2023-06492 - Post-Doctoral Research Visit F/M
Calibration of epidemic models on graphs with Optimal Transport and derivative-free optimization

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 Research Centre of the University of Lille was founded in 2008 and employs a staff of 320, including 280 scientists working in fifteen research teams. Recognised for its outstanding contribution to the socio-economic development of the Hauts-de-France region, the Inria Research Centre of the University of Lille undertakes research in the field of computer science in collaboration with a range of academic, institutional and industrial partners.

The strategy of the Centre is to develop an internationally renowned centre of excellence with a significant impact on the City of Lille and its surrounding area. It works to achieve this by pursuing a range of ambitious research projects in such fields of computer science as the intelligence of data and adaptive software systems. Building on the synergies between research and industry, Inria is a major contributor to skills and technology transfer in the field of computer science.

Context
This project is part of an ongoing collaboration between the team Inria RAPSODI and the team INRAE DYNAMO (BIOEPAR unit, INRAE, Oniris, Nantes) and funded by the IMPT (Institut des Mathématiques pour la Planète Terre).

The team RAPSODI specializes on the design, the analysis, and the efficient implementation of numerical schemes for dissipative models arising in physics or biology. The successful candidate will benefit from the expertise of the team on a wide range of subjects in numerical analysis and scientific computing.

The INRAE team DYNAMO specializes on modelling and inference for animal epidemiology. Several research visits to this team will be organized, and will be funded by the project.

Assignment
Background
Predicting the spread of a pathogen in an animal population is an important task, which can have a profound economical and societal impact, but it is also challenging, mainly because it entails the simulation of a complex system composed by multi interacting individuals subject to both an infection and a spatial dynamics. This is often achieved by means of multi-agent simulations, in which each agent may represent one single animal (or a group of animals), the infection dynamics is described by a compartmental model, and the spatial dynamics is determined by time-dependent trade routes or neighboring contacts, that can be represented by graph layers. Due to the model complexity, state-of-the-art inference methods to determine unknown parameters in this context often rely on extensive manipulations of the model outputs to match simulated results with measurements, which limits their robustness and reliability.

Objectives
This project aims at developing numerical methods to compare epidemic scenarios, that exploit the structure of the model itself, and use these to construct robust calibration techniques via minimum discrepancy estimators. We will achieve this by designing optimal transport problems to measure the discrepancy between data and model outputs, that take into account explicitly the main features of both the infection and the spatial dynamics, and propose efficient methods to compute them using modern derivative-free optimization algorithms.

Main activities
The candidate will be involved in the design of a novel inference framework for the calibration of epidemiological models on graphs, using optimal transport distances. The main focus will be analysing the proposed inference methodology in comparison to more classical approaches, its implementation via efficient optimization algorithms and its validation using both synthetic and real test cases.

Skills
- The successful candidate will hold a PhD in Applied Mathematics with emphasis on numerical analysis/scientific computing.
- Research experience in numerical optimization and statistical inference will be appreciated.

Instruction to apply
CV + application 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
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

Gross monthly salary (before taxes): 2 746 €