Offer #2025-08885

PhD Position F/M PhD - Uncertainty Quantification for PET reconstructed images with AI

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 Saclay-Île-de-France Research Centre was established in 2008. It has developed as part of the Saclay site in partnership with **Paris-Saclay University** and with the **Institut Polytechnique de Paris** .

The centre has **40 project teams**, 27 of which operate jointly with Paris-Saclay University (15 teams) and the Institut Polytechnique de Paris (12 teams). Its activities occupy over 600 people, scientists and research and innovation support staff, including 44 different nationalities.

The centre also hosts the **Institut DATAIA**, dedicated to data sciences and their disciplinary and application interfaces.

Context

In the context of the ANR AAIMME project centered on the use of AI for Positron Emission Tomography (PET), a medical imaging modality, the aim of this PhD thesis is to investigate uncertainty quantification in PET reconstructed images with

AI.

Subject: PET is a functional and quantitative nuclear medicine imaging modality, with applications in oncology, neurology and pharmacology. Estimating images of the injected radiotracer distribution to the patient from the acquired tomographic data is a large-scale ill-posed inverse problem (typically millions of estimates for hundreds of millions of projections) that requires numerically efficient reconstruction methods.
AI-based techniques developped in this context have led to superior signal to noise ratio and contrast recovery compared to generic (non-AI) reconstruction techniques. This opens up the possibility to a reduce the dose injected to the patient without sacrificing image quality and quantification [1]. However a major challenge remains to obtain reliable quantitative estimates.
In the Opis and BioMaps teams, several reconstruction techniques (deep unrolling and Plug and Play) have been proposed for robust image reconstruction using AI [2,3]. In parallel, the teams have investigated uncertainty quantification using Bayesian Neural Networks (BNN) [4] and the posterior bootstrap framework for classical reconstruction [5]. This PhD thesis proposes to investigate the use of these techniques to obtain reliable and robust estimates in PET reconstructed images.

[1] A. J. Reader et al, "Deep Learning for PET Image Reconstruction," in IEEE Transactions on Radiation and Plasma Medical Sciences, vol. 5, no. 1, pp. 1-25, Jan. 2021
[2] F. Sureau et al, « Convergent ADMM Plug and Play PET Image Reconstruction ». Proceedings of the 17th International Meeting on Fully3D In Radiology and Nuclear Medicine; Stony Brook, 2023.
[3] M. Savanier et al. "Deep unfolding of the DBFB algorithm with application to ROI CT imaging with limited angular density." IEEE Transactions on Computational Imaging 9 (2023): 502-516.
[4] Y. Huang et al, « Efficient bayes inference in neural networks through adaptive importance sampling », Journal of the Franklin Institute, Volume 360, Issue 16, pp 12125-12149, 2023,
[5] Filipovi?, Marina, et al. "Reconstruction, analysis and interpretation of posterior probability distributions of PET images, using the posterior bootstrap." Physics in Medicine & Biology 66.12 (2021): 125018.

Assignment

Missions: The recruited student will first implement a BNN, train it on a denoising task and test uncertainty quantification on simple simulated reconstructed PET images. In a second step, deep unrolling of a reconstruction algorithm involving BNNs will be carried out to provide uncertainties.

Environment: The phd student will be supervised by Emilie Chouzenoux (Head of OPIS team, Inria Saclay) and Florent Sureau (CEA researcher, BioMaps Laboratory). The student will join the Inria Saclay team OPIS (https://opis-inria.eu/). He/she will be located in the Centre de la Vision Numérique, in CentraleSupélec campus, Saclay, France. He/she will enjoy an international and

creative environment where research seminars and reading groups take place very often. Informatic material expenses will be covered within the limits of the scale in force.

Main activities

Main activities :

Programming in Python environment

Bibliographical study

Deep learning architecture design

Scientific meetings

Deep learning training/testing

Writing of scientific reports

Skills

Languages : The candidate must be fluent in english and/or french languages.

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

2200€ gross/month

General Information

- **Theme/Domain :** Optimization, machine learning and statistical methods Statistics (Big data) (BAP E)
- **Town/city :** Gif sur Yvette
- **Inria Center :** Centre Inria de Saclay
- **Starting date :** 2025-09-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2025-08-31

Contacts

- **Inria Team :** OPIS
- **PhD Supervisor :**
  Chouzenoux Emilie / emilie.chouzenoux@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 seek for a talented candidate in Master 2 studies, with a solid background in optimization, statistics, and a strong motivation for the medical imaging field. Experience in Python programming is necessary. An experience in PyTorch or TensorFlow is highly recommended.

The candidates are requested to send a CV and a motivation letter to apply for this position.

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.