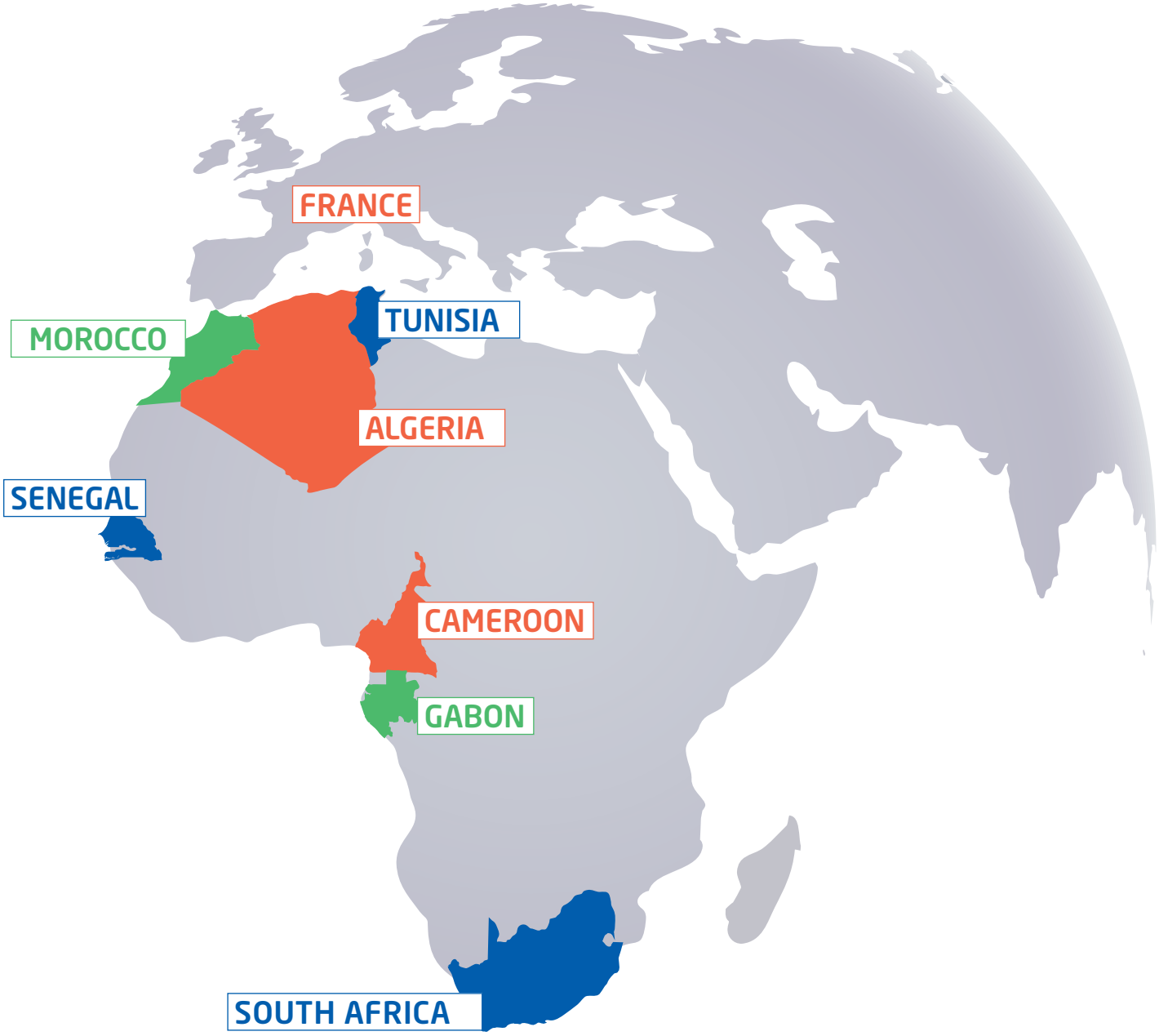
LIRIMA 2017

International Laboratory for Research in Computer Science and Applied Mathematics

inventors for the digital world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LIRIMA: an *Inria International Lab* to strengthen Inria's collaborations with the African continent

LIRIMA, "Laboratoire International de recherche en Informatique et Mathématiques Appliquées", was founded in November 2009 for a period of 5 years by Inria and seven other institutions in sub-Saharan Africa and Maghreb. A new Agreement, signed in 2015, creates the **Inria International Lab "LIRIMA"** for a period of 4 years. The headquarters, based at the University Yaounde I during the period 2010-2014, are hosted by the University Gaston Berger, Saint Louis, Senegal since 2015.

LIRIMA keeps and strengthens its objectives: to produce research at the highest international quality in computer science and mathematics ; to develop an active and structured partnership between the partners of this agreement, in particular through training and the supervision of students ; to contribute to economic and social development in Africa.

LIRIMA remains open to new French and African partners, and also to the creation of new project-teams, selected through the Inria Associate Teams Programme.

PARTNERS INSTITUTIONS

Inria
Gaston Berger University, Saint-Louis, Senegal - *Headquarters of LIRIMA*
University of Yaounde I, Cameroon
Stellenbosch University, South Africa
University of Science and Technology of Masuku, Franceville, Gabon
Ministry of Higher Education and Scientific Research (MESRS-DGRSDT), Algeria
National Centre for Scientific and Technical Research (CNRST), Morocco
Ministry of Higher Education and Scientific Research (MESRS), Tunisia

A word **from the directors ...**

LIRIMA is the **Inria International Laboratory** in Africa. It aims to amplify and structure the collaborations between Inria and its African partners.
New teams would be able to join LIRIMA each year through Inria Associate Teams program.
According to this program, a proposal should follow the following guidelines:

- This is a collaboration driven by an Inria team and a partner team in Africa with a program developed jointly by an African leader and his/her Inria counterpart ;
- This program should be focused on a specific topic with short and medium-term goals (three years, renewable once) and builds on a small team of 2 to 4 permanent researchers from each side together with some PhD students and post-docs ;
- The proposal should focus on the training of young researchers: it is desirable to involve PhD students on both sides or at least to include co-supervised theses.

It is expected that these teams be an opportunity for young researchers to access responsibilities.

We let you discover the main research topics of LIRIMA teams including the 3 new teams: AGRINET, EPITAG and FAST
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Prof. Moussa Lo
UGB Saint-Louis

Dr. Éric Badouel
Inria

The research teams in brief ...

AGRINET

Smart agriculture monitoring

Efficient farming is not possible without relevant and up to date information regarding plant stress, imminent disease, harvest time prognosis and many others. During the last 6-8 years, techniques to implement flexible and adaptive sensor networks have seen major development with excellent application possibilities.
The Agrinet team proposes the development, practical deployment and evaluation of an advanced, self-configuring wireless sensor network (WSN) to support such a data acquisition system, as an important input to precision farming in general and to apply it for viticultural use and potato crops. The system is intended to provide real time, distributed, frequently updated parameter values, at many freely selected vineyard and field locations. This information could be used to monitor a range of vineyard and other crop conditions such as soil water or potassium content.
It is also proposed that the field data acquired by the system be utilised as input to advanced pattern recognition and machine learning techniques, forming a powerful tool to assist with automatic identification of plant health, crop- and environmental conditions. We propose to deploy real pilots to validate the proof of concept of our solution in France and South Africa.


AGRINET team leaders: on the left Riaan Wolhüter and on the right Nathalie Mitton

■ Stellenbosch University, South Africa

Team leader: Riaan Wolhüter

Inria co-team leader: Nathalie Mitton

Inria research team: FUN (Lille - Nord Europe)

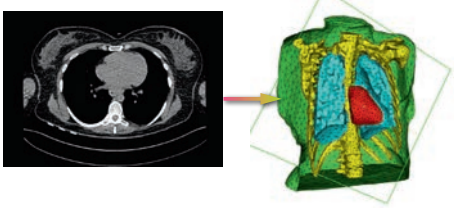
EPICARD

InversE Problems In CARDiac electrophysiology


EPICARD team leaders: on the left Nabil Gmati and on the right Nejib Zemzemi

Improving the information that can be extracted from electrical signals measured on patients with heart diseases is a major priority for the IHU LIRYC in Bordeaux, headed by Professor Michel Haissaguerre. From measurements of the electrical potential on the chest of the patient, the electrical potential on the heart surface can be non-invasively constructed. This helps the medical doctor to visualise an image of the electrical potential of the heart of the patient. It is known that the methods, that have been used in the literature for solving this electrocardiography imaging (ECGI) problem, including those used in commercial medical devices, have several limitations. This problem could be mathematically seen as a boundary data completion problem for elliptic equations. Many works in the literature have been carried out in order to solve this Cauchy problem, but have never been used for solving the ECGI problem.

This project-team aims at developping an experimental platform allowing to test various methods and compare their performance on real life experimental data.



Medical images segmentation (left) and generation of computational meshes (right). The CT- scans are for a 43 years old women and are provided by the CHU-Bordeaux.

■ University Tunis El Manar, ENIT/LAMSIN, Tunisia

Team leader: Nabil Gmati

Co-team leader Inria: Nejib Zemzemi

Inria research team: CARMEN (Bordeaux – Sud-Ouest)

EPITAG

EPIdemiological modelling and control for Tropical AGriculture

EPITAG team leaders: on the left Samuel Bowong and on the right Suzanne Touzeau

Pests and pathogens are responsible for considerable losses in food and cash crops. Their control is hence a major issue, especially in coutries such as Cameroon, where agriculture is an important sector in terms of revenues and employment. To help design efficient strategies for integrated pest management, mathematical models are particularly relevant.

Our main objective is to study the epidemiology and management of tropical crop diseases, with a focus on Cameroon and Sub-Saharan Africa. Our approach consists in developing and analysing dynamical models describing plant-parasite interactions, in order to better understand, predict and control the evolution of damages in crops.

To ensure the relevance of our models, «end users» are closely associated. We focus on three pathosystems: cocoa plant mirids, coffee berry borers and plantain plant-parasitic nematodes.

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■ University of Douala, Cameroon

Team leader: Samuel Bowong

Inria co-team leader: Suzanne Touzeau

Inria research team: BIOCORE (Sophia Antipolis - Méditerranée)

FAST

(Harder Better) FAster STronger cryptography

The objective of FAST team is to develop new cryptographic tools to tackle the new challenge arising in order to achieve secure communications.

FAST Team Leaders
On the left Tony Ezome and on the right Damien Robert

The first challenge is the rise of connected devices (the Internet of Things). These devices offer tremendous development opportunities, in particular in Africa; but they can only be used if they are secure. Their lack of memory and computing power makes any cryptographic computation very hard. The lack of security of these devices (like webcam) has already been used to mount very large denial of service attacks. In case of a cyberwar these objects could probably compromise the internet infrastructure of whole countries. The FAST team will improve algorithms on elliptic curve (which already are the fastest and more compact cryptosystems currently used) to better take into account the specific constraints of these devices. We will also use abelian varieties of greater dimension to be able to gain a factor two in the size of the base field.

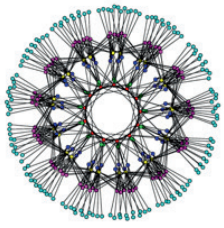
The second challenge is the ongoing development of quantum computers, which would compromise all of classical cryptography. The team will study new protocols based on the isogeny graphs of supersingular elliptic curves which are quantum resistant. The drawback of this new protocol (like the others quantum-resistant protocols) is that it takes considerably more time and memory than the classical one. We will improve these isogenies computations by studying the corresponding moduli spaces. Even if quantum computers are not there yet, for long term secret (like military ones), we already need to be prepared.

■ University of Franceville, Gabon

Team leader: Tony Ezome

Co-team leader Inria : Damien Robert

Inria research team: LFANT (Bordeaux - Sud-Ouest)



Graph of isogenies of abelian surfaces

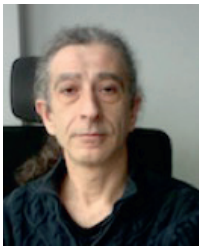
IoT4D

Internet of Things for Developping countries

The Internet of Things for developing countries (DC) research team (IoT4D) works on the integration of emerging technologies with footprint process in African countries.

In fact, the DC environment is by itself a research challenge for connected objects : high temperature or humidity in the tropical and equatorial zones, lack of high speed communication network access, for example, does not alleviate the deployment of a wireless sensor networks in the city or country-wide.

IoT4D will first experiment the interconnection of Internet of Things with the wired Internet. The goal is to allow IoT networks to be easily deployed with an acceptable quality of service.



IoT4D Team Leaders
On the left Thomas Djotio and on the right Emmanuel Nataf

■ University of Yaoundé I, Cameroon

Team leader: Thomas Djotio Ndie

Co-team leader Inria: Emmanuel Nataf

Inria research team: MADYNES (Nancy – Grand Est)

MOHA

Mixed Multi-objective Optimization using Hybrid Algorithms

MOHA Team Leaders
On the left Rachid Ellaia and on the right El-Ghazali Talbi

With the smart grid revolution, house energy consumption will play a significant role in the energy system. The challenge of the mixed multi-objective household energy management problem is to control electrical appliances based on a user's operational information in order to minimize the electrical energy cost for the consumer and to maximize its satisfaction.

MOHA proposes a home automation system that can monitor appliance scheduling in order to simultaneously optimize the total energy cost and the customer satisfaction. The key challenge of this project is to propose new optimization models and new hybrid algorithms to the demand side management of smart grids in a context of uncertainty and in the presence of several conflicting objectives. Those complex optimization problems are also characterized by the presence of both continuous and discrete variables.

Moreover, the model will integrate some uncertainties in the data, so robust solutions, that are not sensitive to those uncertainties, must be found.

Production and consumption optimization in smart grids

■ EMI, Rabat, Morocco

Team leader: Rachid Ellaia

Co-team leader Inria : El-Ghazali Talbi

Inria research team: DOLPHIN (Lille - Nord Europe)

MoReWAIS

Mobile Read Write Access and Intermittent to Semantic Web

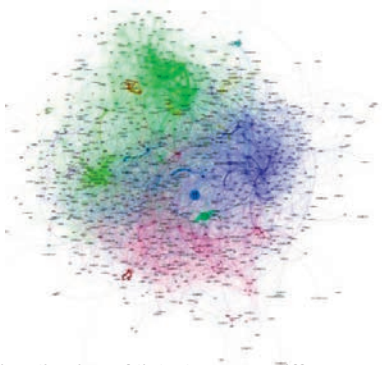

MoReWAIS Team Leaders
On the left Moussa Lo and on the right Fabien Gandon

Knowledge sharing solutions must take into account local realities, especially regarding access to ICTs. So, it seems interesting to study how to develop and use mobile services to enhance access to social semantic web applications in general and to knowledge sharing platform in particular.

MoReWAIS proposes to explore the specificities of mobile knowledge sharing. The mobile application targeted in MoReWAIS must allow communities and their users to enrich and access more easily the knowledge base using the user's context with its richness and addressing its limitations.

The project will design and develop algorithms, methods and tools for mobile devices allowing users to: **(1)** Co-construct locally and on the road the Semantic Web of Data RDF triple stores representing the sociocultural shared knowledge ; **(2)** Access and visualize in context relevant data from the knowledge platform. This requires a complete rethinking of RDF storage and SPARQL querying in a mobile and unreliable network environment.

This will also require dedicated interaction design to ease and encourage access and contribution.



Visualization of links between different themes in a related data network

■ University Gaston Berger, Saint-Louis, Senegal

Team leader: Moussa Lo

Co-team leader Inria: Fabien Gandon

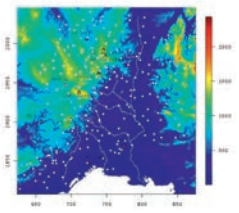
Inria research team: WIMMICS (Sophia Antipolis - Méditerranée)

SIMERGE

Statistical Inference for the Management of Extreme Risks and Global Epidemiology


SIMERGE Team Leaders
On the left Abdou Ka Diongue and on the right Stéphane Girard

SIMERGE is based on two research themes : **(1)** Spatial extremes, application to management of extreme risks : the team investigates the estimation of risk measures making heavy use of the extreme-value theory by focussing both on the cases of spectral and distortion risk measures. SIMERGE also aims at proposing estimators of such extreme risk measures able to deal with covariates ; **(2)** Classification, application to global epidemiology : this work is based on the use of mixture models for classification. The team uses parsimonious multinomial probability distributions to model each class of the mixture. In the verbal autopsy context, the simplest way to achieve parsimony is to assume conditional independence of the symptoms given the cause-of-death. SIMERGE also adapts the classical Gaussian mixture model to binary data thanks to the introduction of a kernel function.



Map of the Cévennes-Vivarais region (France), horizontally: longitude (km), vertically: latitude (km), the color scale represents the altitude (m), the white dots represent some raingauge stations

■ University Gaston Berger / LERSTAD, Saint-Louis, Senegal

Team leader: Abdou Kâ Diongue

Co-team leader Inria: Stéphane Girard

Inria research team: MISTIS (Grenoble – Rhône-Alpes)

For more information
http://lirima.inria.fr/en/

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