STIC AmSud projects - call for proposals 2016

BRILAAM - Bioacoustical Research in Latin America Aquatic Mammals

Abstract

Advanced investigations in bioacoustics involve interdisciplinary teams to include computer science, machine learning, feature learning, signal analysis, acoustics, physics, mathematics, biology, ecology and ethology. We propose forming a net of scientists in Chile, Peru and France (i.e. computer scientists, physicists, mathematicians, oceanographers, and ecologists) that will exchange technologies, data, theoretical models, field experiences, and other information in order to accelerate the development of bioacoustic in South America (Bioacoustics is hugely underdeveloped in Chile for example). We plan to install innovative, low-cost, multi-channel recording equipment from 2016 through 2018 capable of high sampling rates at real time (1 mHz: JASON DAQ – developed by Univ. of Toulon) in conjunction with other equipment already in place to acoustically monitor marine mammals over long periods of time. These acoustic surveys will occur in South American hot spots: Carlos III Island in the Magellan Strait, Corcovado Gulf near Chiloe Island, Chanaral Island in northern Chile, and the Peruvian Amazon. Innovative signal processing techniques that are currently being developed will be applied to the collected data, such as (non exhaustive):

1. Adanced Automatic decomposition of cetacean songs in units (blue whales, Amazon River dolphins, Orca, and Humpback whales as in [1]),
2. Finite element wave propagation models ([2]),
3. Wavelet or scattering representations ([3,4]),
4. Passive acoustic 3D tracking ([5]).

Furthermore, we intend to establish a permanent, international research station in the Peruvian Amazon, where this equipment and signal processing techniques can be used with not only freshwater cetaceans, but also amphibians & fish. A citizen science portal will be created on the Bioacoustics Research in Latin America website (http://sabiod.univ-tln.fr/brila/) which will make the collected audio files and above-mentioned algorithms open sourced, facilitating global analyses

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CC-SEM - Cloud Computing for Smart-City Energy Management

Abstract
The project proposes performing research and development activities oriented to build an integrated platform for smart monitoring, controlling, and planning the energy consumption and generation in urban scenarios from the point of view of both citizens and administrators, by integrating cutting-edge technologies (Big Data analysis, computational intelligence, Internet of Things, High Performance Computing and Cloud Computing).

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e-MONITOR - Chronic DIsease: Ambient Assisted Living and vital teleMONITORing for e-health

Abstract
Chronic diseases, such as diabetes and cardio-vascular pathologies are an important cause of death, as well as in South America as in Europe. They concern several categories of population from younger to older persons. These distress situations can occur in all days life at any moment, when working or dealing with home tasks, which stimulated for last decades remote monitoring solutions for the concerned persons. Due to acceptability and lowest-response time constraints, telemonitoring solutions nowadays necessitate the design and realisation of robust, performant and light ambulatory devices to be coupled to transmission networks and exploitation interfaces the most robust and ergonomic for caregivers exploitation. Elderly persons generally live alone in their home and feels more secure by using also telemonitoring solutions when they are in risk situations, but they can also feel the necessity, when they are in good health, to dispose of information they could manage to preserve their well-being. In this case preventive information technologies based on connected objects, or Internet of Things (IoT), such as smartphones, tablets and/or environmental sensors (such as presence detectors, sound and visions captures) are very useful and effective solutions to predict any deviating.

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EPIC - EPistemic Interactive Concurrency

Abstract
Giving mathematical foundations to today's concurrent systems (i.e., computational systems of multiple agents that interact with each other) is a serious challenge for theoretical computer science. Traditional mathematical models from concurrency theory do not single out two fundamental aspects of these systems: namely, epistemic and spatial behavior.
The intrinsic epistemic nature of these systems arises from social behavior. We have millions of agents (users) posting and sharing partial information, beliefs, opinions and even intentional lies (hoaxes) on social networks. As for the spatial behavior, compelling examples are provided by processes (applications) and data moving across possibly nested spaces defined by friend circles, groups, and shared folders in social networks and cloud storage.
It is therefore crucial to be able to describe, analyze and, in general, reason about concurrent systems exhibiting epistemic and spatial behavior. This reasoning must be precise and reliable. Consequently, it ought to be founded upon mathematical principles in the same way as the reasoning about the behavior of sequential programs is founded upon logic, domain theory and other mathematical disciplines.
In this project we take up the task of developing a mathematical model, conceptually different from existing models of concurrency, for the precise understanding of epistemic and spatial behavior in today's concurrent systems. The model will be able to rigorously predict the behavior of a concurrent system in the presence of complex flow of epistemic information such as knowledge, facts, public announcements, lies and opinions. A compelling application of the model will be to predict if in a given social network, certain intentional lie may lead to unwanted situations such as the public announcement of sensitive information or other intrusive behaviors. In previous work we put forward formalisms from different mathematical domains for analysing some basic epistemic and spatial distributed systems. In particular, we developed a new model of concurrent epistemic computation [26] in concurrency theory, proposed a new algebraic structure for axiomatizing belief and space [50] in order theory, introduced a logical framework for proving epistemic, spatial and temporal properties [44,45] in proof theory. These works represent significant advances towards achieving our main goal but much remains to be done for providing a single robust mathematical model for today's distributed systems.
By building upon our previous work, this multidisciplinary project will coherently combine and develop new mathematical theories and techniques from concurrency theory, mathematical logic, information and order theory in a single model for epistemic and spatial distributed systems. The expected outcome is an executable mathematical model, a process calculus, to specify the spatial topology of a system and predict the epistemic flow of information that may lead to unwanted behavior. We will define a logic to reason about the system and endow it with a proof system.
This will be used to produce automated tools to verify properties of our model.

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PaDMetBio – Parallel and Distributed Metaheuristics for Structural Bioinformatics

Abstract
Structural bioinformatics deals with problems where the rules that govern the biochemical processes and relations are partially known which makes hard to design efficient computational strategies for these problems. There is a wide range of unanswered questions, which cannot be answered neither by experiments nor by classical modeling and simulation approaches. Specifically, there are several problems that still do not have a computational method that can guarantee a minimum quality of solution.
Two of the main challenging problems in Structural Bioinformatics are (1) the three-dimensional (3D) protein structure prediction problem (PSP) and (2) the molecular docking problem for drug design.
Predicting the folded structure of a protein only from its amino acid sequence is a challenging problem in mathematical optimization. The challenge arises due to the combinatorial explosion of plausible shapes, where a long amino acid chain ends up in one out of a vast number of 3D conformations. The problem becomes harder when we have proteins with complex topologies, in this case, their predictions may be only possible with significant increases in high-performance computing power. In the case of the molecular docking problem for drug design, we need to predict the preferred orientation of a small drug candidate against a protein molecule. With the increasing availability of molecular biological structures, smarter docking approaches have become necessary.
These two problems are classified as NP-Complete or NP-Hard, so there is no current computational approach that can guarantee the best solution for them in a polynomial time. Because of the above, there is the need to build smarter approaches that can deliver good solutions to the problem.

In this project, we plan to explore a collaborative work for the design and implementation of population based metaheuristics, like genetic and memetic algorithms. Metaheuristics are one of the most common and powerful techniques used in this case. Although, they do not guarantee the optimal solution, they provide a good approximation within a limited computational effort.

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PEDESTAI - Prediction models for Energy Consumption based on Big Data Analytics of Population Density and Spatio-Social activities.

Abstract
With the growth of urban cities, more and more energy (electricity) is need for daily human activities, such as cooking, heating, watching TV, charging mobile devices. Hence energy consumption and demand estimation is a key activity to plan energetic matrix, upgrade electricity grid, save money, reduce gas emissions, reduce air pollution and even save water. Energy demand estimation and prediction is not a trivial task for energy providers due to different factors linked to local aspects. For instance, in developing countries urban energy needs and special projects like factories or technological centers are analyzed in separately. While urban needs forecast is correlated with the projected
GDP of each country, special projects follow ad-hoc energy demand studies. As for developed countries, urban energy demand and special-purpose project demand are seen together since development is planned in advance. In order to deal with these issues, this collaboration project aims to develop new prediction models to estimate population density so as to classify human activities and to assess energy (electricity) consumption in urban centers using as primary data sources telecommunication, geo-spatial, social media and text data. The overall research will be based on the exploitation of novel Big Data analytics, Machine learning, Social Network Analysis, Data and Text Mining methods and technologies.

Specifically, the project will contribute toward research and development of novel Big Data Analytics approaches to develop a model for predicting energy (electricity) consumption based on new computational techniques for tasks as follows:

- Spatio-temporal analysis: to detect activity zones, which are points of interest in a city.
- Mobility model analysis to estimate dynamic density of people in activity zones over time.
- Automatic text analysis: to infer categories (urban, commerce, industrial, etc.) of activity zones based on social network messages.

The teams of the *Universidad del Pacífico* (Peru), *University of Concepcion* (Chile) and *Telecom Sud Paris/Institut Mines-Telecom* (France) will collaborate around the abovementioned issues to develop new approaches to create models to estimate and predict density, to classify human activity and to calculate energy (electricity) consumption.

Institutions and scientific coordinators:
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SNPs-PHE – Computational models for predicting SNPs-phenotype associations

In a medical post-genomic age the accurate diagnosis of common complex diseases requires a clear correlation between genotype variants and phenotype diseases. As expected, with the advance in Next Generation Sequencing (NGS) technologies, new approaches for the meta-analysis of genetic association studies began to emerge. For all these new approaches, the major challenge is to understand the correlation between SNPs and phenotypic traits. Advances in this problem offer unprecedented opportunities to foster translational health research. However, the high diversity observed in genomes of natural populations, in the order of millions of SNPs, together with the hardness of modeling the underlying genomics and systems biology turns the problem of predicting
SNP-phenotype associations hard to deal with. In this proposal, a multigenic prototype model for predicting non-trivial associations between SNPs and the eye color defective trait in the model organism *Drosophila melanogaster* is considered. For this purpose, SNPs are modeled as information sources and machine learning methods for modeling complex interactions between information sources are considered. We expect these models can be able to, *i*) differentiate between two main types of SNPs interactions, redundant and complementary, and *ii*) to quantify their contributions to the phenotypic trait under study. To accomplish these computational objectives, a two-stage approach based on a supervised fuzzy-measure characterization of sets of SNPs is assumed. The key elements of innovation in this proposal are the integration of expert knowledge to machine learning models and the use of fuzzy measures to aid in the interpretation of SNPs interactions.

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STIC & HERITAGE - Development of STIC tools for the structural diagnosis of heritage constructions

Abstract

The use of STIC for the structural diagnosis of heritage buildings has progressively become an interdisciplinary effort that spreads over several scientific communities. In particular, STIC

applications to cultural heritage include 3D surveying and modeling, non-destructive testing, numerical methods, image processing, and information systems. Much of the research work on this area has focused on the direct acquisition of 3D pointclouds for representation, record keeping and visualization, but there are many other STIC applications which required much researh work. This project will combine the expertise from each international partner of the network to create new techniques to perform structural diagnosis

The first work package deals with 3D surveying. The main points will be to develop 3D-acquisition protocols of heritage constructions combining GPS, topography, lasergrammetry and photogrammetry. The second work package is about non-destrutive testing. The goal will be to identify the most relevant techniques (sound, ultrasound, ground penatrating radar, thermography among others) for structural diagnosis and integrate them into a 3D representation of the monument. The third work package focuses on 3D-model and image processing, in order to obtain both, simple 3D-models useful for structural analysis and detailed 2D/3D records of importat areas highlighting NDT results for structural diagnosis. Finaly, the last work package will open the floor for questions about data base, spatial annotation of data, and information systems.

The project will be applied in each country through the study of specific sites: The château of Chambord in France (stonework), the church of Andahuaylillas in Cusco, Perú (earth) in Lima Peru and Cathedral of Santiago (stone and clay bricks) in Chile.

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