



**Offer #2019-01677**

## **PhD Position F/M - From measures to model : inferring causal states and their relations**

**Contract type :** Fixed-term contract

**Level of qualifications required :** Graduate degree or equivalent

**Fonction :** PhD Position

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

The GeoStat project makes fundamental and applied research on new non linear methods for the analysis of complex signals and systems, using paradigms and tools coming from statistical physics.

### **Context**

This PhD is supervised by Nicolas Brodu (Geostat team, Inria Bordeaux). Short stays are planned at the University of California, Davis, for collaboration with the team of James P. Crutchfield (Complexity Sciences Center). Attending multidisciplinary summer schools will be encouraged

### **Assignment**

#### **Scientific context**

The context of this PhD is modeling physical systems, starting from measured data and accounting for their dynamics [1]. The idea is to statistically describe the evolution of a system in terms of causally-equivalent states; states that lead to the same predictions [2]. Transitions between these states can be reconstructed from data, leading to a theoretically-optimal predictive model [3]. In practice, however, no algorithm is currently able to reconstruct these models from data in a reasonable time and without substantial discrete approximations. Recent progress now allows a continuous formulation of predictive causal models. Within this framework, more efficient algorithms may be found. The broadened class of predictive models promises a new perspective on structural complexity in many applications.

#### **PhD objectives**

The goal is to explore this new class of continuous models. These can be formulated as stochastic differential equations, but in the functional space of causal states. In addition, observed data are often acquired at their own sampling rate, which may differ greatly from the characteristic scale of the original physical processes. A second goal is to ensure consistency between renormalized versions of the model at different scales. A last objective is to validate the new models on real data. This part will be done in collaboration with disciplinary specialists.

[1] James P. Crutchfield, "Between order and chaos". Nature Physics vol 8, p17-24, 2012.

[2] Nicolas Brodu, "Reconstruction of epsilon-machines in predictive frameworks and decisional states". Advances in Complex Systems 14(5), p761-794, 2011.

[3] Cosma R. Shalizi, Kristina L. Klinkner, Robert Haslinger. "Quantifying self-organization with optimal predictors". Physical Review Letters, 93:118701, 2004.

### **Main activities**

Depending on her/his skills, own interests and ideas, the candidate shall participate on some or all the aspects of this project:

- Theory : the properties of stochastic processes describing the evolution of causal states ;
- Algorithmic : how to best estimate the model from data ;
- Applications : validating the model on real data, in collaboration with disciplinary experts on these data.

In any case, it is expected that the candidate is highly motivated by the general context of this PhD proposal.

### **Skills**

Prior experience in physics, scientific data analysis or modeling will be strongly appreciated. Being autonomous with scientific programming is required. It is necessary to be fluent in English. Learning French is not required for working at Inria, but greatly facilitates daily life outside the institute.

## Benefits package

- Subsidized meals (restaurant on site)
- Discount on public transportation
- Possibility of teleworking (after 6 months of employment) and organisation of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc).
- Social, cultural and sports events and activities (Inria Social Work Management Association)
- Access to vocational training
- Social Security

## Remuneration

- 1982€ / month (before taxes) during the first 2 years
- 2085€ / month (before taxes) during the third year

**Note :** Taxes are based on your personal and family situation.

## General Information

- **Theme/Domain :** Stochastic approaches
- **Town/city :** Talence
- **Inria Center :** [Centre Inria de l'université de Bordeaux](#)
- **Starting date :** 2019-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2019-06-30

## Contacts

- **Inria Team :** [GEOSTAT](#)
- **PhD Supervisor :**  
Brodu Nicolas / [nicolas.brodu@inria.fr](mailto:nicolas.brodu@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.

**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

Thank you to send :

- CV
- Cover letter
- Master degree grade and ranking
- Support letter(s)

### **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.