Job vacancy #2023-06856

PhD Position F/M Machine learning and optimization methods for 3D vector-valued microscopy image reconstruction

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 Inria Rennes - Bretagne Atlantique Centre is one of Inria’s eight centres and has more than thirty research teams. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Context

Unlike conventional fluorescence microscopy, the new generation of polarized light-based microscopy instruments allow one to probe the orientation of fluorescently tagged biomolecules in cells. As the generated data are now 3D+time vector-valued signals encompassing density and orientation of molecules, serious challenges in signal and image processing need to be solved before being able to fully exploit the potential of polarized microscopy in biological studies. The aim of of this thesis is then to develop the next generation of information processing techniques for microscopy and bioimaging. This will be achieved through the development of a new methodological framework based on the principled approach of supervised and unsupervised and sparse image representations for vector-valued image data. The new unifying framework will be able to manage heterogeneous data and models in optics and biophysics. Our hope is to build a framework, connected to several theories in statistics, such as Bayesian methods and nonparametric estimation, flexible enough to be combined with machine learning techniques, and able to address tasks going from image reconstruction to spatial high-resolution estimation of molecular motion. Our case-studies in cell biology will be related to the analysis of intracellular trafficking and molecule transport pathways, as they represent a major contributory factor to a number of diseases such as cancer, and viral infection. The advances will result in a new generation of algorithms for 3D polarized microscopy instruments, which will be widely used in the future for applications in precision medicine, with a high potential impact for other vector-valued image modalities and other inverse problems in bioimaging.

Bibliography:

Assignment

Objective: Development of machine learning and optimization methods and algorithms for 3D vector-valued microscopy image reconstruction and visualization.

Collaboration: Institut Curie (Paris)

Main activities

The thesis will be articulated around 3 axes:

- Development of generic analysis algorithms to restore signals, predict missing information in the 3D volume and increase the spatial resolution of multiple microscopy set-ups (TIRF, lattice light sheet, confocal, and multifocus microscopy). We will focus on the design of hybrid approaches that incorporate both deep learning methods and sparse image representations in the context of vector-values signals. A key challenge in the development of such algorithm is the memory and computational costs required for the processing of large 3D+time data.
- Application of the algorithms to dedicated live cell studies (e.g., cancer research, neuroscience). For every application, a user-friendly software for biologists will be developed with a focus on the visualization of the 4D data and the interpretability of the results;
- According to the live cell application studied, we may need to generate 3D+time synthetic datasets that realistically depict the dynamics observed in the real microscopy images. The synthetic datasets will thus be used for this purpose. To be as realistic as possible, the simulation may be driven by biophysical and optical models that describes the considered dynamics at the nanoscale.

Skills

Technical skills and level required:

Languages:

Relational skills:

Other valued appreciated:

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking (90 days per year) and flexible organization of working hours
- Partial payment of insurance costs

Remuneration

Monthly gross salary amounting to 2082 euros for the first and second years and 2190 euros for the third year

General Information

- Theme/Domain: Computational Biology
- Instrumentation et expérimentation (BAP C)
- Town/city: Rennes
- Inria Center: Centre Inria de l'Université de Rennes
- Starting date: 2023-12-01
- Duration of contract: 3 years
- Deadline to apply: 2023-12-27

Contacts

- Inria Team: SAIRPICO
- PhD Supervisor: charles.kervrann@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**

We are looking for a candidate with an engineer or master's degree with a background in signal processing and image analysis, bioinformatics, with skills in machine learning (including deep learning) and programming (python, C++). Background in cell biology is a plus. The candidate will be expected to become knowledgeable in the field of microscopy and cellular dynamics, in order to interact with biologists.

**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**

Please submit online: your resume, cover letter and letters of recommendation eventually

**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.