RESEARCH CENTER
Sophia Antipolis - Méditerranée

FIELD

Activity Report 2019

Section Contracts and Grants with Industry

ABS Project-Team (section vide)

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

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- **Etic Data** (2019-2020): Acumes has set up a 12 months research and development contract with the company Etic Data on "Predictive modeling and proactive driving of customers behaviour in massive data BtoC context".

AROMATH Project-Team

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts with Industry

• **NURBSFIX: Repairing the topology of a NURBS model in view of its approximation.** We have a research contract with the industrial partner GeometryFactory, in collaboration with the project-team Titane (Pierre Alliez). The post-doc of Xiao Xiao is funded by this research contract together with a PEPS from the labex AMIES.

Because of their flexibility and accuracy, NURBS (Non-Uniform Rational Basis Spline) models have become a standard in the modeling community for generating and representing complex shapes. They are made of several surface patches and a collection of curves that are used for trimming. As a direct consequence of software quirks, designer errors, and representation flaws, these NURBS models have inconsistencies that introduce small gaps and overlaps between surface patches. They are mainly located on the singularity graph of a NURBS model, near the trimming curves, especially near singularities such as sharp edges or corners. Building a correct approximation of a NURBS model in the presence of inconsistencies is a challenging problem. Most of the current approaches are based on the repairing of the geometry of the surface patches. This requires an interactive process which is difficult to control and rarely completely successful. In this project, we develop another approach which consists in repairing the topology of the singularity graph within a tolerance volume. This tolerance volume will be considered as a protected region that will not receive any query of geometric computations. Based on that, three types of approximations will be treated: triangular isotropic surface meshing of NURBS models, volume approximation of multi-domains delimited by NURBS surfaces, and NURBS models approximation within a given tolerance volume.

ATHENA Project-Team (section vide)

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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

BioEnTech: the collaboration with the BioEnTech start-up is aiming at developing new functionalities for ODIN in order to improve the advanced monitoring and control of industrial anaerobic digesters.

Inalve: with the Inalve start-up we develop a breakthrough process that we patented, in which microalgae grow within a moving biofilm. The objective of the collaboration is to optimize the process by enhancing productivity, while reducing environmental footprint.

8.2. Bilateral Grants with Industry

Exactcure: in the collaboration with the start-up Exactcure (Nice), the goal of the project is to study pharmacokinetic models. Exactcure and Biocore agreed for a transfer of intellectual property concerning the work of former intern L. Dragoni.

BIOVISION Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Helping visually impaired employees to follow presentations in the company: Towards a mixed reality solution

Participants: Riham Nehmeh [InriaTech], Carlos Zubiaga [InriaTech], Julia-Elizabeth Luna [InriaTech], Arnaud Mas [EDF], Alain Schmid [EDF], Aurélie Calabrèse, Pierre Kornprobst

Duration: 2 months

The objective of the work is to develop a first proof-of-concept (PoC) targeting a precise use-case scenario defined by EDF (contract with InriaTech, supervised by Pierre Kornprobst). The use-case is one of an employee with visual impairment willing to follow a presentation. The idea of the PoC is a vision-aid system based on a mixed-reality solution. This work aims at (1) estimating the feasibility and interest of such kind of solution and (2) identifying research questions that could be jointly addressed in a future partnership.

APP Deposit (on-going)

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

NEURINNOV startup finances half of the PhD thesis salary of Lucie William.

CASTOR Project-Team (section vide)

CHORALE Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. AXYN (2017 - 2021)

Participants: Patrick Rives and Paolo Salaris
This contract (30k€) is linked to the PhD Thesis of Dyanna Hassan (Cifre Thesis). The objective is to develop assistive navigation techniques.

7.1.2. Renault (2018 - 2021)

Participant: Philippe Martinet (in collaboration with A. Spalanzani and C. Laugier from CHROMA)
This contract (CHROMA 45k€, CHORALE (15k€ for supervision)) is linked to the PhD Thesis of Luiz Guardini (Cifre Thesis). The objective is to develop contextualized emergency trajectory planning with minimum criticality by employing dynamic probabilistic occupancy grid.

7.2. Bilateral Grants with Industry

7.2.1. AXYN (2017 - 2021)

Phd Student: Dayanna Hassan
Dayanna Hassan is employed by AXYN (Cifre Thesis).
Title of the PhD: Plate-forme robotisée d'assistance aux personnes à mobilité réduite

7.2.2. Renault (2018 - 2021)

Phd Student: : Luiz Guardini
Luiz Guardini is employed by Renault (Cifre Thesis).
Title of the PhD: Autonomous car driving: use of dynamic probabilistic occupancy grids for contextualized planning of emergency trajectory with minimal criticity

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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Oui!Greens, 2019

Participant: Joanna Moulierac.

Duration: January 2019 - February 2019

Coordinator: Joanna Moulierac

Other partners: Dorian Mazauric from EP ABS

Abstract: Supervision of an InriaTech engineer for the development of the algorithm proposed in a previous collaboration with Oui!Greens.

The aim of the algorithm is to propose to clients the adequate products (fruits or vegetables) that are almost out-of-date with the objective of maximizing the satisfaction of the clients, and the diminution of the wastage. During one month, this algorithm has been implemented into the mobile application pepino, owned by Oui!Greens.

8.1.2. MillionRoads, 2019-2020

Participants: David Coudert, Frédéric Giroire, Luc Hogie, Nicolas Nisse, Michel Syska.

Duration: October 2019 - April 2020

Project title: HumanRoads

Coordinator: Nicolas Nisse

Other partners: SME MillionRoads; EP Zenith (Didier Parigot)

Abstract: HumanRoads uses a graph database, in the Neo4j environment, to store and structure its data. This database is already large and is regularly enriched with new data. However, to date, response times to queries are not satisfactory. This Project aims at identifying the limiting factors and to propose alternatives. More precisely, we will work on analyzing the data structure in the graph database to optimize queries, in the Neo4j environment, and on graph algorithms to speed up queries.

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts with Industry

- Contract with Andra financing the two year postdoctoral position of Joubine Aghili (october 2017 - september 2019) and dealing with the simulation of compositional liquid gas Darcy flows in highly heterogeneous porous medium with network of fractures using Discrete Fracture Matrix models (DFM). It is applied to the simulation of the desaturation of the nuclear waste storage in the neighbourhood of the galleries. Supervision Roland Masson and Konstantin Brenner from LJAD-Inria, Jean-Raynald de Dreuzy from Geosciences Rennes and Laurent Trenty from Andra.

- The team has also on-going collaboration with Storengy (post-doc of Daniel Constantin-Quiroz).

DATASHAPE Project-Team

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts with Industry

- Collaboration with Sysnav, a French SME with world leading expertise in navigation and geopositioning in extreme environments, on TDA, geometric approaches and machine learning for the analysis of movements of pedestrians and patients equipped with inetial sensors (CIFRE PhD of Bertrand Beaufils).
- Research collaboration with Fujitsu on the development of new TDA methods and tools for Machine learning and Artificial Intelligence (started in Dec 2017).
- Research collaboration with MetaFora on the development of new TDA-based and statistical methods for the analysis of cytometric data (started in Nov. 2019).

6.2. Bilateral Grants with Industry

- DATASHAPE and Sysnav have been selected for the ANR/DGA Challenge MALIN (funding: 700 kEuros) on pedestrian motion reconstruction in severe environments (without GPS access).

DIANA Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. Collaboration with Safran

Participant: Damien Saucez.

The research collaboration with Safran on Constrained Software Defined Networks has evolved into a new stage: Damien Saucez took a one year secondment from Inria to join Safran and further develop this activity from "inside".

7.1.2. Collaboration with Ekinops

Participant: Thierry Turletti, Walid Dabbous.

We have started a collaboration with EKINOPS on the topic of Multi-access Edge Computing. The activity started with a CIFRE thesis. The PhD student Mamoutou Diarra started his PhD on this topic on November 2019.

7.1.3. Collaboration with Orange

Participant: Thierry Turletti, Damien Saucez.

We have a collaboration with Orange on the topic of Network Function Virtualization. The activity includes the CIFRE PhD thesis of Giuseppe Di Lena that started his PhD on resilient NFV/SDN environments on April 2018.

7.2. Bilateral Grants with Industry

7.2.1. QWANT

Participant: Arnaud Legout.

The PIA ANSWER project is led by the QWANT search engine and the Inria Sophia Antipolis Méditerranée research center. This proposal is the winner of the "Grand Challenges du Numérique" (BPI) and aims to develop the new version of the search engine http://www.qwant.com with radical innovations in terms of search criteria, indexed content and privacy of users. In the context of this project, we got with Nataliia Bielova from the INDES project-team a funding for a 3 years Ph.D. working on Web tracking technologies and privacy protection.

ECUADOR Project-Team (section vide)

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

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. Microsoft Research

Microsoft Research is funding through the Inria-Microsoft joint lab the projects "4D Cardiac MR Images"[0] and "Medilearn"[0] which aim at analyzing large databases of cardiac images to help the diagnosis of cardiac diseases and planning of therapy. This project involves A. Crimisi from MSR and partially funds the PhDs of Pawel Mlynarski.

7.1.2. Spin-off company inHEART

inHEART[0] is a spin-off of the Epione team and IHU Liryc founded in 2017. inHEART provides a service to generate detailed anatomical and structural meshes from medical images, that can be used during ablation interventions. inHEART received 2 awards, one from Aquitaine region and one i-LAB from the BPI. It currently employs 10 people.

7.1.3. Live Anatomy

A 3 month InriaTech contract was performed with the Live Anatomy start-up between January and March 2019 in order to develop a remote viewer and to optimise image segmentation.

7.1.4. Siemens HealthCare

Siemens Healthcare, Medical Imaging Technologies, Princeton, NJ (U.S.A). is funding the PhD work of Julian Krebs which aims at developing robust medical image registration methods

7.1.5. Quantificare

The company Quantificare is funding the PhD of Florent Jousse through a CIFRE grant, on the statistical analysis of shapes, deformations and appearance of anatomical surfaces for computer-aided dermatology and plastic surgery. The primary purpose is to model complex face deformations such as natural aging, facial expressions, surgical interventions and posture motions.

7.1.6. Oticon Medical

Oticon Medical, Vallauris, France, is co-funding the PhD work of Zihao Wang which aims at developing robust medical image algorithms for cochlea image segmentation.

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[0] http://www.msr-inria.fr/projects/4d-cardiac-mr-images
[0] http://www.msr-inria.fr/projects/medilearn
[0] https://www.inheart.fr/

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. Contract CNES-Inria-Xlim

This contract (reference Inria: 11282) accompanied the PhD of David Martinez Martinez and focused on the development of efficient techniques for the design of matching network tailored for frequency varying loads. Applications of the latter to the design output multiplexers occurring in space applications has also been considered (see new results section). The contract ended mid 2019.

7.1.2. Contract Inria-Inoveos

A contract was signed with the SMB company Inoveos in order to build a prototypical robot dedicated to the automatic tuning of microwave devices, see Section 5.1.1 .

FOCUS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

In 2019 we have started the Innovation Lab on Blockchain and New Technologies (https://site.unibo.it/blockchain-and-newtechnologies/en). The Lab is a new joint laboratory of the Computer Science and Engineering Department of the University of Bologna and KPMG Advisory S.p.A. that is committed to scientific research and technology transfer of systems based on blockchain and new technologies. The laboratory joins the efforts of several researchers of the Department and uses the experience in technology transfer of KPMG Advisory S.p.A.

The Lab has received a grant of 10KE from KPMG and a grant of 10KE from CIRFOOD, one of the biggest Italian companies in organised commercial and collective catering.

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

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- Valentin Deschaintre has a CIFRE PhD fellowship on Material Acquisition using Machine Learning, in collaboration with Optis - Ansys, a company specialized in material acquisition and rendering.

7.2. Bilateral Grants with Industry

- As part of a long standing collaboration with Adobe, this year Julien Philip interned with Michael Gharbi (San Francisco). This follows previous internships of J. Delanoy with Aaron Hertzmann (San Francisco) and Theo Thonnat with Sylvain Paris (Boston),
- Adrien Bousseau and Bastien Wailly worked with the InriaTech engineers to implement a sketch recognition engine in the context of a collaboration with the start-up EpicNPoc.

GRAPHIK Project-Team (section vide)

HEPHAISTOS Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Grants with Industry

7.1.1. Symbolic tools for modeling and simulation
Participant: Yves Papegay.

This activity is the main part of a long-term ongoing collaboration with Airbus whose goal is to directly translate the conceptual work of aeronautics engineers into digital simulators to accelerate aircraft design.

An extensive modeling and simulation platform - MOSELA - has been designed which includes a dedicated modeling language for the description of aircraft dynamics models in term of formulae and algorithms, and a symbolic compiler producing as target an efficient numerical simulation code ready to be plugged into a flight simulator, as well as a formatted documentation compliant with industrial requirements of corporate memory.

Technology demonstrated by our prototype has been transferred : final version of our modeling and simulation environment has been delivered to Airbus in November 2012 and developer level know-how has been transferred in 2013 to a software company in charge of its industrialization and maintenance.

Since 2014, we are working on several enhancements and extension of functionalities, namely to enhance the performances and the numerical quality of the generated C simulation code, ease the integration of our environment into the airbus toolbox, help improving the robustness of the environment and the documentation.

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

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Grants with Industry

The ANSWER project (Advanced aNd Secured Web Experience and seaRch) is lead by the QWANT search engine and the Inria Sophia Antipolis Méditerranée research center. This proposal is the winner of the "Grand Challenges du Numérique" (BPI) and aims to develop the new version of the search engine http://www.qwant.com with radical innovations in terms of search criteria, indexed content and privacy of users. Nataliia Bielova, Manuel Serrano and Tamara Rezk are involved in this project. The project started on January 1, 2018. In the context of this project, we got

- with Arnaud Legout from the DIANA project-team a funding for a 3 years Ph.D. student to work on Web tracking technologies and privacy protection. Imane Fouad was hired to work on this project.
- a funding for 18 months Postdoc to work on Web application security. Yoon Seok Ko has worked on this project as a postdoc.

Kairos Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Safran : Desir/Glose   We participate to the bilateral collaborative program Desir, put up by Safran to work with selected academic partners. We share the Glose project started in this program with two other Inria teams : HyComes, and DiverSE. The aim of the project is to improve early stages of system engineering by allowing early execution and co-simulation of heterogeneous models. The technical content of our contributions is described in section 7.13 . A CIFRE PhD is funded by Renault on related topics.

IRT Saint-Exupery ATIPPIC   This cooperative project aims at building a computing digital electronic structure of micro-satellites on ordinary, "COTS" processors. The project was accepted for 30 months and will reach completion by the end of 2019. It funds two temporary research engineers working under our own supervision, while exchanging extensively with the rest of the ATIPPIC project, which is actually physically hosted by Inria. The technical content of our contributions is described in section 7.2 .

Airbus   In the continuation of the ITEA3 ASSUME project, Airbus has provided funding for the extension of the Real-Time Systems Compilation method to allow parallelization onto multi-cores with classical ARM or POWER architecture. The technical content of our contributions is described in section 7.16 . The technical content of our contributions is described in section 7.2 .

IRT Saint-Exupery   The CAPHCA project of IRT Saint-Exupéry has provided funding for the extension of the Real-Time Systems compilation method to allow parallelization onto timing predictable multi-cores different from the Kalray MPPA 256. The targets of this work are Infineon TC27x and FlexPRET.

Renault Software Lab   We have started, at the end of 2018, a collaboration with Renault Software Labs on the definition of rules for ensuring safe maneuvers in autonomous vehicles. The rules express conditions from the environments, safety rules to preserve the integrity of the vehicles, driving legislation rules, local rules from the authorities. The rules must be updated dynamically when the vehicle evolves and are used to monitor at run-time the behavior of the ADAS. While the ADAS contains several algorithms relying on machine learning, the monitoring system must be predictive and rules must guarantee formally that the system does not cause any accident. So it can be seen as a way to build trustworthy monitoring of learning algorithms. A CIFRE PhD is funded by Renault on this topic and has started in April 2019.

Accenture Labs   We have continued discussions with Accenture Labs, started in 2018, on Smart Contract languages for permissioned blockchains. A CIFRE funding is under way.
In recent years, various platform developments focused on so-called *private* (or *permissioned*) blockchain(s) and digital ledgers. Almost all private blockchains present their own implementation of Smart Contract. Between public and private blockchains we are observing a wide variety of different languages with different capabilities and limitations. Inspired by our researches in object-oriented languages [40], we aim at designing a language which might extend an object instance upon receiving a message, an ability referred to by Cardelli as *self-inflicted* operation. Public and private blockchains would take advantage of this novel capability in building safe and flexible intelligent smart contracts.

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

7. Bilateral Contracts and Grants with Industry

7.1. IRT

In late 2019, we started a new collaboration with IRT Saint-Exupéry for the hybridization of numerical models and large amount of data for the modeling of urban floods.

7.2. Berger-Levrault

A research collaboration convention was signed with Berger-Levrault company (Montpellier) for three years, in the framework of Yassine Bel-Ghaddar thesis (CIFRE ANRT France/Maroc).

7.3. CEREG/GERIMU

The GERIMU project entered its second phase in 2019. The industrial version of the SW2D computational code was parallelized and tested by ASA Company (subcontractor). Integration of all software components into the final software product will take place during the first half of 2020.

MATHNEURO Project-Team (section vide)

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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

- A grant "PEPS AMIES", title: "Conception d'un électrostimulateur intelligent", was obtained, co-financed by AMIES and SEGULA.

  PI: Bernard Bonnard.

  Start: December 2018. Duration: 2 years.

- A grant CIFRE co-financed by and SEGULA, title: "Réalisation d'un prototype d'électrostimulateur intelligent", was obtained.

  PI: Bernard Bonnard and T. Bakir (IMvia).

  Start: January 2020. Duration: 3 years.

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

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

General Electric Healthcare: a 2 months (from feb. 2019 to mar. 2019) for the end of the thesis of E. Poulain.

Bayer, Lyon: a 36 months (from aug. 2018 to jul. 2021) companion contract for the Cifre thesis of S. Laroui.

NACHOS Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. DGTD solver for time-domain elecromagnetics with application to geoseismics

Participants: Andreas Atle [TOTAL], Henri Calandra [TOTAL], Karim El Maarouf [TOTAL], Alexis Gobé, Stéphane Lanteri, Michael Sekachev [TOTAL].

This contract with TOTAL CSE (Computational Science and Engineering) division in Houston, Texas, is concerned with the development of a DGTD solver for applications in geoseismics. The R&D division of the EP (Oil, Gas Exploration & Production) branch of TOTAL has been interested in DG type methods since many years. It acquired a know-how on these methods and developed internally software tools integrating DG methods as solvers of the direct problem (forward propagators) in different seismic imaging processes (RTM - Reverse Time Migration, and FWI - Full Waveform Inversion). These solvers are concerned with the numerical resolution of PDE systems of acoustics and elastodynamics. TOTAL is now interested in having a similar DGTD solver for the numerical resolution of the system of time-domain Maxwell equations, in view of the development of an electromagnetic imaging process to identify conductivity of a medium. This electromagnetic imaging process would then be coupled to the existing seismic imaging ones.

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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

NEO members are involved in the

- Inria-Nokia Bell Labs joint laboratory: the joint laboratory consists of five ADRs (Action de Recherche/Research Action) in its third phase (starting October 2017). NEO members participate in two ADRs: "Distributed Learning and Control for Network Analysis" (see §8.1.1) and "Rethinking the network: virtualizing network functions, from middleboxes to application" (see §8.1.2).
- Inria-QWANT joint laboratory "Smart search is privacy" (see §8.1.3);
- Inria-Orange Labs joint laboratory (see §8.1.4).

NEO has contracts with Accenture (see §8.1.5), Azursoft (see §8.1.6), MyDataModels (see §8.1.7), Huawei (see §8.1.8), and Payback Network (see §8.1.9).

8.1.1. ADR Nokia on the topic "Distributed Learning and Control for Network Analysis" (October 2017 – September 2021)

Participants: Eitan Altman, Konstantin Avrachenkov, Mandar Datar, Maximilien Dreveton.

- Contractor: Nokia Bell Labs (http://www.bell-labs.com)
- Collaborator: Gérard Burnside

Over the last few years, research in computer science has shifted focus to machine learning methods for the analysis of increasingly large amounts of user data. As the research community has sought to optimize the methods for sparse data and high-dimensional data, more recently new problems have emerged, particularly from a networking perspective that had remained in the periphery.

The technical program of this ADR consists of three parts: Distributed machine learning, Multiobjective optimisation as a lexicographic problem, and Use cases / Applications. We address the challenges related to the first part by developing distributed optimization tools that reduce communication overhead, improve the rate of convergence and are scalable. Graph-theoretic tools including spectral analysis, graph partitioning and clustering will be developed. Further, stochastic approximation methods and D-iterations or their combinations will be applied in designing fast online unsupervised, supervised and semi-supervised learning methods.

8.1.2. ADR Nokia on the topic "Rethinking the network: virtualizing network functions, from middleboxes to application" (October 2017 – September 2021)

Participants: Sara Alouf, Giovanni Neglia.

- Contractor: Nokia Bell Labs (http://www.bell-labs.com)
- Collaborators: Fabio Pianese, Massimo Gallo

A growing number of network infrastructures are being presently considered for a software-based replacement: these range from fixed and wireless access functions to carrier-grade middle boxes and server functionalities. On the one hand, performance requirements of such applications call for an increased level of software optimization and hardware acceleration. On the other hand, customization and modularity at all layers of the protocol stack are required to support such a wide range of functions. In this scope the ADR focuses on two specific research axes: (1) the design, implementation and evaluation of a modular NFV architecture, and (2) the modelling and management of applications as virtualized network functions. Our interest is in low-latency machine learning prediction services and in particular how the quality of the predictions can be traded off with latency.

8.1.3. Qwant contract on "Asynchronous on-line computation of centrality measures" (15 December 2017 – 14 May 2020)

Participants: Nicolas Allegra, Konstantin Avrachenkov, Patrick Brown.

- Contractor: Qwant
- Collaborators: Sylvain Peyronnet, Thomas Aynaud

We shall study asynchronously distributed methods for network centrality computation. The asynchronous distributed methods are very useful because they allow efficient and flexible use of computational resources on the one hand (e.g., using a cluster or a cloud) and on the other hand they allow quick local update of centrality measures without the need to recompute them from scratch.

8.1.4. Orange CIFRE on the topic "Self-organizing features in the virtual 5G radio access network" (November 2017 – October 2020)

Participants: Eitan Altman, Marie Masson.

- Contractor: Orange Labs (https://www.orange.com/en/Infographics/Orange-and-Research/Orange-and-Research)
- Collaborator: Zwi Altman

The considerable extent of the complexity of 5G networks and their operation is in contrast with the increasing demands in terms of simplicity and efficiency. This antagonism highlights the critical importance of network management. Self-Organizing Networks (SON), which cover self-configuration, self-optimization and self-repair, play a central role for 5G Radio Access Network (RAN).

This CIFRE thesis aims at innovating in the field of managing 5G RAN, with a special focus on the features of the SON-5G. Three objectives are identified: a) develop self-organizing features (SON in 5G-RAN), b) develop cognitive managing mechanisms for the SON-5G features developed, and c) demonstrate how do the self-organizing mechanisms fit in the virtual RAN.

8.1.5. Accenture contract on the topic "Distributed Machine Learning for IoT applications" (Dec 2019 – May 2020)

Participant: Giovanni Neglia.

- Contractor: Accenture Labs (https://www.accenture.com/fr-fr/accenture-lab-sophia-antipolis)
- Collaborators: Laetitia Kameni, Richard Vidal

IoT applications will become one of the main sources to train data-greedy machine learning models. Until now, IoT applications were mostly about collecting data from the physical world and sending them to the Cloud. Google's federated learning already enables mobile phones, or other devices with limited computing capabilities, to collaboratively learn a machine learning model while keeping all training data locally, decoupling the ability to do machine learning from the need to store the data in the cloud. While Google envisions only users' devices, it is possible that part of the computation is executed at other intermediate elements in the network. This new paradigm is sometimes referred to as Edge Computing or Fog Computing. Model training as well as serving (provide machine learning predictions) are going to be distributed between IoT devices, cloud services, and other intermediate computing elements like servers close to base stations as envisaged by the Multi-Access Edge Computing framework. The goal of this project is to propose distributed learning schemes for the IoT scenario, taking into account in particular its communication constraints. This 6-month contract prepares a CIFRE.

8.1.6. AzurSoft contract on the topic "Proof of concept on automatic detection of false alarms" (May 2019 – April 2020)

Participants: Konstantin Avrachenkov, Andrei Bobu.

- Contractor: AzurSoft (https://www.azursoft.com/)
- Collaborators: Marc Vaillant, Beatrice Escuyer

Intrusion detection or telesurveillance systems generates signals from sensors that allow to raise alarm and start a checking procedure for a potential intrusion or anomaly. Typically, one telesurveillance system surveys many sites and is challenged by a stream of false alarms. In this project, we aim to reduce the rate of false alarms by using various supervised and semi-supervised learning methods.

8.1.7. MyDataModels contract on the topic "Semi supervised variational autoencoders for versatile data" (June 2019 – May 2022)

Participants: Konstantin Avrachenkov, Mikhail Kamalov.

- Contractor: MyDataModels (https://www.mydatamodels.com/)
- Collaborators: Denis Bastiment, Carlo Fanara

Variational autoencoders are highly flexible machine learning techniques for learning latent dimension representation. This model is applicable for denoising data as well as for classification purposes. In this thesis we plan to add semi-supervision component to the variational autoencoder techniques. We plan to develop methods which are universally applicable to versatile data such as categorical data, images, texts, etc. Initially starting from static data we aim to extend the methods to time-varying data such as audio, video, time-series, etc. The proposed algorithms can be integrated into the internal engine of MyDataModels company and tested on use cases of MyDataModels.

8.1.8. Huawei CIFRE on the topic "Scalable Online Algorithms for SDN controllers" (June 2016 – May 2019)

Participants: Zaid Allybokus, Konstantin Avrachenkov.

- Contractor: Huawei   Technologies   (http://www.huawei.com/en/about-huawei/research-development)
- Collaborators: Jérémie Leguay

Software-Defined Networking (SDN) technologies have radically transformed network architectures. They provide programmable data planes that can be configured from a remote controller platform.

The objective of this CIFRE thesis was to provide fundamental answers on how powerful SDN controller platforms could solve large online flow problems to optimize networks in real-time and in a distributed or semi-distributed fashion. We use methods from both optimization and dynamic programming.

8.1.9. Consulting contract with Payback Network (November 2019 - January 2020)

Participant: Giovanni Neglia.

- Contractor: Payback Network
- Collaborators: Tanguy Racinet, Anne Legencre

Consulting with the startup Payback Network on differential privacy techniques.

PRIVATICS Project-Team (section vide)

STAMP Project-Team (section vide)

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts and Grants with Industry

Stars team has currently several experiences in technological transfer towards industrials, which have permitted to exploit research result:

7.1.1. Ekinnox

is a spin-off project of the Stars team which aims at improving the rehabilitation process for caregivers and patients. Thanks to a computer vision based system (camera combined with algorithms detecting human motion), Ekinnox provides a simple and efficient tool to quantify and visualize the performance of patients (e.g. gait parameters computation such as side-by-side video comparison, automatic sequencing of video or 3D display) during their rehabilitation process. This company was created at the beginning of 2017.

7.1.2. Toyota

is working with Stars on action recognition software to be integrated on their robot platform. This project aims at detecting critical situations in the daily life of older adults alone at home. This will require not only recognition of ADLs but also an evaluation of the way and timing in which they are being carried out. The system we want to develop is intended to help them and their relatives to feel more comfortable because they know that potential dangerous situations will be detected and reported to caregivers if necessary. The system is intended to work with a Partner Robot - HSR - (to send real-time information to the robot) to better interact with the older adult.

7.1.3. Vedecom

is interested in developing algorithms for people detection for self-driving cars. Among many challenges in pedestrian detection, the ones of interest are a) Scale- handling, b) Occlusion-handling and c) Cross-dataset generalization. Each of the aforementioned challenges is critical to enable modern applications like self-driving vehicles become safe enough for active deployment. To improve the performance of contemporary pedestrian detectors, one of our first major idea is to use multiple layers of a CNN simultaneously. Towards this, we proposed a new pedestrian detection system called Multiple-RPN. Another recent work is adding pseudo-segmentation information to pedestrian detection. The proposed features of our system perform close to the best performing detectors today.

7.1.4. Kontron

has a collaboration with Stars, which runs from April 2018 until April 2021 to embed CNN based people tracker within a video-camera. Their system uses Intel VPU modules, such as Myriad X (MA2485), based on OpenVino library.

7.1.5. The company ESI

(European System Integration) has a collaboration with Stars, which runs from September 2018 until March 2022 to develop a novel Re-Identification algorithm which can be easily set-up with low interaction for video-surveillance applications. ESI provides software solutions for remote monitoring stations, remote assistance, video surveillance, and call centers. It was created in 1999 and ESI is a leader in the French remote monitoring market. Nowadays, ensuring the safety of goods and people is a major problem. For this reason, surveillance technologies are attracting growing interest and their objectives are constantly evolving: it is now a question of automating surveillance systems and helping video surveillance operators in order to limit interventions and staff. One of the current difficulties is the human processing of video, as the multiplication of video streams makes it difficult to understand meaningful events. It is therefore necessary to give video surveillance operators

suitable tools to assist them with tasks that can be automated. The integration of video analytics modules will allow surveillance technologies to gain in efficiency and precision. In recent times, deep learning techniques have been made possible by the advent of GPU processors, which offer significant processing possibilities. This leads to the development of automatic video processing.

7.1.6. Fantastic Sourcing

is a French SME specialized in micro-electronics, it develops e-health technologies. Fantastic Sourcing is collaborating with Stars through the UCA Solitaria project, by providing their Nodeus system. Nodeus is a IoT (Internet of Things) system for home support for the elderly, which consists of a set of small sensors (without video cameras) to collect precious data on the habits of isolated people. Solitaria project performs a multi-sensor activity analysis for monitoring and safety of older and isolated people. With the increase of the ageing population in Europe and in the rest of the world, keeping elderly people at home, in their usual environment, as long as possible, becomes a priority and a challenge of modern society. A system for monitoring activities and alerting in case of danger, in permanent connection with a device (an application on a phone, a surveillance system ...) to warn relatives (family, neighbours, friends ...) of isolated people still living in their natural environment could save lives and avoid incidents that cause or worsen the loss of autonomy. In this R&D project, we propose to study a solution allowing the use of a set of innovative heterogeneous sensors in order to: 1) detect emergencies (falls, crises, etc.) and call relatives (neighbours, family, etc.); 2) detect, over short or longer predefined periods, behavioural changes in the elderly through an intelligent analysis of data from sensors.

7.1.7. Nively

is a French SME specialized in e-health technologies, it develops position and activity monitoring of activities of daily living platforms based on video technology. Nively's mission is to use technological tools to put people back at the center of their interests, with their emotions, identity and behavior. Nively is collaborating with Stars through the UCA Solitaria project, by providing their MentorAge system. This software allows the monitoring of elderly people in nursing homes in order to detect all the abnormal events in the lives of residents (falls, runaways, strolls, etc.). Nively's technology is based on RGBD video sensors (Kinects type) and a software platform for event detection and data visualization. Nively is also in charge of Software distribution for the ANR Activis project. This project is based on an objective quantification of the atypical behaviors on which the diagnosis of autism is based, with medical (diagnostic assistance and evaluation of therapeutic programs) and computer scientific (by allowing a more objective description of atypical behaviors in autism) objectives. This quantification requires video analysis of the behavior of people with autism. In particular, we propose to explore the issues related to the analysis of ocular movement, gestures and posture to characterize the behavior of a child with autism. Thus, Nively will add autistic behavior analysis software to its product range.

More bilateral Grants with industries is available at: http://www-sop.inria.fr/members/Francois.Bremond/topicsText/researchProje

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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. *Google X*

Participants: Cédric Portaneri, Pierre Alliez.

We developed a novel approach and software prototype for the compression of 3D models. Our main focus is on progressive compression of surface triangle meshes with color textures, with emphasis on fine grain, genericity and flexible metric. The proposed methodology is to turn the input models into a stream of refinements, in which both mesh and texture refinement details are multiplexed in accordance to rate-distortion principles. Fine grain control is achieved through considering all components, local as well as non-local, from both the mesh and its textures: mesh complexity, vertex accuracy, texture definition and accuracy. We leveraged the recent advances on perceptual metrics to improve the visual appearance, and performed joint consolidation and encoding of the models to further optimize the rate-distortion tradeoffs and visual perception.

8.1.2. *Dorea technology*

Participants: Vincent Vadez, Pierre Alliez.

In collaboration with SME Dorea Technology, our objective is to advance the knowledge on the radiative thermal simulation of satellites, via geometric model reduction. The survival of a satellite is related to the temperature of its components, the variation of which must be controlled within safety intervals. In this context, the thermal simulation of the satellite for its design is crucial to anticipate the reality of its operation. This CIFRE project started in August 2018, for a total duration of 3 years.

8.1.3. *Luxcarta*

Participants: Jean-Philippe Bauchet, Florent Lafarge.

The goal of this collaboration is to design automated approaches for producing city models from the last generation of satellites. In particular, this project investigates geometric representations for images and 3D data that are more compact and meaningful than traditional pixel and voxel grids, the intuition being to synthesize massive satellite data to reconstruct objects in 3D in a more scalable manner than existing methods. This CIFRE project started in October 2016, for a total duration of 3 years.

8.1.4. *CNES and Acri-ST*

Participants: Onur Tasar, Yuliya Tarabalka, Pierre Alliez.

The aim is to devise efficient representations for satellite images. The project started in October 2017, for a total duration of 3 years.

8.1.5. *CSTB*

Participants: Hao Fang, Mulin Yu, Florent Lafarge.

This collaboration takes the form of two independent contracts. The first project investigated the automatic conversion of raw 3D data to polyhedral surfaces that approximate man-made objects at some key structural representation scales. This project started in March 2016, for a total duration of 3 years. The second project investigates the design of as-automatic-as-possible algorithms for repairing and converting Building Information Modeling (BIM) models of buildings in different urban-specific CAD formats using combinatorial maps. This project started November 2019, for a total duration of 3 years.

8.1.6. IRT Saint-Exupéry

Participants: Gaetan Bahl, Florent Lafarge.

This project investigates low-power deep learning architectures for detecting, localizing and characterizing changes in temporal satellite images. These architectures are designed to be exploited on-board satellites with low computational resources. The project started in March 2019, for a total duration of 3 years.

8.1.7. Dassault Systèmes

Participants: Julien Vuillamy, Pierre Alliez, Florent Lafarge.

This project investigates algorithms for reconstructing city models from multi-sourced data. 3D objects are reconstructed by filtering, parsing and assembling planar shapes. The project started in April 2018, for a total duration of 3 years.

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

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- M. Bossy is the Coordinator of the POPART Industrial partnership project at UCA-JEDI on the modeling of fibre transport in turbulent flows. This partnership is granted by EDF and by UCA, and in collaboration with CEMEF (J. Bec and S. Allende).

- M. Bossy is member of a MERIC project (MERIC is the marine energy research & innovation center in Chile) on stochastic Lagrangian models to better estimate energy production variability with water turbine, granted with the LEMON Inria Team.

WIMMICS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. PREMISSE Collaborative Project

Participants: Molka Dhouib, Catherine Faron Zucker, Andrea Tettamanzi.

Partner: SILEX France.

This collaborative project with the SILEX France company started in march 2017, funded by the ANRT (CIFRE PhD). SILEX France is developing a B2B platform where service providers and consumers upload their service offers or requests in free natural language; the platform is intended to recommend service providers to the applicant, which are likely to fit his/her service request. The aim of this project is to develop a solution to link together service providers and consumers.

8.1.2. HealthPredict Collaborative Project

Participants: Raphaël Gazzotti, Catherine Faron Zucker, Fabien Gandon.

Partner: Synchronext.

This collaborative project with the Synchronext company started in april 2017, funded by the ANRT (CIFRE PhD). Synchronext is a startup aiming at developing Semantic Web business solutions. The aim of this project is to design a digital health solution for the early management of patients through consultations with their general practitioner and health care circuit. The goal is to develop a predictive Artificial Intelligence interface that allows to cross the data of symptoms, diagnosis and medical treatments of the population in real time to predict the hospitalization of a patient.

8.1.3. Joint Lab EduMICS

Participants: Olivier Corby, Catherine Faron Zucker, Géraud Fokou Pelap, Fabien Gandon, Alain Giboin.

Partner: Educlever.

EduMICS (Educative Models Interactions Communities with Semantics) is a joint laboratory (LabCom) between the Wimmics team and the Educlever company that ended in early 2019. The aim of EduMICS was to develop research and technologies with the ultimate goal to adapt educational progressions and pedagogical resource recommendation to learner profiles.

8.1.4. Curiosity Collaborative Project

Participants: Catherine Faron Zucker, Oscar Rodríguez Rocha.

Partner: TeachOnmars.

This collaborative project with the TeachOnmars company started in October 2019. TeachOnMars is developping a platform for mobile learning. The aim of this project is to develop an approach for automatically indexing and semantically annotating heterogeneous pedagogical resources from different sources to build up a knowledge graph enabling to compute training paths, that correspond to the learner's needs and learning objectives.

8.2. Bilateral Grants with Industry

Accenture gifts (June 2017 - January 2022): Wimmics has received two gifts from Accenture. Together with additional funds from another project these gifts have been used to fund the Engineer position and then the PhD Grant (June 2017 - January 2022) of Nicholas Halliwell on a topic agreed with Accenture: "interpretable and explainable predictions"

ZENITH Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. SAFRAN (2018-2019)

Participants: Reza Akbarinia, Florent Masseglia.

SAFRAN and Inria are involved in the DESIR frame-agreement (Florent Masseglia is the scientific contact on "Data Analytics and System Monitoring" topic). In this context, SAFRAN dedicates 80K€ for a joint study of one year on time series indexing. The specific time series to be exploited are those of engine benchmarking with novel characteristics for the team (multiscale and multidimensional).

8.2. INA (2019-2022)

Participants: Quentin Leroy, Alexis Joly.

The PhD of Quentin Leroy is funded in the context of an industrial contract (CIFRE) with INA, the French company in charge of managing the French TV archives and audio-visual heritage. The goal of the PhD is to develop new methods and algorithms for the interactive learning of new classes in INA archives.