# Proyectos STIC AmSud – convocatoria 2019

## ADMITS - Architecting Distributed Monitoring and Analytics for IoT in Disaster Scenarios

Abstract  
The ADMITS (Architecting Distributed Monitoring and analytics for IoT in disaster Scenarios)

project aims to develop algorithms, protocols and architectures to enable a decentralized

distributed computing environment to provide support for monitoring, failure detection, and

analytics in IoT disaster scenarios.

We face a context where every year, millions of people are affected by natural and man-made disasters, whereby governments all around the world spend huge amounts of resources on preparation, immediate response, and reconstruction. Since November 2015, severe weather brought on by El Ni˜no Southern Oscillation (ENSO), including heavy rains, floods, flash floods and landslides significantly hit South America, causing thousands of homelessness and deaths. In Brazil, the Emergency Management Service early reports thousands of households affected by the rainstorms, Landslides, drought, and, very recently, the devastating mudflows caused by Mariana and Brumadinho dam disasters. In Uruguay, the National Emergency System’s (SINAE) reports thousands of people were displaced by flooding caused by heavy rains, as well as a tornado, which destroyed homes in various areas in the country. Chile attains special attention in Latin America as it is by far the most natural disaster-prone country. Chile is one of the most earthquake-prone countries in the world, mainly due to its location along the Pacific Ring of Fire, an area of intense volcanic activity and earthquakes. Chile is affected by drought, floods, tsunamis, volcanic eruptions, forest fires, earthquakes (in April 2014, a powerful 8.2 magnitude earthquake struck near Chile’s northern coast prompted a tsunami and strong aftershocks) and wildfire (the most devastating in its history was in January 2017).

Recently, the Internet of Things (IoT) paradigm has been extensively used for efficiently managing disaster scenarios, such as volcanic disasters, floods, forest fire, landslides, earthquakes, urban disasters, industrial and terrorists attacks, and so on. The IoT support can provide key capabilities to localize victims, achieve situation awareness, and monitor/actuate the environment. However, in a disaster scenario the communication/processing infrastructure and the devices themselves may fail producing either temporary or permanent network partitions and loss of information. Moreover, it is expected that in the years to come, IoT will generate large amounts of data everyday, making data processing and analysis very difficult and challenging in time-critical applications. The present proposal is based on the expertise of the teams from France, Brazil, Uruguay, and Chile in several complementary fields of research. These include large scale and mobile distributed computing and algorithms, fault tolerance, dynamic and heterogeneous systems, realtime stream processing and data analytics, large scale data management, self-organized systems, computer networks, and post-disaster geolocation information gathering. Our aim is the development of a distributed architecture in which IoT, Fog, and Cloud computing technologies participate to provide required capabilities for IoT data analytics, real-time stream processing, and failure monitoring for environments potentially subject to disasters. The methodology and activities presented are oriented towards the creation of new collaborations between participants of the group, and strengthening the previous collaborations with research meetings, workshops and the common topics of interests proposed in this project. We expect this collaboration produces joint papers in conferences and journals, and co-supervision of undergraduate and graduate students, with perspectives of maintaining the collaboration in the future.

Institutions and scientific coordinators:   
Nicolás Hidalgo, Universidad Diego Portales y Universidad Técnica Federico Santa María, CHILE

Rafael Pasquini, Universidade Federal de Uberlândia, Universidade Federal do Rio Grande do

Norte and Instituto Federal Sul-Rio-Grandense, BRASIL

Javier Baliosian, Universidad de la República, URUGUAY

Luciana Arantes, Sorbonne Université, LIP6, CNRS, INRIA, FRANCIA

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## DeMON - Decomposition Methods for Optimization in Networks

Abstract

This proposal aims to create a new network of cooperation between three teams working on optimization methods for large and difficult classical problems on networks. We focus on three main classical problems: Stochastic Network Design, Resource-constrained Production Scheduling and Competitive Facility Location problems. All three teams have a proved expertise on these three subjects, with similar and complementary methodological approaches to solve them, including the use of decomposition algorithms for exact optimization of large-scale instances, with a particular focus on the computational performance of these algorithms. The teams include in total 4 Senior researchers, 3 Junior researchers and 3 PhD students, with a potential to include more students in the future. We plan several missions with researchers and students from all countries visiting all the other countries, including a Workshop with all the team on the second year. The relevance of these problems will allow to transfer these results to the industry, particularly in areas like telecommunication, logistic, transportation and natural resources.

Institutions and scientific coordinators:

Eduardo Moreno, Universidad Adolfo Ibáñez, CHILE

Eduardo Uchoa, Universidade Federal Fluminense, BRASIL

Ivana Ljubic, LAMSADE, Université Paris Dauphine, FRANCIA

## DyLo-MPC - Dynamic Logics: Model Theory, Proof Theory and Computational Complexity

Abstract

During the project we will advance our understanding of a novel family of modal logics called *dynamic logics*. Dynamic logics are characterized by the inclusion of modal operators that can modify the model in which they are being evaluated. This characteristic made them especially well suited for the description of evolving scenarios like, for example, the temporal evolution of a communication network, where connections are dynamically created and eliminated, constantly changing the actual topology. A number of different dynamic logics have been investigated by members of the project, but a general perspective is still missing, and a number of important open questions remains, ranging from adequate model theoretic characterizations, to a proper understanding of how to define proof calculi for this logics, which are usually not closed under uniform substitutions. The project aims to pull together the strengths of the four international research teams, to unify existing results and attempt to answer these open problems.

Institutions and scientific coordinators:

Carlos Eduardo Areces, Universidad Nacional de Córdoba, Argentina [UNC-AR], Facultad de Matemática, Astronomía, Física y Computación, ARGENTINA

Mario Roberto Folhadela Benevides, Universidade Federal do Rio de Janeiro, Brazil [UFRJ-BR]

Departamento de Ciência da Computação, BRASIL

Lutz Strassburger, Laboratoire d'Informatique de l'Ecole Polytechnique and CNRS, FRANCIA

Stéphane Demri, ENS Paris-Saclay and CNRS [LSV-FR] Laboratoire Spécification et Vérification, FRANCIA

## IMPRESS - Image Modeling and Processing for REmote SenSing in agriculture

Abstract

The field of remote sensing is experiencing an unprecedented acceleration. Besides the large public programs such as Sentinel (see e.g. https://sentinel.esa.int/web/sentinel/missions/ sentinel-2), private actors are creating fleets of micro-satellites capable of monitoring of the earth with daily revisits. This abundant and cheap data is creating opportunities for developing novel applications for the monitoring of industrial and agricultural activity. The automatic exploitation of this data is bound to specific application domain knowledge, which requires a mastery of advanced techniques such as computer vision and machine learning, as well as expert knowledge in the field of agriculture. To do this, the team must master earth observation satellites, be able to define the adequate mathematical detection theories, and build on a deep knowledge of satellite image processing, while also including expert knowledge in agriculture. This project aims at uniting competences across the fields of computer vision and machine learning, remote sensing to address emerging applications in agronomy. This project will in addition foster the creation of reproducible research by adopting a reproducible research methodology thus contributing the resulting algorithms to the journal Image Processing On- Line (IPOL). The IPOL journal is an initiative to establish a clear and reproducible state-of-theart in the domain of image processing and computer vision.

Institutions and scientific coordinators:

Rodrigo Verschae, Universidad de O’Higgins, CHILE

Javier Preciozzi, Universidad de la República, URUGUAY

Gabriele Facciolo, ENS Paris-Saclay, FRANCIA

## NEMBICA - NEw Methods for BIological Control of the Arboviruses

Abstract

The present project is concerned with new strategies to control the spread of established diseases

(such as e.g. dengue, chikungunya and Zika) and potentially emerging or reemerging diseases (e.g. Mayaro, Oropouche and Yellow fever) transmitted by mosquitoes *Aedes aegypti* and *Aedes* *albopictus*. Due especially to the widespread resistance to the insecticides traditionally used to control the vectors, the use of sterile insect (SIT – Sterile Insect Technique), of transgenic mosquitoes (RIDL – Release of Insect carrying Dominant Lethal gene) and/or of mosquitoes infected with the bacterium *Wolbachia* (which drastically reduces their vector competence), are considered as viable control alternatives. These biological control techniques envisage either the elimination of the vector in a locality (SIT or RIDL), or its local substitution by a population refractory to the arboviruses transmitted by these species (*Wolbachia*). How to achieve the releases on a large scale in order to maximize their effect is still a source of some central questions that we aim to study here. We will focus more specifically on the issues related to spatial spreading of the treatment, on observer techniques for estimating the number of mosquitoes during the releases, and on optimal and non-optimal control approaches. An important modeling effort will also be conducted on some key issues: we will assess the effects of the chemical and mechanical control methods on the success of the above techniques; the consequences of inter and intra-species competition in larval phase (an important issue so far overlooked); the questions raised by the use of self-propagating genetic mechanisms and the definition of associated efficacy measures; and develop genome scale model of Wolbachia in order to identify in the parasite-host relationship, crucial biological factors that could dynamically affect the dissemination.

Institutions and scientific coordinators:

Pierre-Alexandre Bliman, INRIA France, FRANCIA

Yves Dumont, CIRAD, FRANCIA

Alain Rapaport, INRA – UMR MISTEA, FRANCIA

Nicolas Vauchelet, CNRS, FRANCIA

Hernán G. Solari, Universidad de Buenos Aires, ARGENTINA

Juan Pablo Aparicio, Universidad Nacional de Salta - INENCO- Facultad de Ciencias Exactas, ARGENTINA

Helio Schechtman, Fiocruz, BRASIL

Moacyr A.H.B. da Silva, FGV, BRASIL

Cláudia Pio Ferreira, Universidade Estadual Paulista “Júlio de Mesquita Filho”, BRASIL

Amit Bhaya, Universidade Federal do Rio de Janeiro, BRASIL

Ziomara Gerdtzen, Universidad de Chile, chile

Irene Duarte Gandica, Universidad del Quindio, COLOMBIA

Christian Schaerer, Universidad Nacional de Asunción, PARAGUAY

## RAPA2 - Randomness and Probabilistic Analysis of Algorithms

Abstract

This project considers problems at the interface of computer science and mathematics, where the notion of randomness plays a central role. Randomness is a primitive notion in probability theory, but that does not su\_ce to determine how to answer questions such as when a given mathematical object should be considered random, or how an algorithm will behave on a random input. These two examples evidence two di\_erent perspectives on randomness, and each of them corresponds to a research line of this project. These two perspectives on randomness meet on the same objects: words, numbers, polynomials, sequences, dynamical systems, [hyper]graphs, etc, which are the fundamental structures in computer science. This project is mainly identi\_ed with the recently created team \Randomness and Analysis of Algorithms" of the Laboratoire International Associ\_e SINFIN (formerly called INFINIS), Universit\_e Paris Diderot-CNRS / Universidad de Buenos Aires-CONICET. There are also new members that are close to the two research lines. They bring with them new methodological skills on graphs and their applications.

Institutions and scientific coordinators:

Verónica Becher, Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, ARGENTINA

Loïck Lhote, ENSICAEN et Université de Caen, FRANCIA

Alfredo Viola, Universidad de la República, Instituto de Computacion, Facultad de Ingeniera, URUGUAY

## RISE e-Well - Remote Intelligent Systems for Elderly and Chronic Patient Follow-up

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| Abstract  Technologies improvements, notably using data analysis, allow more and more monitoring outside of the “normal” domain of the hospital or clinician office. Going from the data collection and processing to the architecture of the complete system, the *RISE e-Well* project proposes to design a complete system to facilitate the continuous and remote monitoring of patients with chronic disease, namely from the sensors level to interpretation system and to ethical questions relative to the personal data, through the medical record and the regular consultation with daily-living inference. To this aim it proposes an original scheme based on the “System of Systems” concept (SoS) allowing to organise the main and necessary healthcare bricks to follow the patients at home through biological signal processing during rehabilitation, actimetric monitoring to prevent falls risks and interactive follow-up of aged and chronic patients. In particular the SoS concept will play a major role by allowing to cope with distributed and heterogeneous smart objects and complex ambient data, which are the main technical bottlenecks when using multiple sensors and/or IoT technologies in such contexts of applications. In order to validate the different stages from design to implementation and validation, the project aims at complying to ethical aspects and making use of living labs, implementing a co-design approach that copes with the ethical guidelines for research in the different countries involved. Five different countries are participating Brazil, Chile, Uruguay, Columbia covering a good part of South America and France – and they will provide balanced and complementary expertise in the different domains concerned by the project.  Institutions and scientific coordinators: |
| Carla Taramasco, Universidad de Valparaíso, CHILE  Daniel Kofman, ICT4V, URUGUAY  Néstor Darío Duque Méndez, Universidad Nacional de Colombia, COLOMBIA  Anthony Fleury, Institut Mines Télécom, FRANCIA  Sofiane Boudaoud, Université Technologique de Compiègne, FRANCIA |

## ROEM - Advanced Robot Control for Outdoor Environmental Monitoring

Abstract

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| According to the International Labor Organization (ILO) it is estimated that USD 1.25 trillion expenses are generated due to industry accidents. Industries such as mining, petrochemical, hydrocarbons, and energy have a major impact with great losses by indemnification to the victims, government fines and cessation of operations. The principal problem is that the inspection and monitoring of operations in these industries are performed by humans and with not enough frequency. Detecting failures on time, especially in hard-to-reach and dangerous areas will prevent material losses, environmental pollution (earth, water, and air) and save human lives. We propose the use of mobile robots with advanced control techniques for environmental monitoring of industrial activities performed in the outdoors. The robots are able to reach difficult areas for humans, perform the inspection and monitoring task with more frequency, quantify the situation with special sensors and algorithms, and provide real time and historical information for decision making.   |  | | --- | | Institutions and scientific coordinators:  Francisco Cuellar Cordova, Pontificia Universidad Catolica del Peru (PUCP), PERU  Mario Arzamendia Lopez, Universidad Nacional de Asuncion (UNA), PARAGUAY  Faïz Ben Amar, Institut des Systemes Intelligents et de Robotique (ISIR), FRANCIA | |

## SAQED - Scalable Approximate Query Evaluation on Document Inverted Files for GPU based Big-Data Applications

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| Abstract  Very large collections of documents have become frequent in several application areas such as in medicine, social sciences, natural language processing, e-commerce and many others. The web is an example of a large document collection. Such collections are continuously growing in terms of the amount of documents, and the number of search operations (e.g. queries, similarity evaluation, document ranking, etc.) executed on the datasets. These factors impact the scalability of search engines twofold. The increase in the number of documents directly impacts the size of document indexes and the complexity of individual text similarity evaluations. The increase in the rate of evaluations demanded also increase the need for throughput. CPUs are optimized for low latency execution of a moderate number of application threads. In contrast, GPU architectures are designed to deliver high throughput computing for massive numbers of threads. In this project, we intend to collaborate in the development of an enhanced parallel version of the WAND ranking algorithm using the heterogeneous power of GPUs and CPUs to execute document evaluation on massive collections of documents in scalable and efficient ways. A scheduling algorithm that uses the GPU as a static cache to process the most frequent and computationally expensive queries will be proposed and evaluated. Additionally, as a case of study we propose to evaluate our proposal in online e-commerce systems. As an outcome from the collaboration between the researchers in this proposal, we expect to publish the results in high ranking conferences and journals in the related research fields. We also expect to collaborate in thesis supervision of MSc and PhD students.  Institutions and scientific coordinators:  Veronica Gil Costa, Universidad Nacional de San Luis – UNSL, ARGENTINA  Mauricio Marin, Universidad de Santiago de Chile – USACH, CHILE  Hermes Senger, Universidade Federal de São Carlos – UFSCAR, BRASIL  Bruno Raffin, INRIA /Laboratoire d´Informatique de Grenoble, FRANCIA |
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