Offer #2024-07864

PhD Position F/M Bayesian optimal sensor placement using model gradients: a majorize-then-optimize strategy

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Level of experience : Recently graduated

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 8 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 Alpes 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 PhD thesis will take place at the Université Grenoble Alpes in the Inria-AIRSEA team. This project is funded by Numpex, the French exascale supercomputing program (https://numpex.org/). Scientific collaboration with fellow academics from Numpex is anticipated.

Assignment

Bayesian optimal sensor placement is critical in various applications, particularly in scenarios where data acquisition is expensive (satelite observation, buoys in the ocean, underground drill etc). The primary challenge lies in determining the optimal locations where to observe the system in order to best inference a specific parameter of interest. While linear models and Gaussian priors are well-understood and relatively straightforward to handle, the problem becomes significantly more complex when dealing with models that are numerically costly to evaluate. This is especially true for large-scale, nonlinear and nonGaussian systems for which evaluating the numerical model is prohibitively expensive.

Recently, a gradient-based approach has been proposed to alleviate this computational burden. The strategy behind this approach is to minimize a bound of the so-called Expected Information Gain (EIG), which is relatively easy to work with, rather than minimizing the EIG itself. In principle, this bound serves as a surrogate for the EIG which providing a computationally favorable way to guide the sensor placement. This is because the error-bound can be evaluated and optimized much more efficiently than the actual error, which requires numerous expensive numerical simulations of the numerical model.

The objective of this project is to address various numerical aspects associated with the gradient-based solution for the Bayesian optimal sensor placement problem. The project has three main goals:

- Firstly, we seek to enhance our understanding of the majorize-then-minimize approach used in the gradient-based solution. We will achieve this by comparing the solutions obtained from the bound-based approach with those obtained from the conventional EIG-based approach. Ultimately, we hope to use the bound-based approach as a preconditioning step for the EIG-based solution to improve its accuracy.
- Secondly, we will employ randomized linear algebra methods to accelerate the computation of the bound which, in the high-dimensional setting, can still be quite expensive to compute. This will help to improve the computational efficiency of the gradient-based approach, making it more practical for large-scale systems.
- Finally, we will address the challenge of incorporating physical constraints into the sensor placement problem. Specifically, we will investigate how to take into account the constraints (physical/technical/financial) on the way the system can be observed, in order to obtain more realistic and practical sensor placement solutions.

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

Remuneration

1st and 2nd year: 2100 euros gross salary /month

3rd year: 2190 euros gross salary / month

General Information

- **Theme/Domain :** Earth, Environmental and Energy Sciences
  Scientific computing (BAP E)
- **Town/city :** Montbonnot
- **Inria Center :** Centre Inria de l'Université Grenoble Alpes
- **Starting date :** 2024-09-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2024-07-20

Contacts

- **Inria Team :** AIRSEA
- **PhD Supervisor :**
  Zahm Olivier / olivier.zahm@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

This PhD project lies at the intersection of Computer Science and Uncertainty Quantification. Candidates must possess strong knowledge in at least one of these fields and be motivated to quickly implement numerical applications. The research will involve both theoretical developments and practical coding. Candidates should demonstrate experience and skills in several of the following areas: scientific creativity, autonomy, writing abilities, oral communication skills (in English, and possibly French), and a passion for teamwork. The balance between theoretical and applied work can be adjusted according to the candidate's preferences.

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

Applications must be submitted online via the Inria website. Processing of applications submitted via other channels is not guaranteed.

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.