding under Marie Skłodowska-Curie grant

#### **Project acronym: MIREL**

Project title: MIning and REasoning with legal text Duration: 2016-2019

Coordinator: Leendert van der Torre, University of Luxembourg

Other partners: 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).

Abstract: 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 International Labs

#### 9.4.1.1. MoReWAIS

Title: Mobile Read Write Access and Intermittent to Semantic Web

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LANI - Moussa LO

Start year: 2016

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

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).

## 9.4.2. Inria International Partners

#### 9.4.2.1. Informal International Partners

Fondazione Bruno Kessler, Digital Humanities and Human Language Technologies research units, Trento, Italy

University of Turin, Computer Science Department, Italy.

University of Luxembourg, Computer Science and Communication Lab, Luxembourg.

Data61, Brisbane, Australia.

MIRE-DNIIT : Innovation & Recherche at Danang International Institute of Technology

The project, in which Nhan Le Thanh (UNS) is involved, consists of installing within Danang University a UCA campus called DNIIT (Danang International Institute of Technology) with the objective of development and valorization of collaborative projects of applied research and implementation of UCA training centers at the Doctoral and Master level for Vietnamese students. The project obtained financial support from Ministry of Research and AUF (University Agency of La Francophonie). DNITT was officially created on May 5th with the opening of six project and the setting up of the UCA e-Tourism Master's office.

## 9.5. International Research Visitors

#### 9.5.1. Visits of International Scientists

9.5.1.1. Internships

#### Oussama Lahlou

May-October

Institution: EMSI (Ecole Marocaine des Sciences de l'Ingénieur)

Subject: "An Ontology for modeling remote museum visits"

Supervisors: Michel Buffa, Thierry Bergeron

#### Yaroslav Nechaev

Ph.D. student, University of Trento, Italy (October 2017-present).

Subject: Improving the prediction of objects and relations on images by using large unsupervised corpora like Twitter and Wikipedia.

#### 9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

Raphaël Gazzotti

Date: March-April.

Visit of the Natural Language Processing research group of the Universidad Nacional de Córdoba, Argentina, for one month as a secondment of the MIREL H2020 Project.

We proceed to the tokenization of a small sample of questions and answers from the customer service of a big insurance company. Then, following a guideline, we annotated, thankfully to a graphical interface developed within the Natural Language Processing research group at the FaMAF, insurance-related concepts from this corpus and considered them as Named Entities. We mapped these concepts to two ontologies -YAGO and Property and Casualty data model developed by the Object Management Group that we translated to OWL format- [50]. We expect to map them to more ontologies and increase existing ones, like a financial ontology and another specific to communication, then ultimately to Linked Open Data. In a future step, we would like to identify and label automatically concepts using a small annotated corpus as a training set. We believe that annotated concepts can improve automatic categorization of questions and help to reason with different levels of abstraction.

## **ZENITH Project-Team**

## 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. Florent Masseglia co-heads the theme on scientific data.

#### 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. PIA (Projets Investissements d'Avenir

9.2.1.1. Projet Floris'Tic (2015-2018), 430Keuro. Participants: Julien Champ, 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.

9.2.1.2. Institut de Convergence Agriculture numérique #DigitAg, (2017-2023), 275Keuro.Participants: Esther Pacitti, Florent Masseglia, 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.

## 9.2.2. Others

## 9.2.2.1. 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. H2020 Projects

#### 9.3.1.1. HPC4E

Participants: Reza Akbarinia, Florent Masseglia, Esther Pacitti, Patrick Valduriez.

Project title: High Performance Computing for Energy Instrument: H2020 Duration: 2015 - 2017 Total funding: 2 Meuros Coordinator: Barcelona Supercomputing Center (BSC), Spain

Partner: Europe: Inria, Lancaster University, Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, Repsol S.A., Iberdrola Renovables Energía S.A., Total S.A. Brazil: COPPE/Universidade Federal de Rio de Janeiro, LNCC, Instituto Tecnológico de Aeronáutica (ITA), Universidade Federal do Rio Grande do Sul, Universidade Federal de Pernambuco, Petrobras. Inria contact: Patrick Valduriez

The main objective is to develop high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using HPC systems. The project also aims at improving the usage of energy using HPC tools by acting at many levels of the energy chain for different energy sources. Another objective is to improve the cooperation between energy industries from EU and Brazil. The project includes relevant energy industral partners from Brazil (Petrobras) and EU (Repsol and Total as O&G industries), which benefit from the project's results. A last objective is to improve the cooperation between the leading research centres in EU and Brazil in HPC applied to energy. This includes sharing supercomputing infrastructures between Brazil and EU. In this project, Zenith is working on Big Data management and analysis of numerical simulations.

#### 9.3.1.2. 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 inmemory 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.
37 Data and Knowledge Representation and Processing - Partnerships and Cooperations - Project-Team ZENITH

## 9.4. International Initiatives

## 9.4.1. Inria International Partners

9.4.1.1. 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)
- Asia: National Univ. of Singapore (Beng Chin Ooi, Stéphane Bressan), Wonkwang University, Korea (Kwangjin Park)
- Europe: Univ. of Madrid (Ricardo Jiménez-Periz), UPC Barcelona (Josep Lluis Larriba Pey), HES-SO (Henning Müller), University of Catania (Concetto Spampinatto), The Open University (Stefan Rüger)
- North Africa: Univ. of Tunis (Sadok Ben-Yahia)
- Australia: Australian National University (Peter Christen)
- Central America: Technologico de Costa-Rica (Erick Mata, former director of the US initiative Encyclopedia of Life)

### 9.4.2. Inria Associate Teams Not Involved in an Inria International Lab

9.4.2.1. SciDISC

Title: Scientific data analysis using Data-Intensive Scalable Computing

Inria principal investigator:Patrick Valduriez

International Partner:

Universidade Federal do Rio de Janeiro (Brazil), Marta Mattoso and Alvaro Coutinho

Laboratorio Nacional de Computação Científica, Petropolis (Brazil), Fabio Porto

Universidade Federal Fluminense, Niteroi (Brazil), Daniel Oliveira

Centro Federal de Educa cao Tecnologica, Rio de Janeiro (Brazil), Eduardo Ogasawara

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. 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.

### 9.4.3. Participation In other International Programs

We are involved in LifeCLEF lab, a self-organized research platform whose main mission is to promote research, innovation, and development of computer-assisted identification of living organisms. It was initiated by Alexis Joly in 2014 in collaboration with several European colleagues: Henning Müller (CH), Robert B Fisher (UK), Andreas Rauber (AU), Concetto Spampinato (IT), Hervé Glotin (FR). Each year, LifeCLEF releases large-scale experimental data covering tens of thousands of species (plants images, birds audio recordings and fish sub-marine videos). About 100-150 research groups register each year to get access to it and tens of them submit reports describing their conducted research (published in CEUR-WS proceedings). Results are then synthesized and further analyzed in joint research papers.

9.4.3.1. International Initiatives

### **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 - 2017

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

- Tamer Özsu (University of Waterloo, Canada): "Approaches to RDF Data Management and SPARQL Query Processing" on March 9.
- Dennis Shasha (NYU) "Reducing Errors by Refusing to Guess (Occasionally)" on June 1.
- Fabio Porto (LNCC, Brazil): "Database System Support of Simulation Data" on January 27 and "Simulation Data Management" on June 1.
- Marta Mattoso (UFRJ, Brazil): "Human-in-the-loop to Fine-tune Data in Real Time" on December 14.

Jose Mario Carranza Rojas (PhD student, Technologico de Costa-Rica) spent two days per week in the team in the context of a 4 months internship at the Montpellier research lab AMAP in the context of the Floris'Tic project).

## **ALICE Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. CPER (2014-2020) 50 k

Sylvain Lefebvre coordinates a work package for the CPER 2014-2020. It involves several members of ALICE as well as laboratories within the Nancy area (Institut Jean Lamour, LRGP, ERPI). Our goal is to consider the interaction between software and material in the additive manufacturing process, with a focus on filament-based printers.

### 9.1.2. PIC (2015-2017) 150 k

The PIC project (Polymères Innovants Composites) is a collaboration between Inria, Institut Jean Lamour and Ateliers Cini, funded by Région Lorraine. The goal is to develop a new additive manufaturing process using filaments of composite materials with applications in mechanical engineering and the medical domain. Our goal in the project is to provide novel ways to deposit the filament that is better suited to the considered materials and improves the quality of the final parts.

### 9.2. National Initiatives

### 9.2.1. EXPLORAGRAM

Inria exploratory project EXPLORAGRAM (in cooperation with MOKAPLAN): We explored new algorithms for computational optimal transport. The project allowed us to hire a post-doc for 18 months (Erica Schwindt). She worked on the semi-discrete algorithm, and its application to the simulation of fluid-structure interactions. The project allowed to strengthen the cooperation with MOKAPLAN. It also allowed us to start exploring new cooperations, with Institut d'Astrophysique de Paris, on early universe reconstruction.

### 9.2.2. ANR MAGA (2016-2020)

We participate to the ANR MAGA (ANR-16-CE40-0014) on the Monge Ampere equation and computational geometry. In this ANR project, we cooperate with Quentin Merigot and other researchers of the MOKAPLAN Inria team on new computational methods for optimal transport.

### 9.2.3. ANR ROOT (2016-2020)

We participate to the Young Researcher ANR ROOT (ANR-16-CE23-0009) on Optimal Transport for computer graphics, with Nicolas Bonneel (CNRS Lyon) as Principal Investigator. In the context of this project, we develop a new symmetric algorithm for semi-discrete optimal transport that optimizes for both the location of the samples and their Lagrange multipliers. An ENS training period will start in Jan. 2018 (Agathe Herrou), hosted in Nancy.

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

#### 9.3.1.1. SHAPEFORGE

Title: ShapeForge: By-Example Synthesis for Fabrication Program: FP7 (ERC Starting Grant) Duration: December 2012 - November 2017 Coordinator: Inria

#### Inria contact: Sylvain Lefebvre

Despite the advances in fabrication technologies such as 3D printing, we still lack the software allowing for anyone to easily manipulate and create useful objects. Not many people possess the required skills and time to create elegant designs that conform to precise technical specifications. 'By-example' shape synthesis methods are promising to address this problem: New shapes are automatically synthesized by assembling parts cutout of examples. The underlying assumption is that if parts are stitched along similar areas, the result will be similar in terms of its low-level representation: Any small spatial neighborhood in the output matches a neighborhood in the input. However, these approaches offer little control over the global organization of the synthesized shapes, which is randomized. The ShapeForge challenge is to automatically produce new objects visually similar to a set of examples, while ensuring that the generated objects can enforce a specific purpose, such as supporting weight distributed in space, affording for seating space or allowing for light to go through. These properties are crucial for someone designing furniture, lamps, containers, stairs and many of the common objects surrounding us. The originality of our approach is to cast a new view on the problem of 'by-example' shape synthesis, formulating it as the joint optimization of 'by-example' objectives, semantic descriptions of the content, as well as structural and fabrication objectives. Throughout the project, we will consider the full creation pipeline, from modeling to the actual fabrication of objects on a 3D printer. We will test our results on printed parts, verifying that they can be fabricated and exhibit the requested structural properties in terms of stability and resistance.

#### 9.3.1.2. ICEXL

Title: IceXL: Advanced modeling and slicing software for additive manufacturing

Program: FP7 (ERC Proof of Concept)

Duration: November 2016 - February 2018

Coordinator: Inria

Inria contact: Sylvain Lefebvre

The ICEXL Proof of Concept projects aims at further developing our software IceSL and its industrial potential. We have released several new major features than allowed the software to gain visibility (as shown by a strong increase in downloads towards the end of 2017, 1500+ downloads in November). We have teamed with a selected number of industrial partners to work towards industrial use, and have ongoing discussions regarding technology transfer and licensing.

## 9.4. International Initiatives

### 9.4.1. Inria Associate Teams Not Involved in an Inria International Lab

#### 9.4.1.1. PREPRINT3D

Title: Model Preparation for 3D Printing

International Partner (Institution - Laboratory - Researcher):

HKU (Hong Kong, China) - Department of Computer Science (CS) - Wenping Wang Start year: 2017

We seek to develop novel ways to prepare and model objects for 3D printing which better take into account limitations of the fabrication processes as well as real-world properties such as the mechanical strength of the printed object. This is especially important when targeting an audience which is not familiar with the intricacies of industrial design. We target complex, intricate shapes such as models of vegetation and highly detailed meshes, as well as models with thin walls such as architectural models.

### 9.4.2. Inria International Partners

#### 9.4.2.1. Informal International Partners

Jean-Francois Remacle (University of Louvain, Belgium), we cooperate on hexahedral-dominant meshing (visits, students exchange). Our former Ph.D. student Jeanne Pellerin is doing a post-doc in his lab.

## 9.5. International Research Visitors

### 9.5.1. Visits of International Scientists

Li-Yi Wei visited us from 05/04/17 to 18/04/17 to work on the topic of element based topology optimization with Jérémie Dumas, Jonàs Martínez and Sylvain Lefebvre. This work was submitted to SIGGRAPH but not accepted, we plan to resubmit it early 2018.

### 9.5.1.1. Internships

Sylvain Lefebvre supervised Mélanie Siret for a 3 months internship, as well as Jimmy Etienne for a 6 months internship.

#### 9.5.2. Visits to International Teams

B. Lévy and Nicolas Ray visited Jean-Francois Remacle (U. Louvain, Belgium). B. Lévy visited Jan Obloj (Oxford, U.K.).

## **AVIZ Project-Team**

# 7. Partnerships and Cooperations

### 7.1. European Initiatives

### 7.1.1. FP7 & H2020 Projects

#### 7.1.1.1. CENDARI

Title: Collaborative EuropeaN Digital/Archival Infrastructure

Programm: FP7 Duration: February 2012 - January 2016

Coordinator: Trinity College - Dublin

Coordinator: Trinity College - Dubli

Partners:

Consortium of European Research Libraries (United Kingdom)

Koninklijke Bibliotheek (Netherlands)

Fondazione Ezio Franceschini Onlus (Italy)

Freie Universitaet Berlin (Germany)

King's College London (United Kingdom)

"matematicki Institutnu, Beograd" (Serbia)

Narodni Knihovna Ceske Republiky (Czech Republic)

Societa Internazionale Per Lo Studio Del Medioevo Latino-S.I.S.M.E.L.Associazione (Italy)

The Provost, Fellows, Foundation Scholars & The Other Members of Board of The College of The Holy & Undivided Trinity of Queen Elizabeth Near Dublin (Ireland)

Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (Germany)

The University of Birmingham (United Kingdom)

Universitaet Stuttgart (Germany)

Universita Degli Studi di Cassino E Del Lazio Meridionale (Italy)

Inria contact: L. Romary

'The Collaborative EuropeaN Digital Archive Infrastructure (CENDARI) will provide and facilitate access to existing archives and resources in Europe for the study of medieval and modern European history through the development of an 'enquiry environment'. This environment will increase access to records of historic importance across the European Research Area, creating a powerful new platform for accessing and investigating historical data in a transnational fashion overcoming the national and institutional data silos that now exist. It will leverage the power of the European infrastructure for Digital Humanities (DARIAH) bringing these technical experts together with leading historians and existing research infrastructures (archives, libraries and individual digital projects) within a programme of technical research informed by cutting edge reflection on the impact of the digital age on scholarly practice. The enquiry environment that is at the heart of this proposal will create new ways to discover meaning, a methodology not just of scale but of kind. It will create tools and workspaces that allow researchers to engage with large data sets via federated multilingual searches across heterogeneous resources while defining workflows enabling the creation of personalized research environments, shared research and teaching spaces, and annotation trails, amongst other features. This will be facilitated by multilingual authority lists of named entities (people, places, events) that will harness user involvement to add intelligence to the system. Moreover, it will develop new visual paradigms for the exploration of patterns generated by the system, from knowledge transfer and dissemination, to language usage and shifts, to the advancement and diffusion of ideas.'

## 7.2. International Initiatives

### 7.2.1. Informal International Partners

- University of Calgary. Pierre Dragicevic and Petra Isenberg collaborate with Wesley Willett on situated data visualization.
- University of Washington, Chicago University and University of Zurich. Pierre Dragicevic collaborates with Matthew Kay, Steve Haroz and Chat Wacharamanotham on transparent statistical reporting and efficient statistical communication
- Stanford University. Pierre Dragicevic and Jean-Daniel Fekete collaborate with Sean Follmer on swarm user interfaces.
- Chicago University and University of Maryland, Evanthia Dimara and Pierre Dragicevic collaborate with Steven Franconeri and Catherine Plaisant on a taxonomy of cognitive biases.

## 7.3. International Research Visitors

### 7.3.1. Visits of International Scientists

- Catherine Plaisant (June–July): Invited professor from University of Maryland, USA. Invited through a DigiCosme grant, Catherine Plaisant has spent two months with Aviz. We have launched two research projects, one on hypergraph visualization and one on tracing users to understand their use of visualization. Catherine Plaisant has interacted with all of the Aviz students and post-doctoral fellows, as well as with the permanent researchers.
- Paolo Buono, from University of Bari, Italy. Paolo Buono has spent two months with Aviz working on the visualization of dynamic networks. He has collaborated with Paoa Valdivia, Catherine Plaisant, and Jean-Daniel Fekete for that project. He has also interacted with all the members of Aviz.

### 7.3.1.1. Internships

- Jaemin Jo (March–April): intern from Seoul National University, Korea. Worked on converting a KNN algorithm into a progressive form.
- Nicola Pezzotti (April–May): intern from University of Delft, The Netherlands. Worked on data structures and algorithms for managing very large (out of core) datasets in the context of progressive algorithms.

## **EX-SITU Project-Team**

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

## 8.1.1. MoveIT – Modeling the Speed/Accuracy Trade-Off of Human Aimed Movement with the Tools of Information Theory

Type: Ph.D. grant Funding: DigiCosme Labex

Duration: 2015-2018

Coordinator: Olivier Rioul (Institut Mines Telecom)

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to conduct fundamental studies of aimed movements based on information theory. The project studies the interaction phenomena involved in pointing, in order to discover novel, more effective pointing techniques. This project funds Wanyu Liu, a joint Ph.D. student between the COMELEC and VIA groups at Institut Mines Telecom and ExSitu.

### 8.1.2. SensoMotorCVE – Sensor-motor Interface for Collaborative Virtual Environments with Heterogeneous Devices: Application to Industrial Design

Type: Ph.D. grant Funding: DigiCosme Labex Duration: 2014-2017 Coordinator: Patrick Bourdot (LIMSI-CNRS)

Partners: Univ. Paris-Sud, Inria, CNRS

Inria contact: Cédric Fleury

Abstract: In the context of collaborative virtual environments, the goal of this project is to develop a sensorimotor interface model for CAD data manipulation that supports heterogeneous interactive systems such as wall-sized displays or immersive virtual reality rooms. This project funds Yujiro Okuya, a joint Ph.D. student between the VENISE group at LIMSI and ExSitu.

### 8.1.3. An Augmented-Reality System for Collaborative Physical Modeling and Design

Type: Equipment

Funding: STIC Paris-Saclay

Duration: 2017-2018

Coordinator: Theophanis Tsandilas

Partners: Univ. Paris-Sud, Inria

Inria contact: Theophanis Tsandilas

Abstract: The goal of the project is to develop an augmented-reality system to support collaboration over 3D models and enhance digital-fabrication approaches. It is a collaboration with the AVIZ group and provides funding (8k) for equipment.

### 8.1.4. Le Plateau des Recherches Infinies

Type: Equipment and subcontracting

Funding: Learning Center Paris-Saclay

Duration: 2017-2018

Coordinator: Michel Beaudouin-Lafon

Partners: Univ. Paris-Sud

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project (30k) is to create an interactive installation presenting the portraits of a hundred researchers from Université Paris-Saclay. It is a collaboration with portrait photographer Didier Goupy. The installation is designed to be exhibited in various sites of Université Paris-Saclay until it is permanently installed in the Learning Center of Université Paris-Saclay. This project supported Shubhangi Gupta, an intern, for two months over the summer.

## 8.2. National Initiatives

### 8.2.1. Investissements d'Avenir

8.2.1.1. Digiscope - Collaborative Interaction with Complex Data and Computation

Type: EQUIPEX (Equipement d'Excellence)

Duration: 2011-2021

Coordinator: Michel Beaudouin-Lafon

Partners: FCS Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, Ecole Centrale Paris, Université Versailles - Saint-Quentin, ENS Cachan, Maison de la Simulation

Overall budget: 22.5 Meuros, including 6.7 Meuros public funding from ANR

Abstract: The goal of the project is to create ten high-end interactive rooms interconnected by high-speed networks and audio-video facilities to support remote collaboration across interactive visualization environments. The equipment will be open to outside users and targets four main application areas: scientific discovery, product lifetime management, decision support for crisis management, and education and training. Digiscope includes the existing WILD room, and funded the WILDER room. ExSitu contributes its expertise in the design and evaluation of advanced interaction techniques and the development of distributed software architectures for interactive systems. At the end of 2017, all ten rooms and the telepresence network are operational. The project was successfully evaluated by an international jury in June, 2017.

## 8.3. European Initiatives

### 8.3.1. European Research Council (ERC)

8.3.1.1. Creating Human-Computer Partnerships

Program: ERC Advanced Grant

Project acronym: CREATIV

Project title: Creating Human-Computer Partnerships

Duration: mois année début - mois année fin

Coordinator: Wendy Mackay

Abstract: CREATIV explores how the concept of co-adaptation can revolutionize the design and use of interactive software. Co-adaptation is the parallel phenomenon in which users both adapt their behavior to the system's constraints, learning its power and idiosyncrasies, and appropriate the system for their own needs, often using it in ways unintended by the system designer. A key insight in designing for co-adaptation is that we can encapsulate interactions and treat them as first class objects, called interaction instruments This lets us focus on the specific characteristics of how human users express their intentions, both learning from and controlling the system. By making instruments co-adaptive, we can radically change how people use interactive systems, providing incrementally learnable paths that offer users greater expressive power and mastery of their technology. The initial goal of the CREATIV project is to fundamentally improve the learning and expressive capabilities of advanced users of creative software, offering significantly enhanced methods for expressing and exploring their ideas. The ultimate goal is to radically transform interactive systems for everyone by creating a powerful and flexible partnership between human users and interactive technology.

#### 8.3.1.2. Unified Principles of Interaction

Program: ERC Advanced Grant

Project acronym: ONE

Project title: Unified Principles of Interaction

Duration: October 2016 - September 2020

Coordinator: Michel Beaudouin-Lafon

Abstract: The goal of ONE is to fundamentally re-think the basic principles and conceptual model of interactive systems to empower users by letting them appropriate their digital environment. The project addresses this challenge through three interleaved strands: empirical studies to better understand interaction in both the physical and digital worlds, theoretical work to create a conceptual model of interaction and interactive systems, and prototype development to test these principles and concepts in the lab and in the field. Drawing inspiration from physics, biology and psychology, the conceptual model combines *substrates* to manage digital information at various levels of abstraction and representation, *instruments* to manipulate substrates, and *environments* to organize substrates and instruments into digital workspaces.

## 8.4. International Initiatives

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

#### 8.4.1.1. DECibel

Title: Discover, Express, Create - Interaction Technologies For Creative Collaboration

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical and Computer Engineering, Center for Magnetic Resonance Research - Bjoern Hartmann

#### Start year: 2016

#### See also: https://www.inria.fr/en/associate-team/decibel

The DECibel associated team includes Inria's ExSitu and the CITRIS Connected Communities Initiative (CCI) at UC Berkeley. ExSitu explores extreme interaction, working with creative professionals and scientists who push the limits of technology to develop novel interactive technologies that offer new strategies for creative exploration. ExSitu's research activities include: developing underlying theory (co-adaptive instruments and substrates), conducting empirical studies (participatory design with creative professionals), and implementing interactive systems (creativity support tools). The CITRIS Connected Communities Initiative investigates collaborative discovery and design through new technologies that enhance education, creative work, and public engagement. It develops interactive tools, techniques and materials for the rapid design and prototyping of novel interactive products, expertise sharing among designers, and citizen science investigations. DECibel will combine the strengths of these two groups to to investigate novel tools and technologies that support Discovery, Expressivity, and Creativity.

## **8.5. International Research Visitors**

### 8.5.1. Visits of International Scientists

- Mobile Life research team (KTH, Sweden) 20 researchers visited ExSitu in January, 2017.
- Susanne Bødker (Aarhus University, Denmark) visited ExSitu in April, 2017.
- Joanna McGrenere (University of British Columbia, Canada) Inria Chair, visited ExSitu in June-July, 2017.

### 8.5.1.1. Internships

- Alessandro Silacci, Haute Ecole d'Ingenierie et d'Architecture de Fribourg (Suisse), "Cross-Surface Expressive Gesture Interactions in Collaboration Scenarios": Michel Beaudouin-Lafon
- Shubhangi Gupta, "Design and Prototyping of Web Interface to the 'Plateau des Recherches Infinies' Installation": Michel Beaudouin-Lafon
- Alexander Eiselmayer, University of Zurich, "Touchstone II": Wendy Mackay and Michel Beaudouin-Lafon

## **GRAPHDECO Project-Team**

# 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

Theo Thonat is funded in part by a Region PACA fellowship.

## 8.2. National Initiatives

### 8.2.1. 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 (see Fig. 10).



Figure 10. streamable dataset using 6500 pictures (usual not-streamable dataset has around 30 pictures)

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. Finally, PicPlay involved the development of several tools for converting and processing datasets.

## 8.2.2. ANR

#### 8.2.2.1. ANR SEMAPOLIS

Participants: George Drettakis, Abdelaziz Djelouah, Theo Thonat.

This ANR project ended in September 2017. The goal was to use semantic information to improve urban reconstruction and rendering. The consortium was led by ENPC (R. Marlet) and includes the Inria Willow team and the GREY-C laboratory on image processing. Our contribution was in the rendering of urban models, in particular using image-based rendering algorithms. Our contribution resulted in several publications or planned publications (e.g., those described in Sec. 6.2.2, 6.2.3)

## 8.3. European Initiatives

## 8.3.1. FP7 & H2020 Projects

8.3.1.1. D<sup>3</sup>: Interpreting Drawings for 3D Design

Type: ERC

Instrument: Starting Grant

Duration: February 2017 - February 2023

Participants: Adrien Bousseau, Yulia Gryaditskaya, Bastien Wailly.

Abstract. 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.

#### 8.3.1.2. PhySound

- Type: Training (ICT)
- Instrument: Marie-Curie Postdoctoral fellowship
- Partner: Columbia
- Abstract: Sound is as important as visuals in modern media (films, video-games). Yet, little effort has been devoted to the rendering of sound from digital environments, compared to the phenomenal advances of visual rendering. Sound is added to virtual scenes through the ad-hoc edition of real sounds, requiring recording phases and manual synchronization between recorded clips and visuals, while yielding limited and repetitive sounds. This project addresses this problem by generating sounds from virtual environments through physically based simulation, and focuses on a challenging family of objects: thin shells. Characteristic thin shell sounds include tearing cloth and paper, crushing cans and plastic bottles, and crumpling a piece of paper and a plastic bag. The high quality, offline simulation and rendering of thin shell sound will be addressed through a set of modeling

approaches and computational tools (model reduction, high frequency bandwidth extension and precomputed sound databases), while the real-time but computationally constrained sound rendering will rely on data-driven approaches. This research will considerably widen the number of real life object sounds that can be digitally generated, and will contribute to the young research field of physically based sound rendering, which has the potential of becoming the next key technology of the media industry.

### 8.3.1.3. EMOTIVE

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

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 does 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, and in particular for the offsite experience for one of the sites (see Fig. 11).

## 8.4. International Initiatives

### 8.4.1. Inria International Partners

#### 8.4.1.1. Informal International Partners

**Canada.** A. Bousseau collaborates regularly with the University of Toronto (K. Singh) and the University of British Columbia (A. Sheffer).

UK. G. Drettakis collaborates with UCL (G. Brostow, P. Hedman) and with R. Mantiuk (Cambridge).

**United States.** We regularly collaborate with Adobe Research (A. Hertzman, S. Paris). We also collaborate with Daniel Aliaga from Purdue University. We collaborate with M. Banks and A. Efros from University of California, Berkeley.

## 8.5. International Research Visitors

#### 8.5.1. Visits of International Scientists

Several students and postdocs of F. Durand visited from MIT during 2017:

#### 8.5.2. Visits to International Teams

#### 8.5.2.1. Sabbatical programme

Fredo Durand was the recipient of the Inria International Chair and spent the academic year 2016-2017 in the group.



Figure 11. Screenshot of Unity IBR system developed for EMOTIVE.

#### 8.5.2.2. Research Stays Abroad

Johanna Delanoy spent 6 months at Adobe Research as an intern to collaborate with Aaron Hertzmann. S. Rodriguez and T. Thonat visited the MIT CSAIL Computer Graphic Lab, in Boston, USA. V. Deschaintre Visited Frederic Durand and Miika Aittala at MIT October/November. Y. Gryaditskaya visited the research group of Daniel Sykora, CTU Prague, Czech Republic, and the Industrial Design Faculty of TU Delft, Netherlands in June.

## **HYBRID Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. Labex Cominlabs SUNSET

Participants: Bruno Arnaldi, Guillaume Claude, Gautier Picard, Valérie Gouranton [contact].

SUNSET is a 4-year Labex Cominlabs project (2016-2020). SUNSET partners are MediCIS-LTSI (coordinator), Hybrid, Hycomes (IRISA/Inria), and CHU Rennes. SUNSET aims at developing an innovative training software suite based on immersive and collaborative virtual reality technology for training and evaluating non-technical skills. This approach will be implemented and evaluated in the context of training neurosurgical scrub nurses. We will notably integrate methods and systems developed in the S3PM project (see bellow). By relying on Human Factors approaches, the project also addresses training and evaluation of interpersonal skills. Whereas the developed technologies and approaches will be generic and adaptable to any surgical specialty, the project will evaluate the developed system within training sessions performed with scrub nurses. We ambition to propose novel approaches for surgical non-technical skill learning and assessment, and to install the developed training factory at the University Hospital of Rennes, and evaluate it with real-scale user studies.

### 9.1.2. Labex Cominlabs S3PM

Participants: Bruno Arnaldi, Guillaume Claude, Valérie Gouranton [contact].

S3PM ("Synthesis and Simulation of Surgical Process Models") is a 4-year Labex Cominlabs project (2013-2017). S3PM partners are MediCIS-LTSI (coordinator), Hybrid, Hycomes (IRISA/Inria), and CHU Rennes. The objective of S3PM is to propose a solution for the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution. The goal of the Hybrid team is to propose and use new models for collaborative and interactive virtual environments for procedural training. The Hybrid team also works on the creation of a surgical training application in virtual reality, exposing the different contributions.

### 9.1.3. Labex Cominlabs HEMISFER

Participants: Anatole Lécuyer [contact], Marsel Mano, Lorraine Perronnet.

**HEMISFER** is a 4-year project (2013-2017) funded by Labex CominLabs. It involves 4 Inria/IRISA teams (Hybrid, Visages (lead), Panama, Athena) and 2 medical centers: the Rennes Psychiatric Hospital (CHGR) and the Reeducation Department of Rennes Hospital (CHU Pontchaillou). The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. Clinical applications concern motor, neurological and psychiatric disorders (stroke, attention-deficit disorder, treatment-resistant mood disorders, etc).

### 9.1.4. Labex Cominlabs SABRE

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Nataliya Kos' Myna.

SABRE is a 3-year project (2014-2017) funded by Labex CominLabs. It involves 1 Inria/IRISA team (Hybrid) and 2 groups from TELECOM BREST engineering school. The goal of SABRE is to improve computational functionnalities and power of current real-time EEG processing pipelines. The project will investigate innovative EEG solution methods empowered and speeded-up by ad-hoc, transistor-level, implementations of their key algorithmic operations. A completely new family of fully-hardware-integrated, new computational EEG imaging methods will be developed that are expected to speed up the imaging process of an EEG device of several orders of magnitude in real case scenarios.

### 9.1.5. IRT b<>com

Participants: Bruno Arnaldi [contact], Valérie Gouranton, Maud Marchal.

**b**<>com is a French Institute of Research and Technology (IRT). The main goal of this IRT is to fasten the development and marketing of tools, products and services in the field of digital technologies. Our team has already collaborated with b<>com within two 3-year projects: ImData (on "Immersive Interaction") and GestChir (on "Augmented Healthcare") which both ended in 2016. A new 3-year project called NeedleWare (on "Augmented Healthcare") has started on October 2016.

### 9.1.6. CNPAO Project

Participants: Valérie Gouranton [contact], Jean-Baptiste Barreau, Ronan Gaugne.

CNPAO ("Conservatoire Numérique du Patrimoine Archéologique de l'Ouest") is an on-going research project partially funded by the Université Européenne de Bretagne (UEB) and Université de Rennes 1. It involves IRISA/Hybrid and CReAAH. The main objectives are: (i) a sustainable and centralized archiving of 2D/3D data produced by the archaeological community, (ii) a free access to metadata, (iii) a secure access to data for the different actors involved in scientific projects, and (iv) the support and advice for these actors in the 3D data production and exploration through the latest digital technologies, modeling tools and virtual reality systems. This project involves a collaboration with Quentin Petit (SED Inria Rennes).

### 9.1.7. Imag'In CNRS IRMA

**Participants:** Bruno Arnaldi, Jean-Baptiste Barreau, Ronan Gaugne, Valérie Gouranton [contact], Théophane Nicolas.

The IRMA project is an Imag'In project funded by CNRS which aims at developping innovative methodologies for research in the field of cultural heritage based on the combination of medical imaging technologies and interactive 3D technologies (virtual reality, augmented reality, haptics, additive manufacturing). It relies on close collaborations with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET. The developed tools are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. We focus on a large number of archeological artefacts of different nature, and various time periods (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We can notably mention the oldest human bones found in Brittany (clavicle Beg Er Vil), a funeral urn from Trebeurden (22), or a Bronze Cauldron from a burial of the Merovingian necropolis "Crassés Saint-Dizier" (51). This project involves a collaboration with Quentin Petit (SED Inria Rennes) and Grégor Marchand (CNRS/UMR CREAAH).

## **9.2.** National Initiatives

#### 9.2.1. ANR-FRQSC INTROSPECT

**Participants:** Valérie Gouranton [contact], Bruno Arnaldi, Ronan Gaugne, Jean-Baptiste Barreau, Flavien Lecuyer.

**INTROSPECT** is a 3-year project funded by French ANR and "Fonds de Recherche Société et Culture" (FRQSC) from Quebec region, Canada. The collaboration involves researchers in computer science and archeology from France and Canada : Hybrid (Inria-IRISA), CReAAH, Inrap, company Image ET, University Laval and INRS-ETE. INTROSPECT aims to develop new uses and tools for archaeologists that facilitate access to knowledge through interactive numerical introspection methods that combine computed tomography with 3D visualization technologies, such as Virtual Reality, tangible interactions and 3D printing. The scientific core of the project is the systematization of the relationship between the artefact, the archaeological context, the digital object and the virtual reconstruction of the archaeological context that represents it and its tangible double resulting from the 3D printing. This axiomatization of its innovative methods makes it possible to enhance our research on our heritage and to make use of accessible digital means of dissemination. This approach changes from traditional methods and applies to specific archaeological problems. Several case studies will be studied in various archaeological contexts on both sides of the Atlantic. Quebec museums are partners in the project to spread our results among the general public.

### 9.2.2. Ilab CertiViBE

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Thierry Gaugry, Cédric Riou.

CertiViBE is a 2-year "Inria Innovation Lab" (2015-2017) funded by Inria for supporting the development of OpenViBE software, and notably its evolution in order to enable and fasten the medical transfer and the medical certification of products based on OpenViBE. This joint lab involves two partners: Hybrid and Mensia Technologies startup company. The project aims at setting up a quality environment, and developping a novel version of the software wich should comply with medical certification rules.

### 9.2.3. IPL BCI-LIFT

**Participants:** Anatole Lécuyer [contact], Jussi Tapio Lindgren, Hakim Si Mohammed, Lorraine Perronnet, Nataliya Kos'Myna.

**BCI-LIFT** is a 4-year "Inria Project Lab" initiative (2015-2019) funded by Inria for supporting a national research effort on Brain-Computer Interfaces. This joint lab involves several Inria teams: Hybrid, Potioc, Athena, Neurosys, Mjolnir, Demar; as well as external partners: INSERM-Lyon, and INSA Rouen. This project aims at improving several aspects of Brain-Computer Interfaces: learning and adaptation of BCI systems, user interfaces and feedback, training protocols, etc.

### 9.2.4. ATT CONSORVIBE

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren [contact].

CONSORVIBE is a 6-month ATT Inria Project funded by Inria for supporting a prospective effort and the feasibility study of building a consortium of partners dedicated to the sustainability and promotion of the OpenViBE software.

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

9.3.1.1. HAPPINESS

Title: HAptic Printed Patterned INtErfaces for Sensitive Surface

Programm: H2020

Duration: January 2015 - December 2017

Coordinator: CEA (France)

Partners:

Arkema France (France)

Robert Bosch (Germany)

Commissariat A L'Energie Atomique et Aux Energies Alternatives (France)

Fundacion Gaiker (Spain)

Integrated Systems Development S.A. (Greece)

University of Glasgow (United Kingdom)

Walter Pak SL (Spain)

Inria contact: Nicolas Roussel and Anatole Lécuyer

The Automotive HMI (Human Machine Interface) will soon undergo dramatic changes, with large plastic dashboards moving from the 'push-buttons' era to the 'tactile' era. User demand for aesthetically pleasing and seamless interfaces is ever increasing, with touch sensitive interfaces now commonplace. However, these touch interfaces come at the cost of haptic feedback, which raises concerns regarding the safety of eyeless interaction during driving. The HAPPINESS project intends to address these concerns through technological solutions, introducing new capabilities for haptic feedback on these interfaces. The main goal of the HAPPINESS project is to develop a smart conformable surface able to offer different tactile sensations via the development of a Haptic Thin and Organic Large Area Electronic technology (TOLAE), integrating sensing and feedback capabilities, focusing on user requirements and ergonomic designs. To this aim, by gathering all the value chain actors (materials, technology manufacturing, OEM integrator) for application within the automotive market, the HAPPINESS project will offer a new haptic Human-Machine Interface technology, integrating touch sensing and disruptive feedback capabilities directly into an automotive dashboard. Based on the consortium skills, the HAPPINESS project will demonstrate the integration of Electro-Active Polymers (EAP) in a matrix of mechanical actuators on plastic foils. The objectives are to fabricate these actuators with large area and cost effective printing technologies and to integrate them through plastic molding injection into a small-scale dashboard prototype. We will design, implement and evaluate new approaches to Human-Computer Interaction on a fully functional prototype that combines in packaging both sensors and actuator foils, driven by custom electronics, and accessible to end-users via software libraries, allowing for the reproduction of common and accepted sensations such as Roughness, Vibration and Relief. In this project, the role of Hybrid team is to design user studies on tactile perception, and study innovative usages of the technologies developed in HAPPINESS.

#### 9.3.1.2. IMAGINE

Title: IMAGINE - Robots Understanding Their Actions by Imagining Their Effects

Programm: H2020

Duration: January 2017 - December 2020

Coordinator: Univ. Innsbruck (Austria)

Partners:

Univ. Innsbruck (Austria)

Univ. Göttingen (Germany)

Karlsruhe Institute of Technology (Germany)

**INSA Rennes (France)** 

Institute of Robotics and Industrial Informatics (Spain)

Univ. Bogazici (Turkey)

Electro Cycling (Germany)

Inria contact: Maud Marchal

Today's robots are good at executing programmed motions, but they do not understand their actions in the sense that they could automatically generalize them to novel situations or recover from failures. **IMAGINE** seeks to enable robots to understand the structure of their environment and how it is affected by its actions. "Understanding" here means the ability of the robot (a) to determine the applicability of an action along with parameters to achieve the desired effect, and (b) to discern to what extent an action succeeded, and to infer possible causes of failure and generate recovery actions. The core functional element is a generative model based on an association engine and a physics simulator. "Understanding" is given by the robot to choose actions and parameters based on their simulated performance, and to monitor their progress by comparing observed to simulated behavior. This scientific objective is pursued in the context of recycling of electromechanical appliances.

Current recycling practices do not automate disassembly, which exposes humans to hazardous materials, encourages illegal disposal, and creates significant threats to environment and health, often in third countries. IMAGINE will develop a TRL-5 prototype that can autonomously disassemble prototypical classes of devices, generate and execute disassembly actions for unseen instances of similar devices, and recover from certain failures. For robotic disassembly, IMAGINE will develop a multi-functional gripper capable of multiple types of manipulation without tool changes. IMAGINE raises the ability level of robotic systems in core areas of the work programme, including adaptability, manipulation, perception, decisional autonomy, and cognitive ability. Since only one-third of EU e-waste is currently recovered, IMAGINE addresses an area of high economical and ecological impact.

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

This year, Hybrid team has welcomed for short periods:

- Gabriel Cirio, Universidad Rey Juan Carlos Madrid (Spain), May 2017
- Victoria Interrante, University of Minnesota (US), December 2017
- Geneviève Treyvaud and Pierre Francus, INRS (Canada), November 2017

#### 9.4.2. Visits to International Teams

Ronan Gaugne and Valérie Gouranton made a short stay at University Laval (Canada) in August 2017

## **ILDA Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

ScaleGest. Surface Gestures for Advanced Graphical Interfaces: Which Gesture for What. (2014-2017) Funded by Digiteo. In collaboration with Telecom ParisTech: **109Keuros**. Participants: Caroline Appert (PI), Rafael Morales Gonzalez, Emmanuel Pietriga.

The project aims at designing gesture-based interaction for expert users who navigate and manipulate large datasets. In the context of advanced graphical applications, the number of gestures should be large-enough to cover the set of controls (*i.e.*, commands and parameter settings) but remain simple-enough to avoid exceeding human abilities. Making gesture-based interaction scale with graphical applications' growing complexity can be achieved only by understanding the foundational aspects of this input modality. This project is about characterizing and structuring both the space of application controls and the space of surface gestures in order to establish guidelines for appropriate control-gesture mappings. It is also about the definition of a sound and systematic evaluation methodology that will serve as a reference benchmark for evaluating these mappings. The resulting control-gesture mappings are demonstrated in the specific application domains of cartography and astronomy.

## 9.2. National Initiatives

### 9.2.1. ANR

MapMuxing - Multi-dimensional Map Multiplexing. (2014-2018) Funded by the French National Research Agency (ANR). In collaboration with IGN (Institut National de l'Information Géographique et Forestière):
208Keuros/499Keuros. Participants: Emmanuel Pietriga (PI), Caroline Appert, Olivier Chapuis, Maria Jesus Lobo Gunther, Vit Rusnak. http://mapmuxing.ign.fr

The project explores novel ways of combining different maps and data layers into a single cartographic representation, and investigates novel interaction techniques for navigating in it. The project aims at going beyond the traditional pan & zoom and overview+detail interface schemes, and at designing and evaluating novel cartographic visualizations that rely on high-quality generalization, *i.e.*, the simplification of geographic data to make it legible at a given map scale, and symbol specification.

### 9.2.2. Inria - Ministère de la Culture

**Visual Exploration of Linked Data on BnF's data portal** (2017-2018) Funded by the French Ministère de la Culture and Inria. **65Keuros**. Participants: Emmanuel Pietriga (PI), Caroline Appert, Hande Gözükan, Marie Destandau, Dylan Lebout.

The project explores novel ways of visually navigating the data exposed by the Bibliothèque Nationale de France as linked data on http://data.bnf.fr.

### 9.2.3. Inria Project Lab

ILDA participates to Inria Project Lab iCODA : Data Journalism : knowledge-mediated Content and Data Interactive Analytics, that started in 2017. A key issue in data science is the design of algorithms that enable analysts to infer information and knowledge by exploring heterogeneous information sources, structured data, or unstructured content. With journalism data as a landmark use-case, iCODA aims to develop the scientific and technological foundation for collaborative, heterogeneous data analysis, guided by formalized, user-centric knowledge. The project relies on realistic scenarios in data-journalism to assess the contribution of the project to this area. iCODA is at the crossroads of several research areas (content analysis, data management, knowledge representation, visualization) and is part of a club of partners of the world of the press. Equipes-projets Inria : Graphik, Ilda, Linkmedia, Cedar. Press partners: Le Monde, OuestFrance, AFP. Participants: Anastasia Bezerianos (PI) and Emmanuel Pietriga.

## 9.3. European Initiatives

### 9.3.1. Collaborations with Major European Organizations

• Deutsches Elektronen-Synchrotron (DESY): Scientific collaboration on the design and implementation of user interfaces for array operations monitoring and control for the Cherenkov Telescope Array (CTA) project, to be built in the Canary Islands (Spain) and in the Atacama desert (Chile).

## 9.4. International Initiatives

### 9.4.1. Inria International Labs

Inria Chile / CIRIC. From 2012 to 2015, Emmanuel Pietriga was the scientific leader of the Massive Data team at Inria Chile, working on projects in collaboration with the ALMA radio-telescope and the Millenium Institute of Astrophysics. He is now scientific advisor to Inria Chile's visualization lab, and is actively involved in the collaboration between Inria Chile and the LSST on the design and development of user interfaces for operations monitoring and control.

### 9.4.2. Inria International Partners

### 9.4.2.1. Informal International Partners

- KISTI (Korea). 2017. We investigated the potential of ultra-high-resolution wall-sized displays for the visualization of stream IOT data in the field of air quality monitoring in large and dense urban areas in Korea. The goal of the project was to design and implement an interactive multi-scale visualization of streamed data collected from vehicles (taxis) equipped with a battery of sensors and geolocation devices. The project focused on how to design effective visualizations that take advantage of the specific characteristics of large surfaces featuring a very high pixel density ; and on how to handle streams of IOT data, in this case the sensor data from all taxis, both live data streams and historical data retrieved from a database.
- University of Konstanz: Daniel Keim and Johannes Fuchs on mapping out the design space for visualization glyphs [16]. Participants: Anastasia Bezerianos.

## 9.5. International Research Visitors

## 9.5.1. Visits of International Scientists

• Iftach Sadeh, DESY/CTA Observatory, February 2017

### 9.5.1.1. Internships

- María Grazia Prato, Inria Chile, October 2017
- Amanda Ibsen, Sebastian Pereira, María Grazia Prato, Inria Chile, June 2017

## **IMAGINE Project-Team**

# 8. Partnerships and Cooperations

### **8.1. Regional Initiatives**

### 8.1.1. ARC6 PoTAsse (2015 - 2018)

Participants: Pablo Coves, Jean-Claude Léon, Damien Rohmer.

We received a doctoral grant (AdR) from the ARC6 program to generate functional CAD assemblies from scanned data (*PoTAsse*: POint clouds To ASSEmblies) as a collaboration between Imagine team (LJK/Inria) and Geomod team (LIRIS). Our PhD student Pablo Coves was advised by Jean-Claude Léon and Damien Rohmer at Imagine, Raphaëlle Chaine and Julie Digne in Geomod team. This project was cancelled after Pablo Coves decided to abandon his PhD thesis.

## 8.2. National Initiatives

### 8.2.1. InriaHub ADT ULTRAHD (January-December 2017)

Participants: Rémi Ronfard, Frédéric Devernay, Alexandre Gauthier.

This one-year contract was funding Alexandre Gauthier as a research engineer, with the goal of re-writing the code from Vineet Gandhi's PhD thesis into a suite of NATRON plugins. The resulting software was entirely re-designed for supporting ultra high definition video. The suite of plugins is collectively known as "Kino AI". The software is being extensively tested on a large dataset of 4K video recordings of theatre rehearsals, in collaboration with the Litt&Arts team at Univ. Grenoble Alpes, theatre director Jean-Francois Peyret in Paris, Theatre de l'Hexagone in Meylan and Theatre de Vidy in Lausanne.

### 8.2.2. FUI LIVE360 (December 2015 - December 2018)

Participants: Frédéric Devernay, Sandra Nabil.

This 3-year contract with industrial partner GoPRO is funding the PhD thesis of Sandra Nabil.

#### 8.2.3. FUI Collodi 2 (December 2016 - December 2018)

Participants: Remi Ronfard, Maguelonne Beaud de Brives, Julien Daval, Damien Rohmer, Marie-Paule Cani.

This 2-year contract with two industrial partners: TeamTo and Mercenaries Engineering (software for production rendering), is a follow-up and a generalization of Dynam'it and Collodi 1. The goal is to propose an integrated software for the animation and final rendering of high-quality movies, as an alternative to the ever-ageing Maya. The project is funding 2 engineers for 2 years.

### 8.2.4. ANR E-ROMA (November 2017 - October 2020)

Participants: Remi Ronfard, Stefanie Hahmann, Damien Rohmer, Marie-Paule Cani, Pierre Casati.

This 3-year contract is a joint project with GeoMod team at LIRIS and the musée gallo-romain in Lyon. The contract started in November 2017 and is funding the PhD thesis of Pierre Casati.

### 8.2.5. ANR FOLDYN (November 2017 - October 2020)

Participants: Damien Rohmer, Marie-Paule Cani, Thomas Buffet.

This 3-year contract is a joint project with the University of Toulouse. The contract started in November 2018 and is funding the PhD thesis of Thomas Buffet.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. ERC Grant Expressive

Title: EXPloring REsponsive Shapes for Seamless desIgn of Virtual Environments.

Programm: ERC Advanced Grant

Duration: 04/2012 - 03/2017

### Inria contact: Marie-Paule Cani

To make expressive and creative design possible in virtual environments, the goal is to totally move away from conventional 3D techniques, where sophisticated interfaces are used to edit the degrees of freedom of preexisting geometric or physical models: this paradigm has failed, since even trained digital artists still create on traditional media and only use the computer to reproduce already designed content. To allow creative design in virtual environments, from early draft to progressive refinement and finalization of an idea, both interaction tools and models for shape and motion need to be revisited from a user-centred perspective. The challenge is to develop reactive 3D shapes – a new paradigm for high-level, animated 3D content – that will take form, refine, move and deform based on user intent, expressed through intuitive interaction gestures inserted in a user-knowledge context. Anchored in Computer Graphics, this work reaches the frontier of other domains, from Geometry, Conceptual Design and Simulation to Human Computer Interaction. The contract ended successfully in March 2017.

#### 8.3.1.2. PIPER

Title: Position and Personalize Advanced Human Body Models for Injury Prediction

Programm: FP7

Duration: November 2013 - April 2017

Inria contact: F. Faure

In passive safety, human variability is currently difficult to account for using crash test dummies and regulatory procedures. However, vulnerable populations such as children and elderly need to be considered in the design of safety systems in order to further reduce the fatalities by protecting all users and not only so called averages. Based on the finite element method, advanced Human Body Models for injury prediction have the potential to represent the population variability and to provide more accurate injury predictions than alternatives using global injury criteria. However, these advanced HBM are underutilized in industrial R&D. Reasons include difficulties to position the models – which are typically only available in one posture – in actual vehicle environments, and the lack of model families to represent the population variability (which reduces their interest when compared to dummies). The main objective of the project will be to develop new tools to position and personalize these advanced HBM. Specifications will be agreed upon with future industrial users, and an extensive evaluation in actual applications will take place during the project. The tools will be made available by using an Open Source exploitation strategy and extensive dissemination driven by the industrial partners.Proven approaches will be combined with innovative solutions transferred from computer graphics, statistical shape and ergonomics modeling. The consortium will be balanced between industrial users (with seven European car manufacturers represented), academic users involved in injury bio-mechanics, and partners with different expertise with strong potential for transfer of knowledge. By facilitating the generation of population and subject-specific HBM and their usage in production environments, the tools will enable new applications in industrial R&D for the design of restraint systems as well as new research applications. This contract ended successfully in April 2017.

## **MANAO Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. Carer xD: "Caractérisation et restitution du réel xD"

Currently, the characterization and display of the real world are limited to techniques focusing on a subset of the necessary physical phenomena. A lot of work has been done to acquire geometric properties. However, the acquisition of a geometry on an object with complex reflection property or dynamic behavior is still a challenge. Similarly, the characterization of a material is limited to a uniform object for complex material or a diffuse material when one is interested in its spatial variations.

To reach full interaction between real and virtual worlds (augmented reality, mixed reality), it is necessary to acquire the real world in all its aspects (spatial, spectral, temporal) and to return it as in all these dimensions. To achieve this goal, a number of theoretical and practical tools will be developed around the development of mixed reality solutions and the development of some theoretical framework that supports the entire project.

### 9.2. National Initiatives

### 9.2.1. ANR

9.2.1.1. "Young Researcher" VIDA (2017-2021)

LP2N-CNRS-IOGS Inria Leader R. Pacanowski (LP2N-CNRS-IOGS) Participant P. Barla (Inria)

#### 9.2.1.2. Context.

Since the beginning of the industrial era, prototyping has been an important stage for manufacturers as a preliminary step before mass production. With the rise of Computer Science and the recent advances of intensive computation, the industry is progressively shifting from a tangible prototype to a fully numerical and virtual prototype with the goal of reducing costs during the R&D phase. During the past few years, the emergence of 3D printers has enabled virtual prototyping methods to take into account, at an early stage, some degree of fabricability, especially regarding the shape of the manufactured object. Beyond the shape of an object, predicting the final appearance of a virtual prototype remains a challenge of high potential for many domains (e.g., furniture, textile, architecture). The challenge is mainly due to the fact that the final appearance of an object is dependent on its shape, the material(s) applied on it as well as the viewing and lighting conditions. As shown in Figure 13, solving the inverse problem that goes from Pictorial Design [A] to the Operational Design [D], where a specialist controls the fabrication process, is very hard and ill-posed.

#### 9.2.1.3. Scientific Objectives.

The VIDA project aims at removing the several scientific locks by establishing a framework for direct and inverse design of material appearance for objects of complex shape. Since the manufacturing processes are always changing and evolving, our goal is to establish a framework that is not tied to a fabrication stage. To provide a rich variety of possible appearances, we will target multi-layered materials. We will ensure that every step of our framework is **validated** by either predictive simulation and/or measurements of the appearance. To illustrate the fabricability of our results, material samples as well as object samples will be fabricated locally or out-sourced to *Ecole des Mines de Saint-Etienne* (http://www.mines-stetienne. fr/en/EMSE) or http://www.saint-gobain-recherche.frSaint-Gobain Recherche and their appearance will also be validated with specific devices developed at the *https://www.institutoptique.fr/enInstitut d'Optique*-http:// www.lp2n.frLP2N.



Figure 13. The different scales involved in the design of object appearance. [A] Pictorial scale: the object is seen as a whole. [B] Radiometric scale: represents the behaviour of a material when light interacts with it. [C] Microscopic scale: the material is described by physical parameters (e.g., index of refraction, absorption coefficient). [D] Operational scale: the parameters control the machine-dependent fabrication process.

#### 9.2.1.4. "Young Researcher" RichShape (2014-2018)

#### MANAO

#### Leader G. Guennebaud

This project aims at the development of novel representations for the efficient rendering and manipulation of highly detailed shapes in a multi-resolution context.

#### 9.2.1.5. ISAR (2014-2018)

POTIOC, MANAO, LIG-CNRS-UJF, Diotasoft

#### Leader M. Hachet (POTIOC)

The ISAR project focuses on the design, implementation and evaluation of new interaction paradigms for spatial augmented reality, and to systematically explore the design space.

### 9.2.1.6. MATERIALS (2015-2019)

MAVERICK, LP2N-CNRS (MANAO), Musée d'Ethnographie de Bordeaux, OCÉ-Print

#### Leader N. Holzschuch (MAVERICK)

#### Local Leader R. Pacanowski (LP2N-CNRS)

Museums are operating under conflicting constraints: they have to preserve the artifacts they are storing, while making them available to the public and to researchers. Cultural artifacts are so fragile that simply exposing them to light degrades them. 3D scanning, combined with virtual reality and 3D printing has been used for the preservation and study of sculptures. The approach is limited: it acquires the geometry and the color, but not complex material properties. Current 3D printers are also limited in the range of colors they can reproduce. Our goal in this project is to address the entire chain of material acquisition and restitution. Our idea is to scan complex cultural artifacts, such as silk cloths, capturing all the geometry of their materials at the microscopic level, then reproduce them for study by public and researchers. Reproduction can be either done through 2.5D printing or virtual reality displays.

#### 9.2.1.7. FOLD-Dyn (2017-2021)

IRIT, IMAGINE, MANAO, TeamTo, Mercenaries Leader L. Barthe (IRIT) Local Leader G. Guennebaud (Inria) The FOLD-Dyn project proposes the study of new theoretical approaches for the effective generation of virtual characters deformations, when they are animated. These deformations are two-folds: character skin deformations (skinning) and garment simulations. We propose to explore the possibilities offered by a novel theoretical way of addressing character deformations: the implicit skinning. This method jointly uses meshes and volumetric scalar functions. By improving the theoretical properties of scalar functions, the study of their joint use with meshes, and the introduction of a new approach and its formalism - called multi-layer 3D scalar functions - we aim at finding effective solutions allowing production studios to easily integrate in their pipeline plausible character deformations together with garment simulations.

### 9.2.2. Competitivity Clusters

### 9.2.2.1. LabEx CPU

IMB (UPR 5251), LABRI (UMR 5800), Inria (CENTRE BORDEAUX SUD-OUEST), I2M (NEW UMR FROM 2011), IMS (UMR 5218), CEA/DAM

Some members of *MANAO* participate in the local initiative CPU. As it includes many thematics, from fluid mechanics computation to structure safety but also management of timetable, safety of networks and protocols, management of energy consumption, etc., numerical technology can impact a whole industrial sector. In order to address problems in the domain of certification or qualification, we want to develop numerical sciences at such a level that it can be used as a certification tool.

## 9.3. International Research Visitors

### 9.3.1. Visits of International Scientists

Invited professor: Pierre Poulin, professor at Université de Montréal, Visiting scholar program of IdEx Bordeaux

## **MAVERICK Project-Team**

# 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

We have frequent exchanges and on-going collaborations with Cyril Crassin from nVIDIA-Research, and Eric Heitz, Laurent Belcour and Jonathan Dupuy from Unity-Research.

Maverick is part of the GPU Research Center labeled by nVIDIA at Inria Grenoble. Team contact: Fabrice Neyret.

### **8.2.** National Initiatives

#### 8.2.1. ANR CONTINT: MAPSTYLE

Participants: Joëlle Thollot [contact], Hugo Loi.

The MAPSTYLE project aims at exploring the possibilities offered by cartography and expressive rendering to propose original and new cartographic representations. Through this project, we target two types of needs. On the one hand, mapping agencies produce series paper maps with some renderings that are still derived from drawings made by hand 50 years ago: for example, rocky areas in the series TOP25 (to 1/25000) of the French Institut Géographique National (IGN). The rendering of these rocky areas must be automated and its effectiveness retained to meet the requirements of hikers safety. On the other hand, Internet mapping tools allow any user to become a cartographer. However, they provide default styles that cannot be changed (GeoPortal, Google Maps) or they are editable but without any assistance or expertise (CloudMade). In such cases, as in the case of mobile applications, we identify the need to offer users means to design map styles more personalised and more attractive to meet their expectations (decision-making, recreation, etc.) and their tastes. The grant started on October 2012, for 48 months.

### 8.2.2. ANR: Materials

Participants: Nicolas Holzschuch [contact], Romain Vergne.

We are funded by the ANR for a joint research project on acquisition and restitution of micro-facet based materials. This project is in cooperation with Océ Print Logic technologies, the Museum of Ethnography at the University of Bordeaux and the Manao team at Inria Bordeaux. The grant started in October 2015, for 48 months.

### 8.2.3. CDP: Patrimalp 2.0

Participants: Nicolas Holzschuch [contact], Romain Vergne.

The main objective and challenge of Patrimalp 2.0 is to develop a cross-disciplinary approach in order to get a better knowledge of the material cultural heritage in order to ensure its sustainability, valorization and diffusion in society. Carried out by members of UGA laboratories, combining skills in human sciences, geosciences, digital engineering, material sciences, in close connection with stakeholders of heritage and cultural life, curators and restorers, Patrimalp 2.0 intends to develop of a new interdisciplinary science: Cultural Heritage Science. The grant starts in January 2018, for a period of 48 months.

### 8.2.4. ANR: CaLiTrOp

Participant: Cyril Soler [contact].

Computing photorealistic images relies on the simulation of light transfer in a 3D scene, typically modeled using geometric primitives and a collection of reflectance properties that represent the way objects interact with light. Estimating the color of a pixel traditionally consists in integrating contributions from light paths connecting the light sources to the camera sensor at that pixel.

In this ANR we explore a transversal view of examining light transport operators from the point of view of infinite dimensional function spaces of light fields (imagine, e.g., reflectance as an operator that transforms a distribution of incident light into a distribution of reflected light). Not only are these operators all linear in these spaces but they are also very sparse. As a side effect, the sub-spaces of light distributions that are actually relevant during the computation of a solution always boil down to a low dimensional manifold embedded in the full space of light distributions.

Studying the structure of high dimensional objects from a low dimensional set of observables is a problem that becomes ubiquitous nowadays: Compressive sensing, Gaussian processes, harmonic analysis and differential analysis, are typical examples of mathematical tools which will be of great relevance to study the light transport operators.

Expected results of the fundamental-research project CALiTrOp, are a theoretical understanding of the dimensionality and structure of light transport operators, bringing new efficient lighting simulation methods, and efficient approximations of light transport with applications to real time global illumination for video games.

## 8.3. International Initiatives

### 8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

Title: "MAIS": Mathematical Analysis of Image Synthesis

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada) - Département d'Informatique et Recherche Opéra-

tionnelle - Derek Nowrouzezahrai

Duration: 2015 - 2019

Start year: 2015

See also: http://diro.umontreal.ca/accueil/

#### 8.3.1.2. Indo-French Center of Applied Mathematics

#### **Topology-driven Visualization of Scientific Data**

Title: Topology-driven Visualization of Scientific Data

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Deptartment of Science and Automation - Vijay Natarajan

Duration: Sept 2016 - Sept 2017

One of the greatest scientific challenges of the 21st century is how to master, organize, and extract useful knowledge from the overwhelming flow of information made available by today's data acquisition systems and computing resources. Visualization is the premium means of taking up this challenge. Topological analysis has recently emerged as a powerful class of methods for visualizing data. From the input data, these methods derive combinatorial structures capturing the essential features of the data. The goal of this project is to design new topological structures, study their properties, and develop efficient algorithms to compute them. In order to solve this challenge, we will combine our expertise in Topology for the Indian partner and in Geometric Modeling for the French partner. We plan to develop new geometric models that accurately and intuitively depict the topological combinatorial structures.

### 8.4. International Research Visitors

#### 8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

- Alexandre Bléron has made a 3 months internship to work with Hock Soon Seah on 3D stylization in the MAGIC group of Nanyang Technological University of Singapour.
- Alban Fichet is making a 12 months stay at Charles University in Prague, to work with Alexander Wilkie and Jaroslav Krivanek on material models.
- Guillaume Loubet has made a 3 months internship in the Hyperion group at Disney, Los Angeles.

## **MIMETIC Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

- SATT "Ouest valorisation" grant for the maturation of the Kimea software and projet (Franck Multon and Pierre Plantard). 12 months of three full-time people 300K€. Creation of the start-up company planned beginning of 2018.
- SATT "Ouest valorisation" grant for the maturation of the Populate software (Fabrice Lamarche). One full-time engineer (2017-2018).

## 9.2. National Initiatives

### 9.2.1. ANR

### 9.2.1.1. Cineviz

Participants: Marc Christie [contact], Christophe Lino, Quentin Galvane, Hui-Yin Wu.

Cineviz is a 3-year ANR LabCom project (2016-2019). Amount: 300kE. Parnters: SolidAnim, UR1.

The project is a bilateral collaboration with the SolidAnim company. The objective is to jointly progress on the design and implementation of novel tools for the preproduction in the film industry. The project will address the challenges related to (i) proposing expressive framing tools, (ii) integrating the technical aspects of shooting (how to place the cameras, lights, green sets) directly at the design stage), and (iii) novel interaction metaphors for designing and controlling the staging of lights in preproduction, using an example-based approach.

#### 9.2.1.2. Entracte

**Participants:** Charles Pontonnier [contact], Georges Dumont, Franck Multon, Pierre Plantard, Ana Lucia Cruz Ruiz, Antoine Muller, Anthony Sorel, Nicolas Bideau, Richard Kulpa.

The ANR project ENTRACTE is a collaboration between the Gepetto team in LAAS, Toulouse (head of the project) and the Inria/MimeTIC team. The project started in November 2013 and ended in August 2017. The purpose of the ENTRACTE project is to address the action planning problem, crucial for robots as well as for virtual human avatars, in analyzing human motion at a biomechanical level [16] and in defining from this analysis bio-inspired motor control laws and bio-inspired paradigms for action planning. The project is launched since november 2013 and Ana Lucia Cruz Ruiz, who has been recruited as a PhD student since this date, defended her thesis on muscle-based control based on synergies last year.

### 9.2.2. National scientific collaborations

#### 9.2.2.1. Cavaletic

Participant: Franck Multon [contact].

The Cavaletic collaborative project is leaded by University Bretagne Sud and also involves University Rennes2 (CREAD Lab.). It has been funded by the National IFCE (Institut Français du Cheval et de l'Equitation) in order to develop and evaluate technological assistance in horse riding learning, thanks to a user-centered approach. MimeTIC is involved in measuring expert and non-expert horse riders' motions in standardized situations in order to develop metrics to measure riders' performance. It will be used to develop a technological system embedded on users to evaluate their performance and provide them with real-time feedback to correct potential errors.

#### 9.2.2.2. FFT

Participants: Richard Kulpa [contact], Benoit Bideau, Pierre Touzard.

An exclusive contract has been signed between the M2S laboratory and the French Federation of Tennis for three years. The goal is to perform biomechanical analyses of 3D tennis serves on a population of 40 players of the Pôle France. The objective is to determine the link between injuries and biomechanical constraints on joints and muscles depending on the age and gender of the players. At the end, the goal is to evaluate their load training.

### 9.2.2.3. gDGA

Participants: Antonio Mucherino [contact], Ludovic Hoyet, Franck Multon.

gDGA (generalization of the Distance Geometry and its Applications) is a INS2I/CNRS PEPS project involving local and national partners. Distance geometry can nowadays be seen as a classical problem in operational research, having a wide range of applications. The main aim of this interdisciplinary project is to extend the definition and the range of applicability of distance geometry. In particular, our main interest is on dynamical problems, motivated by a certain number of applications of interest, including interaction motion adaptation, the simulation of crowd behaviours, and the conception of modern recommender systems. The classical application of distance geometry arising in the biological field is also taken into consideration. The necessity of a strong computational power for the considered applications motivates the need of implementing our algorithms in environments capable of exploiting the resources on GPU cards.

#### 9.2.2.4. IRMA

Participants: Ronan Gaugne [contact], Georges Dumont.

The IRMA project is an Imag'In project funded by CNRS which aims at developping innovative methodologies for research in the field of cultural heritage based on the combination of medical imaging technologies and interactive 3D technologies (virtual reality, augmented reality, haptics, additive manufacturing). It relies on close collaborations with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET. The developed tools are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. We focus on a large number of archeological artefacts of different nature, and various time periods (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We can notably mention the oldest human bones found in Brittany (clavicle Beg Er Vil), a funeral urn from Trebeurden (22), or a Bronze Cauldron from a burial of the Merovingian necropolis "Crassés Saint-Dizier" (51). This project involves a strong collaboration with members of the team Hybrid (Valérie Gouranton, Bruno Arnaldi and Jean-Baptiste Barreau), Théophane Nicolas (Inrap/UMR Trajectoires), Quentin Petit (SED Inria Rennes), and Grégor Marchand (CNRS/UMR CReAAH).

#### 9.2.3. ADT: Immerstar

Participants: Franck Multon, Georges Dumont [contact], Ronan Gaugne.

The ADT-Immerstar is driven by the SED and aims at developing new tools and facilities for the scientific community in order to develop demos and use the two immersive rooms in Rennes: Immersia and Immermove. The engineer (Quentin Petit, SED) has the responsibility of homogenizing the software modules and development facilities in each platform, of installing new upgrades and of developping collaborative applications between the two sites.

### 9.2.4. PRE

Participants: Franck Multon [contact], Ludovic Hoyet, Antonio Mucherino.

The Inria PRE projet entitled "Smart sensors and novel motion representation breakthrough for human performance analysis" aims at designing a new description for human motion in order to automatically capture, measure and transfer the intrinsic constraints of human motion. Current approached consisted in manually editing the constraints associated with a motion, to use classical skeleton representation with joint angles based on direct or indirect measurements, and then perform inverse kinematics to fulfill these constraints. We aim at designing a new representation to simplify this process pipeline and make it automatic, together with relevant motion sensors that could provide enough information to automatically extract these intrinsic

constraints. To this end, this project has been jointly proposed with the Inria CAIRN team, which develops sensors based on joint orientations and distances between sensors. We aim at extending this type of device to measure new types of information that would help to simplify the above mentionned pipeline. A postdoc arrived in November 2016 to jointly work with CAIRN. We also involved Hubert Shum from Northumbria University to link this project with the long-term collaboration with Dr. Shum about this type of problem. ype of problems.

## 9.3. International Initiatives

### 9.3.1. FORMOSA

Title: Fostering Research on Models for Storytelling Applications

International Partner (Institution - Laboratory - Researcher):

NCCU (Taiwan) - Intelligent Media Lab (IML) - Tsai-Yen Li

Start year: 2016

See also: http://www.irisa.fr/mimetic/GENS/mchristi/EA-FORMOSA/

Interactive Storytelling is a new media which allows users to alter the content and outcome of narratives through role-playing and specific actions. With the quality, the availability and reasonable costs of display technologies and 3D interaction devices on one side, and the accessibility of 3D content creation tools on the other, this media is taking a significant share in entertainment (as demonstrated by the success of cinematographic games such as Heavy Rain or Beyond: two souls). These advances push us to re-think the way narratives are traditionally structured, explore new interactive modalities and provide new interactive cinematographic experiences. As a sequel of the first associate team FORMOSA 1, we propose to address new challenges pertained to interactive storytelling such as the use of temporal structures in narratives, interaction modalities and their impact in terms of immersion, and the adaptation of cinematographic real data to 3D environments. To achieve these objectives, the associate team will rely on the complementary skills of its partners and on the co-supervision of students.

### 9.3.2. SIMS

Title: REal data against crowd SImulation AlgorithMS

International Partner (Institution - Laboratory - Researcher):

University of North Carolina at Chapel Hill (United States) - GAMMA Research Group (GAMMA) - Ming LIN

Start year: 2015

See also: http://www.irisa.fr/mimetic/GENS/jpettre/EASIMS/easims.html

RE-SIMS aims at gathering the best international research teams working on crowd simulation to allow significant progresses on the level of realism achieved by crowd simulators. To this end, RE-SIMS aims at improving methods for capturing crowd motion data that describe real crowd behaviors, as well as by improving data assimilation techniques.

In this renewal, RE-SIMS extends the previous SIMS partnership and follows a multidiciplinary direction.

### 9.3.3. Inria International Partners

9.3.3.1. Informal International Partners

- Dr. Edouard Auvinet, Imperial College London, UK (collaboration with Franck Multon)
- Dr. Huber Shum, Northumbria University, Newcastle, UK (collaboration with Franck Multon and Ludovic Hoyet, with joint papers and supervision)

- Dr. Rachel McDonnell, Trinity College Dublin, Ireland (on-going collaboration with Ludovic Hoyet, including a 6-month internship from one of her PhD student in Rennes)
- Prof. Carol O'Sullivan, Trinity College Dublin, Ireland (on-going collaboration with Ludovic Hoyet)
- Prof. Carlile Lavor, UNICAMP, Campinas, Sao Paulo, Brazil (collaboration with Antonio Mucherino)
- Dr. Douglas S. Gonçalves, Federal University of Santa Catarina, Florianpolis, Brazil (collaboration with Antonio Mucherino)
- Jung-Hsin Lin, Academia Sinica, Taipei, Taiwan (collaboration with Antonio Mucherino)

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

### 9.4.1.1. Professors and associate professors

- Victoria Interrante, Professor, Department of Computer Science and Engineering, University of Minnesota USA, December 8th, 2017
- Michael Cinelli, Associate Professor, Kinesiology and Physical Education, Wilfrid Laurier University, Canada, June 2017

#### 9.4.1.2. Internships

• Emma Carrigan, Trinity College Dublin, Ireland (PhD supervisor: Dr. Rachel McDonnell), 6-month internship in collaboration with Technicolor (Quentin Avril), Jan. to June 2017.

## **MINT2 Team**

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

#### 8.1.1. StimTac, 2015-2017

**Participants:** Frédéric Giraud [correspondant], Patricia Plénacoste, Laurent Grisoni, Michel Amberg, Nicolas Bremmard.

The aim of this project is to create the first digital book, enhanced with haptic feedback, in order to anticipate the integration of this technology into everyday products. This project addresses technological issues, like programming haptic content in a multimedia software, and design issues to understand how the haptic feedback is perceived by the users.

Stimtac is a book, and could thus be presented to non-specialists users and to a wide public during presentations, demos and forums. The scenario and the illustrations were made by Dominique Maes, a Belgium artist, who did the digital book "Bleu de toi" among other things. The Public Library of Lille is a partner of this project and allows us to meet the public.





(a)

(b)

Figure 1. Demo session at "La nuit des Bibliothèques (Lille, October 2016), and a page of Stimtac; the ellipse highlights the tactile feedback on E-Vita.

This project has been granted 8Keuros from IRCICA.

### 8.1.2. MATRICE (sept 2015-sept. 2017

Participant: Laurent Grisoni [correspondant].

This regional project, funded by ERDF, led by Lille School of Architecture, aims at understanding in which way 3D printing may be interesting for the building economy. partners: Ecole d'architecture de Lille, Inria, Ecole Centrale de Lille, Télécom Lille 1, Ecole des Mines de Douai.

## 8.2. National Initiatives

### 8.2.1. Equipex IRDIVE (ANR project 2012-2020)

3 Meuros project, co-funded by ERDF for the development of a pluri-disciplinary project on ICT-based tools for understanding human perception of visual contents. Laurent Grisoni is member of the lead group of this project, and animates an axis devoted to art-sciences and technologies collaborations.

## 8.2.2. MAUVE CPER ("Contrat de Plan État-Région") 2016-2020 project

Funds: 4 Meuros (validated at national level, funded by Region), and 1 Meuro additional funding provided by ERDF.

Subject: ICT tools for mediation and access to knowledge.

Lead: University of Lille, University of Artois. Laurent Grisoni is co-lead of this project.

### 8.2.3. InriaRT

Participants: Laurent Grisoni [correspondant], Samuel Degrande, Francesco de Comité.

Art/science Inria internal network gathering projects interested in collaborating with artists. Inria teams involved: MuTANT (Paris), Imagine (Grenoble), Flowers, Potioc (Bordeaux), Hybrid, MimeTic (Rennes). This initiative will take advantage of an agreement between Inria and French Ministry of Culture, signed early December 2016.

## 8.3. European Initiatives

### 8.3.1. Collaborations in European Programs, Except FP7 & H2020

MINT participates to the VR4REHAB (2018-2020) project, funded by ENO Interreg. This project gathers rehabilitation structures and provides animation of hackathons for prototyping VR systems for rehabilitation. MINT role is to provide technical support and help mature relevant approaches for getting closer to using VR for personnal, lightweight rehabilitation systems. Funds for the team: 430 Keuros. Contact for the team: Laurent Grisoni.

## 8.3.2. Collaborations with Major European Organizations

we collaborate with INESC-ID (through exchange of students, join publications).
# **Mjolnir Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

### 9.1.1. Mjolnir/UCLIC associate team (Inria Lille, 2015-2017)

Participants: Sylvain Malacria [correspondent], Nicolas Roussel.

The goal of this project, whose funding ends 2017, is the design and implementation of novel cross-device systems and interaction techniques. Thanks to this funding, the Mjolnir group and UCLIC are currently working on two scientific research projects. The first one investigates the design of notification systems for smart watches, smartphones, and in distributed computing environments based on device proximity, location, and time. A group of three Computer Science students from UCL is currently designing and implementing the first prototype of this system. The second project studies the influence of the shape and color of icons on visual search, on smartphones and smartwatches. In addition, UCLIC and the Mjolnir group also collaborate on the design and implementation of a software tool for helping HCI researchers to create non-photorealistic figures aimed at illustrating interaction techniques.

Partner: University College London Interaction Centre (United Kingdom).

## 9.2. National Initiatives

### 9.2.1. Turbotouch (ANR, 2014-2019)

**Participants:** Géry Casiez [correspondent], Sylvain Malacria, Mathieu Nancel, Thomas Pietrzak, Sébastien Poulmane, Nicolas Roussel.

Touch-based interactions with computing systems are greatly affected by two interrelated factors: the transfer functions applied on finger movements, and latency. This project aims at transforming the design of touch transfer functions from black art to science to support high-performance interactions. We are working on the precise characterization of the functions used and the latency observed in current touch systems. We are developing a testbed environment to support multidisciplinary research on touch transfer functions and will use this testbed to design latency reduction and compensation techniques, and new transfer functions.

Partners: Inria Lille's NON-A team and the "Perceptual-motor behavior group" from the Institute of Movement Sciences.

Web site: http://mjolnir.lille.inria.fr/turbotouch/

Related publications: [21], [17], [12], [18]

## 9.2.2. ParkEvolution (Carnot Inria - Carnot STAR, 2015-2018)

Participants: Géry Casiez [correspondent], Sébastien Poulmane.

This project studies the fine motor control of patients with Parkinson disease in an ecological environment, at home, without the presence of experimenters. Through longitudinal studies, we collect raw information from pointing devices to create a large database of pointing behavior data. From the analysis of this big dataset, the project aims at inferring the individual's disease progression and influence of treatments.

Partners: the "Perceptual-motor behavior group" from the Institute of Movement Sciences and Hôpital de la Timone.

Web site: http://parkevolution.org/

### 9.2.3. BCI-LIFT (Inria Project Lab, 2015-2019)

Participants: Géry Casiez [correspondent], Nicolas Roussel.

The goal of this large-scale initiative is to design a new generation of non-invasive Brain-Computer Interfaces (BCI) that are easier to appropriate, more efficient, and suited for a larger number of people.

Partners: Inria's ATHENA, NEUROSYS, POTIOC, HYBRID & DEMAR teams, *Centre de Recherche en Neurosciences de Lyon* (INSERM) and INSA Rouen.

Web site: https://bci-lift.inria.fr/

Related publications: [22], [33]

# 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

9.3.1.1. Happiness (H2020-ICT-2014-1/ICT-03-2014/RIA, 2015-2018)

Participants: Julien Decaudin, Christian Frisson, Thomas Pietrzak [correspondent], Nicolas Roussel.

The main objective of this project is to develop and evaluate new types of haptic actuators printed on advanced Thin, Organic and Large Area Electronics (TOLAE) technologies for use in car dashboards. These actuators are embedded in plastic molded dashboard parts. The expected outcome is a marketable solution for haptic feedback on curved interactive surfaces.

In this project, Inria is responsible for WP2: Human Factors and Interaction Design, as well as the software development of the project main demo. A first version of this demo was showcased at the Geneva Motor Show 2017. We developed the dashboard software of the Mojave concept car, built by the Sbarro school.

Partners: CEA (coordinator), Inria Rennes' HYBRID team, Arkema, Bosch, Glasgow University, ISD, Walter Pack, Fundacion Gaiker.

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

Related publications: [26], [36]

## 9.4. International Initiatives

### 9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Andy Cockburn, University of Canterbury, Christchurch, NZ [12] Daniel Vogel, University of Waterloo, Waterloo, CA [14] Nathalie Henry Riche, Microsoft Research, Seattle, USA [16] Audrey Girouard, Carleton University, Ottawa, CA [23] Daniel Wigdor, University of Toronto, Toronto, CA [25] Ravin Balakrishnan, University of Toronto, Toronto, CA [26]

### 9.5. International Research Visitors

## 9.5.1. Visits of International Scientists

Ed Lank, Associate Professor at the University of Waterloo, has already spent one year in our team until Aug. 2017 (funded by Région Hauts-de-France and Université Lille 1). His stay was extended until Feb. 2018, funded by Inria.

Marcelo Wanderley, Professor at McGill University, who has been awarded an Inria International Chair in our team in 2016, spent 2 months in our group this year (June to July).

#### 9.5.1.1. Internships

Shaishav Siddhpuria, Master student, Univ of Waterloo, from Feb. to Apr. 2017 Keiko Katsuragawa, Postdoc, Univ of Waterloo, Mar. 2017 Rina Wehbe, PhD student, Univ of Waterloo, Mar. 2017 Jeff Avery, PhD student, Univ of Waterloo, from Jun. to Aug. 2017

# **POTIOC Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### Introspectibles - Collaborative research project :

Funding: Région Aquitaine
Duration: 2017-2018
Local coordinator: Martin Hachet
Partners: ULLO,
Following our work with the Introspectibles (Teegi, TOBE, Inner Garden), we are currently working with the ULLO company to bring these new interfaces to healthcare centers.

### **HOBIT - Maturation project :**

Funding: Aquitaine Science Transfer
Duration: 2017-2018
Local coordinator: Martin Hachet
Partners: Université de Bordeaux
We are currently moving our platform HOBIT from his lab state to a commercial product.

#### Km 2.0 - Arts an Sciences program :

Funding: Idex Université Bordeaux Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: Léna D'Azy

We work with Cécile Léna for creating artistic installations based on interactive projection. See http://www.facts-bordeaux.fr/RESIDENCES/KM-2.0

#### Telekinetik juggling - Arts an Sciences program :

Funding: Idex Université Bordeaux

Duration: 2017-2018

Local coordinator: Martin Hachet

Partners: Le Cirque Inachevé

We work with Antoine Cléé from Cirque Inachevé for the design of an interactive environment where the artist will be able to juggle with zero gravity objects. The artist wear gloves, and interact with mini-drones supporting balls. See http://www.facts-bordeaux.fr/RESIDENCES/Jonglerie-telekinetique

#### Neuroperf :

Funding: Idex Université Bordeaux Duration: 2017-2019 Coordinator: Jean-Arthur Micoulaud Franci Local coordinator: Fabien Lotte Partners: SANPSY - Potioc This project aims at studying EEG-based Neurofeedback to reduce fatigue symptoms in sleepdeprived individuals. See http://brain.labex.u-bordeaux.fr/Actualites/Selection-projets-recherche-Clinique-2017-i5064.html

## 9.2. National Initiatives

### eTAC: Tangible and Augmented Interfaces for Collaborative Learning:

Funding: EFRAN

Duration: 2017-2021

Coordinator: Université de Lorraine

Local coordinator: Martin Hachet

Partners: Université de Lorraine, Inria, ESPE, Canopé, OpenEdge,

the e-TAC project proposes to investigate the potential of technologies "beyond the mouse" in order to promote collaborative learning in a school context. In particular, we will explore augmented reality and tangible interfaces, which supports active learning and favors social interaction.

### ANR Rebel:

Duration: 2016-2019

Coordinator: Fabien Lotte

Funding: ANR Jeune Chercheur Jeune Chercheuse Project

Partners: Disabilities and Nervous Systems Laboratory Bordeaux

Brain-Computer Interfaces (BCI) are communication systems that enable their users to send commands to computers through brain activity only. While BCI are very promising for assistive technologies or human-computer interaction (HCI), they are barely used outside laboratories, due to a poor reliability. Designing a BCI requires 1) its user to learn to produce distinct brain activity patterns and 2) the machine to recognize these patterns using signal processing. Most research efforts focused on signal processing. However, BCI user training is as essential but is only scarcely studied and based on heuristics that do not satisfy human learning principles. Thus, currently poor BCI reliability is probably due to suboptimal user training. Thus, we propose to create a new generation of BCI that apply human learning principles in their design to ensure the users can learn high quality control skills, hence making BCI reliable. This could change HCI as BCI have promised but failed to do so far.

### **ANR Project ISAR:**

Duration: 2014-2017

Coordinator: Martin Hachet

Partners: LIG-CNRS (Grenoble), Diotasoft (Paris)

Acronym: Interaction en Réalité Augmentée Spatiale / Interacting with Spatial Augmented Reality The ISAR project (Interaction with Spatial Augmented Reality) focuses on the design, implementation, and evaluation of new paradigms to improve interaction with the digital world when digital content is directly projected onto physical objects. It opens new perspectives for exciting tomorrow's applications, beyond traditional screen-based applications.

website: https://team.inria.fr/potioc/scientific-subjects/papart/

### Inria Project Lab BCI-LIFT:

Duration: 2015-2018

Partners: Inria team Athena (Inria Sophia-Antipolis), Inria team Hybrid (Inria Rennes), Inria team Neurosys (Inria Nancy), LITIS (Université de Rouen), Inria team DEMAR (Inria Sophia-Antipolis), Inria team MINT (Inria Lille), DyCOG (INSERM Lyon)

Coordinator: Maureen Clerc (Inria Sophia Antipolis)

Local coordinator: Fabien Lotte

The aim 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. With this concern of usability as our driving objective, we will build non-invasive systems that benefit from advanced signal processing and machine learning methods, from smart interface design, and where the user immediately receives supportive feedback. What drives this project is the concern that a substantial proportion of human participants is currently categorized "BCI-illiterate" because of their apparent inability to communicate through BCI. Through this project we aim at making it easier for people to learn to use the BCI, by implementing appropriate machine learning methods and developping user training scenarios.

website: http://bci-lift.inria.fr/

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

Program: ERC Starting Grant

Project acronym: BrainConquest

Project title: Boosting Brain-Computer Communication with High Quality User Training

Duration: 07/2017-06/2022

Coordinator: Fabien Lotte

Abstract: Brain-Computer Interfaces (BCIs) are communication systems that enable users to send commands to computers through brain signals only, by measuring and processing these signals. Making computer control possible without any physical activity, BCIs have promised to revolutionize many application areas, notably assistive technologies, e.g., for wheelchair control, and manmachine interaction. Despite this promising potential, BCIs are still barely used outside laboratories, due to their current poor reliability. For instance, BCIs only using two imagined hand movements as mental commands decode, on average, less than 80% of these commands correctly, while 10 to 30% of users cannot control a BCI at all. A BCI should be considered a co-adaptive communication system: its users learn to encode commands in their brain signals (with mental imagery) that the machine learns to decode using signal processing. Most research efforts so far have been dedicated to decoding the commands. However, BCI control is a skill that users have to learn too. Unfortunately how BCI users learn to encode the commands is essential but is barely studied, i.e., fundamental knowledge about how users learn BCI control is lacking. Moreover standard training approaches are only based on heuristics, without satisfying human learning principles. Thus, poor BCI reliability is probably largely due to highly suboptimal user training. In order to obtain a truly reliable BCI we need to completely redefine user training approaches. To do so, I propose to study and statistically model how users learn to encode BCI commands. Then, based on human learning principles and this model, I propose to create a new generation of BCIs which ensure that users learn how to successfully encode commands with high signal-to-noise ratio in their brain signals, hence making BCIs dramatically more reliable. Such a reliable BCI could positively change man-machine interaction as BCIs have promised but failed to do so far.

### 9.3.2. Collaborations in European Programs, Except FP7 & H2020

• Program: DGA-DSTL Project

Project title: Assessing and Optimising Human-Machine Symbiosis through Neural signals for Big Data Analytics

Duration: 2014-2018

Coordinator: Damien Coyle and Fabien Lotte

Partners: Ulster University, UK, Potioc, France

Abstract: This project objective is to design new tools for Big Data analysis, and in particular visual analytics tools that tap onto human cognitive skills as well as on Brain-Computer Interfaces. The goal is to enable the user to identify and select relevant information much faster than what can be achieved by using automatic tools or traditional human-computer interfaces. More specifically, this project will aim at identifying in a passive way various mental states (e.g., different kinds of attention, mental workload, relevant stimulus perception, etc.) in order to optimize the display, the arrangement of the selection of relevant information.

• Program: ERASMUS+

Project acronym: VISTE

Project title: Empowering spatial thinking of students with visual impairment

Duration: 2016-2019

Coordinator: National Technical University of Athens (Greece)

Local coordinator: Anke Brock

Other partners: Intrasoft International SA (Greece), Casa Corpolui Didatic Cluj (Romania), Liceul Special pentru Deficienti de Vedere Cluj-Napoca (Romania), Eidiko Dimotiko Sxolio Tiflon Kallitheas (Greece)

Abstract: VISTE addresses inclusion and diversity through an innovative, integrated approach for enhancing spatial thinking focusing on the unique needs of students with blindness or visual impairment. However, since spatial thinking is a critical competence for all students, the VISTE framework and associated resources and tools will focus on cultivating this competence through collaborative learning of spatial concepts and skills both for sighted and visually impaired students to foster inclusion within mainstream education. The VISTE project will introduce innovative educational practices for empowering students with blindness or visual impairment with spatial skills through specially designed educational scenarios and learning activities as well as through a spatial augmented reality prototype to support collaborative learning of spatial skills both for sighted and visually impaired students.

### 9.3.3. Collaborations with Major European Organizations

Partner 1: Univ. Freiburg, Brain State Decoding Laboratory (M. Tangermann), Germany

Topic 1: robust EEG spatial filters for single trial regression

Partner 2: TU Graz, Neural Engineering lab (R. Scherer), Austria

Topic 2: BCI pitfalls, negative results in BCI, guidelines for BCI design

Partner 3: EPFL, Defitech Foundation Chair in Brain-machine Interface (R. Chavarriaga), Switzerland

Topic 3: BCI pitfalls, negative results in BCI

Partner 4: Oldenbourg University, Neuropsychology department (S. Debener, C. Zich), Germany

Topic 4: guidelines for BCI design

Partner: Twente University (A. Nijholt), Enschede, The Netherlands Topic: Handbook of Brain-Computer Interfaces

## 9.4. International Initiatives

### 9.4.1. Inria International Labs

### 9.4.1.1. Other IIL projects

Presentation of Potioc research activities during the annual Inria-EPFL Workshop (Session MOOCS & e-learning)

### 9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Partner: Université du Québec à Montréal, Institut des Sciences Cognitives (R. N'Kambou), Montreal, Canada

Topic: Learning companions for Brain-Computer Interfaces

Partner: North Carolina State University (Chang S. Nam), USA

Topic: Handbook of Brain-Computer Interfaces

## 9.4.3. Participation in Other International Programs

Partner: Flowers & Potioc teams, Inria Bordeaux, University of Waterloo, Canada

Funding: Univ. Bordeaux/Univ Waterloo joint grant call for project Date: 2017-2018

Topic: Designing for Curiosity in Physical Spaces

## 9.5. International Research Visitors

### 9.5.1. Visits to International Teams

### 9.5.1.1. Research Stays Abroad

3 Members of team Potioc spend several months at the RIKEN Brain Science Institute (BSI), Cichocki's advanced brain signal processing laboratory, Wakoshi, Japan.

- Fabien Lotte: 10 months in total, with the JSPS (Japan Society for the Promotion of Science) Invitation fellowship program
- Léa Pillette: 6 months in total, funded by the RIKEN BSI
- Aurélien Appriou: 3 months in total, funded by the RIKEN BSI

# **TITANE Project-Team**

# 9. Partnerships and Cooperations

# 9.1. National Initiatives

## 9.1.1. ANR

9.1.1.1. 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.

- Starting date: October 2017 - Duration: 4 years

9.1.1.2. 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 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.

- Starting date: October 2017 - Duration: 4 years

## 9.2. European Initiatives

## 9.2.1. FP7 & H2020 Projects

9.2.1.1. TITANIUM - Software Components for Robust Geometry Processing

Type: IDEAS

Instrument: ERC Proof of concept

Duration: 18 months

Coordinator: Pierre Alliez

Inria contact: Pierre Alliez

Abstract: The TITANIUM project aims to develop a software demonstrator for geometry processing and 3D urban modeling, in order to facilitate the pre-commercialization of novel software components for the Computational Geometry Algorithms Library. The demonstrator will include novel approaches resulting from the ERC-funded IRON project (Robust Geometry Processing, StG-2010-257474), which are illustrated by publications presented at premier conferences in our field and a patent submitted in 2015. The expected outcomes of TITANIUM will be versatile methods for 3D reconstruction and simplification of data gathered from geometric measurements, as well as related methods specifically tailored to urban modeling. These methods represent a significant step forward by offering unrivaled levels of robustness, and automated generation of levels of detail that are semantically meaningful. The acronym TITANIUM, a robust and lightweight material, conveys our wish to streamline the geometric modeling pipeline through robust algorithms and lightweight representations. This Proof of Concept project will also implement the steps required for pre-commercialization. In view of this goal, we have included an industrial partner, GeometryFactory, a spinoff from Inria. We have already established preliminary contacts in the fields of metrology and geographic information systems. These contacts will provide real-world industrial case studies.

# 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, and Bedrich Benes from Purdue University.

# 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

- Mathieu Desbrun, Professor at Caltech, visited us from August to October.
- Gianmarco Cherchi, PhD student from University of Cagliary (Sardinia), visited us for three months (October-December) to collaborate on the refinement and optimization of polycubes.
- David Bommes, junior researcher from RWTH Aachen, visited us in September.

### 9.4.1.1. Internships

- Leman Feng (Ecole des ponts): Generation and optimization of high-order meshes. In collaboration with Laurent Busé and Hervé Delingette.
- Vinay Datta Renigunta (Hyderabad, India): Sinkorn iteration for optimal transport. In collaboration with David Cohen-Steiner.
- Armand Zampieri (Arts et Métiers Paristech): Aligning large-scale remote sensing images using neural networks.

# **ALMANACH Team**

# 9. Partnerships and Cooperations

# 9.1. National Initiatives

## 9.1.1. ANR

- **ANR SoSweet** (2015-2019, PI J.-P. Magué, resp. ALMAnaCH: DS; Other partners: ICAR [ENS Lyon, CRNS], Dante [Inria]). Topic: studying sociolinguistic variability on Twitter, comparing linguistic and graph-based views on tweets
- **ANR ParSiTi** (2016-2021, PI Djamé Seddah, Other partners: LIMSI, LIPN). Topic: context-aware parsing and machine translation of user-generated content
- **ANR PARSE-ME** (2015-2020, PI. Matthieu Constant, resp. Marie Candito [ALPAGE, then LLF], ALMAnaCH members are associated with Paris-Diderot's LLF for this project). Topic: multi-word expressions in parsing
- **ANR Profiterole** (2016-2020, PI Sophie Prévost [LATTICE], resp. Benoit Crabbé [ALPAGE, then LLF], ALMAnaCH members are associated with Paris-Diderot's LLF for this project). Topic: modelling and analysis of Medieval French
- **ANR TIME-US** (2016-2019, PI Manuela Martini [LARHRA], ALMAnaCH members are associated with Paris-Diderot's CEDREF for this project). Topic: Digital study of remuneration and time budget textile trades in XVIIIth and XIXth century France

### 9.1.2. Competitivity Clusters

- LabEx EFL (2010-2019, PI Christian Puech [HTL, Paris 3], Sorbonne Paris Cité). Topic: empirical foundations of linguistics, including computational linguistics and natural language processing. ALPAGE was one of the partner teams of this LabEx, which gathers a dozen of teams within and around Paris whose research interests include one aspects of linguistics or more. BS serves as deputy head (and former head) of one of the scientific strands of the LabEx, namely strand 6 dedicated to language resources. BS and DS are in charge of a number of scientific "operations" within strands 6, 5 ("computational semantic analysis") and 2 ("experimental grammar"). BS, EVdLC and DS are now individual members of the LabEx EFL since 1st January 2017, and BS still serves as the deputy head of strand 6. Main collaborations are on language resource development (strands 5 and 6), syntactic and semantic parsing (strand 5, especially with CRLAO [CNRS and U.Paris 13]) and computational morphology (strands 2 and 6, especially with CRLAO [CNRS and Inalco]).
- **PSL project LAKME** (2015-2017, PI Thierry Poibeau [LATTICE]). Topic: language resource development for morphologically rich languages, especially Rabbinic Hebrew (syntactic level), Medieval French (morphological level) and some Finno-Ugric languages (to a lesser extent).
- **PSL Iris project SCRIPTA** This project emanates from the history and philology department of the EPHE (DSBE). It is directed by Andreas Stauder (EPHE) with Philip Huyse (EPHE) and Charlotte Schmid (EFEO). It unites the forces of a great number of researchers in PSL (EPHE, ENS, EHESS, ENC, Collège de France and in addition the IRHT) working on written texts in all its forms, on all kinds of material, from all periods and regions and has important digital and computational ambitions especially with regard to epigraphy, palaeography, digital editions and NLP.

### 9.1.3. Other National Initiatives

• **TGIR Huma-Num** ALPAGE was a member of the CORLI consortium on "corpora, languages and interactions" (BS is a member of the consortium's board), and ALMAnaCH is in the process of joining this consortium. With a joint funding of Huma-Num and the H2020 project Parthenos (on which see below), ALMAnaCH members have also co-organised a workshop on 3D techniques for Humanities in Bordeaux (December 2016).

- Institut de Linguistique Française (ILF): ALPAGE was a member of this CNRS "federation". ALMAnaCH is in the process of joining this federation if possible, especially as BS is the scientific head of the "Corpus de Référence du Français" initiative, an ILF project whose other head is Franck Neveu and whose goal is to develop a French National Corpus, a resource that has been awaited for a long time.
- Notary registers project (2017-2018): An explorative study has been launched in collaboration with the National Archives in France, in the context of the framework agreement between Inria and the Ministry of Culture, to explore the possibility of extracting various components from gigitized 19th Century notary registers.
- Nénufar (DGLFLF Délégation générale à la langue française et aux langues de France): The projects is intended to digitize and exploit the early editions (beginning of the 20th Century) of the Petit Larousse dictionary. ALMAnaCH is involve to contribute to the automatic extraction of the dictionary content by means of GROBID-dictionaries and define a TEI compliant interchange format for all results.
- **PIA Opaline**: The objective of the project is to provide a better access to published French literature and reference material for visually impaired persons. Financed by the Programme d'Investissement d'Avenir, it will integrate technologies related to document analysis and re-publishing, textual content enrichment and dedicated presentational interfaces. Inria participate to deploy the GROBID tool suite for the automatic structuring of content from books available as plain PDF files.

# 9.2. European Initiatives

## 9.2.1. FP7 & H2020 Projects

- **H2020 Parthenos** (2015-2019, PI Franco Niccolucci [University of Florence]; LR is a work package coordinator) Topic: strengthening the cohesion of research in the broad sector of Linguistic Studies, Humanities, Cultural Heritage, History, Archaeology and related fields through a thematic cluster of European Research Infrastructures, integrating initiatives, e-infrastructures and other world-class infrastructures, and building bridges between different, although tightly interrelated, fields.
- **H2020 EHRI** "European Holocaust Research Infrastructure" (2015-2019, PI Conny Kristel [NIOD-KNAW, NL]; LR is task leader) Topic: transform archival research on the Holocaust, by providing methods and tools to integrate and provide access to a wide variety of archival content.
- **H2020 Iperion CH** (2015-2019, PI Luca Pezzati [CNR, IT], LR is task leader) Topic: coordinating infrastructural activities in the cultural heritage domain.
- **H2020 HIRMEOS**: HIRMEOS objective is to improve five important publishing platforms for the open access monographs in the humanities and enhance their technical capacities and services and rendering technologies, while making their content interoperable. Inria is responsable for improving integrating the entity-fishing component deplyed as an infrastructural service for the five platforms.
- **H2020 DESIR**: The DESIR project aims at contributing to the sustainability of the DARIAH infrastructure along all its dimensions: dissemination, growth, technology, robustness, trust and education. Inria is responsable for providing of a portfolio of text analytics services based on GROBID and entity-fishing.

### 9.2.2. Collaborations in European Programs, Except FP7 & H2020

- ERIC DARIAH "Digital Research Infrastructure for the Arts and Humanities" (set up as a consortium of states, 2014-2034; LR is president of the board of director) Topic: coordinating Digital Humanities infrastructure activities in Europe (17 partners, 5 associated partners).
- **COST enCollect** (2017-2020, PI Lionel Nicolas [European Academy of Bozen/Bolzano]) Topic: combining language learning and crowdsourcing for developing language teaching materials and more generic language resources for NLP

## 9.2.3. Collaborations with Major European Organizations

Informal collaborations with institutions not cited above (for the SPMRL initiative, see below):

- University of Ljubljana (Darja Fišer) [wordnet development]
- University of Zürich, Switzerland (Géraldine Walther) [computational morphology, lexicons]
- Academy of Sciences, Berlin, Germany (Karl-Heinz Moerth) [lexicology]
- University of Fribourg, Switzerland [historical document analysis]
- University of Valencia, Spain [historical document analysis]
- University of Groningen, Netherlands [historical document analysis]
- University of Innsbruck, Austria [historical document analysis]

## 9.3. International Initiatives

### 9.3.1. International Partners

- ANR-NSF project MCM-NL (2016-2020, PI John Hale [Cornell University, USA], resp. for Inria Paris / ALMAnaCH: EVdLC) Topic: exploring correlations between data from neuro-imagery (fMRI, EEG) and data from NLP tools (mostly parsers). The data will come from "Le Petit Prince" read in French and English, and parsed with different parsers. Other partners: Cornell Univ., Univ. Michigan, Paris Saclay/Neurospin, Univ. Paris 8. Informal collaborations:
- The SPMRL initiative (Statistical Parsing of Morphologically Rich Languages): a worldwide network of internationally renowned teams that was initiated during the IWPT'09 conference ALPAGE organised in Paris, DS playing a leading role since then. Other institutions involved include the University of Heidelberg (Germany), Bar Ilan University (Israel), Potsdam University (Germany) and Indiana University (USA). The outcomes of this initiative include the successful SPMRL Workshop and Shared Task series hosted successively by NAACL-HLT (2010), IWPT (2011), ACL (2012), EMNLP (2013), CoLing (2014) and IWPT (2015), in which DS as well as other ALPAGE/ALMAnaCH members played an active role. DS also served as a co-editor of a special issue of Computational Linguistics on this topic.
- Sofer Mahir ("fast scribe") project. Joint work on the computational processing of Rabbinic Hebrew manuscripts involving DSBE: Nachum Dershowitz (Tel Aviv University, Israel), Moshe Koppel (DICTA, Bar Ilan University, Israel), Meni Adler (DICTA, Ben Gurion University, Israel), Michael Elhadad (Ben Gurion University, Israel) on the NLP side and Hayim Lapin (University of Maryland, USA), Tal Ilan (FU Berlin, Germany) Shamma Friedmann (Bar Ilan University, Israel) on morphological analysis of Rabbinic Hebrew, alignment of manuscript witnesses (textual criticism), finding parallels, aligning related but different texts (like the Gospels). This work is also connected to the LAKME project mentioned above.

# 9.4. International Research Visitors

## 9.4.1. Visits of International Scientists

- Daniel Dakota (Indiana University, 4 months, until Jan 2017)
- Theresa Lynn (Dublin City University, 10 days in January 2017)
- Amir More (Open University of Israel, 10 days in April 2017)

### 9.4.1.1. Internships

• Basant Agarwal (ERCIM, Aug-Sep 2017)

# **COML Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

Collaboration with the Willow Team:

- co-advising with J. Sivic and I. Laptev of a PhD student: Ronan Riochet.
- construction of a naive physics benchmark

# 9.2. National Initiatives

## 9.2.1. ANR

Transatlantic Platform "Digging into Data". Title: "Analysis of Children's Language Experiences Around the World. (ACLEW)"; (coordinating PI : M. Soderstrom; Leader of tools development and co-PI : E. Dupoux), (2017–2020. 5 countries; Total budget: 1.4M€)

# 9.3. European Initiatives

## 9.3.1. FP7 & H2020 Projects

ERC Advanced Grant (BOOTPHON, PI: E. Dupoux, Budget 2.4M€).

# 9.4. International Initiatives

### 9.4.1. Informal International Partners

- Johns Hopkins University, Baltimore, USA: S. Kudanpur, H. Hermanksy
- RIKEN Institute, Tokyo, Japan: R. Mazuka

# 9.5. International Research Visitors

## 9.5.1. Visits of International Scientists

Valentina Gliozzi (Professor, Univ. di Torino, Visiting Professor Spring 2017)

# **MULTISPEECH Project-Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

## 9.1.1. CPER LCHN

Project acronym: CPER LCHN

Project title: CPER "Langues, Connaissances et Humanités Numériques"

Duration: 2015-2020

Coordinator: Bruno Guillaume (LORIA) & Alain Polguère (ATILF)

Participants: Dominique Fohr, Denis Jouvet, Odile Mella, Yves Laprie

Abstract: The main goal of the project is related to experimental platforms for supporting research activities in the domain of languages, knowledge and numeric humanities engineering.

MULTISPEECH contributes to automatic speech recognition, speech-text alignment and prosody aspects. This year we have also developped a complete system for the transcription of English broadcast TV shows to participate to the MGB challenge.

## 9.1.2. CPER IT2MP

Project acronym: CPER IT2MP

Project title: CPER "Innovation Technologique Modélisation et Médecine Personalisée"

Duration: 2015-2020

Coordinator: Faiez Zannad (Inserm-CHU-UL)

Participants: Romain Serizel, Vishnu Varanasi, Emmanuel Vincent

Abstract: The goal of the project is to develop innovative technologies for health, and tools and strategies for personalized medicine.

MULTISPEECH will investigate acoustic monitoring using an array of microphones.

### 9.1.3. Dynalips

Project title: Control of the movements of the lips in the context of facial animation for an intelligible lipsync.

Duration: February 2017 - January 2018

Coordinator: Slim Ouni

Participants: Valerian Girard, Slim Ouni

Funding: SATT

Abstract: We propose in this project the development of tools of lipsync which from recorded speech will provide realistic mechanisms of animating the lips. These tools will be available to be integrated into existing 3D animation software and existing game engines. One objective is that these lipsync tools fit easily into the production pipeline in the field of 3D animation and video games. The goal of this maturation is to propose a product ready to be exploited in the industry whether by the creation of a start-up or by the distribution of licenses.

# 9.2. National Initiatives

## 9.2.1. E-FRAN METAL

Project acronym: E-FRAN METAL

Project title: Modèles Et Traces au service de l'Apprentissage des Langues

Duration: October 2016 - September 2020

Coordinator: Anne Boyer (LORIA)

Other partners: Interpsy, LISEC, ESPE de Lorraine, D@NTE (Univ. Versailles Saint Quentin), Sailendra SAS, ITOP Education, Rectorat.

Participants: Theo Biasutto-Lervat, Anne Bonneau, Vincent Colotte, Dominique Fohr, Denis Jouvet, Odile Mella, Slim Ouni

Abstract: METAL aims at improving the learning of languages (both written and oral components) through the development of new tools and the analysis of numeric traces associated with students' learning, in order to adapt to the needs and rythm of each learner.

MULTISPEECH is concerned by oral language learning aspects.

### 9.2.2. PIA2 ISITE LUE

Project acronym: ISITE LUE

Project title: Lorraine Université d'Excellence

Duration: starting in 2016

Coordinator: Univ. Lorraine

Participants: Ioannis Douros, Yves Laprie

Abstract: The initiative aims at developing and densifying the initial perimeter of excellence, within the scope of the social and economic challenges, so as to build an original model for a leading global engineering university, with a strong emphasis on technological research and education through research. For this, we have designed LUE as an "engine" for the development of excellence, by stimulating an original dialogue between knowledge fields.

MULTISPEECH is mainly concerned with challenge number 6: "Knowledge engineering", i.e., engineering applied to the field of knowledge and language, which represent our immaterial wealth while being a critical factor for the consistency of future choices. In 2016, this project has funded a new PhD thesis.

# 9.2.3. ANR ContNomina

Project acronym: ContNomina

Project title: Exploitation of context for proper names recognition in diachronic audio documents

Duration: February 2013 - March 2017

Coordinator: Irina Illina

Other partners: LIA, Synalp

Participants: Dominique Fohr, Irina Illina, Denis Jouvet, Odile Mella, Imran Sheikh

Abstract: The ContNomina project was focus on the problem of proper names in automatic audio processing systems by exploiting in the most efficient way the context of the processed documents. To do this, the project has addressed the statistical modeling of contexts and of relationships between contexts and proper names; the contextualization of the recognition module (through the dynamic adjustment of the lexicon and of the language model in order to make them more accurate and certainly more relevant in terms of lexical coverage, particularly with respect to proper names); and the detection of proper names (on the one hand, in text documents for building lists of proper names, and on the other hand, in the output of the recognition system to identify spoken proper names in the audio/video data).

MULTISPEECH contributes to speech recognition and proper names handling (prediction, introduction in models, ...)

## 9.2.4. ANR DYCI2

Project acronym: DYCI2 (http://repmus.ircam.fr/dyci2/)

Project title: Creative Dynamics of Improvised Interaction

Duration: March 2015 - February 2018

Coordinator: Ircam (Paris)

Other partners: Inria (Nancy), University of La Rochelle

Participants: Ken Deguernel, Nathan Libermann, Emmanuel Vincent

Abstract: The goal of this project is to design a music improvisation system which will be able to listen to the other musicians, improvise in their style, and modify its improvisation according to their feedback in real time.

MULTISPEECH is responsible for designing a system able to improvise on multiple musical dimensions (melody, harmony) across multiple time scales.

### 9.2.5. ANR JCJC KAMoulox

Project acronym: KAMoulox

Project title: Kernel additive modelling for the unmixing of large audio archives

Duration: January 2016 - January 2019

Coordinator: Antoine Liutkus

Participants: Mathieu Fontaine, Antoine Liutkus

Abstract: The objective is to develop the theoretical and applied tools required to embed audio denoising and separation tools in web-based audio archives. The applicative scenario is to deal with large audio archives, and more precisely with the notorious "Archives du CNRS — Musée de l'homme", gathering about 50,000 recordings dating back to the early 1900s.

## 9.2.6. ANR ArtSpeech

Project acronym: ArtSpeech

Project title: Synthèse articulatoire phonétique

Duration: October 2015 - March 2019

Coordinator: Yves Laprie

Other partners: Gipsa-Lab (Grenoble), IADI (Nancy), LPP (Paris)

Participants: Ioannis Douros, Benjamin Elie, Yves Laprie, Anastasiia Tsukanova

Abstract: The objective is to synthesize speech from text via the numerical simulation of the human speech production processes, i.e. the articulatory, aerodynamic and acoustic aspects. Corpus based approaches have taken a hegemonic place in text to speech synthesis. They exploit very good acoustic quality speech databases while covering a high number of expressions and of phonetic contexts. This is sufficient to produce intelligible speech. However, these approaches face almost insurmountable obstacles as soon as parameters intimately related to the physical process of speech production have to be modified. On the contrary, an approach which rests on the simulation of the physical speech production process makes explicitly use of source parameters, anatomy and geometry of the vocal tract, and of a temporal supervision strategy. It thus offers direct control on the nature of the synthetic speech.

Acquisition and processing of cineMRI, new developments of acoustic simulations concercing the production of fricatives and trills, and first workds in the implementation of coarticulation in articulatory synthesis are the main activities of this year.

### 9.2.7. ANR VOCADOM

Project acronym: VOCADOM (http://vocadom.imag.fr/)

Project title: Robust voice command adapted to the user and to the context for AAL

Duration: January 2017 - December 2020

Coordinator: CNRS - LIG (Grenoble)

Other partners: Inria (Nancy), Univ. Lyon 2 - GREPS, THEORIS (Paris)

Participants: Dominique Fohr, Sunit Sivasankaran, Emmanuel Vincent

Abstract: The goal of this project is to design a robust voice control system for smart home applications. We are responsible for the speech enhancement and robust automatic speech recognition bricks.

MULTISPEECH is responsible for wake-up word detection, overlapping speech separation, and speaker recognition.

### 9.2.8. FUI VoiceHome

Project acronym: VoiceHome

Duration: February 2015 - July 2017

Coordinator: VoiceBox Tachnologies France

Other partners: Orange, Delta Dore, Technicolor Connected Home, eSoftThings, Inria (Nancy), IRISA, LOUSTIC

Participants: Irina Illina, Karan Nathwani, Emmanuel Vincent

Abstract: The goal of this project was to design a robust voice control system for smart home and multimedia applications. We were responsible for the robust automatic speech recognition brick.

MULTISPEECH was responsible for robust automatic speech recognition by means of speech enhancement and uncertainty propagation.

### 9.2.9. MODALISA

Project acronym: MODALISA

Project title: Multimodality during Language Acquisition: Interaction between Speech Signal and gestures

Duration: January 2017 - December 2017

Coordinator: Christelle Dodane (Praxiling, UMR 5267, Montpellier)

Other partners: Slim Ouni

Participants: Slim Ouni

Funding: CNRS DEFI Instrumentation aux limites

Abstract: The objective of this project was to setup a multimodal platform allowing simultaneous visualization of gestural (motion capture system) and prosodic data during speech and more specifically during language acquisition.

Les contributions de MULTISPEECH concernent l'acquisition et le traitement des données multimodales grâce à la plateforme multimodale MultiMod.

## 9.3. European Initiatives

### 9.3.1. Collaborations in European Programs, Except FP7 & H2020

9.3.1.1. AMIS

Program: CHIST-ERA Project acronym: AMIS Project title: Access Multilingual Information opinionS Duration: Dec 2015- Nov 2018 Coordinator: Kamel Smaïli

Other partners: University of Avignon, University of Science and Technology Krakow, University of DEUSTO (Bilbao)

Participants: Dominique Fohr, Denis Jouvet, Odile Mella

Abstract: The idea of the project is to develop a multilingual help system of understanding without any human being intervention. What the project would like to do, is to help people understanding broadcasting news, presented in a foreign language and to compare it to the corresponding one available in the mother tongue of the user.

MULTISPEECH contributions concern mainly the speech recognition in French, English and Arabic videos.

### 9.3.2. Collaborations with Major European Organizations

Jon Barker: University of Sheffield (UK)

Robust speech recognition [22], [10], [9], [70]

## 9.4. International Initiatives

### 9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Shinji Watanabe, Johns Hopkins University (USA) Robust speech recognition [22], [10], [9], [70]

### 9.4.2. Participation in Other International Programs

9.4.2.1. PHC UTIQUE - Arabic speech synthesis

PHC UTIQUE - Arabic speech synthesis, with ENIT (École Nationale d'Ingénieurs de Tunis, Tunisia)

Duration: 2015 - 2018.

Coordinators: Vincent Colotte (France) and Zied LACHIRI (Tunisia).

Participants: Vincent Colotte, Amal Houidhek, Denis Jouvet

Abstract: Modeling of a speech synthesis system for the Arabic language. This includes the use of an Arabic speech corpus, the selection of linguistic features relevant to an Arabic speech synthesis, as well as improving the quality of the speech signal generated by the system (prosodic and acoustic features).

MULTISPEECH co-supervises PhD students.

9.4.2.2. FIRAH - La famille face au handicap

Program: FIRAH, International Foundation of Applied Disability Research

Project title: La famille face au handicap : la gestion du stress parental des parents d'enfants souffrant du syndrome de Dravet

Duration: Jan 2017- Dec 2019

Coordinator: T. Leonova, University of Lorraine (Perseus)

Other partners: MHS-USR 3261 CNRS, Université de Lorraine, Associations Alliance Syndrome de Dravet (France) and Alliance Syndrome de Dravet (Suisse), Hopital de Hautepierre - Strasbourg University (France), Hopital Necker enfants malades - Paris Descartes University - INSERM U1129, Hôpital Robert Debré - Paris Diderot University- INSERM U1141, Hôpitaux Universitaires de Genève - Université de Genève (Suisse), Université catholique du Sacré Cœur - Rome (Italie), Quebec University (Canada), McMaster Children's Hospital - McMaster University - Hamilton (Canada), MIA518-AgroParisTech/INRA.

Participant: Agnès Piquard-Kipffer

Abstract: the aims of the project are, in a first step, to explore parental stress with Chidren with Dravet syndrom which combine infant epilepsy and autism and in a second step to create a training programm for professionnals of Education [68], [69]

In this project, MULTISPEECH is involved in finding the best ways to maximize the communication efficiency between the children and their families, using the methodology or the tools created by the Handicom project.

# 9.5. International Research Visitors

### 9.5.1. Visits of International Scientists

### Ziteng Wang

Date: Sep 2016 - Sep 2017

Institution: Institute of Acoustics, Chinese Academy of Sciences (China)

Vishnuvardhan Varanasi

Date: Feb - Aug 2017

Institution: Indian Institute of Science, Kanpur (India)

Md Sahidullah

Date: Aug - Oct 2017

Institution: University of Eastern Finland (Finland)

## 9.5.2. Visits to International Teams

### 9.5.2.1. Research Stays Abroad

Antoine Liutkus was invited by Kazuyoshi Yoshii (RIKEN, Kyoto University) to work on multichannel extensions to his tensor-factorization methods, that would also allow for much easier inference. This led to a joint publication [47] about the resulting method.

# **PANAMA Project-Team**

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. Labex Comin Labs projects

CominLabs is a Laboratoire d'Excellence funded by the PIA (Programme Investissements d'Avenir) in the broad area of telecommunications.

### 9.1.1.1. HEMISFER

Participant: Rémi Gribonval.

Acronym: HYBRID (Hybrid Eeg-MrI and Simultaneous neuro-feedback for brain Rehabilitation)

http://www.hemisfer.cominlabs.ueb.eu/

Research axis: 3.1

CominLabs partners : VISAGES, HYBRID and PANAMA Inria project-teams;

External partners : EA 4712 team from University of Rennes I; ATHENA Inria project-team, Sophia-Antipolis;

Coordinator: Christian Barillot, VISAGES Inria project-team

Description: The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. We propose to combine advanced instrumental devices (Hybrid EEG and MRI platforms), with new man-machine interface paradigms (Brain computer interface and serious gaming) and new computational models (source separation, sparse representations and machine learning) to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major neurological and psychiatric disorders of the developmental and the aging brain (stroke, attention-deficit disorder, language disorders, treatment-resistant mood disorders, ...).

Contribution of PANAMA: PANAMA, in close cooperation with the VISAGES team, contributes to a coupling model between EEG and fMRI considered as a joint inverse problem addressed with sparse regularization. By combining both modalities, one expects to achieve a good reconstruction both in time and space. This new imaging technique will then be used for improving neurofeedback paradigms in the context of rehabilitation and psychiatric disorders, which is the final purpose of the HEMISFER project.

#### 9.1.1.2. TEPN

Participant: Rémi Gribonval.

Acronym: TEPN (Toward Energy Proportional Networks)

#### http://www.tepn.cominlabs.ueb.eu/

Research axis: 3.1

CominLabs partners : IRISA OCIF - Telecom Bretagne; IETR SCN; IETR SCEE; PANAMA Inria project-team

Coordinator: Nicolas Montavont, IRISA OCIF - Telecom Bretagne

Description: As in almost all areas of engineering in the past several decades, the design of computer and network systems has been aimed at delivering maximal performance without regarding to the energy efficiency or the percentage of resource utilization. The only places where this tendency was questioned were battery-operated devices (such as laptops and smartphones) for which the users accept limited (but reasonable) performance in exchange for longer use periods. Even though the end users make such decisions on a daily basis by checking their own devices, they have no way of minimizing their energy footprint (or conversely, optimize the network resource usage) in the supporting infrastructure. Thus, the current way of dimensioning and operating the infrastructure supporting the user services, such as cellular networks and data centers, is to dimension for peak usage. The problem with this approach is that usage is rarely at its peak. The overprovisioned systems are also aimed at delivering maximal performance, with energy efficiency being considered as something desired, but non-essential. This project aims at making the network energy consumption proportional to the actual charge of this network (in terms of number of served users, or requested bandwidth). An energy proportional network can be designed by taking intelligent decisions (based on various constraints and metrics) into the network such as switching on and off network components in order to adapt the energy consumption to the user needs. This concept can be summarized under the general term of Green Cognitive Network Approach.

Contribution of PANAMA: PANAMA, in close cooperation with the SCEE team at IETR (thesis of Marwa Chafii, 2016), focuses on the design of new waveforms for multi carrier systems with reduced Peak to Average Power Ratio (PAPR).

### *9.1.2. ANR INVATE project with IRT b<>com, Rennes*

Participants: Rémi Gribonval, Nancy Bertin, Mohammed Hafsati.

Thesis on 3D audio scene decomposition for interactive navigation Duration: 3 years (2016-2019) Research axis: 3.2.2 Partners: IRT b<>com; Inria-Rennes; IRISA Funding: ANR INVATE project (PIA)

The objective of this thesis is to develop tools to analyze audio scenes in order to identify, locate, and extract the sources present in the scene to re-spatialize them according to the user head orientation and the movement of the user in the targeted virtual scene.

### 9.1.3. ANR OATMIL project

Participants: Rémi Gribonval, Antoine Chatalic.

Duration: 4 years (2017-2021)

Acronym: OATMIL (Bringing Optimal Transport and Machine Learning Together)

# http://people.irisa.fr/Nicolas.Courty/OATMIL/

Research Axis 3.1

Partners: Obelix team and PANAMA Inria project-team, IRISA; LITIS, Rouen; Lagrange Laboratory, Nice; Technicolor R&I France, Rennes.

Coordinator: Nicolas Courty (Obelix team)

Description: The OATMIL project will propose novel concepts, methodologies, and new tools for exploiting large data collections. This will result from a cross-fertilization of fundamental tools and ideas from optimal transport (OT) and machine learning (ML). The main objective of OATMIL is to develop new techniques for large-scale machine learning, encompassing adaptability, scalability, and robustness, by a cross-fertilization of ideas coming from OT and ML. This cross-fertilization leads to two complementary scientific challenges : bringing OT to ML and bringing ML to OT.

Contribution of PANAMA: PANAMA will explore the use of dimension-reduction with sketching strategies in the context compressive optimal transport.

Funding: ANR

### 9.1.4. OSEO-FUI: voiceHome

Participants: Nancy Bertin, Frédéric Bimbot, Romain Lebarbenchon, Ewen Camberlein.

Duration: 3 years (2015-2017)

Research axis: 3.2

Partners: voicebox (formerly known as onMobile), Delta Dore, eSoftThings, Orange, Technicolor R&I France, LOUSTIC, Inria Nancy

Coordinator: voicebox

Description: The goal of the project is to design and implement a multi-channel voice interface for smart home and multimedia (set-top-box) appliances.

Contributions of PANAMA are focused on audio source localization and separation with distant microphones in real environments. In both cases, the issue of energy frugality is central and strongly constrains the available resources. This cooperation, which reached its end in November 2017, allowed us to make progress towards operational low-resource audio source localization and separation schemes, to disseminate software, collected data and scientific results, and to identify new research and development perspectives in adaptive microphone array processing for fast and robust audio scene analysis.

# 9.2. International Initiatives

## 9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

PANAMA has strong recurrent collaborations with the LTS2 lab at EPFL, the Center for Digital Music at Queen Mary University of London, the Institute for Digital Communications at the University of Edimburgh, and the Institute for Mathematics of the Postdam University.

# 9.3. International Research Visitors

### 9.3.1. Visits of International Scientists

- Flavio Castro Alves Teixeira, in May-June 2017, Post-doc, University of Innsbruck, Austria
- Pierre Vandergheynst, in June-July 2017, Professor of Signal and Image Processing, EPFL (Chaire Internationale Inria), Lausanne, Switzerland
- Gilles Blanchard, in September 2017, Professor, University of Potsdam, Germany
- Mike Davies, in October 2017, Professor, University of Edimburgh, UK
- Jérémy Cohen, in November 2017, Post-doc, University of Mons, Belgium
- Andreas Loukas, in December 2017, Post-doc, EPFL, Lausanne, Switzerland

9.3.1.1. Internships

- Helena Peic Tukuljac, from October to December 2017, PhD Student at EPFL, Lausanne, Switzerland
- Martin Strauss, from October to December 2017, M1 student, Friedrich-Alexander University, Erlangen, Germany

# **SEMAGRAMME Project-Team**

# 7. Partnerships and Cooperations

# 7.1. Regional Initiatives

## 7.1.1. SLAM

Participants: Maxime Amblard [coordinator], Philippe de Groote, Sylvain Pogodalla.

Schizophrenia is well known among mental illnesses for the strength of the thought disorders it involves, and for their widespread and spectacular manifestations: from deviant social behavior to delusion, not to speak about affective and sensitive distortions. The SLAM project aims at exploring the specific manifestation of disorders in conversational speech. This is an interdisciplinary research, both empirical and theoretical, from several domains, namely psychology, philosophy, linguistic, and computer science.

After having built building a corpus of pathological uses of language [9], the first transcriptions of pathological interviews have been analyzed [8]. A processing chain was implemented for disfluences and part-of-speech. We have focused on implementing the treatment of lexicographical issues, and proposed an interface for SDRT-annotations. We also started to collect new data with new patients at the Centre Médical d'Aix-en-Provence, and to re-implement the SLAMtk tool.

The SLAM project was supported by the MSH–Lorraine, USR 3261, the region Grand Est, and the Université de Lorraine. We have organized the fourth workshop (In)Coherence of Discourse which gathered linguists, psychologists, and computer scientists in March 2017.

# 7.2. National Initiatives

## 7.2.1. DGLFLF (Délégation générale à la langue française et aux langues de France)

### 7.2.1.1. PLURAL

Participants: Bruno Guillaume [coordinator], Nicolas Lefebvre.

The objective of the PLURAL project is to build linguistic resources with GWAPs (Game With A Purpose) for poorly endowed languages. Unlike other languages, poorly endowed languages lack of freely available raw corpora. The goal of the PLURAL project is to provide a web inferface to gather corpora in poorly endowed languages of France. First target languages are Alsacian and Guadeloupean creole. The main difficulty is to take into account orthographic diversity and regional diversity for these languages.

Partners of the PLURAL projet are: Université Paris-Sorbonne (Karën Fort, Alice Millour, André Thibault) and Université de Strasbourg (Delphine Bernhard).

Nicolas Lefebvre is engineer in the PLURAL project from October 2017 to March 2018.

# 7.3. International Initiatives

## 7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

Maxime Amblard have started discussing with the Centre for Linguistic Theory and Studies in Probability (CLASP, University of Gothenburg, Sweden), about computational treatments of dialogues of patients with schizophrenia. We have common issues about the management such corpora and about the modeling of such interactions. As for now, ongoing discussions have not yet been turned into a formal project.

# 7.4. International Research Visitors

### 7.4.1. Visits to International Teams

### 7.4.1.1. Research Stays Abroad

Timothée Bernard visited New York University, USA, from September 1st to December 15th, 2017.

# **CHROMA Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. COMODYS project, FIL (Federation d'Informatique de Lyon), 2017-19

Participants: Laetitia Matignon, Olivier Simonin, Alessandro Renzaglia, Jilles Dibangoye.

Project of the Informatics Federation of Lyon (FIL) between two teams of two laboratories: CHROMA (CITI) and SMA (LIRIS), entitled "COoperative Multi-robot Observation of DYnamic human poSes", 2017-2019. Leader : L. Matignon & O. Simonin.

This project funds materials, missions and internships and its objectives are the on-line adaptation of a team of robots that observe and must recognize human activities.

### 9.1.2. CORDES ADT Inria project, 2017-18

Participants: Olivier Simonin, Jilles Dibangoye, Alessandro Renzaglia, Vincent Le Doze.

The project CORDES (Coordination d'une Flotte de Drones Connectés pour la Cartographie 3D d'édifices) is an Inria ADT coordinated by Olivier Simonin. It funds an Inria expert engineer position in Chroma (Vincent Le Doze, 10/17-11/19) focusing on UAVs control and path-planning. The project aims to deploy a fleet of UAVs able to autonomously fly over an unknown infrastructure and to build a 3D map.

### 9.1.3. Regional AAP ARC6 project, 2015-18

Participants: Olivier Simonin, Anne Spalanzani, Fabrice Valois [Insa de Lyon, Inria AGORA].

Regional project (Rhône-Alpes) "Mobilité au sein de flottes de robots sous contrainte de maintien de la connectivité" ARC6, 2015-2018. Leader : O. Simonin.

This project funds the PhD thesis of Mihai-Ioan Popescu, who started on november 2015, and co-advized by O. Simonin, A. Spalanzani and F. Valois. The project involves also the Pole de compétitivité "Via Meca".

### 9.1.4. Regional AAP ARC6 project 'TENSIVE', 2016-19

Participants: Remi Cambuzat, Gérard Bailly [CNRS, GIPSA Lab. Grenoble], Olivier Simonin, Anne Spalanzani.

Regional project (Rhône-Alpes) "TENSIVE Robots de TEléprésence : Navigation Sociale et Interaction VErbale immersives" ARC6, 2016-2019. Leader : G. Bailly.

This project funds the PhD thesis of Remi Cambuzat who started on october 2016, and co-advized by G. Bailly (Dir.), O. Simonin and A. Spalanzani.

## 9.2. National Initiatives

### 9.2.1. ANR

### 9.2.1.1. ANR "VIMAD" (2015-17)

The VIMAD project, led by A. Martinelli, aims at developing a robust and reliable perception system, only based on visual and inertial measurements, to enhance the navigation capabilities of fully autonomous micro aerial drones. It also aims at acquiring a deep theoretical comprehension of the problem of fusing visual and inertial measurements, by investigating its observability properties in challenging scenarios.

The activities related to this project, followed the work-plan (first year). They regarded the usage of our closed-form solution (recently published on the journal of computer vision, [64]) in the framework of micro aerial navigation in order to:

- 1. automatically perform state initialization;
- 2. improve the data matching process.

Additionally, the activities of VIMAD regarded the investigation of an unsolved problem in control theory, which is the unknown input observability problem in the nonlinear case, and its applications to the visual-inertial structure from motion problem.

See section 3.2.5 for a description of the results obtained during this year of the project.

#### 9.2.1.2. ANR "Valet" (2016-18)

The ANR VALET project proposes a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers. An optimal routing algorithm is in charge of defining platoons drivers' routes to the parking areas where the followers are parked in a complete automated mode. The consortium is made of 2 academic partners : Inria (RITS, Chroma, Prima) and Ircyyn Ecole Centrale de Nantes and the AKKA company. The phD student (Pavan Vashista) recruited in this project focus on integrating models of human behaviors to evaluate and communicate a risk to pedestrians that may encounter the trajectory of the VALET vehicle. His phD thesis started in february 2016 and is codirected by D. Vaufreydaz (Inria/PervasiveInteraction).

### 9.2.1.3. ANR "HIANIC" (2017-20)

The HIANIC project, led by A. Spalanzani, proposes to endow autonomous vehicles with smart behaviors (cooperation, negotiation, socially acceptable movements) that better suit complex SharedSpace situations. It will integrate models of human behaviors (pedestrian, crowds and passengers), social rules, as well as smart navigation strategies that will manage interdependent behaviors of road users and of cybercars. The consortium is made of 3 academic partners: Inria (RITS, Chroma, Pervasive Interaction teams), Lig Laboratory (Magma team) and LS2N laboratory (ARMEN and PACCE teams). A. Spalanzani is the leader of this project.

### 9.2.1.4. PIA Ademe "CAMPUS" (2017-20)

The CAMPUS project aims to identify, develop and deploy new functions for the autonomous cars in urban environments. In this project, Chroma will focus on finding solutions to navigate in complex situations such as crowded environments or dense traffic. The consortium is made of 1 academic partner: Inria (Rits and Chroma teams) and 3 companies: Safran electronics, Gemalto and Valeo.

### 9.3. European Initiatives

## 9.3.1. FP7 & H2020 Projects

Program: ECSEL

Project acronym: ENABLE-S3

Project title: European Initiative to Enable Validation for Highly Automated Safe and Secure Systems

Duration: June 2016 – May 2019

Coordinator: AVL List GesmbH

Other partners: Major European Organizations, including academic partners (such as Inria or KIT) and a Large number of industrial partners from various application domains such as automotive industry or Aeronautics or Train industry

Abstract: ENABLE-S3 is *industry-driven* and therefore aims to foster the leading role of the European industry. This is also reflected in its *use case driven approach*. The main technical objectives are extracted from the use cases defined by the industrial partners, in order to validate the success of the developed methods and tools.

The ENABLE-S3 project will provide European industry with leading-edge technologies that support the development of reliable, safe and secure functions for highly automated and/or autonomously operating systems by enabling the validation and verification at reduced time and costs.

Enables-S3 is a large European consortium, involving a French consortium leaded by Renault and Inria Grenoble Rhône-Alpes. The Inria Tamis team (Rennes) is also involved in the project.

### 9.3.2. Collaborations with Major European Organizations

ETHZ, Zurich, Autonomous System laboratory, (Switzerland) University of Zurich, Robotics and Perception Group (Switzerland) Vision and IMU data Fusion for 3D navigation in GPS denied environment. Karlsruhe Institut fur Technologie (KIT, Germany) Autonomous Driving (student exchanges and common project). University of Babes-Bolyai, Cluj-Napoca (Romania). Multi-robot patrolling and Machine Learning (PHC "DRONEM" 2017-18). Vislab Parma (Italy) Embedded Perception & Autonomous Driving (visits, projects submissions, and book chapter in the new edition of the Handbook of Robotics).

## 9.4. International Initiatives

## 9.4.1. Inria International Labs

Program: International Center of Excellence Duration: 2012 – 2017 Coordinator: C. Laugier Other partners: UPMC & CNRS (France), NTU (Taiwan)

The iCeiRA <sup>0</sup> international robotics laboratory led by Prof. Ren Luo from NTU (Taiwan) and strongly supported by the Taiwanese government, has been launched in 2012 for 5 years. Christian Laugier (Inria) and Raja Chatila (UPMC & CNRS) have actively participated to the starting of this laboratory in 2012 and are external Principal Investigators. The addressed research is about the concept of Human centered robotics.

## 9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- UC Berkeley & Stanford University (CA, USA) Subject: Autonomous Driving (postdoc in the scope of Inria@SV, common publications and patent).
- NUS Singapore & NTU Singapore.
   Subject: Autonomous Driving (visits, common ICT Asia project, common organization of workshops, review of PhD students).
- Massachussetts Institute of Technology (MIT), Cambridge, MA (USA) Subject: Decentralized Control of Markov Decision Processes.
   Subject: Autonomous Driving (visits and common organization of a workshop).

## 9.5. International Research Visitors

### 9.5.1. Visits of International Scientists

 Visits of researchers from University Babes-Bolyai, Cluj-Napoca (Romania). In the context of our PHC "DRONEM" (2017-18), some members from the MLyRE team visited CHROMA, at CITI lab. in Lyon, July 8-13. Prof. Gabriela Czibula, Dr. Istvan-Gergely Czibula, Dr. Marian Zsuzsanna-Edit and Diana Lucia-Miholca given some talks about Machine Learning.

<sup>&</sup>lt;sup>0</sup>International Center of Excellence in Intelligent Robotics and Automation Research.

# **DEFROST Project-Team**

# 9. Partnerships and Cooperations

## 9.1. National Initiatives

### 9.1.1. Inserm

Olivier Goury was hired as a postdoctoral researcher by the "Réhabilitation chirurgicale mini-invasive et robotisée de l'audition" to collaborate with the DEFROST team on the simulation of Cochlear Implant surgery. The contract stopped since Olivier has been recruited as a Research scientist. The collaboration with Inserm has been continued since, with the hiring of Piyush Jain as an engineer.

### 9.1.2. ANR

- Tremplin ERC Christian Duriez recieved a ANR grant "tremplin ERC" (150k€) given the result obtained last year on the ERC proposal (evaluated at "grade A"). The project has allowed to allocate new resources on the developments that were presented in this ERC.
- **CO2DMod** Control-Oriented Data-Driven Modeling of Complex System. The goal of this project was to propose Data-Driven Modelling technique (model reduction as well as model identification) that provides an Uncertainty Certificate (UC). The goal of these certificates are (i) to guarantee that the models obtained from data are good enough for control, (ii) to help the user determine the class of controller design problem the model is tuned for. Unfortunately, the project has not been funded. It was resubmitted this year with hopefully a better outcome.
- **ROBOCOP** ROBOtization of COchlear imPlant. ROBOCOP aims at creating a new prototype of cochlear implant, and robotize (i.e. actuate and control) its insertion process to facilitate the work of surgeon, to increase the success ratio, and to decrease the probability of trauma. Partnership with IEMN (Institute of Electronics, Microelectronics and Nanotechnology), OTICON Medical and UMRS-1159 at Inserm. This project was submitted in 2017 and we are awaiting the answer from the ANR.

### 9.2. European Initiatives

### 9.2.1. Collaborations in European Programs, Except FP7 & H2020

### Program: FEDER

Project acronym: COMOROS

Project title: Control of deformable robots for surgery

Duration april 2017 to march 2020 (in two phases)

Coordinator: C. Duriez

Abstract: Surgical procedures are often carried out using instruments made of stiff materials that interact with delicate biological tissues such as internal organs, blood vessel walls and small cavities. This incompatibility of stiffness is one of the sources of danger in many surgical procedures. The use of robots made of soft materials, also called soft robots, would limit such risks by reducing contact pressures and stress concentrations. Their intrinsic deformability would also increase the ability to manoeuvre in confined spaces. However, the promising concept of using soft robots for surgical procedures cannot be practically implemented, due to the lack of precise modelling and control methods for soft robots. This scientific obstacle, identified as a pending issue by major surveys in this field, becomes particularly challenging when interacting with an environment as complex as the human anatomy. Drawing on our background in soft tissue simulation, contact models, surgical applications and soft robotics, our ambition in this project is to:

- Develop accurate and generic numerical methods for continuum mechanics, adapted to strong real-time constraints in order to demonstrate the ability to model soft mechatronics systems.
- Reconsider parametrization methodologies of digital models of the patient anatomy through the observation of mechanical interactions with soft robots via embedded sensors and medical imaging.
- Rethink motion generation and teleoperation control with force feedback so as to be compatible with the large number of degrees of freedom of soft robots and be based on accurate, rapidly-computed deformable models and interaction models.

The project also targets the development of software with the required performance and features, as well as the experimental validation of models and methods using prototypes in realistic environments.

## 9.2.2. Collaborations with Major European Organizations

- Université Libre Brussels, Pr. Terwagne, Pr.Massar and Mr Tillema
- Artificial Intelligence Algorithms for the control of soft robots, based on the simulation (associated north-european team 2016-2017)
- University of Luxembourg: Pr Bordas
- Model order reduction and topological changes (journal in 2013 & submission of a proposal in 2017)
- King's college: Pr Liu
- Robotic catheter navigation and control and soft surgcial robotics (conference publication at IROS in 2017)

## 9.3. International Research Visitors

### 9.3.1. Visits of International Scientists

Margaret Koehler is a PhD student in Mechanical Engineering from the Collaborative Haptics and Robotics in Medicine (CHARM) Lab at Stanford University, led by Allison Okamura. Her PhD topic is "Design and Control of Soft Haptic Devices." Supported by a Chateaubriand Fellowship in partnership with Inria, she is conducting a 6-month research internship with the DEFROST team from September 2017 through February 2018. Her internship is part of a year-long collaboration between the DEFROST team and the CHARM Lab. In 2018, Christian Duriez will spend six months as a visiting scholar in the CHARM Lab to continue this exchange. The collaboration focuses on the development of a soft haptic device using the SOFA framework and soft robot control methods developed by the DEFROST team for design and control.

# **FLOWERS Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. Poppy Education

Poppy Education Program: Feder - Région Aquitaine Duration: January 2014 - December 2017 Coordinator: PY Oudeyer, Inria Flowers Partners: Inria Flowers

Funding: 1 million euros (co-funded by Feder/EU Commission, Region Aquitaine and Inria)

Poppy Education aims to create, evaluate and disseminate pedagogical kits "turnkey solutions" complete, open-source and low cost, for teaching computer science and robotics. It is designed to help young people to take ownership with concepts and technologies of the digital world, and provide the tools they need to allow them to become actors of this world, with a considerable socio-economic potential. It is carried out in collaboration with teachers and several official french structures (French National Education/Rectorat, Highschools, engineering schools, ...). It targets secondary education and higher education, scientific literacy centers, Fablabs.

Poppy robotic platform used in the project is free hardware and software, printed in 3D, and is intended primarily for:

- learning of computer science and robotics,
- introduction to digital manufacturing (3D printing ...)
- initiation to the integration of IT in physical objects in humanoid robotics, mechatronics.
- artistic activities.

Educational sectors covered by the project are mainly: Enseignement d'exploration ICN en seconde, enseignement ISN en terminale S et bientôt en 1ère, filière STI2D, MPS seconde. Web: http://www.poppy-project.org/ education.

#### 9.1.1.1. Perseverons Project

The Perseverons project (Perseverance with / by digital objects), carried by the university via the ESPE (Higher School of Teaching and Education) of Aquitaine, and by the Rectorate of Bordeaux via the DANE (Academic Delegation digital education), aims to measure the real effectiveness of digital techniques in education to improve school motivation and perseverance, and, in the long term, reduce dropout. The project proposes to analyze the real effects of the use of two types of objects, robots, tablets, by comparing the school and non-school contexts of the *fablabs*. He is one of the 22 winners http://www.gouvernement.fr/efran-les-22-laureats of the "E-Fran" call for projects (training, research and digital animation spaces), following the Monteil mission on digital education, as part of the Investissement d'Avenir 2 program http:// ecolenumerique.education.gouv.fr/2016/09/23/1244/. Formed of 12 sub-projects, "perseverons" has many partnerships, especially with the Poppy Education project http://perseverons.espe-aquitaine.fr/sp6-robotique-inria/.

9.1.1.2. Partner schools

In 2017, we have 36 partner schools (show Fig 25). 15 directly from the Poppy Education project. 19 new establishments were equipped in September 2017 by the Perseverons project. 21 of these establishments are located in Gironde. We have 27 high schools, 5 middle school.

Attachement	Туре	Name	Adresse	Tel	Web
Poppy Éducation	High School	Alfred Kastler	14 Avenue de l'Université,33402 Talence, France	+33 5 57 35 40 70	http://www.lyceekastler.fr/
Poppy Éducation	Middle School	Anatole France	28 Rue des Micocouliers,33410 Cadillac, France	+33 5 56 62 98 42	http://www.afcadillac.net/
PERSEVERONS	High School	André Malraux	3 Rue du 8 Mai 1945,64200 Biarritz, France	+33 5 59 01 20 40	http://lycee-malraux-biarritz.fr/
Poppy Éducation	High School	Camille Jullian	29 Rue de la Croix Blanche,33000 Bordeaux, France	+33 5 56 01 47 47	http://www.camillejullian.com/
Poppy Éducation	Middle School	de France	Rue du Cimetière Saint-Benoist,75005 Paris, France	+33 1 44 27 12 11	http://www.college-de-france.fr/
Poppy Éducation	High School	des Graves	238 Cours du Général de Gaulle,33170 Gradignan, France	+33 5 56 75 77 56	http://www.grandlebrun.com/
PERSEVERONS	High School	Élie Faure	63 Avenue de la Libération,33310 Lormont, France	+33 5 56 38 23 23	http://www.lyc-eliefaure.fr/
PERSEVERONS	High School	Elisée Reclus	7 Avenue de Verdun,33220 Pineuilh, France	+33 5 57 41 92 50	http://lycee-foyen.fr/
Poppy Éducation	High School	François Mauriac	1 Rue Henri Dunant,33000 Bordeaux, France	+33 5 56 38 52 82	http://lyceemauriac.fr/
PERSEVERONS	High School	Gaston Febus	20 Avenue Georges Moutet,64300 Orthez, France	+33 5 59 67 07 26	http://webetab.ac-bordeaux.fr/cite-gaston-febus- orthez/
PERSEVERONS	Middle School	Giraud de Borneil	10 Boulevard André Dupuy,24160 Excideuil, France	+33 5 53 62 21 16	http://www.gdeborneil.fr/
PERSEVERONS	High School	Grand Air	Avenue du Docteur Lorentz Monod,33120 Arcachon, France	+33 5 56 22 38 00	http://webetab.ac-bordeaux.fr/lycee-grand-air/
PERSEVERONS	High School	Gustave Eiffel	143 Rue Ferbos,33000 Bordeaux, France	+33 5 56 33 83 00	http://www.eiffel-bordeaux.org/
PERSEVERONS	High School	Jacques Monod	10 Rue du Parvis,64230 Lescar, France	+33 5 59 77 92 00	http://lyceejacquesmonod.fr/
Poppy Éducation	High School	Jean Moulin	Avenue de la République,33210 Langon, France	+33 5 56 63 62 30	http://webetab.ac-bordeaux.fr/lycee-jean-moulin- langon/
Poppy Éducation	Middle School	Jean Zay	41 Rue Henri Cochet,33380 Biganos, France	+33 5 57 17 01 70	http://collegebiganos.fr/
Poppy Éducation	High School	La Morlette	62 Rue du Docteur Roux,33150 Cenon, France	+33 5 57 80 37 00	http://lycee-lamorlette.fr/
PERSEVERONS	High School	Les Iris	13 Rue Sourbès,33310 Lormont, France	+33 5 57 80 10 60	http://www.lyceelesiris.fr/
PERSEVERONS	High School	Louis Barthou	2 Boulevard Barbanègre,64000 Pau, France	+33 5 59 98 98 00	http://www.cyberlycee.fr/
PERSEVERONS	High School	Louis de Foix	4 Avenue Jean Rostand,64100 Bayonne/Bayona/Baiona, France	+33 5 59 63 31 10	http://www.louisdefoix.com/
PERSEVERONS	High School	Maine de Biran	108 Rue Valette,24100 Bergerac, France	+33 5 53 74 50 00	http://webetab.ac-bordeaux.fr/lycee-maine-de- biran/
Poppy Éducation	Middle School	Mios	Route du Pujeau,33380 Mios, France	+33 5 56 03 00 77	http://www.villemios.fr/enfance-jeunesse/college/
PERSEVERONS	High School	Nord Bassin	128 Avenue de Bordeaux,33510 Andernos-les-Bains, France	+33 5 56 82 20 77	http://www.lyceenordbassin.com/
Forum Poppy	Primary School	Notre-Dame du Mur	19 Rue de Kermadiou,29600 Morlaix, France	+33 2 98 88 18 69	http://lycee.ecmorlaix.fr/
PERSEVERONS	High School	Pape Clément	1 Rue Léo Lagrange,33600 Pessac, France	+33 5 57 26 63 00	http://lyceepapeclement.fr/
PERSEVERONS	High School	Pays de Soule	Avenue Jean Monnet,64130 Chéraute, France	+33 5 59 28 22 28	http://www.lyceedupaysdesoule.fr/index.php
PERSEVERONS	High School	Pré De Cordy	5 Avenue Joséphine Baker,24200 Sarlat- la-Canéda, France	+33 5 53 31 70 70	http://lycee-predecordy-sarlat.com/
Poppy Éducation	High School	Raoul Follereau	9 Boulevard Saint-Exupéry,58000 Nevers, France	+33 3 86 60 36 00	http://lyc58-renardfollereau.ac-dijon.fr/
PERSEVERONS	High School	René Cassin	2 Rue de Lasseguette,64100 Bayonne/Bayona/Baiona, France	+33 5 59 58 42 00	http://webetab.ac-bordeaux.fr/lycee-rene-cassin/
PERSEVERONS	High School	Saint-Cricq	4 Piste Cyclable,64000 Pau, France	+33 5 59 30 50 55	http://www.lycee-saint-cricq.org/
Poppy Éducation	High School	Saint-Genès	160 Rue de Saint-Genès,33000 Bordeaux, France	+33 5 56 33 84 84	http://www.saint-genes.com/
PERSEVERONS	High School	Saint-John Perse	2 Chemin de Barincou,64000 Pau, France	+33 5 59 62 73 11	http://www.lycee-saint-john-perse.fr/
Poppy Éducation	High School	Sainte-Marie Grand Lebrun	164 Rue François Mauriac,33200 Bordeaux, France	+33 5 56 08 32 13	http://www.grandlebrun.com/
inria	High School	Sainte-Saintonge	12 Rue de Saintonge,33000 Bordeaux, France	+33 5 56 99 39 29	http://www.lyceesaintefamille.com/
Poppy Éducation	High School	Sud-Médoc	Piste du Médoc Bleu,33320 Le Taillan- Médoc, France	+33 5 56 70 10 10	http://www.lyceesudmedoc.fr/
Poppy Éducation	High School	Victor Louis	2 Rue de Mégret,33400 Talence, France	+33 5 56 80 76 40	http://lyceevictorlouis.fr/

Figure 25. List of partner schools of the Poppy Education project

## 9.1.2. ENSAM

The orientation of a (high school) student, choosing a career, is often based on an imagined representation of a discipline, sector of activity or training. Moreover, higher education is sometimes for a college student or a student a self centered universe, with inaccessible teaching methodologies and level of competence.

The Arts and Métiers campus at Bordeaux-Talence in partnership with Inria contributes with its educational and scientific expertise to the development of new teaching methods and tools. The objective is to develop teaching sequences based on a project approach relying on an attractive multidisciplinary technological system: the humanoid Inria Poppy robot. These teaching sequences will be built and tailored to different levels of training, from high schools to Engineer schools.

The new formation "Bachelor of Technology", started in September 2014 at Ensam Bordeaux, is resolutely turned towards a project based pedagogy, outlining concepts from concrete situations. The humanoid Inria Poppy robot offers an open platform capable of providing an unifying thread for the different subjects covered during the 3-years of the Bachelor formation: mechanics, manufacturing (3D printing), electrical, mecha-tronics, computer sciences, design...

For the 1st and 2nd year of the ENSAM Engineer cursus, the Poppy robot is now used to support the teaching and to conduct further investigation.

### 9.1.3. KidLearn and Region Aquitaine

A Conseil Régional d'Aquitaine Project (KidLearn, 2015-) began, coordinated by Manuel Lopes entitled KidLearn. Will fund 50% of a 3 years PhD student.

We propose here a research project that aims at elaborating algorithms and software systems to help humans learn efficiently, at school, at home or at work, by adapting and personalizing sequences of learning activities to the particularities of each individual student. This project leverages recent innovative algorithmic models of human learning (curiosity in particular, developed as a result of ERC European project of the Flowers team), and combines it with state-of-the-art optimization algorithms and an original integration with existing expert knowledge (human teachers). Given a knowledge domain and a set of possible learning activities, it will be able to propose the right activity at the right time to maximize learning progress. It can be applied to many learning situations and potential users: children learning basic knowledge in schools and with the support of their teachers, older kids using educational software at home, of adults needing to acquire new skills through professional training ("formation professionnelle"). Because it combines innovations in computational sciences (machine learning and optimization) with theories of human cognition (theories of human learning and of education), this project is also implementing a strong cross-fertilization between technology and human sciences (SHS).

### 9.1.4. Comacina Capsule Creative Art/Science project and Idex/Univ. Bordeaux

The artist community is a rich source of inspiration and can provide new perspectives to scientific and technological questions. This complementarity is a great opportunity that we want to enforce in the Poppy project by making the robot accessible to non-robotic-expert users. The Comacina project, in collaboration with the Flowers team and supported by funding from Idex/Univ. Bordeaux, explored the role of movements and light in expressing emotions: http://comacina.org . This project was implemented through several residencies during the year, and several performances at various cultural places in Aquitaine, including at Pole Evasion in Ambares-et-Lagrave. a report is available at https://flowers.inria.fr/RencontreAutourDuGeste.pdf . It benefitted from funding from the Art/Science Idex call for project.

## 9.2. National Initiatives

PY Oudeyer collaborated with Aymar de Rugy, Daniel Cattaert, Mathilde Couraud, Sébastien Mick and Florent Paclet (INCIA, CNRS/Univ. Bordeaux) about the design of myoelectric robotic prostheses based on the Poppy platform, and on the design of algorithms for co-adaptation learning between the human user and the prosthesis. This was funded by a PEPS CNRS grant.

D. Roy is the Inria leader of project "Voyageurs du Code - Code Décode" https://www.bibliosansfrontieres. org/tag/les-voyageurs-du-codecode-decode/, https://www.code-decode.net/ which provides teachers and animators formations and learning games to initiate young people to computer science and robotics.

Around Robotics for education, many collaborations were put in place. With the LSRO Laboratory from EPFL (Lausanne) and others collaborations with French National Education/Rectorat d'Aquitaine, with Canopé Educational Network, with ESPE (teacher's school) Aquitaine, ESPE Martinique, ESPE Poitiers, LINE Laboratory (ESPE Nice University), National Directorate of Digital Education, Fondation "La Main à la Pâte", Maison for Science in Bordeaux University, Orange Fondation.

## 9.3. European Initiatives

## 9.3.1. FP7 & H2020 Projects

9.3.1.1. 3rd HAND

Title: Semi-Autonomous 3rd Hand Programm: FP7 Duration: October 2013 - September 2017 Coordinator: Inria Partners: Technische Universität Darmstadt (Germany) Universität Innsbruck (Austria)

Universität Stuttgart (Germany)

Inria contact: Manuel Lopes

Robots have been essential for keeping industrial manufacturing in Europe. Most factories have large numbers of robots in a fixed setup and few programs that produce the exact same product hundreds of thousands times. The only common interaction between the robot and the human worker has become the so-called 'emergency stop button'. As a result, re-programming robots for new or personalized products has become a key bottleneck for keeping manufacturing jobs in Europe. The core requirement to date has been the production in large numbers or at a high price.Robotbased small series production requires a major breakthrough in robotics: the development of a new class of semi-autonomous robots that can decrease this cost substantially. Such robots need to be aware of the human worker, alleviating him from the monotonous repetitive tasks while keeping him in the loop where his intelligence makes a substantial difference. In this project, we pursue this breakthrough by developing a semi-autonomous robot assistant that acts as a third hand of a human worker. It will be straightforward to instruct even by an untrained layman worker, allow for efficient knowledge transfer between tasks and enable a effective collaboration between a human worker with a robot third hand. The main contributions of this project will be the scientific principles of semiautonomous human-robot collaboration, a new semi-autonomous robotic system that is able to: i) learn cooperative tasks from demonstration; ii) learn from instruction; and iii) transfer knowledge between tasks and environments. We will demonstrate its efficiency in the collaborative assembly of an IKEA-like shelf where the robot acts as a semiautonomous 3rd-Hand.

#### 9.3.1.2. DREAM

Title: Deferred Restructuring of Experience in Autonomous Machines Programm: H2020 Duration: January 2015 - December 2018 Coordinator: UPMC

Partners:

Armines (ENSTA ParisTech)

Queen Mary University London (England) University of A Coruna (Spain) Vrije University Amsterdam (Holland)

Contact: David Filliat

Abstract: A holy grail in robotics and artificial intelligence is to design a machine that can accumulate adaptations on developmental time scales of months and years. From infancy through adult- hood, such a system must continually consolidate and bootstrap its knowledge, to ensure that the learned knowledge and skills are compositional, and organized into meaningful hierarchies. Consolidation of previous experience and knowledge appears to be one of the main purposes of sleep and dreams for humans, that serve to tidy the brain by removing excess information, to recombine concepts to improve information processing, and to consolidate memory. Our approach - Deferred Restructuring of Experience in Autonomous Machines (DREAM) - incorporates sleep and dream-like processes within a cognitive architecture. This enables an individual robot or groups of robots to consolidate their experience into more useful and generic formats, thus improving their future ability to learn and adapt. DREAM relies on Evo- lutionary Neurodynamic ensemble methods (Fernando et al, 2012 Frontiers in Comp Neuro; Bellas et al., IEEE-TAMD, 2010 ) as a unifying principle for discovery, optimization, re- structuring and consolidation of knowledge. This new paradigm will make the robot more autonomous in its acquisition, organization and use of knowledge and skills just as long as they comply with the satisfaction of pre-established basic motivations. DREAM will enable robots to cope with the complexity of being an information-processing entity in domains that are open-ended both in terms of space and time. It paves the way for a new generation of robots whose existence and purpose goes far beyond the mere execution of dull tasks. http://www.robotsthatdream.eu

### 9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. IGLU

Title: Interactive Grounded Language Understanding (IGLU)

Programm: CHIST-ERA

Duration: October 2015 - September 2018

Coordinator: University of Sherbrooke, Canada

Partners:

University of Sherbrooke, Canada

Inria Bordeaux, France

University of Mons, Belgium

KTH Royal Institute of Technology, Sweden

University of Zaragoza, Spain

University of Lille 1, France

University of Montreal, Canada

Inria contact: Pierre-Yves Oudeyer

Language is an ability that develops in young children through joint interaction with their caretakers and their physical environment. At this level, human language understanding could be referred as interpreting and expressing semantic concepts (e.g. objects, actions and relations) through what can be perceived (or inferred) from current context in the environment. Previous work in the field of artificial intelligence has failed to address the acquisition of such perceptually-grounded knowledge in virtual agents (avatars), mainly because of the lack of physical embodiment (ability to interact physically) and dialogue, communication skills (ability to interact verbally). We believe that robotic agents are more appropriate for this task, and that interaction is a so important aspect of human language learning and understanding that pragmatic knowledge (identifying or conveying intention)

must be present to complement semantic knowledge. Through a developmental approach where knowledge grows in complexity while driven by multimodal experience and language interaction with a human, we propose an agent that will incorporate models of dialogues, human emotions and intentions as part of its decision-making process. This will lead anticipation and reaction not only based on its internal state (own goal and intention, perception of the environment), but also on the perceived state and intention of the human interactant. This will be possible through the development of advanced machine learning methods (combining developmental, deep and reinforcement learning) to handle large-scale multimodal inputs, besides leveraging state-of-the-art technological components involved in a language-based dialog system available within the consortium. Evaluations of learned skills and knowledge will be performed using an integrated architecture in a culinary use-case, and novel databases enabling research in grounded human language understanding will be released. IGLU will gather an interdisciplinary consortium composed of committed and experienced researchers in machine learning, neurosciences and cognitive sciences, developmental robotics, speech and language technologies, and multimodal/multimedia signal processing. We expect to have key impacts in the development of more interactive and adaptable systems sharing our environment in everyday life. http://iglu-chistera.github.io/

## 9.4. International Initiatives

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

### 9.4.1.1. NEUROCURIOSITY

Title: NeuroCuriosity

International Partner (Institution - Laboratory - Researcher):

Columbia Neuroscience (United States) - Cognitive Neuroscience - JACQUELINE GOT-TLIEB

Start year: 2016

#### See also: https://flowers.inria.fr/neurocuriosity

Curiosity can be understood as a family of mechanisms that evolved to allow agents to maximize their knowledge of the useful properties of the world. In this project we will study how different internal drives of an animal, e.g. for novelty, for action, for liking, are combined to generate the rich variety of behaviors found in nature. We will approach such challenge by studying monkeys, children and by developing new computational tools.

### 9.4.1.2. Informal International Partners

Pierre-Yves Oudeyer and Didier Roy have create a collaboration with LSRO EPFL and Pr Francesco Mondada, about Robotics and education. The two teams co-organize the annual conference "Robotics and Education" in Bordeaux. Didier Roy teaches "Robotics and Education" in EPFL several times a year.

Pierre-Yves Oudeyer collaborated with Edith Law's HCI research group at University of Waterloo on the topic of "Curiosity in HCI system". They co-organized the "Designing for curiosity" workshop at CHI 2017, Denver, Colorado, and obtained a grant from Univ. Bordeaux to set up a project with Inria Potioc team and with Dana Kulic, Robotics lab, Univ. Waterloo.

Didier Roy has created a collaboration with HEP VAud (Teachers High School) and Bernard Baumberger and Morgane Chevalier, about Robotics and education. Scientific discussions and shared professional training.

Florian Golemo is in an active collaboration with Aaron Courville from MILA Montreal to work on the IGLU project together.

William Schueller visited Vittorio Loreto's team in Rome from January till August 2017, funded by the Idex program of the University of Bordeaux. Vittorio Loreto is an Associate Professor in Physics at University Sapienza of Rome, and head of the research team Social Dynamics Lab. William Schueller also participated to a conference organized by V. Loreto in Rome, the Kreyon Conference, by giving a talk and presenting a user experiment: an interactive Naming Game.

### 9.4.2. Participation in Other International Programs

David Filliat participates in the ITEA3 DANGUN project with Renault S.A.S. in france and partners in Korea. The purpose of the DANGUN project is to develop a Traffic Jam Pilot function with autonomous capabilities using low-cost automotive components operating in France and Korea. By incorporating low-cost advanced sensors and simplifying the vehicle designs as well as testing in different scenarios (France & Korea), a solution that is the result of technical cooperation between both countries should lead to more affordable propositions to respond to client needs in the fast moving market of intelligent mobility.

# 9.5. International Research Visitors

## 9.5.1. Visits of International Scientists

- Georges Kachergis, University of Radboud, The Netherlands
- Cynthia Liem, University of Delft, The Netherlands
- Mike Schaekermann, Univ. Waterloo, Canada
- Roboy team, Univiersity of Munich, Germany
- Lauriane Rat-Fiseher, Univ. Toulouse, France
- Lisa Jacquey, LPP, Paris (May 12th, 2017)
- Mai Nguyen, ENST Bretagne, France

### 9.5.1.1. Internships

- Kelian Schindowski, project Poppy Education
- Octave Delorme, project Poppy Education
- Alexandre Péré, Deep learning and intrinsic motivation
- Pierre Manceron, Deep Reinforcement Learning
- Timothée Anne, Intrinsically Motivated Goal Exploration

# **HEPHAISTOS Project-Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

- CPER project MADORSON for the assistance to elderly people (with the STARS project)
- the project REVMED involving Hephaistos and the CHU team CobTeK has been funded by the local IDEX. It will allow us to continue our work on rehabilitation in an immersive environment.

# 9.2. National Initiatives

## 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
# **LAGADIC Project-Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

### 9.1.1. ARED DeSweep

Participants: Lesley-Ann Duflot, Alexandre Krupa.

no Inria Rennes 8033, duration: 36 months.

This project funded by the Brittany council started in October 2014. It supports in part Lesley-Ann Duflot's Ph.D. about visual servoing based on the shearlet transform (see Section 7.3.1).

## 9.1.2. ARED Locoflot

Participants: Ide Flore Kenmogne Fokam, Vincent Drevelle, Eric Marchand.

no Inria Rennes 9944, duration: 36 months.

This project funded by the Brittany council started in October 2015. It supports in part Ide Flore Kenmogne Fokam's Ph.D. about cooperative localization in multi-robot fleets using interval analysis (see Section 7.6.2).

### **9.1.3.** ARED Mod4Nav

Participants: Aline Baudry, Marie Babel.

no INSA Rennes 2016/01, duration: 36 months.

This project funded by the Brittany council started in October 2016. It supports in part Aline Baudry's Ph.D. about wheelchair modeling.

### 9.1.4. "Equipement mi-lourd Rennes Métropole"

Participant: Paolo Robuffo Giordano.

no CNRS Rennes 14C0481, duration: 36 months.

This grant from "Rennes Métropole" has been obtained in June 2014 and supported the activities related to the use of drones (quadrotor UAVs). The platform described in Section 6.8.5 has been purchased in part thanks to this grant.

### 9.1.5. "Allocation d'installation scientifique"

Participant: Claudio Pacchierotti.

no CNRS Rennes 17C0487, duration: 36 months.

This grant from "Rennes Métropole" has been obtained in July 2017 and supported the activities related to the teleoperation of drones (quadrotor UAVs) using wearable haptics interfaces.

### 9.1.6. IRT Jules Verne Mascot

Participant: François Chaumette.

no Inria Rennes 10361, duration: 36 months.

This project started in October 2015. It is managed by IRT Jules Verne in Nantes and achieved in cooperation with LS2N, Airbus, Renault, Faurecia and Alsthom. Its goal is to perform screwing for various industrial applications.

### 9.1.7. IRT b<>com NeedleWare

Participants: Hadrien Gurnel, Alexandre Krupa.

### no Inria Rennes 9072, duration: 36 months.

This project started in October 2016. It supports Hadrien Gurnel's Ph.D. about the study of a shared control strategy fusing haptic and ultrasound visual control for assisting manual steering of needles for biopsy or therapy purposes in a synergetic way (see Section 7.3.4).

### 9.1.8. Prisme

Participants: Solenne Fortun, Marie Babel.

### no Insa Rennes 9072, duration: 24 months.

This project started in January 2017 and is supported by Brittany region/BPI. This project aims at designing a fall prevention strategy based on the sensing collaboration of a smart wheelchair and a smart medical bed. Fall detection and automatic positioning of the wheelchair next to the bed issues are planned to be addressed (see Section 7.5.5).

# 9.2. National Initiatives

### 9.2.1. France Life Imaging WP3-FLI ANFEET

Participant: Alexandre Krupa.

### duration: 24 months.

This project started in January 2016. Its objective is to initiate collaborative research with the ICube laboratory (Strasbourg) on the control and supervision of flexible endoscopes in the digestive tube using ultrasound images.

### 9.2.2. ANR Contint Visioland

Participants: Noël Mériaux, Pierre-Marie Kerzerho, Patrick Rives, François Chaumette.

no Inria Rennes 8304, duration: 48 months.

This project ended in October 2017. It involved a consortium managed by Onera in Toulouse with Airbus, Spikenet Technology, LS2N, and Lagadic. Its aim was to develop vision-based localization and navigation techniques for autonomous landing on a runway (see Section 7.1.4).

### 9.2.3. ANR Contint Entracte

Participant: Julien Pettré.

### no Inria Rennes 8013, duration: 42 months.

This project ended in April 2017. It was realized in collaboration with the Gepetto group at Laas, Toulouse, and the Mimetic group at Irisa and Inria Rennes Bretagne Atlantique. It addressed the problem of motion planning for anthropomorphic systems, and more generally, the problem of manipulation path planning. Entracte proposed to study in parallel both the mathematical foundations of artificial motion and the neurocognitive structures used by humans to quickly solve motion problems.

### 9.2.4. ANR JCJC Percolation

Participant: Julien Pettré.

no Inria Rennes 7991, duration: 42 months.

The ANR "Jeune Chercheur" Percolation project ended on June 2017. It aimed at designing perception-based crowd simulation algorithms. We developed agents able of perceiving their virtual environment through virtual sensors, and able to navigate in it, as well as to interact with the other agents.

### 9.2.5. ANR JCJC SenseFly

Participants: Thomas Bellavoir, Muhammad Usman, Paolo Robuffo Giordano.

no Irisa CNRS 50476, duration: 36 months.

The ANR "Jeune Chercheur" SenseFly project started in August 2015. Its goal is to advance the state-of-theart in multi-UAV in the design and implementation of fully decentralized and sensor-based group behaviors by only resorting to onboard sensing (mainly cameras and IMU) and local communication (e.g., Bluetooth communication, wireless networks). Topics such as individual flight control, formation control robust against sensor limitations (e.g., limited field of view, occlusions), distributed estimation of relative positions/bearings from local sensing, maintenance of architectural properties of a multi-UAV formation are studied in the project. Part of the platforms described in Section 6.8.5 has been purchased thanks to this grant.

## 9.2.6. ANR PLaTINUM

Participants: Eduardo Fernandez Moral, Vincent Drevelle, Patrick Rives.

no Inria Sophia 10204, duration: 42 months.

This project started in November 2015. It involves a consortium managed by Litis in Rouen with IGN Matis (Paris), Le2i (Le Creusot) and Lagadic group. It aims at proposing novel solutions to robust long-term mapping of urban environments.

### 9.2.7. BPI Romeo 2

Participants: Giovanni Claudio, Fabien Spindler, François Chaumette.

no Inria Rennes 7114, duration: 60 months.

This project ended in October 2017. It involved a large consortium managed by Softbank Robotics (ex Aldebaran Robotics) with Laas in Toulouse, Isir in Paris, Lirmm in Montpellier, Inria groups Lagadic, Bipop (Pierre-Brice Wieber), Flowers (Pierre-Yves Oudeyer), etc. It aimed at developing advanced control and perception functionalities to a humanoid robot. In this project, we developed visual manipulation and navigation tasks with Romeo and Pepper.

### 9.2.8. Equipex Robotex

Participants: Fabien Spindler, François Chaumette.

### no Inria Rennes 6388, duration: 9 years.

Lagadic is one of the 15 French academic partners involved in the Equipex Robotex network that started in February 2011. It is devoted to get and manage significant equipment in the main robotics labs in France. In the scope of this project, we have got the humanoid robot Romeo (see Section 6.8.4).

# 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

9.3.1.1. FP7 Space RemoveDEBRIS

Participants: Eric Marchand, François Chaumette.

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2018

Coordinator: University of Surrey (United Kingdom)

Partners: Surrey Satellite Technology (United Kingdom), Airbus (Toulouse, France and Bremen, Germany), Isis (Delft, The Netherlands), CSEM (Neuchâtel, Switzerland), Stellenbosch University (South Africa).

Inria contact: François Chaumette

Abstract: The goal of this project is to validate model-based tracking algorithms on images acquired during an actual space debris removal mission [22], [47].

### 9.3.1.2. H2020 ICT Comanoid

Participants: Giovanni Claudio, Souriya Trinh, Fabien Spindler, François Chaumette.

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programme: H2020

Duration: January 2015 - December 2018

Coordinator: CNRS (Lirmm)

Partners: Airbus Group (France), DLR (Germany), Università Degli Studi di Roma La Sapienza (Italy), CNRS (I3S)

Inria contact: Francois Chaumette

Comanoid investigates the deployment of robotic solutions in well-identified Airbus airliner assembly operations that are laborious or tedious for human workers and for which access is impossible for wheeled or rail-ported robotic platforms. As a solution to these constraints a humanoid robot is proposed to achieve the described tasks in real-use cases provided by Airbus Group. At a first glance, a humanoid robotic solution appears extremely risky, since the operations to be conducted are in highly constrained aircraft cavities with non-uniform (cargo) structures. Furthermore, these tight spaces are to be shared with human workers. Recent developments, however, in multi-contact planning and control suggest that this is a much more plausible solution than current alternatives such as a manipulator mounted on multi-legged base. Indeed, if humanoid robots can efficiently exploit their surroundings in order to support themselves during motion and manipulation, they can ensure balance and stability, move in non-gaited (acyclic) ways through narrow passages, and also increase operational forces by creating closed-kinematic chains. Bipedal robots are well suited to narrow environments specifically because they are able to perform manipulation using only small support areas. Moreover, the stability benefits of multi-legged robots that have larger support areas are largely lost when the manipulator must be brought close, or even beyond, the support borders. COMANOID aims at assessing clearly how far the state-of-the-art stands from such novel technologies. In particular the project focuses on implementing a real-world humanoid robotics solution using the best of research and innovation. The main challenge are to integrate current scientific and technological advances including multi-contact planning and control; advanced visual-haptic servoing; perception and localization; human-robot safety, and the operational efficiency of cobotics solutions in airliner manufacturing.

#### 9.3.1.3. H2020 ICT Romans

**Participants:** Firas Abi Farraj, Fabien Spindler, François Chaumette, Claudio Pacchierotti, Paolo Robuffo Giordano.

Title: Robotic Manipulation for Nuclear Sort and Segregation

Programme: H2020

Duration: May 2015 - April 2018

Coordinator: University of Birmingham

Partners: NLL (UK), CEA (France), Univ. Darmstadt (Germany)

CNRS contact: Paolo Robuffo Giordano

The RoMaNS (Robotic Manipulation for Nuclear Sort and Segregation) project will advance the state of the art in mixed autonomy for tele-manipulation, to solve a challenging and safety-critical "sort and segregate" industrial problem, driven by urgent market and societal needs. Cleaning up the past half century of nuclear waste, in the UK alone (mostly at the Sellafield site), represents the largest environmental remediation project in the whole of Europe. Most EU countries face related challenges. Nuclear waste must be "sorted and segregated", so that low-level waste is placed in low-level storage containers, rather than occupying extremely expensive and resource intensive high-level storage containers and facilities. Many older nuclear sites (>60 years in UK) contain large

numbers of legacy storage containers, some of which have contents of mixed contamination levels, and sometimes unknown contents. Several million of these legacy waste containers must now be cut open, investigated, and their contents sorted. This can only be done remotely using robots, because of the high levels of radioactive material. Current state-of-the-art practice in the industry, consists of simple tele-operation (e.g. by joystick or teach-pendant). Such an approach is not viable in the long-term, because it is prohibitively slow for processing the vast quantity of material required. The project aims at: 1) Develop novel hardware and software solutions for advanced bi-lateral master-slave tele-operation. 2) Develop advanced autonomy methods for highly adaptive automatic grasping and manipulation actions. 3) Combine autonomy and tele-operation methods using state-of-the-art understanding of mixed initiative planning, variable autonomy and shared control approaches. 4) Deliver a TRL 6 demonstration in an industrial plant-representative environment at the UK National Nuclear Lab Workington test facility.

### 9.3.2. Collaborations in European Programs, Except FP7 & H2020

#### 9.3.2.1. Interreg Adapt

Participants: Nicolas Le Borgne, Marie Babel.

Programme: Interreg VA France (Channel) England

Project acronym: Adapt

Project title: Assistive Devices for empowering disAbled People through robotic Technologies

Duration: 01/2017 - 06/2021

Coordinator: ESIGELEC/IRSEEM Rouen

Other partners: INSA Rennes - IRISA, LGCGM, IETR (France), Université de Picardie Jules Verne -MIS (France), Pôle Saint Hélier (France), CHU Rouen (France), Réseau Breizh PC (France), Ergovie (France), Pôle TES (France), University College of London - Aspire CREATE (UK), University of Kent (UK), East Kent Hospitals Univ NHS Found. Trust (UK), Health and Europe Centre (UK), Plymouth Hospitals NHS Trust (UK), Canterbury Christ Church University (UK), Kent Surrey Sussex Academic Health Science Network (UK), Cornwall Mobility Center (UK).

Abstract: This project aims to develop innovative assistive technologies in order to support the autonomy and to enhance the mobility of power wheelchair users with severe physical/cognitive disabilities. In particular, the objective is to design and evaluate a power wheelchair simulator as well as to design a multi-layer driving assistance system.

### 9.3.3. Collaborations with European Partners

#### 9.3.3.1. ANR Opmops

Participants: Florian Berton, Julien Pettré.

Programme: ANR

Project acronym: Opmops

Project title: Organized Pedestrian Movement in Public Spaces: Preparation and Crisis Management of Urban Parades and Demonstration Marches with High Conflict Potential

Duration: June 2017 - June 2020

Coordinator: Université de Haute Alsace (for France), Technische Universität Kaiserslautern (for Germany)

Other partners: Gendarmerie Nationale, Hochschule München, ONHYS S.A.S, Polizei Rheinland-Pfalz, Universität Koblenz-Landau, VdS GmbH Abstract: This project is about parades of highly controversial groups or of political demonstration marches are considered as a major threat to urban security. Due to the movement of the urban parades and demonstration marches (in the following abbreviated by UPM) through large parts of cities and the resulting space and time dynamics, it is particularly difficult for forces of civil security (abbreviated in the following by FCS) to guarantee safety at these types of urban events without endangering one of the most important indicators of a free society. In this proposal, partners representing the FCS (police and industry) will cooperate with researchers from academic institutions to develop a decision support tool which can help them both in the preparation phase and crisis management situations of UPMs. Specific technical issues which the French-German consortium will have to tackle include the following: Optimization methods to plan UPM routes, transportation to and from the UPM, location and personnel planning of FCS, control of UPMs using stationary and moving cameras, and simulation methods, including their visualization, with specific emphasis on social behavior.

### 9.3.3.2. iProcess

Participants: Agniva Sengupta, Fabien Spindler, Eric Marchand, Alexandre Krupa, François Chaumette.

Project acronym: i-Process

Project title: Innovative and Flexible Food Processing Technology in Norway

Duration: January 2016 - December 2019

Coordinator: Sintef (Norway)

Other partners: Nofima, Univ. of Stavanger, NMBU, NTNU (Norway), DTU (Denmark), KU Leuven (Belgium), and about 10 Norwegian companies.

Abstract: This project is granted by the Norwegian Government. Its main objective is to develop novel concepts and methods for flexible and sustainable food processing in Norway. In the scope of this project, the Lagadic group is involved for visual tracking and visual servoing of generic and potentially deformable objects (see Section 7.1.2). Prof. Ekrem Misimi from Sintef spent a 4-month visit from May 2017 and a 1-week visit in November 2017. François Chaumette and Alexandre Krupa spent a short period at Sintef in Trondheim in February and June 2017 respectively.

# 9.4. International Initiatives

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

9.4.1.1. SIMS

Title: Realistic and Efficient Simulation of Complex Systems

International Partners:

University of North Carolina at Chapel Hill (USA) - GAMMA Group - Ming C. Lin, Dinesh Manocha

University of Minnesota (USA) - Motion Lab - Stephen Guy

Brown University (USA) - VenLab - William Warren

Start year: 2012

See http://people.rennes.inria.fr/Julien.Pettre/EASIMS/easims.html

The general goal of SIMS is to make significant progress toward realistic and efficient simulation of highly complex systems, which raise combinatory explosive problems. This proposal is focused on human motion and interaction, and covers 3 active topics with wide application range:

- 1. Crowd simulation: virtual human interacting with other virtual humans,
- 2. Autonomous virtual humans interacting with their environment,
- 3. Physical simulation: real humans interacting with virtual environments.

SIMS is orthogonally structured by transversal questions: the evaluation of the level of realism reached by a simulation (which is a problem by itself in the considered topics), considering complex systems at various scales (micro, meso and macroscopic ones), and facing combinatory explosion of simulation algorithms.

### 9.4.1.2. ISI4NAVE

Title: Innovative Sensors and adapted Interfaces for assistive NAVigation and pathology Evaluation International Partner (Institution - Laboratory - Researcher):

University College London (United Kingdom) - Aspire CREATe - Tom Carlson Start year: 2016

#### See also: http://www.irisa.fr/lagadic/team/MarieBabel/ISI4NAVE/ISI4NAVE.html

The global ageing population, along with disability compensation constitutes major challenging societal and economic issues. In particular, achieving autonomy remains a fundamental need that contributes to the individual's wellness and well-being. In this context, innovative and smart technologies are designed to achieve independence while matching user's individual needs and desires.

Hence, designing a robotic assistive solution related to wheelchair navigation remains of major importance as soon as it compensates partial incapacities. This project then addresses the following two issues. First, the idea is to design an indoor / outdoor efficient obstacle avoidance system that respects the user intention, and does not alter user perception. This involves embedding innovative sensors to tackle the outdoor wheelchair navigation problem. The second objective is to take advantage of the proposed assistive tool to enhance the user Quality of Experience by means of biofeedback. Indeed, adapted interfaces should improve the understanding of people that suffer from cognitive and/or visual impairments.

The originality of the project is to continuously integrate medical validation as well as clinical trials during the scientific research work in order to match user needs and acceptation.

### 9.4.2. Participation in International Programs

### 9.4.2.1. ACRV

The Lagadic group is one of the five external partners of the Australian Center for Robotic Vision (see http:// roboticvision.org). This center groups QUT in Brisbane, ANU in Canberra, Monash University and Adelaide University. In the scope of this project, Quentin Bateux received a grant to participate to the 2017 Robotic Vision Summer School in Kioloa (New South Wales) and spent a 1-week visit at QUT in March 2017.

# 9.5. International Research Visitors

## 9.5.1. Visits of International Scientists

- Prof. Denis Wolf, Associate Professor at Univ. Sao Paulo, Brazil, spent a sabbatical year in Sophia Antipolis from July 2016 to August 2017. He worked on semantic learning applied to intelligent vehicles.
- Prof. Dan Zelazo (Technion) and Prof. Antonio Bicchi (Univ. Pisa) spent a short visit in the group in Rennes in 2017.

### 9.5.1.1. Internships

- Giuseppe Sirignano (Univ. Salerno), from October 2017 to March 2018
- Mario Selvaggio (Univ. Naples), from November 2017 till end of December 2017

## 9.5.2. Visits to International Teams

### 9.5.2.1. Research Stays Abroad

- Jason Chevrie spent a 3-month visit in Sarthak Misra's lab at the Surgical Robotics Laboratory (SRL) of University of Twente (Netherlands) where he performed robotic experiments in the scope of his Ph.D (see Section 7.3.2).
- François Chaumette was invited for a 1-week visit at Zhejiang University in November 2017.

# **LARSEN Project-Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

## 9.1.1. SATELOR

Title: SATELOR Program: AME Region Lorraine Duration: September 2013 - September 2017 Coordinator: Diatelic

PI for Inria: François Charpillet

The Economic Mobilisation Agency in Lorraine has launched a new project Satelor providing it with 2.5 million Euros of funding over 3 years, out of an estimated total of 4.7 million. The leader of the project is Pharmagest-Diatelic. Pharmagest, in Nancy, is the French leader in computer systems for pharmacies, with a 43.5 % share of the market, 9,800 clients and more than 700 employees. Recently, the Pharmagest Group expanded its activities into e-health and the development of telemedicine applications. The Satelor project will accompany the partners of the project in developing services for maintaining safely elderly people with loss of autonomy at home or people with a chronic illness. Larsen team will play an important role for bringing some research results such as:

- developing a low cost environmental sensor for monitoring the daily activities of elderly people at home
- developing a low cost sensor for fall detection
- developing a low cost companion robot able to interact with people and monitoring their activities while detecting emergency situations.
- developing a general toolbox for data-fusion: Bayesian approach.

Publications: [16], [18]

### 9.1.2. Project PsyPhINe: Cogitamus ergo sumus

Title: Cogitamus ergo sumus

Program: PEPS CNRS

Duration: January 2016 - January 2018

Coordinator: MSH Lorraine (USR3261)

Larsen member: Amine Boumaza

This project gathers researchers from the following institutes: InterPsy (EA 4432), APEMAC, EPSaM (EA4360), Archives Henri-Poincaré (UMR7117), Inria Bordeaux Sud-Ouest, Loria (UMR7503). Refer to sec. 7.2.2.2 for the goals of the project.

# 9.2. European Initiatives

## 9.2.1. FP7 & H2020 Projects

### 9.2.1.1. RESIBOTS

Title: Robots with animal-like resilience Program: H2020 Type: ERC Duration: May 2015 - April 2020

Coordinator: Inria

Inria contact: Jean Baptiste Mouret

Despite over 50 years of research in robotics, most existing robots are far from being as resilient as the simplest animals: they are fragile machines that easily stop functioning in difficult conditions. The goal of this proposal is to radically change this situation by providing the algorithmic foundations for low-cost robots that can autonomously recover from unforeseen damages in a few minutes. The current approach to fault tolerance is inherited from safety-critical systems (e.g. spaceships or nuclear plants). It is inappropriate for low-cost autonomous robots because it relies on diagnostic procedures, which require expensive proprioceptive sensors, and contingency plans, which cannot cover all the possible situations that an autonomous robot can encounter. It is here contended that trial-and-error learning algorithms provide an alternate approach that does not require diagnostic, nor pre-defined contingency plans. In this project, we will develop and study a novel family of such learning algorithms that make it possible for autonomous robots to quickly discover compensatory behaviors. We will thus shed a new light on one of the most fundamental questions of robotics: how can a robot be as adaptive as an animal? The techniques developed in this project will substantially increase the lifespan of robots without increasing their cost and open new research avenues for adaptive machines.

#### 9.2.1.2. CODYCO

Title: Whole-body Compliant Dynamical Contacts for Humanoids

Programme: FP7

Type: ICT STREP (No. 600716)

Duration: March 2013 - February 2017

Coordinator: IIT

PI for Inria: Serena Ivaldi

The aim of CoDyCo was to improve the current control and cognitive understanding about robust, goal-directed whole-body motion interaction with multiple contacts. CoDyCo went beyond traditional approaches: proposing methodologies for performing coordinated interaction tasks with complex systems; combining planning and compliance to deal with predictable and unpredictable events and contacts; validating theoretical progresses in real-world interaction scenarios. CoDyCo advanced the state-of-the-art in the way robots coordinate physical interaction and physical mobility.

#### 9.2.1.3. ANDY

Title: Advancing Anticipatory Behaviors in Dyadic Human-Robot Collaboration

Programme: H2020

Type: ICT RIA (No. 731540)

Duration: January 2017 - December 2020

Coordinator: IIT

PI for Inria: Serena Ivaldi

Recent technological progress permits robots to actively and safely share a common workspace with humans. Europe currently leads the robotic market for safety-certified robots, by enabling robots to react to unintentional contacts. AnDy leverages these technologies and strengthens European leadership by endowing robots with the ability to control physical collaboration through intentional interaction.

To achieve this interaction, AnDy relies on three technological and scientific breakthroughs. First, AnDy will innovate the way of measuring human whole-body motions by developing the wearable AnDySuit, which tracks motions and records forces. Second, AnDy will develop the AnDyModel, which combines ergonomic models with cognitive predictive models of human dynamic behavior

in collaborative tasks, which are learned from data acquired with the AnDySuit. Third, AnDy will propose the AnDyControl, an innovative technology for assisting humans through predictive physical control, based on AnDyModel.

By measuring and modeling human whole-body dynamics, AnDy provides robots with an entirely new level of awareness about human intentions and ergonomy. By incorporating this awareness online in the robot's controllers, AnDy paves the way for novel applications of physical human-robot collaboration in manufacturing, health-care, and assisted living.

AnDy will accelerate take-up and deployment in these domains by validating its progress in several realistic scenarios. In the first validation scenario, the robot is an industrial collaborative robot, which tailors its controllers to individual workers to improve ergonomy. In the second scenario, the robot is an assistive exoskeleton which optimizes human comfort by reducing physical stress. In the third validation scenario, the robot is a humanoid, which offers assistance to a human while maintaining the balance of both.

Partners: Italian Institute of Technology (IIT, Italy, coordinator), Josef Stefan Institute (JSI, Slovenia), DLR (Germany), IMK Automotive Gmbh (Germany), XSens (Netherlands), AnyBody Technologies (Denmark)

# 9.3. International Research Visitors

### 9.3.1. Visits of International Scientists

### 9.3.1.1. Internships

- Waldez Azevedo Gomes Junior (Brazil) from May 2017 to November 2017
- Kazuya Otani (USA, Carnegie Mellon) from May 2017 to November 2017
- Kapil Sawant (India, BITS Pilani) from July to December 2017
- Luigi Penco (Italy, La Sapienza University) from October 2017 to February 2018

119 Robotics and Smart environments - Partnerships and Cooperations - Project-Team PERVASIVE INTERACTION

# **PERVASIVE INTERACTION Project-Team**

# 8. Partnerships and Cooperations

# 8.1. National Initiatives

### 8.1.1. ANR Project Involved

Participants: Amr Alyafi, Patrick Reignier.

Other Partners: UMR G-SCOP, UMR LIG (Persuasive Interaction, IIHM, Getalp), CEA Liten, PACTE, Vesta Systems and Elithis.

Dates: Jan 2015 to Dec 2018

The ANR project Involved focuses on bringing solutions to building actors for upcoming challenges in energy management in residential buildings. The project explores a user centric energy management system, where user needs and tacit knowledge drive the search of solutions. These are calculated using a flexible energy model of the living areas. The system is personified by energy consultants with which building actors such as building owners, building managers, technical operators but also occupants, can interact with in order to co-define energy strategies, benefiting of both assets: tacit knowledge of human actors, and measurement with computation capabilities of calculators. Putting actors in the loop, i.e. making energy not only visible but also controllable is the needed step before large deployment of energy management solutions.

The project will develop interactive energy consultants for all the actors, providing energy management aided systems embedding models in order to support the decision making processes. MIRROR (interactive monitoring), WHAT-IF (interactive quantitative simulation), EXPLAIN (interactive qualitative simulation), SUGGEST- AND-ADJUST (interactive management) and RECOMMEND (interactive diagnosis) functionalities will be developed.

## 8.1.2. ANR Project CEEGE: Chess Expertise from Eye Gaze and Emotion

Participants: James Crowley, Dominique Vaufreydaz, Rafaellea Balzarini

Other Partners: Dept of NeuroCognition, CITEN, Bielefeld University

Dates: Jan 2016 to Dec 2019

CEEGE is a multidisciplinary scientific research project conducted by the Inria PRIMA team in cooperation with the Dept of Cognitive Neuroscience at the University of Bielefeld. The primary impacts will be improved scientific understanding in the disciplines of Computer Science and Cognitive NeuroScience. The aim of this project is to experimentally evaluate and compare current theories for mental modelling for problem solving and attention, as well as to refine and evaluate techniques for observing the physiological reactions of humans to situation that inspire pleasure, displeasure, arousal, dominance and fear.

In this project, we will observe the visual attention, physiological responses and mental states of subject with different levels of expertise solving classic chess problems, and participating in chess matches. We will observe chess players using eye-tracking, sustained and instantaneous face-expressions (micro-expressions), skin conductivity, blood flow (BVP), respiration, posture and other information extracted from audio-visual recordings and sensor readings of players. We will use the recorded information to estimate the mental constructs with which the players understand the game situation. Information from visual attention as well as physiological reactions will be used to determine and model the degree to which a player understands the game situation in terms of abstract configurations of chess pieces. This will provide a structured environment that we will use for experimental evaluation of current theories of mental modeling and emotional response during problem solving and social interaction.

# 120 Robotics and Smart environments - Partnerships and Cooperations - Project-Team PERVASIVE INTERACTION

The project is organized in three phases. During the first phase, we will observe individual players of different levels of chess expertise solving known chess problems. We will correlate scan-path from eye tracking and other information about visual attention to established configurations of pieces and known solutions to chess problems. This will allow us to construct a labeled corpus of chess play that can be used to evaluate competing techniques for estimating mental models and physiological responses. In a second phase, we will observe the attention and face expressions of pairs of players of different levels of chess ability during game play. In particular, we will seek to annotate and segment recordings with respect to the difficulty of the game situation as well as situations that elicit particularly strong physiological reactions. In the final phase, we will use these recordings to evaluate the effectiveness of competing techniques for mental modeling and observation of emotions in terms of their abilities to predict the chess abilities of players, game outcomes and individual moves and player self reports. Results of our work will be published in scientific conferences and journals concerned with cognitive science and cognitive neuroscience as well as computer vision, multimodal interaction, affective computing and pervasive computing. Possible applications include construction of systems that can monitor the cognitive abilities and emotional reactions of users of interactive systems to provide assistance that is appropriate but not excessive, companion systems that can aid with active healthy ageing, and tutoring systems that can assist users in developing skills in a variety of domains including chess.

## 8.1.3. CDP EcoSesa - Cross Disciplinary Project of the ComUE UGA

Participants: James Crowley, Patrick Reignier, Rafaellea Balzarini Dates: Jan 2017 to Dec 2020

Cities and their energy systems are undergoing profound transformations. Electric Power networks are being transformed from centralized, high capacity, generating plants, dimensioned to meet peak loads to decentralized, local, production based on intermittent renewable sources. This transformation is made possible by integration of information and energy technologies, new energy materials and components, and the rapid spread of pervasive computing. The result is a change in the socio-economics of energy distribution, and a change in the role of users from passive consumers to active participants in a dynamically fluctuating energy market. Many cities worldwide have initiated research projects and experiments to accelerate the spread of clean technologies. However, these initiatives generally focus on a specific issue that depends on the priorities and preferences of the local decision makers and stakeholders. At the same time, academic research has generally been confined to specialized silos in energy materials and management systems, in Social Sciences as well as in Information and Communication Technologies (ICT), resulting in piecemeal knowledge.

The vision of Eco-SESA is to address the problems resulting from the transition to clean decentralized energy production based on renewable sources with a holistic integrated humansystem approach. The project will address the development of Safe, Efficient, Sustainable and Accessible energy systems, from the individual end-user to dynamic communities of stakeholders at the district and grid levels.

Pervasive is involved in two research front of the project :

- Interactive systems to involve occupants of buildings
- Emerging behaviors from individual to communities

# 8.1.4. LabEx Persyval - Project MicroBayes: Probabilistic Machines for Low-level Sensor Interpretation

Participants: Emmanuel Mazer, Raphael Frisch Other Partners: Laurent Girin (TIMA), Laurent Girin (GIPSA Lab), Didier Piau (L'Institut Fourier)

Dates: Nov 2016 to Nov 2019

The project MicroBayes builds on results of the recently completed EC FET Open project BAMBI to explore a new technique for Blind source separation and acoustic signal location using a new form of Bayesian Computer. The techniques have recently been demonstrated using a software simulation. Current plans are to implement and demonstrate the Bayesian computer using an FPGA. By the end of the project we expect to produce a hardware implementation suitable for use in low-cost low-power applications.

121 Robotics and Smart environments - Partnerships and Cooperations - Project-Team PERVASIVE INTERACTION

## 8.1.5. Competitivity Clusters

James Crowley is on the scientific committee for the Minalogic Competitivity Cluster. Minalogic is the global innovation cluster for digital technologies serving France's Auvergne-Rhône-Alpes region. The Scientific Committee advises the pole of strategy, advises local industry in proposal preparation, reviews FUI project proposals, and makes recommendations about labelling and support of project proposals.

# **RITS Project-Team**

# 8. Partnerships and Cooperations

# 8.1. National Initiatives

### 8.1.1. ANR

8.1.1.1. COCOVEA

Title: Coopération Conducteur-Véhicule Automatisé

Instrument: ANR

Duration: November 2013 - April 2017

Coordinator: Jean-Christophe Popieul (LAMIH - University of Valenciennes)

Partners: LAMIH, IFSTTAR, Inria, University of Caen, COMETE, PSA, CONTINENTAL, VALEO, AKKA Technologies, SPIROPS

Inria contact: Fawzi Nashashibi

Abstract: CoCoVeA project aims at demonstrating the need to integrate from the design of the system, the problem of interaction with the driver in resolving the problems of sharing the driving process and the degree of freedom, authority, level of automation, prioritizing information and managing the operation of the various systems. This approach requires the ability to know at any moment the state of the driver, the driving situation in which he finds himself, the operating limits of the various assistance systems and from these data, a decision regarding activation or not the arbitration system and the level of response.

### 8.1.1.2. VALET

Title: Redistribution automatique d'une flotte de véhicules en partage et valet de parking

Instrument: ANR

Duration: January 2016 - December 2018

Coordinator: Fawzi Nashashibi

Partners: Inria, Ecole Centrale de Nantes (IRCCyN), AKKA Technologies

Inria contact: Fawzi Nashashibi

Abstract: The VALET project proposes a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers. An optimal routing algorithm is in charge of defining platoons drivers' routes to the parking areas where the followers are parked in a complete automated mode. The main idea of VALET is to retrieve vehicles parked randomly on the urban parking network by users. These parking spaces may be in electric charging stations, parking for car sharing vehicles or in regular parking places. Once the vehicles are collected and guided in a platooning mode, the objective is then to guide them to their allocated parking area or to their respective parking lots. Then each vehicle is assigned a parking place into which it has to park in an automated mode.

# 8.1.2. FUI

8.1.2.1. Sinetic

Title: Système Intégré Numérique pour les Transports Intelligents Coopératifs Instrument: FUI Duration: December 2014 - May 2017 Coordinator: Thomas Nguyen (Oktal)

# Partners: Oktal, ALL4TEC, CIVITEC, Dynalogic, Inria, EURECOM, Renault, Armines, IFSTTAR, VEDECOM

Inria contact: Jean-Marc Lasgouttes

Abstract: The purpose of the project SINETIC is to create a complete simulation environment for designing cooperative intelligent transport systems with two levels of granularity: the system level, integrating all the components of the system (vehicles, infrastructure management centers, etc.) and its realities (terrain, traffic, etc.) and the component-level, modeling the characteristics and behavior of the individual components (vehicles, sensors, communications and positioning systems, etc.) on limited geographical areas, but described in detail.

#### 8.1.2.2. PAC V2X

Title: Perception augmentée par coopération véhicule avec l'infrastructure routière

Instrument: FUI

Duration: September 2016 - August 2019

Coordinator: SIGNATURE Group (SVMS)

Partners: DigiMobee, LOGIROAD, MABEN PRODUCTS, SANEF, SVMS, VICI, Inria, VEDE-COM

Inria contact: Raoul de Charette

Abstract: The objective of the project is to integrate two technologies currently being deployed in order to significantly increase the time for an automated vehicle to evolve autonomously on European road networks. It is the integration of technologies for the detection of fixed and mobile objects such as radars, lidars, cameras ... etc. And local telecommunication technologies for the development of ad hoc local networks as used in cooperative systems.

### 8.1.3. Competitivity Clusters

RITS team is a very active partner in the competitivity clusters, especially MOV'EO and System@tic. We are involved in several technical committees like the DAS SUR of MOV'EO for example. RITS is also the main Inria contributor in the VEDECOM institute (IEED). VEDECOM is financing the PhD theses of Mr. Fernando Garrido and Mr. Zayed Alsayed.

## 8.2. European Initiatives

## 8.2.1. FP7 & H2020 Projects

8.2.1.1. AUTOCITS

Title: AUTOCITS Regulation Study for Interoperability in the Adoption of Autonomous Driving in European Urban Nodes

Program: CEF- TRANSPORT Atlantic corridor

Duration: November 2016 - December 2018

Coordinator: Indra Sistemas S.A. (Spain)

Partners: Indra Sistemas S.A. (Spain); Universidad Politécnica de Madrid (UPM), Spain; Dirección General de Tráfico (DGT), Spain; Inria (France); Instituto Pedro Nunes (IPN), Portugal; Autoridade Nacional de Segurança Rodoviária (ANSR), Portugal; Universidade de Coimbra (UC), Portugal.

Inria contact: Fawzi Nashashibi, Mohammad Abualhoul

Abstract: The aim of the Study is to contribute to the deployment of C-ITS in Europe by enhancing interoperability for autonomous vehicles as well as to boost the role of C-ITS as catalyst for the implementation of autonomous driving. Pilots will be implemented in 3 major Core Urban nodes (Paris, Madrid, Lisbon) located along the Core network Atlantic Corridor in 3 different Member States. The Action consists of Analysis and design, Pilots deployment and assessment, Dissemination and communication as well as Project Management and Coordination.

### 8.2.2. Collaborations with Major European Organizations

RITS is member of the **euRobotics AISBL** and the Leader of "People transport" Topic. This makes from Inria one of the rare French robotics representatives at the European level. See also: http://www.eu-robotics.net/

RITS is a full partner of **VRA – Vehicle and Road Automation**, a support action funded by the European Union to create a collaboration network of experts and stakeholders working on deployment of automated vehicles and its related infrastructure. VRA project is considered as the cooperation interface between EC funded projects, international relations and national activities on the topic of vehicle and road automation. It is financed by the European Commission DG CONNECT and coordinated by ERTICO – ITS Europe. See also: http://vra-net.eu/

### 8.3. International Initiatives

### 8.3.1. Participation in Other International Programs

### 8.3.1.1. ICT-Asia

### SIM-Cities

Title: "Sustainable and Intelligent Mobility for Smart Cities"

International Partner (Institution - Laboratory - Researcher):

- Nanyang Technical University (NTU), School of Electrical and Electronic Engineering – Singapore. Prof. Dan Wei Wang

- National University of Singapore (NUS), Department of Mechanical Engineering – Singapore. Dr. Marcelo Ang

- Kumamotoo University - Japan. Intelligent Transportation Systems Lab, Graduate School of Science and Technology, Prof. James Hu / Prof. Ogata

- Shanghai Jiao-Tong University (SJTU), Department of Automation - China. Prof. Ming Yang

- Hanoi University of Science and Technology, International Center MICA Institute – Vietnam. Prof. Eric Castelli

- Inria, RITS Project-Team - France. Dr. Fawzi Nashashibi

- Inria, e-Motion/CHROMA Project-Team - France. Dr. Christian Laugier

- Ecole Centrale de Nantes, IRCCyN - France. Prof. Philippe Martinet

Duration: Jan. 2015 - May 2017

Start year: 2015

This project aims at conducting common research and development activities in the field of sustainable transportation and advanced mobility of people and goods in order to move in the direction of smart, clean and sustainable cities.

RITS and MICA lab have obtained from the Vietnamese Program 911 the financing of the joint PhD thesis of Dinh-Van Nguyen (co-directed by Eric Castelli from MICA lab and Fawzi Nashashibi).

### 8.3.1.2. ECOS Nord – Venezuela

### **ECOS Nord**

Title: "Les Techniques de l'Information et de la Communication pour la Conception de Systèmes Avancés de Mobilité durable en Milieu Urbain."

International Partner (Institution - Laboratory - Researcher):

- Simon Bolivar University, Department of Mecatronics - Venezuela. Dr. Gerardo Fernandez

- Inria, RITS Project-Team - France. Dr. Fawzi Nashashibi

Duration: Jan. 2014 - Dec. 2017

### Start year: 2014

The main objective of this project is to contribute scientifically and technically to the design of advanced sustainable mobility systems in urban areas, particularly in dense cities where mobility, comfort and safety needs are more important than in other types of cities. In this project, we will focus on the contribution of advanced systems of perception, communication and control for the realization of intelligent transport systems capable of gradually integrating into the urban landscape. These systems require the development of advanced dedicated urban infrastructures as well as the development and integration of on-board intelligence in individual vehicles or mass transport. This year, a session of courses has been organized at University Simon Bolivar, Caracas (Venezuela). Following several PhDs and interns recruitments from this university, prof G. Fernandez and J. Capeletto invited Raoul de Charette to organize a 32Hr Computer Vision Master Class in December 2017. PhDs Carlos Flores and Luis Roldao were also part of the master class and teached control (10Hr) and point cloud processing (7Hr), respectively.

## 8.4. International Research Visitors

## 8.4.1. Visits of International Scientists

### 8.4.1.1. Internships

Julio Blanco Deniz, Nievsabel Molina from Simon Bolivar University, Venezuela.

They both worked on a cascade control architecture based on PID controllers for a Citroen C1: the longitudinal control was developed by Julio Blanco Deniz, under the supervision of Carlos Flores and the lateral control (for the action on the steering wheel) was done by Nievsabel Molina, under the supervision of Francisco Navas. Using this architecture, a reference trajectory can be smoothly followed by the vehicle at different speeds.

Aitor Gomez, Alfredo Valle, Edgar Talavera Munoz from Universidad Politécnica de Madrid, Spain.

Ziyang Hong from Université de Bourgogne, Dijon, France.

Maradona Rodrigues from University of Warwick, United Kingdom.

Sule Kahraman from MIT, USA.

Arthur Lecert from ESIEE Paris, France. He was supervised by Pierre de Beaucorps.

126 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team LINKMEDIA

# **LINKMEDIA Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. CominLabs Project Linking Media in Acceptable Hypergraphs (LIMAH)

Participants: Rémi Bois, Vincent Claveau, Guillaume Gravier, Pascale Sébillot, Arnaud Touboulic.

Duration: 4 years, started in April 2014 Partners: Telecom Bretagne (IODE), Univ. Rennes II (CRPCC, PREFics), Univ. Nantes (LINA/TAL) URL: http://limah.irisa.fr

LIMAH aims at exploring hypergraph structures for multimedia collections, instantiating actual links reflecting particular content-based proximity—similar content, thematic proximity, opinion expressed, answer to a question, etc. Exploiting and developing further techniques targeting pairwise comparison of multimedia contents from an NLP perspective, LIMAH addresses two key issues: How to automatically build from a collection of documents an hypergraph, i.e., a graph combining edges of different natures, which provides exploitable links in selected use cases? How collections with explicit links modify usage of multimedia data in all aspects, from a technology point of view as well as from a user point of view? LIMAH studies hypergraph authoring and acceptability taking a multidisciplinary approach mixing ICT, law, information and communication science as well as cognitive and ergonomy psychology.

### 9.1.2. CominLabs Project BigCLIN

Participants: Vincent Claveau, Ewa Kijak, Clément Dalloux.

Duration: 3 years, started in September 2016 Partners: STL-CNRS, Inserm/CHU Rennes, Inria URL: http://www.bigclin.cominlabs.ueb.eu

Data collected or produced during clinical care process can be exploited at different levels and across different domains. Yet, a well-known challenge for secondary use of health big data is that much of detailed patient information is embedded in narrative text, mostly stored as unstructured data. The project proposes to address the essential needs when reusing unstructured clinical data at a large scale. We propose to develop new clinical records representation relying on fine-grained semantic annotation thanks to new NLP tools dedicated to French clinical narratives. To efficiently map this added semantic information to existing structured data for further analysis at big scale, the project also addresses distributed systems issues: scalability, management of uncertain data and privacy, stream processing at runtime, etc.

# 9.2. National Initiatives

### 9.2.1. ANR Project IDFRAud

Participant: Teddy Furon.

Duration: 3 years, started in Feb. 2015 Partners: AriadNext, IRCGN, École Nationale Supérieure de Police

# 127 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team LINKMEDIA

The IDFRAud project consists in proposing an automatic solution for ID analysis and integrity verification. Our ID analysis goes through three processes: classification, text extraction and ID verification. The three processes rely on a set of rules that are externalized in formal manner in order to allow easy management and evolving capabilities. This leads us to the ID knowledge management module. Finally, IDFRAud addresses the forensic link detection problem and to propose an automatic analysis engine that can be continuously applied on the detected fraud ID database. Cluster analysis methods are used to discover relations between false IDs in their multidimensional feature space. This pattern extraction module will be coupled with a suitable visualization mechanism in order to facilitate the comprehension and the analysis of extracted groups of interlinked fraud cases.

## 9.2.2. FUI 19 NexGenTV

Participants: Vincent Claveau, Guillaume Gravier, Ewa Kijak, Gabriel Sargent, Ronan Sicre.

Duration: 2.5 years, started in May 2015 Partners: Eurecom, Avisto Telecom, Wildmoka, Envivio-Ericsson

Television is undergoing a revolution, moving from the TV screen to multiple screens. Today's user watches TV and, at the same time, browses the web on a tablet, sends SMS, posts comments on social networks, searches for complementary information on the program, etc. Facing this situation, NexGen-TV aims at developing a generic solution for the enrichment, the linking and the retrieval of video content targeting the cost-cutting edition of second screen and multiscreen applications for broadcast TV. The main outcome of the project will be a software platform to aggregate and distribute video content via a second-screen edition interface connected to social media. The curation interface will primarily make use of multimedia and social media content segmentation, description, linking and retrieval. Multiscreen applications will be developed on various domaine, e.g., sports, news.

## 9.2.3. Inria Project Lab Knowledge-driven data and content collaborative analytics (iCODA)

Participants: Laurent Amsaleg, Vincent Claveau, Cheikh Brahim El Vaigh, Guillaume Gravier, Pascale Sébillot.

### Duration: 4.5 years, started in April 2017

### Partners: Inria project-teams Linkmedia, CEDAR, GraphIK and ILDA, with Ouest France, Le Monde and AFP

One of today's major issues in data science is the design of algorithms that allow analysts to efficiently infer useful information and knowledge by collaboratively inspecting heterogeneous information sources, from structured data to unstructured content. 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 collaborative data analytics on heterogeneous information sources, and to demonstrate the effectiveness of the approach in realistic, high-visibility use-cases. The project stands at the crossroad of multiple research fields—content analysis, data management, knowledge representation, visualization—that span multiple Inria themes, and counts on a club of major press partners to define usage scenarios, provide data and demonstrate achievements.

# 9.3. European Initiatives

## 9.3.1. CHIST ERA ID\_IOT

Participant: Teddy Furon.

Duration: 3 years, started in Oct. 2016 Partners: Eindhoven Univ. of Technology, Univ. of Geneva

# 128 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team LINKMEDIA

The IoT will contain a huge number of devices and objects that have very low or nonexistent processing and communication resources, coupled to a small number of high-power devices. The weakest devices, which are most ubiquitous, will not be able to authenticate themselves using cryptographic methods. This project addresses these issues using physical unclonable functions (PUFs). PUFs, and especially quantum readout PUFs, are ideally suited to the IoT setting because they allow for the authentication and identification of physical objects without requiring any crypto or storage of secret information.

Furthermore, we foresee that back-end systems will not be able to provide security and privacy via cryptographic primitives due to the sheer number of IoT devices. Our plan is to address these problems using privacypreserving database structures and algorithms with good scaling behaviour. Approximate nearest neighbour (ANN) search algorithms, which have remarkably good scaling behaviour, have recently become highly efficient, but do not yet have the right security properties and have not yet been applied to PUF data. Summarised in a nutshell, the project aims to improve the theory and practice of technologies such as PUFs and ANN search in the context of generic IoT authentication and identification scenarios.

## 9.3.2. Collaborations with Major European Organizations

Big Data Value Association (BDVA): LINKMEDIA is a co-founder and co-leader of the media group (TF7) within BDVA

# 9.4. International Initiatives

## 9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

- National Institute for Informatics, Japan
- University of Amsterdam, The Netherlands
- Czech Technical University, Czech Republic
- Katholieke Universiteit Leuven, Belgium

## 9.4.2. Participation in Other International Programs

- CNRS CONFAP FIGTEM
  - Title: Fine-grained text-mining for clinical trials
  - International Partner (Institution Laboratory Researcher): Pontifícia Universidade Católica do Paraná - Health Informatics dept, Claudia Moro

FIGTEM aims at developing natural language processing methods, including information extraction and indexing, dedicated to the clinical trial domain. The goal is to populate a formal representation of patients (via their electronic patient records) and clinical trial data in different languages (French, English, Portuguese).

– Jan. 2016 – Dec. 2018

# 9.5. International Research Visitors

## 9.5.1. Visits of International Scientists

## Giorgos Tolias

Date: Sept. 2017 (1 week)

Institution: Czech Technical University, Czech Republic

### Vincent Oria

Date: July 2017 (2 weeks)

Institution: New Jersey Institute of Technology, Newark, USA

### Michael Houle

Date: July 2017 (2 weeks) Institution: National Institute of Informatics, Tokyo, Japan

## 9.5.1.1. Internships

Gabriel B. de Fonseca Date: Nov. 2016 - Jan. 2017 Institution: PUC Minas, Brazil

# 9.5.2. Visits to International Teams

Laurent Amsaleg
Date: Oct. 2017 (2 days)
Institution: New Jersey Institute of Technology, Newark, USA
Laurent Amsaleg
Date: May. 2017 (1 week)
Institution: East China Normal University, Shanghai, PRC
Clément Dalloux
Date: NovDec 2017 (1 month)
Institution: Pontifícia Universidade Católica do Paraná, Brazil
Guillaume Gravier
Date: Nov. 2017 (1 week)
Institution: Universidad de Chile, Santiago, Chile
Guillaume Gravier
Date: May. 2017 (1 week)
Institution: East China Normal University, Shanghai, PRC

# **MAGRIT Project-Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

The MAGRIT and the MIMESIS teams have been working for several years on the use of augmented reality for deformable organs and especially on liver surgery. The PhD of Jaime Garcia Guevara started in October 2015 and is funded by the Région Lorraine. It is co-supervised by M.-O. Berger and S. Cotin (MILESIS, Strasbourg). It follows on from our past works and aims at improving the reliability and the robustness of AR-based clinical procedures.

A one year post-doc position was granted by the Region Lorraine and the Université de Lorraine. Cong Yang started this position in November 2016 and ended in October 2017. He developed algorithms for object recognition in large-scale industrial environments (factories, vessels, ...), with the aim to enrich the operator's field of view with digital information and media. The main issues concerned the size of the environment, the nature of the objects (often non textured, highly specular, ...) and the presence of repeated patterns.

# 9.2. National Initiatives

## 9.2.1. Projet RAPID EVORA

Participants: M.-O. Berger, V. Gaudillière, G. Simon, C. Yang.

This 3-year project is supported by DGA/DGE and led by the SBS-Interactive company. The objective is to develop a prototype for location and object recognition in large-scale industrial environments (factories, ships...), with the aim to enrich the operator's field of view with digital information and media. The main issues concern the size of the environment, the nature of the objects (often non textured, highly specular...) and the presence of repeated patterns. Use cases will be provided by industrial partners such as DCNS and Areva. A class of officer cadets and professors of the Merchant Marine School will also be associated to judge the pedagogical interest of such a tool. A PhD student, Vincent Gaudillière, has been recruited to work on this project and his contract started in December 2016.

## 9.2.2. Project funded by GDR ISIS in collaboration with Institut Pascal

#### Participant: F. Sur.

Between September 2014 and September 2017, we have been engaged in a collaboration with Institut Pascal funded by GDR ISIS. The aim of this project was the investigation of image processing tools for enhancing the metrological performance of contactless measurement systems in experimental mechanics.

## 9.2.3. AEN Inria SOFA-InterMedS

Participants: R. Anxionnat (CHU Nancy), M.-O. Berger, E. Kerrien.

The SOFA-InterMedS large-scale Inria initiative is a research-oriented collaboration across several Inria project-teams, international research groups and clinical partners. Its main objective is to leverage specific competences available in each team to further develop the multidisciplinary field of Medical Simulation research. Our action within the initiative takes place in close collaboration with both the MIMESIS team and the Department of diagnostic and therapeutic interventional neuroradiology of Nancy University Hospital. Two PhD students - R. Trivisonne and J. Guarcia Guevara- are currently co-supervised by the Magrit and the MIMESIS teams.

131 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team MAGRIT

# 9.3. International Initiatives

### 9.3.1. Inria Associate Teams Not Involved in an Inria International Lab

### 9.3.1.1. CURATIVE

Title: CompUteR-based simulAtion Tool for mItral Valve rEpair

International Partner (Institution - Laboratory - Researcher):

Harvard University (United States) - Harvard Biorobotics Lab (HBL) - Robert Howe

Start year: 2017

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

The mitral valve of the heart ensures one-way flow of oxygenated blood from the left atrium to the left ventricle. However, many pathologies damage the valve anatomy producing undesired backflow, or regurgitation, decreasing cardiac efficiency and potentially leading to heart failure if left untreated. Such cases could be treated by surgical repair of the valve. However, it is technically difficult and outcomes are highly dependent upon the experience of the surgeon.

One way to facilitate the repair is to simulate the mechanical behavior of the pathological valve with subject-specific data. Our main goal is to provide surgeons with a tool to study solutions of mitral valve repairs. This tool would be a computer-based model that can simulate a potential surgical repair procedure in order to evaluate its success. The surgeons would be able to customize the simulation to a patient and to a technique of valve repair. Our methodology will be to realistically simulate valve closure based on segmentation methods faithful enough to capture subject-specific anatomy and based on a biomechanical model that can accurately model the range of properties exhibited by pathological valves.

During the first year, we worked on three aspects of this project: i) developing a fast image-based mitral valve simulation, ii) extracting the mitral valve chordae from a CT scan (see section New Results) and iii) developing a Cosserat model for catheter robot for heart surgical procedures. The work on fast image-based mitral valve simulation has been accepted to the The International Journal of Medical Robotics and Computer Assisted Surgery [17].

## 9.4. International Research Visitors

### 9.4.1. Visits of International Scientists

Douglas Perrin, a senior researcher at Harvard University (http://people.seas.harvard.edu/~dperrin), visited the MAGRIT team from 05/29/17 to 06/02/17. He gave a talk to the Department 1 in Loria, he helped out with scientific understanding of the mitral valve anatomy and he provided advice to Daryna Panicheva supervision during one week.

Thomas Waite, an undergrad student at Harvard University, visited the MAGRIT team from 06/05/17 to 06/09/17. He gave a talk to the Department 1 in Loria, he worked with Pierre-Frédéric Villard on modeling a heart surgical catheter robot with Cosserat model and started writing a journal paper on this subject.

## 9.4.2. Visits to International Teams

### 9.4.2.1. Research Stays Abroad

Pierre-Frederic Villard spent one month (August 2017) at Uppsala University working on the INVIVE project http://www.it.uu.se/research/scientific\_computing/project/rbf/biomech. His work there includes supervising PhD student Igor Tominec, meeting with a physiologist expert in respiration muscles and working on both the mesh and the boundary conditions in the case of a passive diaphragm.

132 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team MORPHEO

# **MORPHEO Project-Team**

# 9. Partnerships and Cooperations

# 9.1. National Initiatives

## 9.1.1. Persyval-Lab exploratory project Carambole

The Carambole projects initiates a new collaboration between the Morpheo team and biophysicists from University Paris Diderot. The objectives are to develop hardware and software to help tracking feature points on a leaf of Averrhoa Carambola during its growth with a multi-camera system and to measure their 3D motion. Averrhoa carambola is of special interest because of the distinctive nutation balancing motion of a leaf during its growth.

This exploratory project was funded for 18 months in 2016 and 2017 by the Persyval-Lab LabEx.

## 9.1.2. ANR

### 9.1.2.1. ANR PRCE CaMoPi - Capture and Modelling of the Shod Foot in Motion

The main objective of the CaMoPi project is to capture and model dynamic aspects of the human foot with and without shoes. To this purpose, video and X-ray imagery will be combined to generate novel types of data from which major breakthroughs in foot motion modelling are expected. Given the complexity of the internal foot structure, little is known about the exact motion of its inner structure and the relationship with the shoe. Hence the current state-of-the art shoe conception process still relies largely on ad-hoc know-how. This project aims at better understanding the inner mechanisms of the shod foot in motion in order to rationalise and therefore speed up and improve shoe design in terms of comfort, performance, and cost. This requires the development of capture technologies that do not yet exist in order to provide full dense models of the foot in motion. To reach its goals, the CaMoPi consortium comprises complementary expertise from academic partners : Inria (combined video and X-ray capture and modeling) and Mines St Etienne (finite element modeling), as well as industrials : CTC Lyon (shoe conception and manufacturing) and Sporaltec (dissemination). The project has effectively started in October 2017 with Claude Goubet's recruitment as a PhD candidate.

### 9.1.2.2. ANR project Achmov – Accurate Human Modeling in Videos

The technological advancements made over the past decade now allow the acquisition of vast amounts of visual information through the use of image capturing devices like digital cameras or camcorders. A central subject of interest in video are the humans, their motions, actions or expressions, the way they collaborate and communicate. The goal of ACHMOV is to extract detailed representations of multiple interacting humans in real-world environments in an integrated fashion through a synergy between detection, figure-ground segmentation and body part labeling, accurate 3D geometric methods for kinematic and shape modeling, and large-scale statistical learning techniques. By integrating the complementary expertise of two teams (one French, MORPHEO and one Romanian, CLVP), with solid prior track records in the field, there are considerable opportunities to move towards processing complex real world scenes of multiple interacting people, and be able to extract rich semantic representations with high fidelity. This would enable interpretation, recognition and synthesis at unprecedented levels of accuracy and in considerably more realistic setups than currently considered. This project is currently ongoing with 2 PhDs on the Inria side: Vincent Leroy and Jinlong Yang.

## 9.1.3. Competitivity Clusters

## 9.1.3.1. FUI project Creamove

Creamove is a collaboration between the Morpheo team of the Inria Grenoble Rhône-Alpes, the 4D View Solution company specialized in multi-camera acquisition systems, the SIP company specialized in multi-media and interactive applications and a choreographer. The objective is to develop new interactive and artistic applications where humans can interact in 3D with virtual characters built from real videos. Dancer performances will be pre-recorded in 3D and used on-line to design new movement sequences based on inputs coming from human bodies captured in real time. Website: http://www.creamove.fr.

133 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team MORPHEO

### 9.1.3.2. FUI24 SPINE PDCA - SPINE Plan-Do-Check-Act

The goal of the SPINE PDCA project is to develop a unique medical platform that will streamline the medical procedure and achieve all the steps of a minimally invasive surgery intervention with great precision through a complete integration of two complementary systems for pre-operative planning (EOS platform from EOS IMAGING) and imaging/intra-operative navigation (SGV3D system from SURGIVISIO). Innovative low-dose tracking and reconstruction algorithms will be developed by Inria, and collaboration with two hospitals (APHP Trousseau and CHU Grenoble) will ensure clinical feasibility. The medical need is particularly strong in the field of spinal deformity surgery which can, in case of incorrect positioning of the implants, result in serious musculoskeletal a high repeat rate (10 to 40% of implants are poorly positioned in spine surgery) and important care costs. In paediatric surgery (e.g. idiopathic scoliosis), the rate of exposure to X-rays is an additional major consideration in choosing the surgical approach to engage. For these interventions, advanced linkage between planning, navigation and postoperative verification is essential to ensure accurate patient assessment, appropriate surgical procedure and outcome consistent with clinical objectives.

134 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team PERCEPTION

# **PERCEPTION Project-Team**

# 8. Partnerships and Cooperations

# 8.1. European Initiatives

### 8.1.1. FP7 & H2020 Projects

8.1.1.1. VHIA

Title: Vision and Hearing in Action EU framework: FP7 Type: ERC Advanced Grant Duration: February 2014 - January 2019 Coordinator: Inria Inria contact: Radu Horaud

'The objective of VHIA is to elaborate a holistic computational paradigm of perception and of perception-action loops. We plan to develop a completely novel twofold approach: (i) learn from mappings between auditory/visual inputs and structured outputs, and from sensorimotor contingencies, and (ii) execute perception-action interaction cycles in the real world with a humanoid robot. VHIA will achieve a unique fine coupling between methodological findings and proof-of-concept implementations using the consumer humanoid NAO manufactured in Europe. The proposed multimodal approach is in strong contrast with current computational paradigms influenced by unimodal biological theories. These theories have hypothesized a modular view, postulating quasi-independent and parallel perceptual pathways in the brain. VHIA will also take a radically different view than today's audiovisual fusion models that rely on clean-speech signals and on accurate frontal-images of faces; These models assume that videos and sounds are recorded with hand-held or head-mounted sensors, and hence there is a human in the loop who intentionally supervises perception and interaction. Our approach deeply contradicts the belief that complex and expensive humanoids (often manufactured in Japan) are required to implement research ideas. VHIA's methodological program addresses extremely difficult issues: how to build a joint audiovisual space from heterogeneous, noisy, ambiguous and physically different visual and auditory stimuli, how to model seamless interaction, how to deal with high-dimensional input data, and how to achieve robust and efficient human-humanoid communication tasks through a well-thought tradeoff between offline training and online execution. VHIA bets on the high-risk idea that in the next decades, social robots will have a considerable economical impact, and there will be millions of humanoids, in our homes, schools and offices, which will be able to naturally communicate with us. Website: https://team.inria.fr/perception/projects/erc-vhia/

8.2. International Initiatives

## 8.2.1. Inria International Partners

### 8.2.1.1. Informal International Partners

- Bar Ilan University, Israel (prof. Sharon Gannot and his team)
- University of Trento, Italy (prof. Nicu Sebe and prof. Elisa Ricci)
- Dr. Rafael Munoz-Salinas and prof. Manuel Marin-Jimenez, University of Cordoba, Spain,
- Dr. Christine Evers and prof. Patrick Naylor, Imperial College of Science and Medecine, UK.
- Dr. Miriam Redi, Wikimedia Foundation, UK.
- Prof. Shih-Fu Chang, Columbia University, USA.

# 8.3. International Research Visitors

## 8.3.1. Visits of International Scientists

- Prof. Sharon Gannot (Bar Ilan University)
- Oscar David Gomez Lopez (University of Granada)

135 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team SIROCCO

# **SIROCCO Project-Team**

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

### 9.1.1. CominLabs/InterCom project

Participants: Aline Roumy, Thomas Maugey.

- Title : Interactive Communication (INTERCOM): Massive random access to subsets of compressed correlated data .
- Research axis : 7.4.2
- Partners : Inria-Rennes (Sirocco team and i4S team); LabSTICC, Telecom Bretagne, Signal & Communications Department; External partner: Kieffer L2S, CentraleSupelec, Univ. Paris Sud.
- Funding : Labex CominLabs.
- Period : Oct. 2016 Nov. 2019.

This project aims to develop novel compression techniques allowing massive random access to large databases. Indeed, we consider a database that is so large that, to be stored on a single server, the data have to be compressed efficiently, meaning that the redundancy/correlation between the data have to be exploited. The dataset is then stored on a server and made available to users that may want to access only a subset of the data. Such a request for a subset of the data is indeed random, since the choice of the subset is user-dependent. Finally, massive requests are made, meaning that, upon request, the server can only perform low complexity operations (such as bit extraction but no decompression/compression). Algorithms for two emerging applications of this problem will be developed: Free-viewpoint Television (FTV) and massive requests to a database collecting data from a large-scale sensor network (such as Smart Cities).

## 9.2. European Initiatives

## 9.2.1. FP7 & H2020 Projects

#### 9.2.1.1. ERC-CLIM

**Participants:** Pierre David, Elian Dib, Simon Evain, Christine Guillemot, Laurent Guillo, Mikael Le Pendu, Xiaoran Jiang, Jinglei Shi, Xin Su, Lara Younes.

Light fields yield a rich description of the scene ideally suited for advanced image creation capabilities from a single capture, such as simulating a capture with a different focus and a different depth of field, simulating lenses with different apertures, for creating images with different artistic intents or for producing 3D views. Light fields technology holds great promises for a number of application sectors, such as photography, augmented reality, light field microscopy, but also surveillance, to name only a few.

The goal of the ERC-CLIM project is to develop algorithms for the entire static and video light fields processing chain, going from compact sparse and low rank representations and compression to restoration, high quality rendering and editing.

136 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team SIROCCO

# 9.3. International Initiatives

### 9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

Title: Graph-based Omnidirectional video Processing

International Partner (Institution - Laboratory - Researcher):

Ecole Polytechnique Fédérale de Lausanne (Switzerland) - LTS4 - Pascal Frossard

Start year: 2017

See also: http://people.rennes.inria.fr/Thomas.Maugey/wp/projects/gop/

Due to new camera types, the format of the video data has become more complex than simple 2D images or videos as it was the case a few years ago. In particular, the omnidirectional cameras provide pixels on a whole sphere around a center point and enable a vision in 360°. In addition to the fact that the data size explodes with such cameras, the inherent structure of the acquired signal fundamentally differs from the 2D images, which makes the traditional video codec obsolete. In parallel of that, an important effort of research has been lead recently, especially at EPFL, to develop new processing tools for signals lying on irregular structures (graphs). It enables in particular to build efficient coding tools for new types of signals. The proposed research project will actually study how graphs can be built for defining a suitable structure on one or several 360° videos and then used for compression.

The collaboration between SIROCCO (Inria) and LTS4 (EPFL) has been very active in the recent years. However, only one-to-one collaboration was involved. When opening these new ambitious research direction, the project GOP will involve more than two or three researchers, and build a bidirectional collaboration between different people of the SIROCCO and LTS4 teams.

### 9.3.2. Inria International Partners

### 9.3.2.1. Informal International Partners

We have international collaborations with:

- Reuben Farrugia, Prof. at the University of Malta, with whom we continue collaborating on light field super-resolution. The collaboration strated during the sabbatical year (Sept. 2015-Aug. 2016) he spent within the team.
- Ehsan Miandji and Prof.Jonas Unger from Linkoping Univ. with whom we collaborate on compressive sampling of light fields. Ehsan Miandji has spent 1.5 month (June- July 2017) within the team.
- Chiara Galdi and Jean Luc Dugelay, prof. at Eurecom, with whom we collaborate on the application of light fields to biometry. Chiara Galdi has spent one month in the team (April 2017).
- Ole Johanssen and Prof. Bastian Goldluecke, from Univ. of Konstanz, with whom we collaborate on scene flow estimation with deep learning. Ole Johanssen has spent one month (Nov. 20- Dec. 20, 2017) in the team.
- The study on guided image inpainting is carried out in collaboration with Prof. Pascal Frossard from EPFL (Ecole Polytechique Federal de Lausanne).

# **STARS Project-Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

• **NeuComp** is a project of the UCA Académie d'excellence: Réseaux, Information et Société Numérique" (C@UCA). NeuComp is focusing on the model of neuron networks Leaky Integrate and Fire (LIF). The main objective of C@UCA is the brain modelling and its simulation. In this framework, the Neucomp project focuses on (1) the implementation and verification of temporal properties of neural structures; (2) the design of electronic architectures of LIF neural networks; and (3) the comparison of this electronic implementation with neuromorphic computer results. In the NeuComp project, Inria (Stars) collaborate with the LEAT (Laboratoire d'Electronique, Antennes et Télécommunications), I3S (Laboratoire d'Informatique, Signaux et Systèmes), LJAD (Laboratoire J.A. Dieudonné), Clermond Ferrand University and Arizona Unniversity.

# 9.2. National Initiatives

## 9.2.1. ANR

### 9.2.1.1. MOVEMENT

Program: ANR CSOSG

Project acronym: MOVEMENT

Project title: AutoMatic BiOmetric Verification and PersonnEl Tracking for SeaMless Airport ArEas Security MaNagemenT

Duration: January 2014-June 2017

Coordinator: MORPHO (FR)

Other partners: SAGEM (FR), Inria Sophia-Antipolis (FR), EGIDIUM (FR), EVITECH (FR) and CERAPS (FR)

Abstract: MOVEMENT is focusing on the management of security zones in the non public airport areas. These areas, with a restricted access, are dedicated to service activities such as maintenance, aircraft ground handling, airfreight activities, etc. In these areas, personnel movements tracking and traceability have to be improved in order to facilitate their passage through the different areas, while insuring a high level of security to prevent any unauthorized access. MOVEMENT aims at proposing a new concept for the airport's non public security zones (e.g. customs control rooms or luggage loading/unloading areas) management along with the development of an innovative supervision system prototype.

### 9.2.1.2. SafEE

Program: ANR TESCAN

Project acronym: SafEE

Project title: Safe & Easy Environment for Alzheimer Disease and related disorders

Duration: December 2013-May 2017

Coordinator: CHU Nice

Other partners: Nice Hospital(FR), Nice University (CobTeck FR), Inria Sophia-Antipolis (FR), Aromatherapeutics (FR), SolarGames(FR), Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW), BDE (TW)

### 138 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team STARS

Abstract: SafEE project aims at investigating technologies for stimulation and intervention for Alzheimer patients. More precisely, the main goals are: (1) to focus on specific clinical targets in three domains behavior, motricity and cognition (2) to merge assessment and non pharmacological help/intervention and (3) to propose 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.

### 9.2.1.3. 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 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.

### 9.2.2. FUI

9.2.2.1. 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 Hospitaliere Sainte-Marie.

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

### 9.2.2.2. 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 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.

### 9.2.2.3. 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).

# 9.3. European Initiatives

## 9.3.1. FP7 & H2020 Projects

9.3.1.1. CENTAUR

Title: Crowded ENvironments moniToring for Activity Understanding and Recognition

Programm: FP7

Duration: January 2013 - December 2016

Coordinator: Honeywell

Partners:

Ecole Polytechnique Fédérale de Lausanne (Switzerland)

Honeywell, Spol. S.R.O (Czech Republic)

Neovision Sro (Czech Republic)

Queen Mary University of London (United Kingdom)

Inria contact: François Brémond

We aim to develop a network of scientific excellence addressing research topics in computer vision and advancing the state of the art in video surveillance. The cross fertilization of ideas and technology between academia, research institutions and industry will lay the foundations to new methodologies and commercial solutions for monitoring crowded scenes. Research activities will be driven by specific sets of scenarios, requirements and datasets that reflect security operators' needs for guaranteeing the safety of EU citizens. CENTAUR gives a unique opportunity to academia to be exposed to real life dataset, while enabling the validation of state-of-the-art video surveillance methodology developed at academia on data that illustrate real operational scenarios. The research agenda is motivated by ongoing advanced research activities in the participating entities. With Honeywell as a multi-industry partner, with security technologies developed and deployed in both its Automation and Control Solutions and Aerospace businesses, we have multiple global channels to exploit the developed technologies. With Neovison as a SME, we address small fast paced local markets, where the quick assimilation of new technologies is crucial. Three thrusts identified will enable the monitoring of crowded scenes, each led by an academic partner in collaboration

with scientists from Honeywell: a) multi camera, multicoverage tracking of objects of interest, b) Anomaly detection and fusion of multimodal sensors, c) activity recognition and behavior analysis in crowded environments. We expect a long term impact on the field of video surveillance by: contributions to the state-of-the-art in the field, dissemination of results within the scientific and practitioners community, and establishing long term scientific exchanges between academia and industry, for a forum of scientific and industrial partners to collaborate on addressing technical challenges faced by scientists and the industry.'

# 9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: EIT Digital Activity

Project acronym: ELEMENT

Project title: Early detection of cognitive disorders on the basis of speech analysis

Duration: Jan 2017-Dec 2017

Coordinator: German Research Centre for Artificial Intelligence DFKI (Germany)

Other partners: Inria, Association Innovation Alzheimer (France) and University of Edinburgh (UK)

Abstract: ELEMENT is a new Innovation Activity to facilitate faster, earlier diagnosis and intervention for cognitive decline. The project aims to bring a unique new product o the European market that enables light-touch screening for cognitive decline in non-clinical settings, resulting in faster, earlier diagnosis and intervention.

# 9.4. International Initiatives

## 9.4.1. Informal International Partners

- **Collaborations with Asia:** Stars has been cooperating with the Multimedia Research Center in Hanoi MICA on semantics extraction from multimedia data. Stars also collaborates with the National Cheng Kung University in Taiwan and I2R in Singapore.
- Collaboration with U.S.A.: Stars collaborates with the University of Southern California.
- **Collaboration with Europe:** Stars collaborates with Multitel in Belgium, the University of Kingston upon Thames UK, and the University of Bergen in Norway.

## 9.4.2. Other IIL projects

## 9.4.2.1. The ANR SafEE (see section)

Stars collaborates with international partners such as Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW) and BDE (TW).

# 9.5. International Research Visitors

## 9.5.1. Visits of International Scientists

This year, Stars has been visited by the following international scientists:

- Salwa Baabou, Ecole Nationale d'Ingénieurs de Gabès, Tunisia;
- Adlen Kerboua, University of Skikda, Algeria;

### 9.5.1.1. Internships

Abhishek Goel

Date: Aug 2017-Dec 2017 Institution: BITS Pilani, Rajasthan, India Supervisor: Michal Koperski

#### Srijan Das

Date: Jan 2017- May 2017 Institution: National Institute of Technology, Rourkela, India Supervisor: Michal Koperski

### Salwa Babou

Date: Apr 2017-Sep 2017 Institution: Laboratoire d'Electroniques et des Technologies de l'Information, à l'ENIS, SFAX, Tunisia Supervisor: Francçois Brémond

### Yu-Fen Chen

Date: Feb 2017-Aug 2017 Institution: National Tapei University of Technology, Tawain Supervisor: Carlos Fernando Crispim Junior

#### Kuan-Ru Lee

Date: Aug 2017- Dec 2017 Institution: National Tapei University of Technology, Tawain Supervisor: Carlos Fernando Crispim Junior

### Chandraja Dharmana

Date: June 2017- Dec 2017 Institution: BITS Hyderabad, India Supervisor: François Brémond

### Shaira Kansal

Date: Jul 2017- Dec 2017 Institution: PEC, Chandigarh, India Supervisor: Carlos Fernando Crispim Junior

### Kartik Kartik

Date: Jul 2017- Dec 2017 Institution: PEC, Chandigarh, India Supervisor: Carlos Fernando Crispim Junior

### Rahul Pandey

Date: May 2017- Dec 2017 Institution: LMNIT, Rajasthan, India Supervisor: Carlos Fernando Crispim Junior

## Francesco Verrini

Date: Jun 2017- Dec 2017 Institution: Universita degli Studi di Genova, Italy Supervisor: Carlos Fernando Crispim Junior, Michal Koperski

# **THOTH Project-Team**

# 9. Partnerships and Cooperations

# 9.1. Regional Initiatives

# 9.1.1. DeCore (Deep Convolutional and Recurrent networks for image, speech, and text)

Participants: Jakob Verbeek, Maha Elbayad.

DeCore is a project-team funded by the Persyval Lab for 3.5 years (september 2016 - February 2020), coordinated by Jakob Verbeek. It unites experts from Grenoble's applied-math and computer science labs LJK, GIPSA-LAB and LIG in the areas of computer vision, machine learning, speech, natural language processing, and information retrieval. The purpose of DeCore is to stimulate collaborative interdisciplinary research on deep learning in the Grenoble area, which is likely to underpin future advances in machine perception (vision, speech, text) over the next decade. It provides funding for two full PhD students. Maha Elbayad is one of them, supervised by Jakob Verbeek and Laurant Besacier (UGA).

# 9.2. National Initiatives

## 9.2.1. ANR Project Macaron

**Participants:** Julien Mairal, Zaid Harchaoui [University of Washington], Laurent Jacob [CNRS, LBBE Laboratory], Michael Blum [CNRS, TIMC Laboratory], Joseph Salmon [Telecom ParisTech], Mikita Dvornik, Thomas Dias-Alves, Daan Wynen.

The project MACARON is an endeavor to develop new mathematical and algorithmic tools for making machine learning more scalable. Our ultimate goal is to use data for solving scientific problems and automatically converting data into scientific knowledge by using machine learning techniques. Therefore, our project has two different axes, a methodological one, and an applied one driven by explicit problems. The methodological axis addresses the limitations of current machine learning for simultaneously dealing with large-scale data and huge models. The second axis addresses open scientific problems in bioinformatics, computer vision, image processing, and neuroscience, where a massive amount of data is currently produced, and where huge-dimensional models yield similar computational problems.

This is a 3 years and half project, funded by ANR under the program "Jeunes chercheurs, jeunes chercheuses", which started in October 2014. The principal investigator is Julien Mairal.

## 9.2.2. ANR Project DeepInFrance

### Participant: Jakob Verbeek.

DeepInFrance (Machine learning with deep neural networks) project also aims at bringing together complementary machine learning, computer vision and machine listening research groups working on deep learning with GPUs in order to provide the community with the knowledge, the visibility and the tools that brings France among the key players in deep learning. The long-term vision of Deep in France is to open new frontiers and foster research towards algorithms capable of discovering sense in data in an automatic manner, a stepping stone before the more ambitious far-end goal of machine reasoning. The project partners are: INSA Rouen, Univ. Caen, Inria, UPMC, Aix-Marseille Univ., Univ. Nice Sophia Antipolis.

# 9.3. European Initiatives

## 9.3.1. FP7 & H2020 Projects

## 9.3.1.1. ERC Advanced grant Allegro

**Participants:** Cordelia Schmid, Pavel Tokmakov, Nicolas Chesneau, Vasiliki Kalogeiton, Konstantin Shmelkov, Daan Wynen, Xiaojiang Peng.

# 143 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team THOTH

The ERC advanced grant ALLEGRO started in April 2013 for a duration of five years extended in 2017 for one year. The aim of ALLEGRO is to automatically learn from large quantities of data with weak labels. A massive and ever growing amount of digital image and video content is available today. It often comes with additional information, such as text, audio or other meta-data, that forms a rather sparse and noisy, yet rich and diverse source of annotation, ideally suited to emerging weakly supervised and active machine learning technology. The ALLEGRO project will take visual recognition to the next level by using this largely untapped source of data to automatically learn visual models. We will develop approaches capable of autonomously exploring evolving data collections, selecting the relevant information, and determining the visual models most appropriate for different object, scene, and activity categories. An emphasis will be put on learning visual models from video, a particularly rich source of information, and on the representation of human activities, one of today's most challenging problems in computer vision.

### 9.3.1.2. ERC Starting grant Solaris

**Participants:** Julien Mairal, Ghislain Durif, Andrei Kulunchakov, Dexiong Chen, Alberto Bietti, Hongzhou Lin.

The project SOLARIS started in March 2017 for a duration of five years. The goal of the project is to set up methodological and theoretical foundations of deep learning models, in the context of large-scale data processing. The main applications of the tools developed in this project are for processing visual data, such as videos, but also structured data produced in experimental sciences, such as biological sequences.

The main paradigm used in the project is that of kernel methods and consist of building functional spaces where deep learning models live. By doing so, we want to derive theoretical properties of deep learning models that may explain their success, and also obtain new tools with better stability properties. Another work package of the project is focused on large-scale optimization, which is a key to obtain fast learning algorithms.

# 9.4. International Initiatives

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

9.4.1.1. GAYA

Title: Semantic and Geometric Models for Video Interpretation

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Robotics Institute - Deva Ramanan

Start year: 2016

### See also: https://team.inria.fr/gaya/

The primary goal of the associate team GAYA is to interpret videos, in terms of recognizing actions, understanding the human-human and human-object interactions. Despite several years of research, it is yet unclear what is an efficient and robust video representation to attack this challenge. In order to address this, GAYA will focus on building semantic models, wherein we learn the video feature representation with limited supervision, and also geometric models, where we study the geometric properties of object shapes to better recognize them. The team consists of researchers from two Inria project-teams (Thoth and WILLOW) and a US university (Carnegie Mellon University [CMU]). It will allow the three teams to effectively combine their respective strengths in areas such as inference and machine learning approaches for vision tasks, feature representation, large-scale learning, geometric reasoning. The main expected outcomes of this collaboration are: effective learnt representations of video content, new machine learning algorithms for handling minimally annotated data, large-scale public datasets for benchmarking, theoretical analysis of objects shapes and contours. In 2017, Gunnar Sigurdsson (PhD student of Abhinav Gupta [CMU]) visited the Thoth team to develop a new dataset of first- and third-person videos and an approach for learning a joint representation of these two modalities.

144 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team THOTH

## 9.4.2. Inria International Partners

### 9.4.2.1. Informal International Partners

- University of Edinburgh: C. Schmid collaborates with V. Ferrari, full professor at university of Edinburgh. Vicky Kalogeiton started a co-supervised PhD in 2013 and graduated in 2017; she has been bi-localized between Uni. Edinburgh and Inria. Her subject is automatic learning of object representations in videos. The collaboration resulted in two joint publications in 2017 [19], [18].
- **MPI Tübingen:** C. Schmid collaborates with M. Black, a research director at MPI, starting in 2013. End of 2015 she was award a Humbolt research award funding a long-term research project with colleagues at MPI. She spent one month at MPI in May 2017. In 2017 the project resulted in the development of a large-scale synthetic human action dataset [12].
- University of Washington: Julien Mairal collaborates with Zaid Harchaoui, former member of the Lear team, on the topic of large-scale optimization. They co-advised one student, Hongzhou Lin, who defended his PhD in 2017.

## 9.4.3. Participation in Other International Programs

• Indo-French project EVEREST with IIIT Hyderabad, India, funded by CEFIPRA (Centre Franco-Indien pour la Promotion de la Recherche Avancee). The aim of this project between Cordelia Schmid, Karteek Alahari and C. V. Jawahar (IIIT Hyderabad) is to enable the use of rich, complex models that are required to address the challenges of high-level computer vision. The work plan for the project will follow three directions. First, we will develop a learning framework that can handle weak annotations. Second, we will build formulations to solve the non-convex optimization problem resulting from the learning framework. Third, we will develop efficient and accurate energy minimization algorithms, in order to make the optimization computationally feasible.

# 9.5. International Research Visitors

## 9.5.1. Visits to International Teams

## 9.5.1.1. Research Stays Abroad

• A. Bietti visited Microsoft Research at New York from September to December 2017, as part of the MSR-Inria joint centre collaboration.
# WILLOW Project-Team

# 9. Partnerships and Cooperations

### **9.1. National Initiatives**

#### 9.1.1. Agence Nationale de la Recherche (ANR): SEMAPOLIS

Participants: Mathieu Aubry, Josef Sivic.

The goal of the SEMAPOLIS project is to develop advanced large-scale image analysis and learning techniques to semantize city images and produce semantized 3D reconstructions of urban environments, including proper rendering. Geometric 3D models of existing cities have a wide range of applications, such as navigation in virtual environments and realistic sceneries for video games and movies. A number of players (Google, Microsoft, Apple) have started to produce such data. However, the models feature only plain surfaces, textured from available pictures. This limits their use in urban studies and in the construction industry, excluding in practice applications to diagnosis and simulation. Besides, geometry and texturing are often wrong when there are invisible or discontinuous parts, e.g., with occluding foreground objects such as trees, cars or lampposts, which are pervasive in urban scenes. This project will go beyond the plain geometric models by producing semantized 3D models, i.e., models which are not bare surfaces but which identify architectural elements such as windows, walls, roofs, doors, etc. Semantic information is useful in a larger number of scenarios, including diagnosis and simulation for building renovation projects, accurate shadow impact taking into account actual window location, and more general urban planning and studies such as solar cell deployment. Another line of applications concerns improved virtual cities for navigation, with objectspecific rendering, e.g., specular surfaces for windows. Models can also be made more compact, encoding object repetition (e.g., windows) rather than instances and replacing actual textures with more generic ones according to semantics; it allows cheap and fast transmission over low- bandwidth mobile phone networks, and efficient storage in GPS navigation devices.

This is a collaborative effort with LIGM / ENPC (R. Marlet), University of Caen (F. Jurie), Inria Sophia Antipolis (G. Drettakis) and Acute3D (R. Keriven).

### 9.2. European Initiatives

### 9.2.1. European Research Council (ERC) Starting Grant: "Activia" - Ivan Laptev

Participant: Ivan Laptev.

WILLOW will be funded in part from 2013 to 2017 by the ERC Starting Grant "Activia" awarded to Ivan Laptev by the European Research Council.

'Computer vision is concerned with the automated interpretation of images and video streams. Today's research is (mostly) aimed at answering queries such as 'Is this a picture of a dog?', (classification) or sometimes 'Find the dog in this photo' (detection). While categorisation and detection are useful for many tasks, inferring correct class labels is not the final answer to visual recognition. The categories and locations of objects do not provide direct understanding of their function i.e., how things work, what they can be used for, or how they can act and react. Such an understanding, however, would be highly desirable to answer currently unsolvable queries such as 'Am I in danger?' or 'What can happen in this scene?'. Solving such queries is the aim of this proposal. My goal is to uncover the functional properties of objects and the purpose of actions by addressing visual recognition from a different and yet unexplored perspective. The main novelty of this proposal is to leverage observations of people, i.e., their actions and interactions to automatically learn the use, the purpose and the function of objects and scenes from visual data. The project is timely as it builds upon the two key recent technological advances: (a) the immense progress in visual recognition of objects, scenes and human actions achieved in the last ten years, as well as (b) the emergence of a massive amount of

public image and video data now available to train visual models. ACTIVIA addresses fundamental research issues in automated interpretation of dynamic visual scenes, but its results are expected to serve as a basis for ground-breaking technological advances in practical applications. The recognition of functional properties and intentions as explored in this project will directly support high-impact applications such as detection of abnormal events, which are likely to revolutionise today's approaches to crime protection, hazard prevention, elderly care, and many others.'

#### 9.2.2. European Research Council (ERC) Starting Grant: "Leap" - Josef Sivic Participant: Josef Sivic.

The contract has begun on Nov 1st 2014. WILLOW will be funded in part from 2014 to 2018 by the ERC Starting Grant "Leap" awarded to Josef Sivic by the European Research Council.

'People constantly draw on past visual experiences to anticipate future events and better understand, navigate, and interact with their environment, for example, when seeing an angry dog or a quickly approaching car. Currently there is no artificial system with a similar level of visual analysis and prediction capabilities. LEAP is a first step in that direction, leveraging the emerging collective visual memory formed by the unprecedented amount of visual data available in public archives, on the Internet and from surveillance or personal cameras a complex evolving net of dynamic scenes, distributed across many different data sources, and equipped with plentiful but noisy and incomplete metadata. The goal of this project is to analyze dynamic patterns in this shared visual experience in order (i) to find and quantify their trends; and (ii) learn to predict future events in dynamic scenes. With ever expanding computational resources and this extraordinary data, the main scientific challenge is now to invent new and powerful models adapted to its scale and its spatio-temporal, distributed and dynamic nature. To address this challenge, we will first design new models that generalize across different data sources, where scenes are captured under vastly different imaging conditions such as camera viewpoint, temporal sampling, illumination or resolution. Next, we will develop a framework for finding, describing and quantifying trends that involve measuring long-term changes in many related scenes. Finally, we will develop a methodology and tools for synthesizing complex future predictions from aligned past visual experiences. Our models will be automatically learnt from large-scale, distributed, and asynchronous visual data, coming from different sources and with different forms of readily-available but noisy and incomplete metadata such as text, speech, geotags, scene depth (stereo sensors), or gaze and body motion (wearable sensors). Breakthrough progress on these problems would have profound implications on our everyday lives as well as science and commerce, with safer cars that anticipate the behavior of pedestrians on streets; tools that help doctors monitor, diagnose and predict patients' health; and smart glasses that help people react in unfamiliar situations enabled by the advances from this project.'

# 9.3. International Initiatives

### 9.3.1. IMPACT: Intelligent machine perception

Participants: Josef Sivic, Jean Ponce, Ivan Laptev.

IMPACT is a 5-year collaborative project with Czech Technical University, Center for Robotics, Informatics and Cybernetics (CIIRC) (2017-2022). The IMPACT project focuses on fundamental and applied research in computer vision, machine learning and robotics to develop machines that learn to perceive, reason, navigate and interact with complex dynamic environments. For example, people easily learn how to change a flat tire of a car or perform resuscitation by observing other people doing the same task. This involves advanced visual intelligence abilities such as interpreting sequences of human actions that manipulate objects to achieve a specific task. Currently, however, there is no artificial system with a similar level of cognitive visual competence. Breakthrough progress in intelligent machine perception will have profound implications on our everyday lives as well as science and commerce, with smart assistive robots that automatically learn new skills from the Internet, safer cars that autonomously navigate in difficult changing conditions, or intelligent glasses that help people navigate never seen before environments.

147 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team WILLOW

#### 9.3.2. Inria CityLab initiative

Participants: Josef Sivic, Jean Ponce, Ivan Laptev, Alexei Efros [UC Berkeley].

Willow participates in the ongoing CityLab@Inria initiative (co-ordinated by V. Issarny), which aims to leverage Inria research results towards developing "smart cities" by enabling radically new ways of living in, regulating, operating and managing cities. The activity of Willow focuses on urban-scale quantitative visual analysis and is pursued in collaboration with A. Efros (UC Berkeley).

Currently, map-based street-level imagery, such as Google Street-view provides a comprehensive visual record of many cities worldwide. Additional visual sensors are likely to be wide-spread in near future: cameras will be built in most manufactured cars and (some) people will continuously capture their daily visual experience using wearable mobile devices such as Google Glass. All this data will provide large-scale, comprehensive and dynamically updated visual record of urban environments.

The goal of this project is to develop automatic data analytic tools for large-scale quantitative analysis of such dynamic visual data. The aim is to provide quantitative answers to questions like: What are the typical architectural elements (e.g., different types of windows or balconies) characterizing a visual style of a city district? What is their geo-spatial distribution? How does the visual style of a geo-spatial area evolve over time? What are the boundaries between visually coherent areas in a city? Other types of interesting questions concern distribution of people and their activities: How do the number of people and their activities at particular places evolve during a day, over different seasons or years? Are there tourists sightseeing, urban dwellers shopping, elderly walking dogs, or children playing on the street? What are the major causes for bicycle accidents?

Break-through progress on these goals would open-up completely new ways smart cities are visualized, modeled, planned and simulated, taking into account large-scale dynamic visual input from a range of visual sensors (e.g., cameras on cars, visual data from citizens, or static surveillance cameras).

#### 9.3.3. Associate team GAYA

Participants: Jean Ponce, Matthew Trager.

GAYA is a joint research team bringing together two Inria project-teams (Thoth, Grenoble and WILLOW, Paris) and Carnegie Mellon University, USA. It focuses on two research themes: (i) semantic structured interpretation of videos, and (ii) studying the geometric properties of object shapes to enhance state-of-the-art object recognition approaches.

Interpreting videos semantically in a general setting, involving various types of video content like home video clips, news broadcasts, feature films, which contain a lot of clutter, non-rigid motion, many "actors" performing actions, person-object and person-person interactions, varying viewpoints, is challenging. This task is being examined increasingly over the past decade, with the availability of large video resources, e.g., YouTube. Despite this progress, an effective video representation for recognizing actions is still missing. To address this critical challenge, we propose a joint optimization framework, wherein we learn the video representation and also develop models for action recognition. Specifically, we aim to exploit the spatio-temporal relations among pixels in a video through graphical models and novel deep learning feature representations.

The second research theme explores geometric aspects of computer vision, in particular how to model three-dimensional objects from their two-dimensional projections, and how the appearance of these objects evolves with changes in viewpoint. Beyond its theoretical interest, this work is critical for developing object recognition algorithms that take into account the three-dimensional nature of the visual world and go beyond the template-matching approaches dominant today. Duality is an important concept in this area, and we are investigating its application to the construction of visual hulls as well as the characterization of the topology of image contours using the Gauss map. Existing results are essentially limited to the Euclidean setting, and we are investigating their generalization to the general projective case.

Partners: CMU (Deva Ramanan, Martial Hebert, Abhinav Gupta, Gunnar Sigurdsson), Inria Thoth (Cordelia Schmid, Karteek Alahari, Pavel Tokmakov).

148 Vision, perception and multimedia interpretation - Partnerships and Cooperations - Project-Team WILLOW

## 9.4. International Research Visitors

## 9.4.1. Visits of International Scientists

Prof. Alexei Efros (UC Berkeley, USA) visited Willow during June. Hildegard Kuehne (University of Bonn) and Jason Corso (University of Michigan) visited Willow during April.

#### 9.4.1.1. Internships

Kai Han has visited Willow from the University of Hong Kong.

#### 9.4.2. Visits to International Teams

#### 9.4.2.1. Research Stays Abroad

Jean Ponce is visiting New York University since September 2017.