Offer #2024-07262

Post-Doctoral Research Visit F/M Control theory methods for epidemiological systems

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Inria University of Lille centre, created in 2008, employs 360 people including 305 scientists in 15 research teams. Recognised for its strong involvement in the socio-economic development of the Hauts-De-France region, the Inria University of Lille centre pursues a close relationship with large companies and SMEs. By promoting synergies between researchers and industrialists, Inria participates in the transfer of skills and expertise in digital technologies and provides access to the best European and international research for the benefit of innovation and companies, particularly in the region.

For more than 10 years, the Inria University of Lille centre has been located at the heart of Lille's university and scientific ecosystem, as well as at the heart of Frenchtech, with a technology showroom based on Avenue de Bretagne in Lille, on the EuraTechnologies site of economic excellence dedicated to information and communication technologies (ICT).

Context

About the Inria center at the University of Lille

The Inria center at the University of Lille, created in 2008, is based on two sites: one on the University of Lille campus at La Haute-Borne and one in the midst of the EuraTechnologies entrepreneurial ecosystem.

The Inria center at the University of Lille has 15 project teams. Its activities occupy over 360 people, scientists and research and innovation support staff, including 38 different nationalities. Its scientific priority areas are data science, Software engineering, and cyber-physical systems.

About the VALSE team

The VALSE team studies the problems arising in analyzing distributed, uncertain, and interconnected dynamical systems with the design of estimation and control algorithms using the concepts of finite-time/fixed-time/hyper exponential convergence and stability. The main idea is to separate and hierarchize, in time, space-distributed control, and estimation processes, greatly simplifying their analysis and the design for large-scale solutions.
For additional information on the VALSE team, please see https://team.inria.fr/valse/

This is a postdoc within the ANR project [NOCIME.](NOCIME)

Assignment

Emerging and re-emerging diseases are a continuous threat to our planet. This menace has grown over the last decades, leading to serious public health issues, significant mortality, and financial expenses, as the COVID-19 pandemic has shown. Various phenomena, such as urbanization and globalization, might explain this escalation.

Many mathematical models are already used to describe the transmission of an epidemic. However, the methods of automatic control theory are still not widespread in epidemiologic studies. The ANR NOCIME project aims to solve novel, broadly defined control theory problems connected to optimal control and the observation/identification of epidemiological dynamics, which demonstrate many challenging features.

In particular, fundamental properties of the system, namely identifiability, and observability, are generally required so that parameter estimation and observer design techniques can then be implemented, with a global guarantee of convergenceon the domain, or guaranteed upper and lower estimates. Many epidemiological models exhibit several equilibria: all disease-free states are equilibrium points when births and deaths are neglected, which is appropriate at the outbreak time scale. These equilibria are often singular points of the identifiability and observability maps:

no information on the disease parameters and susceptible proportion can be inferred in the absence of infected individuals.

Assuming that observability (or identifiability) conditions and related sets are settled, the design of related estimators follows. Different types of observers will be developed, such as nonlinear or adaptive observers [1], [2] and interval observers [3], [4].

Bibliographical references

[1] M. Fang, P.-A. Bliman, D. Efimov, R. Ushirobira, Nonlinear Adaptive Observers for an SIS System Counting Primo-infections, IFAC 2023.

[2] N. Cunnife, F. Hamelin, A. Iggidr, A. Rapaport, and G. Sallet. Observability, identifiability, and epidemiology - a primer. Springer Briefs series in mathematics, 2023 (to appear)

[3] D. Efimov and R. Ushirobira. On an interval prediction of COVID-19 development based on a SEIR epidemic model. Annual Reviews in Control, 51:477–487, 2021

[4] T. Raïssi and D. Efimov. Some recent results on the design and implementation of interval observers for uncertain systems. Automatisierungstechnik, 66(3):213–224, 2018.

Main activities

The postdoctoral job will first study the observability and identifiability of several epidemiological models and develop specific (analytic and numerical) tools adapted for these kinds of nonlinear models. The question of observer synthesis will be addressed in a second step with different techniques. Finally, using observers with the control laws developed in the project (particularly optimal controls) will be a matter of investigation.

The young researcher will be expected to exchange with the NOCIME project's other partners based in Paris, Metz, and Montpellier.

Skills

Skills and profile

- PhD in Mathematics or Applied Mathematics in Automatic Control
- A strong background in the observation and identification of dynamic systems
- A background in Matlab programming will be an advantage
- Interest in epidemiological questions

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 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

2 788€ gross per month

General Information

- **Theme/Domain :** Optimization and control of dynamic systems
- **Town/city :** Villeneuve d'Ascq
- **Inria Center :** Centre Inria de l'Université de Lille
- **Starting date :** 2024-10-01
- **Duration of contract :** 2 years
- **Deadline to apply :** 2024-06-30

Contacts

- **Inria Team** : VALSE
- **Recruiter** :
  Ushirobira Rosane / Rosane.Ushirobira@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

CV + Cover 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.