



**Offer #2024-08275**

## **Internship: Towards expressive and tractable surrogate models for large scale inverse problems**

**Level of qualifications required** : Master's or equivalent

**Fonction** : Internship Research

### **About the research centre or Inria department**

The Centre Inria de l'Université de Grenoble groups together almost 600 people in 23 research teams and 9 research support departments.

Staff is present on three campuses in Grenoble, in close collaboration with other research and higher education institutions (Université Grenoble Alpes, CNRS, CEA, INRAE, ...), but also with key economic players in the area.

The Centre Inria de l'Université Grenoble Alpe is active in the fields of high-performance computing, verification and embedded systems, modeling of the environment at multiple levels, and data science and artificial intelligence. The center is a top-level scientific institute with an extensive network of international collaborations in Europe and the rest of the world.

### **Context**

This internship will be done within an ongoing collaboration between Statify Inria team, Ipag laboratory (UGA), and Inria's software development service.

Recently Inria's Statify research team has developed a scientific library based on the so-called xLLiM (Gaussian Locally-Linear Mapping) model, whose target is the resolution of Bayesian inverse problems using physical direct models and simulations from them (<https://gitlab.inria.fr/kernelo-mistis/kernelo-gllim-is>). In the current implementation, the model is learned from training data using a batch implementation requiring to upload all data into memory, which can limit its use to moderate volumes of data. In terms of expressiveness, the current parameterization is tailored for real-valued data and assumes only two options for the noise part of the model.

Contact: in addition to the application to the platform, more information can be requested by contacting [florence.forbes@inria.fr](mailto:florence.forbes@inria.fr), [sylvain.doute@univ-grenoble-alpes.fr](mailto:sylvain.doute@univ-grenoble-alpes.fr), [stan.borkowski@inria.fr](mailto:stan.borkowski@inria.fr), [luc.meyer@inria.fr](mailto:luc.meyer@inria.fr)

### **Assignment**

The goal of this internship is to extend the approach with three new functionalities, namely:

- Implementation of an incremental learning of the model parameters to allow reading the data sequentially and going beyond hardware limitations,
- Extension of the noise modelling to parsimonious parametrization by introducing an additional latent component,
- Reformulate the model with complex-valued Gaussian distributions to handle complex valued data.

These improvements should be implemented efficiently in C++ and binded to python.

These functionalities will have to be developed and then implemented in the current GLLiM framework (xLLiM toolbox and application PlanetGLLiM). Validation analyses of the resulting new procedures will have to be conducted, assessing their efficiency, accuracy, and scalability. The goal is to test and improve the performance of the GLLiM model in two specific domains: space remote sensing in high-dimensional settings, and medical imaging analysis, with a particular emphasis on Magnetic Resonance Imaging (MRI).

### **Main activities**

- Mathematical formulation of one or more extensions for the GLLiM method
- Implementation of the extensions in Python and in C++
- Performing tests and benchmarks
- Integrating your code into the existing xLLiM code base
- Testing for non-regression of xLLiM and PlanetGLLiM
- Writing documentation

## Skills

- Good programming skills in C++ and Python
- Familiarity with probability & statistics, eg. Gaussian mixtures, EM algorithm, Bayesian models
- Solid understanding of mathematics, especially linear algebra and optimization.
- Experience with Github, GitLab, CI, Docker
- Analytical and modeling skills: writing specifications, requirement documents, and user documentation

## Benefits package

- - Subsidized meals
  - Partial reimbursement of public transport costs
  - Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
  - Possibility of teleworking (90 days / year) and flexible organization of working hours
  - Social, cultural and sports events and activities
  - Access to vocational training
  - Social security coverage under conditions

## Remuneration

Gratification = 4,35 € gross / hour

## General Information

- **Theme/Domain** : Optimization, machine learning and statistical methods  
Biologie et santé, Sciences de la vie et de la terre (BAP E)
- **Town/city** : Montbonnot
- **Inria Center** : [Centre Inria de l'Université Grenoble Alpes](#)
- **Starting date** : 2025-02-03
- **Duration of contract** : 6 months
- **Deadline to apply** : 2025-12-01

## Contacts

- **Inria Team** : [STATIFY](#) (DGD-I)
- **Recruiter** :  
Borkowski Stanislaw / [stan.borkowski@inria.fr](mailto:stan.borkowski@inria.fr)

## About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

## The keys to success

Essential qualities in order to fulfil this assignment are:

- Currently pursuing a M2 degree in computer science, applied mathematics, or a related field.
- Solid experience in scientific computing and statistical modeling
- Strong proficiency in software development
- Comfortable in a scientific environment, eager to learn and listen
- Good listening skills and strong interpersonal abilities
- Sense of initiative and responsibility
- Being rigorous and well-organized
- Strong problem-solving skills and the ability to work both independently and in a collaborative team environment.

**Warning** : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

## Instruction to apply

CV + letter

**Defence Security :**

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

**Recruitment Policy :**

As part of its diversity policy, all Inria positions are accessible to people with disabilities.