Offer #2023-06906

Post-Doctoral Research Visit F/M Interacting particle systems for optimization and sampling

Contract type: Fixed-term contract
Renewable contract: Yes
Level of qualifications required: PhD or equivalent
Function: Post-Doctoral Research Visit
Level of experience: From 3 to 5 years

Context

Equipment: A laptop will be provided to the postdoctoral researcher.
Travel: Travel expenses to national and international conferences will be covered.

Assignment

Context:
Methods for sampling and optimisation are often two sides of the same coin. A prominent example of this is statistical inference: sampling approaches typically aim at generating samples from the probability measure describing the unknown parameter given the data and prior knowledge, known as the Bayesian posterior distribution, while optimization approaches aim at calculating the maximum likelihood or maximum a posteriori estimator, i.e. the pointwise maximizer of the Bayesian posterior. Sampling and optimisation methods also coexist in the field of machine learning, where use of the former is driven by the need for explainable and transparent algorithms, which requires to analyse the parameter uncertainties present in trained neural networks. Many key recent developments in the fields of sampling and optimisation are based on the use of interacting particle systems and their analysis at the level of the nonlocal Fokker--Planck equation describing the systems in the limit of infinitely many particles, known as the mean field limit. This approach to numerical algorithms based on interacting particle systems emerged initially from the optimization community and has since then brought considerable insight. It has enabled, notably, significant progress towards proving rigorously the longtime convergence of widely-used interacting particle methods, including the ensemble Kalman filter and particle swarm optimization.

Assignments:
The project lies at the interface between numerical optimization, computational statistics and partial differential equations (PDEs). The central goal is to improve, mathematically analyse and implement efficient high-dimensional sampling and optimization methods based on interacting particle systems. Two particular classes of methods will be considered: consensus-based methods inspired by particle swarm optimisation, and ensemble Kalman-based methods, which were recently revealed to have a close connection to interacting Langevin diffusions. The emphasis will be placed on the former class of methods in the beginning.

Main activities

First research track:
The first research track of this postdoctoral project concerns the analysis and improvement of consensus-based optimization and sampling methods. The main goals are to improve and generalize existing theoretical results related to the mean field limit and long-time behaviour of these methods. The postdoctoral researcher will also study whether the methodologies can be improved in terms of computational efficiency and, in the context of sampling accuracy of the invariant measure as an approximation of the target probability distribution. In order to complete the latter objective, simple approaches based on metropolization and preconditioning will be tested.

Second research track:
The second research track is devoted to numerical aspects for consensus-based and ensemble Kalman methods, including implementation, testing, and discretization. Consensus-based optimization will be
studied at the discrete-time level, and the postdoctoral research will participate in an effort to produce robust and efficient implementations of consensus-based methods intended for dissemination.

Skills

Programming languages : Python or Julia
Languages : French and English

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

General Information

- **Theme/Domain**: Optimization, machine learning and statistical methods
  Scientific computing (BAP E)
- **Town/city**: Champs-sur-Marne
- **Inria Center**: Centre Inria de Paris
- **Starting date**: 2024-01-01
- **Duration of contract**: 1 year
- **Deadline to apply**: 2024-01-31

Contacts

- **Inria Team**: MATHERIALS
- **Recruiter**: Vaes Urbain / urbain.vaes@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

The expected profile is that of an independent researcher with strong analytical skills. Applicants should hold a PhD in applied mathematics and have experience in scientific computation, stochastic analysis and partial differential equations. Prior experience in computational statistics and the analysis of mean field equations is desirable.

**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.