Proyectos STIC AmSud – convocatoria 2020

AGROFAIR – Agro-Knowledge Integration: Developing a FAIR data science approach for adding value to the agricultural supply chain

Abstract
Farms are the engine to support rural employment making a considerable contribution to territorial development. Even though they have always been considered a cornerstone of agricultural activity in the European Union (EU) and in Latin America, this sector most often suffers from very low efficiency and effectiveness, sensitivity to weather, market disruptions and other external factors. Two different problems in knowledge sharing are present in this domain. First of all, the various interoperability regulations between the countries. Although some efforts are done to bypass this problem, like the EU-Mercosur signed in the summer of 2019, the different process semantics implemented in each region are a serious threat to the fulfilment of the process interoperability. Another problem is that in most of the cases, the knowledge transferred from generation to generation is paramount from a cultural point of view, but most of the time, it does not answer to the needs nor the requirements of the agri-food value chain.
We aim at creating the core technology for a knowledge hub that integrates and aligns international regulations in agricultural activities, such as FAO's best practices, and possibly the last born EU-Mercosur regulations with the local restrictions, such as national policies, allowing the small farmers to access, in an easy way, a wider market through the certification of the practices and products.
In order to develop this core technology, we propose to deploy various methodologies and tools working on the domains of knowledge formalisation, domain alignment and visualization.
The domain formal representation allows for the semantic alignment of rules and restrictions from different institutional regulation bodies. Simultaneously, we will propose a model for incoherence detection letting us to highlight contradictory regulations. Those knowledge atoms and constructs will be represented through some visualization information interfaces according to the users' needs.

Institutions and scientific coordinators:
Mario Lezoche, Le Centre de Recherche en Automatique de Nancy (CRAN) - Université de Lorraine, France
Víctor Codocedo, Universidad Técnica Federico Santa María, Chile
Julio Hurtado, Universidad del Cauca, Popayán-Colombia

AICaBI – Artificial Intelligence for Cancer Biomarkers Identification

Abstract
The analysis of biological data aims at helping medical practitioners to better understand the biological processes that happen in several situations like diseases, treatment, environmental conditions, time, among others. In this project we aim at developing and applying metaheuristics, machine learning techniques and ad-hoc computational strategies to integrate and analyse omic data for the identification of novel biomarkers for diagnostic and prognostic. Base on bioinformatic approach, we specifically aim at looking at cancer data, involving the participation of researchers from Computer Science and Biology and Medicine background.
The main contributions of this project are: publication of scientific articles, scientific dissemination through lectures, papers presented in congresses, meetings and workshops; development and availability of online tools containing project results; training of postgraduate students; development of tools for the scientific community: technical reports, libraries, methodologies and tools developed will be made available to the scientific community. Also it is expected the preparation, submission and approval of projects for additional research funding to foster the cooperation between these research groups.

Institutions and scientific coordinators:
Mario Inostroza-Ponta, Universidad de Santiago de Chile, Chile
Marcio Dorn, Universidade Federal de Rio Grande do Sul, Brasil
Juliana Silva Bernardes, Sorbonne Université, France

AmPI - Atoms, photons and their interactions

Abstract
Atoms are very sensitive particles, with an already demonstrated potential for quantum computation and memories. We propose to show how their properties can be tuned by modifying their electromagnetic environment. We plan to study the impact of light-atom and atom-atom interactions on scattered photon-photon correlations, on the lifetime and energy of the excited state and on the light transport, gathering the skills from five experiments.

The main objective of this project is to create an efficient network of collaborations between different countries (France, Brazil, Uruguay and Argentina) and between experimentalists and theorists, on the common topic of interactions of atoms with their surroundings.

Institutions and scientific coordinators:
Romain Bachelard, Universidade Federal de São Carlos, Brazil
Philippe W. Courteille, Instituto de Física de São Carlos, Universidade de São Paulo, Brazil
Arturo Lezama, Universidad de la República, Uruguay

Angel – IoT e-Health Platform to Monitor and Improve Quality of Life

Abstract
The world's population is aging. With this, new socioeconomic challenges emerge from the desire for a long life with health and well-being. This desire becomes even more important in the face of situations such as the new coronavirus pandemic. Considering this context, technologies for continuous monitoring and assistance to the older adults allow systems and applications to provide data about the patient's behavior outside a hospital environment and within their daily lives. Using this data, the elderly Quality of Life (QoL) can be monitored to guide faster and more accurate actions to be improved. Also, chronic and acute diseases can be monitored, providing support and alarms for patients and health services on how to react to anomalies. Thus, this project proposes to develop a new IoT platform to help the continuous monitoring of QoL of older adults and patients with chronic or acute diseases using smart objects called Angel. For that, the project has six parts, called Work Packages (WP). Each package will investigate important aspects for the development of smart health applications with Angel such as (i) continuous monitoring of quality of life using smart objects, (ii) the detection of mobility problems or falls, sensing and analytics of vital signs in order to monitor chronic and acute diseases, (iii) runtime testing approaches to ensure quality of dynamic smart health systems, (iv) data enrichment, (v) the infrastructure and connectivity necessary for the execution of critical health applications that require low latency and high availability, and (vi) strategies using blockchain to provide privacy and security for health data. During the project, we define some integration checkpoints to combine the results obtained in each WP inside Angel.

Institutions and scientific coordinators:
Yacine Ghamri-Doudane, Université De La Rochelle, France
Alvaro Henry Mamani Aliaga, Universidad Nacional De San Agustin De Arequipa, Peru
Alejandro Andrés Veloz Baeza, Universidad De Valparaiso, Chile
Dario Vieira Conceição, Ecole D'ingénieur Informatique & Technologies Du Numérique, France
Anis Laouiti, Télécom Sudparis, France
Jérôme François, Inria / Laboratoire Lorrain De Recherche En Informatique Et Ses Applications, France

ASPMLM-Voice - Advanced Signal Processing, Machine Learning and Modeling on Voice-related Problems

Abstract
Recent insights into biophysics and the pathophysiology of human phonation have become valuable for improving current technological applications, ranging from telecommunication to man-machine interface and medical diagnosis. Dealing with the most challenging problems in the area has demanded to take advantage and to combine different methods from signal processing, machine learning, and system modeling. The current project focuses on investigating different innovations and advances in these fields to boost further this interdisciplinary approach, fostering also the development of new technologies. A community of specialists is gathered with know-how in the most challenging aspects of the subject: non-stationary signal processing and deep learning (LSyDnL), high-order synchrosqueezing and advanced time-frequency analysis (LJK), time-scale analysis and inverse problems (IRIT), physiologically-inspired numerical modeling of the vocal folds (UnB), development of clinical tools based on subject-specific computer models and signal processing (USM), non-invasive aerodynamic assessment for the week-long ambulatory monitoring of vocal function (UChile). The proposal focuses on several aspects of voice production with an emphasis on under-researched issues including diagnosis support and speaker characterization, for both normal and pathological conditions. Besides strengthening existing scientific relationships, this project would aid to promote long-term collaborations between the resulting South American tripartite research network and the French partners beyond the two-years project duration.

Institutions and scientific coordinators:
Matías Zañartu, Universidad Técnica Federico Santa María, Chile
Gastón Schlotthauer, Universidad Nacional de Entre Ríos, Argentina
Jorge Carlos Lucero, Universidade de Brasília, Brasil
Sylvain Meignen, Laboratoire Jean Kuntzmann (LJK) – Université Grenoble-Alpes, France

AUMD - Analysis of Urban Mobility Data

Abstract
Modern cities continuously evolve and face problems that were not present a couple of decades before. Nowadays, societies strive to create smart cities that improve the quality of life of its citizens. Creating smart cities requires identifying mobility problems in urban areas by studying and visualizing dynamic data using mathematical and computational techniques. The identification of urban problems involves the development of efficient analysis, simulation, pattern recognition, and visualization algorithms to process all the data. These algorithms have to consider vast amounts of data from diverse sources like cameras, positioning systems, and population census. The nature of the data and the complexity of the techniques require that these algorithms propose efficient alternatives to find spatio-temporal relations. The utilization of sophisticated algorithms helps to visualize different levels of abstraction and to provide simulations that are a fit representation of reality. This project proposes to develop theoretical and computational methods that allow us to visualize and find dynamic data patterns related to urban mobility. These patterns will be studied and compared using real data and data from simulation models. The manipulation of high-volumes of data will be emphasized, and the tools that we will develop throughout this project will be validated using statistical tests.

Institutions and scientific coordinators:
Israel Pineda, Yachay Tech University, Ecuador
Hugo Alatrista-Salas, Universidad del Pacífico, Peru
Aracelis Hernández, Universidad de Carabobo, Venezuela
Pascal Poncelet, University of Montpellier, France

C-CAIT - Control of Complex Systems: Classical and Artificial Intelligence Tools

Abstract
This project focuses on the modeling, identification, control synthesis considering classical and automatic learning and artificial intelligence tools for complex dynamical systems. The modeling and identification problems will be concentrated on infinite-dimensional systems through the theory of partial differential equations (PDEs). Engineering applications can be found in many fields such as chemical and thermal processes, distribution and energy production systems, and systems related with fluid transport and medical science. Interestingly, several of these applications have parameters and mathematical functions that are little known in practice. In this context, we intend to address problems such as identifying the unknown structure of the equations that describe the underlying phenomenon given only measurements of the system's output and integrating automatic learning and artificial intelligence techniques into the classical modeling and identification methodologies. In the topics related to control theory, we will address those that arise in complex systems modeled by several coupled nonlinear PDEs. In general, the available results can be applied only in particular cases with fairly conservative assumptions. In this sense, we aim at developing control design methods combining innovative methods of systems theory, with modern optimization and artificial intelligence tools for the control and stability analysis. Our goal is to address these issues for the parabolic and hyperbolic cases. It turns out that artificial intelligence and machine learning tools will be used in all research areas of the project. This will make possible to address some novel challenges in control and systems theory by combining well-known control engineering tools with artificial intelligence methods.

Institutions and scientific coordinators:
Eduardo Cerpa, Pontificia Universidad Católica de Chile, Chile
Daniel Ferreira Coutinho, Universidade Federal de Santa Catarina, Brasil
Christophe Prieur, GIPSA-lab, CNRS, France

EMISTRAL - An Environmental Monitoring and Inspection Sailboat via Transfer, Reinforcement and Autonomous Learning

Abstract
The current climate crisis calls for the use of all available technology to try to understand, model, predict and hopefully work towards its mitigation. Oceans play a key role in grasping the complex and intertwined processes that govern these phenomena. Oceans -and rivers- play a key role in regulating the planet's climate, weather and ecology.
Recent advances in computer sciences and applied mathematics, such as machine learning, artificial intelligence, scientific computation, among others, have produced a revolution in our capacity for understanding the emergence of patterns and dynamics in complex systems while at the same time the complexity of these problems pose significant challenges to computer science itself.
The key factor deciding about the success of failure of the application of these methods is having sufficient and adequate data. Oceanographic vessels have been extensively used to gather this data. However, they have been shown to be insufficient because their high operation cost, the risks involved and their limited availability.
Autonomous sailboats present themselves as a viable alternative. In principle, by relying on wind energy they could operate for indefinite periods being only limited by the effects of fouling and the wear and tear of materials.
Recent results in the area of machine learning are especially suited to fill this gap. In particular, reinforcement learning (RL), transfer learning (TL) and autonomous learning (AL). The combination of those methods could overcome the need of programming particular controller for every boat as it would be capable of replicating at some degree, the learning process of human skippers and sailors.

Institutions and scientific coordinators:
Luis Martí, INRIA Chile, Chile
Esteban Clua, Universidade Federal Fluminense, Brasil
Gonzalo Tejera, Universidad de la República, Uruguay
Philippe Preux, INRIA, France

MAWSER - MAchine Intelligence based Wavefront SEnsing and Reconstruction for Adaptive Optics

Abstract
Adaptive optics is an automatic control technique aimed to overcome atmospheric turbulence, enabling high resolution terrestrial astronomical imaging and high-speed optical communications. Adaptive optics heavily rely on wavefront sensors to obtain estimations of the varying phase aberrations induced by the atmosphere. Traditional wavefront sensors have intrinsic limitations in terms of speed, resolution, sensitivity, linearity, calibration and cost. In the standard way of using a WFS, one always ends-up in a trade-off between these parameters, where optimizing one (e.g. linearity) results in degrading another (e.g. sensitivity). Lately, machine intelligence methods based on deep neural networks have shown to be the ultimate solving strategy for ill-posed inverse problems, which allows—in principle—to turn any imaging system into a potential wavefront sensor, and potentially break the trade-off situation described above. The aim of this project is to explore new architectures and training strategies for deep neural networks to design and test a variety of image-based wavefront sensors. Experimental validation against traditional wavefront sensors using a laboratory test bench will finally indicate whether any of the new sensors can be useful in practical adaptive optics scenarios. As a result of this project, a series of jointly developed, novel artificial intelligent-driven wavefront sensors, with potential application in astronomy adaptive optics, will be demonstrated. The execution of this project will not only benefit the adaptive optics community from the demonstrated usage of artificial intelligence methods into its sensors and algorithms, but it will also allow a rich transfer of knowledge between the adaptive optics community (French partners) and the computational imaging community (Latin-American partners), which will surely derive into future joint technological developments in astronomy, biology and space applications.

Institutions and scientific coordinators:
Esteban Vera, Pontificia Universidad Catolica de Valparaiso, Chile
Jaime Meneses, Universidad Industrial de Santander, Colombia
Benoit Neichel, Laboratoire d'Astrophysique de Marseille, France

QAPLA - Quantum aspects of programming languages

Abstract

The design of quantum programming languages is a rich framework that allows studying intrinsic properties of the computation we are modelling, such as parallelism, entanglement, superposition, etc; also, it is a way to study new logics (quantum logics with a computational ground), as well as to study classical logics from a new perspective. Finally, studying the foundational bases of programming languages gives a path to develop proper implementations.

This project proposes to study several aspects of quantum programming languages, with different approaches (quantum control/classical data, quantum control and data, categorical techniques, semantical techniques, realizability). The final aim is to merge different approaches in order to study from logics to implementations.

Institutions and scientific coordinators:

Alejandro Díaz-Caro, Instituto de Investigación en Ciencias de la Computación (CONICET/UBA), Argentina

Octavio Malherbe, Universidad de la República, Uruguay

Federico Olmedo, Universidad de Chile, Chile

Gilles Dowek, Inria / LSV, France

Simon Perdrix, CNRS / LORIA, France

SILIDOC - In silico modeling of single-subject neuroimaging data for the characterization and prognosis of patients with disorders of consciousness

Abstract
Studying the brain mechanisms supporting a temporally extended state of consciousness is a major challenge both for basic neuroscience and clinical applications. In spite of sustained efforts, there is no such thing as a unique biomarker that can precisely define the state of consciousness of a neurological patient, for instance, a brain injured patient. This is in contrast with other areas of neurology, where the pathophysiology is better understood, and can assist in differential diagnosis and prognosis. Many of the biomarkers proposed are empirically defined (EBM), setting thresholds between groups of patients in a data-driven way. In this project, we propose a novel approach using model-based biomarkers (MBM). This new family of biomarkers will not only complement the EBMs, but will also address the knowledge gaps associated with the understanding of the underlying causal mechanisms behind different states of consciousness.
Models combining the structural and functional connectivity of the brain will be combined with novel, systematic perturbational approaches that can provide new insights into the human brain's ability to integrate and segregate information over times. To address the development of these biomarkers, we propose a highly interdisciplinary project, which will benefit from the complementary synergy between four groups, that combines whole-brain computational modeling, diffusion MRI (dMRI)-based structural connectivity and tissue microstructure, and clinical neuroscience. The applied clinical relevance of our proposal is manifest in the fact that, in contrast to previous developments, we will construct computational whole-brain models based on single-patient neuroimaging data. We will extract MBM from the adjusted model parameters and from in-silico simulations tailored to each individual patient and we will analyze the diagnostic and prognostic capacity of these biomarkers in DOC patients in both chronic and acute stages.

Institutions and scientific coordinators:
Enzo Tagliazucchi, Universidad de Buenos Aires, Argentina
Patricio Orio, Universidad de Valparaíso, Chile
Jacobo SITT, ICM Research Center Hôpital Pitié-Salpêtrière, France
Demian Wasserman, Inria Saclay Île-de France CEA NeuroSpin Université Paris-Saclay, France

STARS - SaTellite networks Architectures pRotocols and informaticS

Abstract

Constellations of nano and small satellites are being deployed to expand the range of possible services provided by space communications infrastructure in aspects such as machine-to-machine communications, emergency communications, long-range monitoring, and the Internet of Things (IoT), among others. Big players such as SpaceX, Amazon, and Boeing, are part of a list comprising more than 17,000 satellites to be launched before 2027. In the region, national space programs are being launched considering the local development of constellations of small/nano satellites, which not only involves the integration of several academic actors, but also governmental and private initiatives. These programs will contribute to the research in topics such as space physics and space weather, astronomy, engineering science, and data collection in natural disasters, among others. Consequently, space communications and networking have been subject to a redefinition process as a low-cost global coverage wireless network. In this project, we tackle the challenges involved in the modernization of satellite-based communications by considering the requirements and restrictions of the deployments of large-scale satellite constellations including nano and small satellites. The contributions of the participant institutions are threefold: 1) the application of state-of-the-art informatics for the operation and design of large scale satellite constellations; 2) the definition and evaluation of hybrid architectures with LPWA and nano/small satellite technologies, and 3) the design of networking protocols for challenging and restricted networks in space communications. Besides developing a strong international collaboration network around these topics, during the execution of this project we expect to provide student mobility and scientific training to the participants. Dissemination activities will also take place to share the results and possibly to incorporate new actors for further collaborations in the next stages of this research.

Institutions and scientific coordinators:

Sandra Céspedes, Universidad de Chile, Chile

Juan Fraire, Universidad Nacional de Córdoba, Argentina

Christophe Louembet, Laboratoire d'analyse et d'architecture des systèmes, France

TELearning - Development of computational methods for modeling and analyzing biological sequence data in plants

Abstract
The major fraction of plant genomes is composed of repetitive elements, of which transposable elements (TE) have received particular attention due to their significant roles and impact in crop production. For instance, traits such as color in grape and corn, size and shape in tomato, or flavor in orange, have been shown to be linked to TEs. For these reasons, TEs have deep applications in biotechnology and agriculture, especially to countries such as Brazil, Chile, Colombia and France. However, most of the current methods used for an automatic classification of TE sequences in plant genomes are based on manually pre-defined features, which uses homology-based search as one of the key features to classify TE sequences. The big issue here is the dependency of data available in databases and the time-consuming process used for filtering these sequences and perform homology searches. This project aims to exchange knowledge among the members of a network between Latin America and France, in order to deploy an automated IT system for large-scale TE analysis in plants through the proposal of hybrid artificial intelligence methods. Our proposal intends to use only sequence data exclusively as input for a predictive tool for TE identification. To accomplish it we propose to: (i) use of artificial intelligence methods to create a free-alignment TE identification approach; (ii) to understand the influence of features in the used methods; (iii) to analyze the noise level in the public data and how it could impact the performance of the methods; (iv) to create an automatic system for TE large-scale data analysis; (v) to create a network between Latin America and France on the ICT theme of this project, making high-level research and training of human resources through scientific exchange and academic mobility.

Institutions and scientific coordinators:
Vinicius Ramos Henriques Maracaja Coutinho, Universidad De Chile, Chile
Gustavo Adolfo Isaza Echeverri, Universidad De Caldas, Colombia
Romain Guyotinstitut De Recherche Pour Le Développement, France