



## Job vacancy #2023-05909

### Post-Doctoral Research Visit F/M Causal discovery of extended summary causal graphs for noisy-OR models of event sequences

**Contract type :** Fixed-term contract

**Renewable contract :** Yes

**Level of qualifications required :** PhD or equivalent

**Fonction :** Post-Doctoral Research Visit

#### About the research centre or Inria department

The Centre Inria de l'Université de Grenoble groups together almost 600 people in 22 research teams and 7 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

The work will be in collaboration with Nokia Bell Labs and the LIG laboratory, Grenoble. It will take place at Inria Univ. Grenoble Alpes, Montbonnot, France, with frequent travels to Nokia Bell Labs, Massy, France.

#### Assignment

**Context.** Networks such as modern telecommunications networks or distributed embedded systems are permanently monitored to allow identification of failure situations; thousands of new data points reflecting the system state changes are generated every minute. Even if faults are rare events, they can easily propagate driven by local and remote dependencies, which makes it challenging to distinguish causes from effects among the thousands of highly correlated alerts.

A timely automated identification and root cause analysis (RCA) of the origins of performance issues allows executing the most adequate corrective actions and preventing their further propagation. In general, RCA is a hard problem, because it requires a deep knowledge of cause-effect dependencies among many features, physical and logical components the network nodes. In a data driven approach, where most of this knowledge is unavailable a priori, a major difficulty emanates from hidden or unknown variables. Furthermore, even in a fully observable system we are faced with the combinatorial explosion of potential cause-effect dependencies and the difficulty to collect enough information for distinguishing causality from spurious correlations.

**Goals.** The objective of this project is to develop methods to infer causal graphs from observational time series/event-type data generated according to generic noisy-OR models [1]. The causal graphs considered can either be full window causal graphs or a summarized version as extended summary causal graphs [2] and may contain or not hidden common causes. Generic noisy-OR models are structural causal models (SCM) with noisy-OR gates which allow to estimate the effect of multiple causes even if they have never been observed together. We will consider here both simple noisy-OR models in which the noisy-OR gates directly define the SCM, and complex ones in which the noisy-OR gates are sub-parts of an underlying SCM.

#### References

[1] L. Jakovljevic, D. Kostadinov, A. Aghasaryan, T. Palpanas. Towards building a digital twin of complex systems using causal modelling. *Complex Networks*, 2021.

[2] C. K. Assaad, E. Devijver, E. Gaussier. Discovery of extended summary graphs in time series. *Uncertainty in Artificial Intelligence*, 2022.

## Main activities

We will first focus on the situation with no hidden common causes and will explore methods to infer extended summary causal graphs both with simple and complex noisy-OR models. In the latter case, we will postulate different underlying SCMs which will have to be both plausible and inferable. Among the discovery methods, we want to consider constraint-based, noise-based and score-based methods, which may be applicable to complex noisy-OR models with underlying probabilistic models, as well as methods based on algorithmic information theory. In a second step, we will study the situation with hidden common causes and explore how to adapt the methods developed in the first step.

## Skills

Candidates should be pursuing internationally recognized research in ML/AI, or Information Theory with a strong interest in causal inference and causal reasoning.

## 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 (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

## Remuneration

Monthly gross salary : 2 788 euros per month before income taxes

## General Information

- **Theme/Domain** : Optimization, machine learning and statistical methods
- **Town/city** : Grenoble
- **Inria Center** : [Centre Inria de l'Université Grenoble Alpes](#)
- **Starting date** : 2023-10-01
- **Duration of contract** : 1 year
- **Deadline to apply** : 2023-10-31

## Contacts

- **Inria Team** : [SPADES](#)
- **Recruiter** :  
Goessler Gregor / [gregor.goessler@inria.fr](mailto:gregor.goessler@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

### 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.

