# Proyectos STIC AmSud – convocatoria 2018

## ACCON – Algorithms for the Capacity Crunch problem in Optical Networks

Abstract
The rapid increase in demand for bandwidth from existing networks has caused a growth in the use

of telecommunications technologies, especially WDM optical networks. So far, communication

technologies have been able to meet the bandwidth demand. Nevertheless, this decade

researchers have anticipated a coming “Capacity Crunch” potential problem associated with these

networks. It refers to fact that the transmission capacity limit on optical fibers is close to be

reached in the near future. It is then urgent to make the current network architectures evolve, in

order to satisfy the relentless exponential growth in bandwidth demand. In other words, the performance bottleneck for optical infrastructures is concentrated around this limiting situation,

and the most efficient way of preparing the future of these fundamental technological systems that

support the backbone of the Internet is to focus on solving the related management problems.

In the previously described scientific context, the ACCON project has a main scientific goal:

the development of new strategies capable to provide better resource management techniques to

face the threat of the Capacity Crunch. To this end, we will explore the utilization of different

analytical techniques to evaluate the performance of several network architecture paradigms, in

order to assess their viability in the near future. This will provide us the needed insight leading to

finding new strategies for efficiently managing the network resources, and consequently, to

contribute addressing this coming Capacity Crunch problem.

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## C2S2 – Constructing Cryptographically Secure Structures

Abstract

The importance and impact of cryptography in Information Theory and Communications can hardly be overstated, and there is a constant drive to develop better and faster cryptosystems, both from a practical and theoretical perspective, to avoid new attacks or perceived treaths, take advantage of new approaches and technological advancements, or simply to improve the performance of existing algortihms.

Although quantum computing would eventually allow to compute discrete logarithms in polynomial time (via Shor’s algorithm), technological developments in the area have not yet reached the levels necesarry to do so at current cryptographic sizes. At the same time, post-quantum cryptosystems are still significantly slower than discrete-log based systems at the same (current, non-quantum) security level, so discrete-log cryptosystems are still highly interesting for many cryptographic applications.

Obtaining new and more secure groups for discrete logarithm based cryptosystems is a natural continuing concern, and any improvements along these lines is always welcome. Although obtaining

cryptographically interesting elliptic curves (genus 1) has been accessible for years, and computing the group order hyperelliptic curves of genus two over fields of small characteristic can also be done very efficiently, doing so over large prime fields is still rather expessive. The same holds for constructing hyperelliptic curves with a desired group order.

However, these are precisely the cases that are of greater interest for many cryptographic applications, whether it is to use a random non-standardized curve to have more flexibility, to avoid concerns about hidden specialized weaknesses in the standardized curve, and to obtain a good curve for pairing-based cryptography. Over the last few years, several separate improvements have been made in various aspects of the algorithms used in “point counting” and curve construction algorithms for hyperelliptic curves of genus two, and many of the researchers in this project are involved in ongoing research on these algorithms, and it is our hope that the project will help bring these separate expertices together to product better and faster results.

In addition to this classical aspect of curve-based cryptography (in which we also include pairings),

the project will also explore new pre-quantum cryptographic constructions and, keeping an eye to a

possible future, some post-quantum curve-based schemes. Our hope is that the union of the different expertises from the various nodes will enable us not to embrace the full “chain of production" of these new cryptographic tools, from the mathematical core to its specifications for real-life protocols. It will also provide a solid base for long-term collaborations.

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## CoDANet – Computation and dynamics of deterministic automata networks

Abstract

*Cellular automata* are locally-defined dynamical systems, discrete in time, space and state

variables. They are made up of a group of units (cells) connected in a regular lattice with other

units, and subjected to a local function (or rule) that determines the next state of each individual

unit, according to the current unit’s state together with on those of its neighbouring cells (i.e., those

locally connected to the unit). *Boolean networks* are a similar system to cellular automata, with the

main differences being that their constituting components may be connected in an arbitrary graphlike structure, not necessarily a regular lattice, and the state of a unit is usually binary. Even with simply defined local interaction rules, both systems may be capable of displaying arbitrarily complex global emergent behaviours, and consitute paradigmatic examples of automata networks of great academic interest and utility in many real-world applications, due to their being, at the same time, discrete dynamical systems and models of an unconventional model of computation characterised by local action; as such, the ability to better understand these systems might yield a deep impact on computing technology and theory. The present project has a fundamental nature, whose objective is to deepen current understanding on binary cellular automata and Boolean networks, by developing mathematical and computational methods related to them in order to study their computational abilities and limitations, as well as the global dynamics entailed by the action of their local, deterministic state update functions, be them synchronous or asynchronous.

More specifically, we aim at studying the effect of asynchronous updates on known benchmark

decision problems in the literature, as well as in generic computations; analyse properties of the

systems under study that bear relevance to their computational abilities and dynamical behaviour;

and characterise the limit behaviour of specific local functions or sets of them.

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## DLRCV – Optimized Deep Learning based Representations for Computer Vision Problems

Abstract

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| The performance of any machine learning model depends strongly on the choice of the representation. This explains why most of development time of real world pattern recognition systems is spent on defining a good representation of the problem (feature extraction). In the last years, deep learning models have achieved impressive performance in a plurality of computer vision task such as image classification, object detection, image captioning, among others. The high performance achieved in those problems make us to think that deep learning models are implicitly learning discriminative descriptions that can then be used in other problems that need to apply an image-vs-image comparison. Indeed, deep-learning based features have showed outperforming behavior in problems like image/ sketch retrieval or signature verification. However, there is still an open problem about how we can learn optimal representations in terms of size and memory memory consumption. Therefore, this project is intended to explore different alternatives to learn optimized deep-learning representations for a variety of applications including; handwriting recognition, signature verification, document spotting, 3D shape retrieval. To achieve the objectives defined in this project we collaborate with teams of France, Brazil, Chile and Perú which cover theoretical issues as well as practical aspects. In addition, one participant of the project is a technology-based Chilean company that develops pattern recognition applications. This allows us to assess the outcomes of our research in real environments related to industrial problems. Besides, this project will give the opportunity to pursue and strengthen the cooperation we have started in SticAmsud 2014.  |

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Laurent Heutte – Université de Rouen - FRANCE

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## GALOP – Graphs Algorithms for Optimization Problems

Abstract

This proposal aims at allowing to continue the fruitful and long-standing collaboration between

Inria and UFC and between Inria and UAI. Another goal is to reinforce the collaboration between

UFC and UAI that has been recently initiated.

Our goal is to study the Computational Complexity of several important problems arising in

networks (routing, resources assignment...). In particular, we will focus on the computation of

metric or structural properties and parameters of large networks (e.g., transportation and social

networks...). We plan to design efficient exact algorithms for solving these problems or to

theoretically prove that such algorithms cannot exist. In the latter case, we will then design

approximation algorithms, or prove that none exists. In all cases, we aim at implementing our

algorithms and use them on real-world instances such as large road networks or huge social

networks.

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## O2ERF – Optimizing energy efficiency in radio frequency communications

Abstract

In this project we will reduce the power consumption of an RF communication system working at several levels in order to achieve a real breakthrough in energy efficiency. As a first level, there is technology. We will use FDSOI for its low leakage current and low variability of the threshold voltage, which enables working with low supply voltages, while maintaining the performance of the analog and digital circuits. This reduction in supply voltage has a direct impact on consumption. We will also reduce power consumption at circuit design level, of each of the system components. In particular, we will rely on current reuse techniques (current reuse) or by working below the conduction threshold of the transistors (subthtreshold) in moderate or low inversion regime. At system level, we will use a low-power technique, called RF power gating, consisting of varying the active time ratio (ATR) of the RF front end at a symbol time scale. This technique is especially well suited for adapting the power consumption of the receiver to the performance needs without changing its architecture.

Institutions and scientific coordinators:

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Sylvain Bourdel – IMPE-LaHC - FRANCE

## OPCD - Outcome Prediction of Complex Diseases and Clinical Pathway Discovery

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| AbstractComplex diseases, such as diabetes, cardiovascular pathologies and cancer, are an important cause of death, in South America as well as in Europe. Such diseases affect several categories ofpopulation, irrespective of age, and can occur at any moment of a person's life. Over the lastdecades, remote monitoring solutions have been developed to supervise patients throughout their daily routines, both at work and at home. Another important issue is the prevention and treatment of Multidrug-Resistant bacterias, that according to WHO will be the main cause of death worldwide by 2050. The multi-resistant bacterias are already prevalent in ICUs frommiddle-income countries, as Brazil and Colombia, but WHO forecasts that it will also be a burden to developed countries in the next years.Moreover, data has become highly valuable for many of companies and organizations. With thedevelopment of advanced data science methods and computer power, extraction of intelligibleknowledge using predictive models has become helpful in decision-making. In healthcare,opportunities are numerous and Machine Learning applications may help to better understand the care pathway of each patient, medical decisions, or the impact of new drugs.In this project we aim at providing a set of tools and methods to take advantage of available data in national health databases in France, Brazil and Colombia to analyze clinical pathway of patients with complex diseases. A scientific challenge lies in the application of process mining and machine learning tools to health data taking into account the special features of the countries involved in the project. Then, two major research axes will be tackled in this project, related to (i) process discovery using process mining applied to these health databases, and (ii) clinical pathway prediction using custom machine learning approaches.Institutions and scientific coordinators: |
| Silvio Hamacher – Pontifical Catholic University of Rio de Janeiro (PUC-Rio), BRAZILJavier Leonardo Gonzalez Rodriguez – Universidad del Rosario – COLOMBIAVincent Augusto – Institut Mines-Télécom – Mines Saint-Etienne (IMT/MSE) – FRANCEEdgar Alfonso – Université Jean Monnet - FRANCE |

## VLmC – Visible Light Mine Communications

Abstract

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| This project aims to strengthen the scientific collaboration around the field of VLC as an enabling technology for future wireless mine communications networks. It is built around multidisciplinary scientific researchers in France, Ecuador and Chile, working on different applications of VLC communications systems such as, high data rate wireless communications networks, indoor positioning and vehicular communications. This project is built around a first kick-off meeting in Ecuador. During the execution of the project, it is expected that student mobility as well as scientific transfer with mining-related and VLC technology development companies such as Codelco, AngloAmerican, Oledcomm and others will be carried out. Dissemination activities to the academic education will be lead as far as possible. A final meeting in Nancy, France is proposed in order to summarize the team results that will be shown in the final report and promote results in a scientific workshop. We also expect to develop further collaboration and joint projects application.

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## WirelessWine – Yield Estimation and Sensor Location for Frost Prediction in Vineyards

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| AbstractVineyard producers have been gathering significant operational information about their fields, and the most advanced estates can produce years of data about how each acre has been planted, irrigated, fertilized, and how the grapes have been maturing. Despite this wealth of operational data, no tool exists today that can efficiently complement and manage this data to (1) provide an accurate yield forecast and (2) predict the destructive effects of frost events.These two points are absolutely critical in the wine production process.Yield Forecasting is the process to estimate the amount of grape production for each section of a field in terms of kilos per unit surface.Recent Machine Learning techniques solve problems that cannot be tackled by standard analytical models nor statistical approaches. *The first goal of WirelessWine is to develop a ready-to-use machine learning-based solution that combines the wealth of operational information from producers, regional weather data, field-level meteorological stations, and additional IoT devices deployed directly inside the field to provide accurate yield forecasting*. One crucial step is to annotate each dataset with features from the other datasets, train the system with those datasets, and in an iterative manner identify the set of features that most contribute to yield forecasting.In the Mendoza region, frost events have caused the 2016 grape production to be 40% lower than that of 2015. Producers can fight a frost event by heating up the field -- typically using burners -, but they have to know the frost event is coming a couple of hours in advance. Weather forecasts at the regional scale, or even meteorological stations at the vineyard level do not provide the measurement accuracy needed to dependably predict frost events, as temperature and humidity varies significantly even within an acre. The PEACH STIC-AmSud project (www.savethepeaches.com, finishing in 2017) has been wildly successful is building a solution based on low-power wireless sensors and machine learning to predict frost events in peach orchards. PEACH gives us a significant head-start, as the sensors and networks solutions can be reused as-is, while the machine learning algorithms are different for each application. Yet, the fruit height, leaf and fruit shape, size and distribution, blooming and harvest time of grapes are completely different from peaches. *The second goal of WirelessWine is to identify, possibly in an* *iterative fashion, the location of the sensors (in the foliage, in the grape, at different heights, etc) that yields the most accurate frost event prediction.*This project builds an interdisciplinary and perfectly complementary team of top experts inagriculture (DHARMa, INTA), low-power wireless IoT (Inria, UDP), and Machine Learning(UTN) researchers. This team of experts works in close collaboration with world-class wineproducers (including Accolade Wines andFundo Centinela) who provide the real-world problems they are facing, and industry partners (including ViLab and Unisource).Project partners come from Argentina, Chile and France, three countries where winemaking is a central part of culture and economy. The close collaboration with winemakers, the pragmaticsolution-oriented approach, and the strong connections with industry are guarantees of the transfer of the technology to the industry, on top of the excellent academic outcome of the project.Institutions and scientific coordinators:Diego Dujovne – Universidad Diego Portales - Escuela de Informática y Telecomunicaciones – Santiago – CHILEGustavo Mercado – Universidad Tecnológica Nacional – Facultad Regional Mendoza – Grupo de ID en Tecnologías de la Información y Comunicaciones (GridTICS) - ARGENTINAThomas Watteyne – Institut National de Recherche en Informatique – FRANCE  |
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