STIC AmSud

2024 call for proposal approved projects

CANARD
Computational Approaches in Neuroscience for Aging and Retinal Neuro Degeneration

Crypto4All
Cryptography for everyone

DORSAL-IoT
Downlink Optimization for Robust Direct-to-Satellite LoRaWAN IoT

ECO-DIST
Energy Efficiency in Distributed Computing

IdNext
Interconnected Digital Identities for Next-Generation Transport Systems

ITERATION-D
IntelligenT mEthods foR enAbling The computIng cOntiNumm for Dsps

Leishmann@IA
Artificial Intelligence-based Spectral Imaging Techniques for Sustainable Development of Remote Communities in Health: Study of Leishmaniasis Skin Ulcers.

Mussasa
Multilingual, structural, and semantic automatic speech analysis in children to support the diagnosis of Impulse Control Disorders

SEEEPIRS
Sustainable, Efficient and Equitable Energy Planning for Industrial and Residential Systems.

CANARD

Computational Approaches in Neuroscience for Aging and Retinal Neuro Degeneration

As the global population ages, the incidence of neurodegenerative diseases is projected to triple by 2050. Developing computational models to enhance mechanistic insights into these diseases is crucial. This proposal focuses on the retina, a promising source of biomarkers for various neurodegenerative conditions, to study the impact of pathological processes on retinal circuits, emphasizing the temporal dynamics of neuronal activity. The Biovision Team at INRIA, France, will use the Macular platform to model cellular degeneration and its effects on the retinal network. The model will be refined with neural data from rodent (degus and mice) retinas and in vivo recordings from feline retinas and LGN. Rodent experiments at the Universidad de Valparaíso, Chile, in collaboration with Pontificia Universidad Católica de Chile, will utilize genetically modified mouse models. Experiments at Instituto do Cérebro-UFRN, Brazil, will develop an Alzheimer's disease model in cats using intraocular injections of betaamyloid oligomers. Building on prior collaborations, we aim to share signal-processing innovations across groups. Our data-informed model is expected to advance diagnostic and therapeutic approaches for neurodegenerative diseases.

Project coordinators

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Crypto4All
Cryptography for everyone

In the last few years there has been a very strong drive toward the generation of new cryptographic protocols for post-quantum cryptography, especially with the first NIST competition for post-quantum scheme completed in 2022 and the call for a second competition for additional signature schemes (with the first round of evaluations currently in progress). Even with the selection process of the NIST candidate ongoing, the interest for possible new candidates (for future applications) remains high.

Among the various sources of post-quantum cryptosystems, three will be of special interest in this project: those based on coding theory (CROSS, LESS, Wave, to name a few) and those based on isogeny computations (in particular the SQIsign scheme and its variants). Each of these provides a whole line of research to be explored.

The groups participating in this project bring different perspectives and experiences in each one of these two lines of research, and the synergy between the different groups would help to bring forward new ideas, techniques, etc.

While post-quantum cryptography is offering possible future cryptosystems, the standard (pre-quantum) systems still offer important advantages until the development of large-scale quantum computing: faster processes and more compact digital signatures, and as such may be preferred for some applications until further developments in quantum computing become available.

These cryptosystems also come with interesting computational problems. One such problem is the generation of (pre-quantum) secure curves, which requires computing the group order of algebraic curves. Recent advances have significantly reduced the computational time for curves of genus 2, and we expect to apply similar ideas for curves of genus 3 and 4.

Project coordinators

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DORSAL-IoT
Downlink Optimization for Robust Direct-to-Satellite LoRaWAN IoT

The DORSAL-IoT project is dedicated to pioneering efficient downlink communication algorithms and protocols within the Direct-to-Satellite IoT (DtS-IoT) landscape, utilizing Low Earth Orbit (LEO) satellite networks. While Long Range Wide Area Network technologies such as LoRa/LoRaWAN are
widely used in today's Internet of Things, their efficiency is yet to be proven in the satellite domain. DORSAL-IoT focuses on optimizing the use of LoRa/LoRaWAN for effective operation within the unique challenges of space. The central ambition of DORSAL-IoT is to develop downlink communication algorithms and protocols that address the constraints of IoT communications in space. This initiative is poised to catalyze advancements in the Non-Terrestrial Networks (NTN) sector, offering innovative solutions for efficiently transmitting data back to Earth in resource-limited satellite environments.

The DORSAL-IoT project proposal focuses on improving downlink communication in Direct-to-Satellite Internet of Things (DtS-IoT) systems, particularly for LoRaWAN-based networks. The key aim is to develop efficient techniques to address challenges in downlink communication, which is crucial for robust data exchanges and remote device operations in DtS-IoT. The project brings together experts from Inria (through the Agora research group) and several Chilean, and Brazilian institutions to leverage their strengths in satellite network operations, medium access control (MAC) layer, Low-Power Wide Area Networks (LPWAN) protocols, physical layer, deterministic routing, energy-aware relay, data compression, and nano-satellite engineering. The first year's activities include system survey, use case identification, requirement definition, downlink design and optimization, and dissemination. The project has a strong potential for academic and industrial impact in areas like asset tracking, remote environmental monitoring, and global data collection.

Project coordinators

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ECO-DIST
Energy Efficiency in Distributed Computing

Designing energy-efficient distributed algorithms has garnered significant interest within the distributed computing community, resulting in a substantial number of publications on this topic in recent years. The primary objective of these works is to develop algorithms that solve fundamental problems in distributed computing while optimizing energy efficiency. The initiative we present here focuses on joint research, underpinning its guidelines with a strong emphasis on collaborative knowledge. In technical terms, the natural way to save energy is to allow each agent of a system the possibility of switching off its communication devices. The state in which the agent is online
is known as the awake state. In the sleeping state, an agent does not receive, listen, or send messages. It is important to note that being idle and just listening consumes nearly as much energy as sending or receiving messages.

In other words, to save energy, agents must be completely offline. This complicates the design of algorithms as messages sent to a node in the sleeping state are lost. Scheduling the rounds in which a node should alternate between sleeping and awake states becomes the central challenge in algorithm design for the sleeping model. We aim to promote student training through research internships and potential co-supervision by team members from different institutions. We intend to merge specialized knowledge to forge significant advancements in the field, leading to top-tier publications.

Project coordinators

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IdNext

Interconnected Digital Identities for Next-Generation Transport Systems

STIC AmSud

With vehicles becoming increasingly connected, urban traffic management faces new challenges. We envision a future where urban transportation is seamless, secure, and sustainable. This project explores advancements in mobile networking, autonomous vehicles, digital identity infrastructure, and blockchain to enhance trust in transport systems. It aims to design a communication framework for transport scenarios based on Self-Sovereign Identity (SSI), creating a resilient Intelligent Transportation Systems (ITS) infrastructure based on mobile networks, particularly in managing blockchain-based digital identities, credential verification, and developing blockchain to provide a trusted execution environment for decentralized applications. The project consists of seven Work Packages (WP): (i) Project Management, (ii) Use Case Definition & Requirements, (iii) ITS services based on SSI, (iv) Network Management for ITS Services, (v) SSI Blockchain for ITS, (vi) Framework Integration, and (vii) Dissemination, Communication & Intellectual Property Management. Thirteen different institutions (UFC, UFABC, UFMG, UNSA, PUJ, EFREI, IMT-TSP, ULR, UNIFESP, UFRN, UFCA, UFRJ, and UENF) from four countries (Brazil, Peru, Colombia, and France) are involved, facilitating a rich exchange of knowledge on the challenges and technologies related to this proposal.

The societal impacts of this endeavor are expected to unfold gradually, offering substantial long-term benefits such as strengthened driver-vehicle links to minimize identity theft and fraud, enhanced transportation safety and privacy, improved emergency response efficiency through automated information sharing post-incident, potential for reduced greenhouse gas emissions, and enhanced environmental sustainability through data-driven traffic management. Additionally, strengthening vehicle identity systems could lead to non-repudiation solutions, reducing fine disputes and improving transportation security and privacy.

Project coordinators

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ITERATION-D

IntelligenT mEthods foR enAbling The computIng cOntiNumm for Dsps

The ITERATIVE-D project is focused on developing intelligent methods for enabling selfadaptive features on distributed data stream processing systems and exploiting edge-cloud continuum to perform online data analytics. The project's primary objective is to enhance decisionmaking in post-disaster scenarios, potentially saving lives and minimizing the impact of natural catastrophes on society. Climate change has severely impacted society's welfare by unrolling more frequent and violent natural catastrophes, affecting broad areas and compromising the welfare of millions of people and public infrastructure. In such scenarios, data stream processing systems are a powerful tool for analyzing real-time data. However, these systems are subject to changing workloads, input rates, and environmental conditions, which can compromise their performance. Therefore, the project aims to develop self-adaptive features that can maintain the system's quality of service even under varying conditions, taking advantage of the integration of the edge-cloud.

The present proposal is based on the expertise of the teams from France, Brazil, and Chile in several complementary areas, including large-scale and mobile distributed computing and algorithms, artificial intelligence, dynamic and heterogeneous systems, real-time stream processing and data analytics, large-scale data management, self-organized systems, and post-disaster information management.

This project involves research in Computer Science: (1) distributed computing infrastructure, (2) real-time data analytics and processing, and (3) artificial intelligence models, all focusing on proving an integrated self-adaptive edge-cloud processing infrastructure for post-disaster scenarios.

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.

Project coordinators

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Artificial Intelligence-based Spectral Imaging Techniques for Sustainable Development of Remote Communities in Health: Study of Leishmaniasis Skin Ulcers.

The United Nations presents 17 goals for the sustainable development of all of us. In goal number 3 “Ensure healthy lives and promote well-being for all at all ages”, the UN indicates that “more efforts are needed to fully eradicate a wide range of diseases and address many different persistent and emerging health issues.” Among the goal’s targets, it is expected to end the epidemics of AIDS,
tuberculosis, malaria, and neglected tropical diseases by 2030. By neglected tropical disease we can find leishmanasis, which affects the inhabitants of remote communities in countries such as Colombia and Peru, and few efforts have been made towards researching novel tools that allow its understanding, diagnosis, and treatment follow-up.

Leishmaniasis is a parasitic disease caused by protozoan parasites of the genus Leishmania. Among its clinical presentations, cutaneous leishmaniasis (CL) is one of the most frequent manifestations. CL can be associated with systemic involvement that increases the risk of death, representing a significant burden of disease due to social stigma, decreased productivity, and psychological suffering. All this is due to the skin ulcers that CL produces on the body. The socioeconomic burden that CL entails has caused a significant loss of healthy life for affected patients; by 2019 the disease was responsible for 293,000 Disability Adjusted Life Years.

This project aims to establish partnerships between Colombia, France, and Peru, in the study of skin ulcers occurring in remote areas, thus promoting sustainable development in the health sector. The aim is to transfer knowledge on artificial intelligence-based techniques, optimizing algorithms for quantifying skin components responsible for the reflectance of light in the visible-near-infrared spectrum. The correlation of these parameters with the diagnosis of ulcers caused by leishmaniasis will be investigated. Also, new techniques for acquisition and image processing will be explored.

Project coordinators

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Mussasa

Multilingual, structural, and semantic automatic speech analysis in children to support the diagnosis of Impulse Control Disorders

Impulse Control Disorders (ICD) describe the mental disorders that share impulsivity as a common symptom. ICD might remain unrecognized by most of the population. Many ICD patients reach adulthood undiagnosed. A delayed diagnosis can have significant implications, especially since ICD can have detrimental consequences for patients, families, and society when there is no proper diagnosis.

ICD diagnosis is challenging because of the scarcity of specialized mental health personnel available in places affected by these mental disorders, as well as the current lack of objective and ecological validity methodology that facilitates the diagnosis of ICD.

Automatic speech analysis (ASA) uses natural language processing (NLP) techniques to build speech representations and measure features that reflect language patterns related to psychosis prognosis. ASA facilitates obtaining results that are relatively immune to the specialist's influence on the patient's results since the presence of syntactic and semantic features of the speech are automatically assessed. Moreover, ASA is non-intrusive and cost-effective, as verbal behavior can be captured remotely without expensive equipment.

Remarkably, current research addressing speech data around ICD focuses on ASA in adults diagnosed with ADHD. Furthermore, only two studies are looking for speech biomarkers to support the diagnosis of a particular mental disorder belonging to the ICD set. To the best of our knowledge, no research addresses the automatic study of speech in children to support the ICD diagnosis.
The Mussasa project aims to propose a methodology based on ASA to model structural and semantic speech biomarkers to support diagnosing children with ICD whose native language is Spanish or French. Our automated approach aims to provide an objective and ecologically valid quantitative methodology. We presume that the Mussasa project's results promote the construction of diagnostic tools in mental health. Therefore, we seek to help mitigate the lack of a specialized mental health workforce. We anticipate that the project's achievement will result in the creation of new international collaborations thanks to joint work and academic mobilizations, co-authored scientific publications, scientific events, support for the development of PhD theses, and a digital presentation (video or brochure/flyer) summarizing the project's results.

Project coordinators

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SEEEPIRS

Sustainable, Efficient and Equitable Energy Planning for Industrial and Residential Systems.

This project develops an optimization framework to explore energy supply strategies for industrial facilities and smart commercial and residential buildings, considering scenarios with high penetration of distributed energy resources (DERs) and the associated uncertainties they bring. At the industrial level, we investigate how companies can leverage a hybrid approach, combining on-site renewable energy generation with traditional grid power, to optimize their energy needs. For commercial and residential levels, we focus on fair energy sharing between the smart building users based on dynamic assignment criteria for the energy self-generated.

This project aims to lay the foundations of decision-support tools that allow industrial managers to plan energy supply efficiently and, for smart buildings, efficiently assign the energy generated on-site. These tools consider the activities required in sustainable production planning, consumption profiles, electricity tariff schemes, and the uncertainty in the data needed for decision-making. The novelty of this project thus relies on two main pillars: (i) the investigation of novel energy supply planning problems under uncertainty and (ii) the development of new mathematical formulations and algorithms to deal with them effectively, i.e., to find good quality solutions in realistic computation times compatible with operational use. Additionally, the project seeks to strengthen existing collaborations between the different institutions and generate new collaborations between the different units, combining forces to produce better results than would have been possible separately.

We consider a work plan over a 24-month divided into 4 work packages: WP1 aims to investigate different mathematical formulations for the problems. In WP2, we will conduct extensive simulations to gain insights into the practical interest of the proposed formulations. WP3 will assess the impact of different models' parameters on the sustainability indicators. In WP4, we will focus on disseminating findings through publications in scientific journals and conferences and through an open workshop to discuss and present the project's contributions. The results in terms of scientific production expected for this work are at least 3 journal articles. We also expect to train advanced human capital in mathematical optimization by collaborative supervision of at least 5 master's undergraduates, 6 Ph.D. students, and 1 post-doctoral assistant throughout the project.

Project coordinators

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