Offer #2025-08815

Post-Doctoral Research Visit F/M Longitudinal AI-based modelling for an improved characterization of post-radiotherapy brain lesions and their evolution

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

Level of experience : From 3 to 5 years

About the research centre or Inria department

The Centre Inria de l'Université de Grenoble Alpes groups together almost 600 people in 22 research teams and 7 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 Alpe 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

Radiotherapy plays an important role in the treatment of aggressive brain tumors such as glioblastoma. Although it undeniably helps extend patients' survival, it can also be accompanied by neurological complications in the short or long term, the most frequent being leukoencephalopathy - a progressive and diffuse abnormality of the white matter characterized by demyelination, axonal loss, and vascular lesions. The underlying pathophysiological mechanisms and the processes of cognitive decline associated with leukoencephalopathy remain poorly understood.

This post-doc position is part of an ANR project entitled RADIO-AIDE for "RADIation-induced neurOtoxicity assessed by spatio-temporal modelling combined with Artificial Intelligence after brain raDiothErapy". The project is guided by the rich and multimodal data from the EpiBrainRad cohort including patients treated by RT for a high-grade glioma. More details about the project can be found at https://www.irsn.fr/recherche/projet-radio-aide

Assignment

In this context, the goal of the post-doc is thus to help characterizing different possible side-effects of radiotherapy and in particular white matter lesions, identified as white matter hyperintensities (WMH) in the patient brain. We will aim at investigating and developing advanced spatio-temporal (ST) models and AI tools [Young et al 2024, Couronne et al 2019] to extract, if it exists, a set of ST features which characterize WMH of different nature that may be associated either to post-RT side-effects (eg radio-induced leukoencephalopathies, radio-necrosis, post-RT oedema) or to treatment responses (eg brain tumor progression, peritumoral oedema). So doing we will help in improving knowledge about the radiosensitivity of healthy brain tissues**.**

Main activities

More specifically, we will focus on two main sources of such WMH, leukoencephalopathies and oedema, which are not easily distinguished by radiologists when they delineate them on eg. FLAIR images. The hope is that radiomics [van Griethuysen et al 2017] and accounting for the temporal dynamics of the observed lesions will help in better separating them.

The task thus aims at adapting a radiomics approach based on multivariate statistical tools to extract specific signatures of WMH. Several attempts have been made to analyse in this way multimodal MR images but mainly in a quantitative radiomics context eg. [Arnaud et al. 2018]. In this project, we will aim at leveraging the information extracted from various MR modalities by turning it into meaningful features in order to adapt radiomics techniques. The hope is to perform a first

meaningful analysis by combining some global features**.** We will target an automated lesion identification procedure where identification includes both location and characterization via so-called signatures representative of various physiological parameters in accordance with the expected tissue types.

To extract discriminative multivariate features and turned them into individual lesion signatures, we will first investigate multivariate statistical tools based on mixtures of generalized multivariate Student distributions that allow a variety of distributional forms [Arnaud et al., 2018]. The signatures can then be subsequently pooled together to build a statistical fingerprint model of the different lesion types that captures lesion characteristics while accounting for inter-subject variability. We also propose to investigate more recent machine learning tools such as diffusions and flows in the longitudinal context [Yang et al 2024, Puglisi et al 2024] to assess their ability to directly provide spatio-temporal signature, possibly by combining them with more standard mixed effect models as for example done in [Sauty et al 2022].

References:

Arnaud A., Forbes F., et al. (2018). IEEE Transactions on Medical Imaging, doi: 10.1109/TMI.2018.2794918.

Yiyuan Yang, Ming Jin, Haomin Wen et al. A Survey on Diffusion Models for Time Series and Spatio-Temporal Data, 2024.

L. Young, N. P. Oxtoby, S. Garbarino, N. C. Fox, F. Barkhof, J. M. Schott, and D. C. Alexander,“Data-driven modelling of neurodegenerative disease progression: Thinking outside the blackbox”, Nature Reviews Neuroscience, vol. 25, no. 2, pp. 111–130, Feb. 2024.

Raphael Couronne, Marie Vidailhet, Jean-Christophe Corvol, Stephane Lehericy, and Stanley Durleman. Learning disease progression models with longitudinal data and missing values. In ISBI 2019 - International Symposium on Biomedical Imaging, Venice, Italy, April 2019.

Benoît Sauty, Stanley Durrleman. Progression models for imaging data with Longitudinal Variational Auto Encoders. MICCAI 2022, International Conference on Medical Image Computing and Computer Assisted Intervention, Sep 2022, Singapore, Singapore.

Puglisi, D. C. Alexander, and D. Ravì, Enhancing spatiotemporal disease progression models via latent diffusion and prior knowledge, 2024.

van Griethuysen, J. J. M., Fedorov, A., Parmar, C., Hosny, A., Aucoin, N., Narayan, V., Beets-Tan, R. G. H., Fillon-Robin, J. C., Pieper, S., Aerts, H. J. W. L. (2017). Computational Radiomics System to Decode the Radiographic Phenotype. Cancer Research, 77(21), e104–e107. https://doi.org/10.1158/0008-5472.CAN-17-0339.

Skills

Machine learning, statistics, deep learning

Image processing

Neurosciences and medical applications

Software development skills: Python, TensorFlow et Pytorch

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
- Complementary health insurance under conditions

Remuneration

- 2788 gross salary per month

General Information

- **Theme/Domain :** Optimization, machine learning and statistical methods Statistics (Big data) (BAP E)
- **Town/city :** Montbonnot
- **Inria Center :** Centre Inria de l'Université Grenoble Alpes
- **Starting date :** 2025-06-02
- **Duration of contract :** 1 year, 7 months
- **Deadline to apply :** 2025-05-31

Contacts

- **Inria Team :** STATIFY
- **Recruiter :**
  Forbes Florence / florence.forbes@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

Rich and multidisciplinary, the subject takes place in a larger project that brings together various experts in image processing and neuroimaging, statistics and machine learning, radiotherapy and neuro-oncology, as well as a start-up, Pixyl, which develops AI-based tools for clinical applications. Collaboration with Grenoble Institute of Neursciences is expected

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.