Offer #2025-09063

Post-Doctoral Research Visit F/M Network-based biomarker discovery of neurodegenerative diseases using multimodal connectivity

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 Inria Centre at Rennes University is one of Inria's nine centres and has more than thirty research teams. The Inria Centre 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

The neurodegenerative diseases like Alzheimer’s (AD) and Parkinson’s (PD) disease are the consequences of pathological processes that begin decades before the onset of the typical clinical symptoms [1][2]. However, current diagnosis comes quite late in the course of the disease, while evidences underline the multiple benefits that would be associated with earlier diagnosis [3]. An outstanding challenge for clinical neurosciences is therefore to provide reliable, non-invasive, affordable and easy-to-track biomarkers able to improve both the early detection and the monitoring of neurodegenerative diseases, that can be applied at an individual level. It is well acknowledged that AD and PD display a progressive multifactorial disruption of cerebral networks, all along the course of the diseases, which is highly related to the clinical phenotype [4].

In the search for those biomarkers, the introduction of non-invasive imaging techniques, such as functional magnetic resonance imaging (fMRI) and diffusion weighted imaging (DWI), prompted important discoveries to provide a comprehensive map of neural connections, known as the connectome. The field of network science for analyzing the connectome offers new insights into networks

disruptions that are characteristic of specific brain disorders [5]. Mathematical modelling using graph theory, which appeared in neuroimaging at the beginning of this century, provides powerful quantitative tools and measures for the analysis of complex cerebral networks [6][7]. Undirected brain connectivity has been classified in two categories: (i) structural connectivity estimated by DWI, where links represent axons or neuronal fiber density or (ii) functional connectivity (measured for instance with fMRI) where links represent statistical dependencies between brain signals from different areas, such as correlations, coherence, or transfer entropy. However, prior studies have largely focused on the comparison between patients suffering from AD or PD versus healthy subjects. As a result, the relevance of the reported alterations in brain network may be limited due to a lack of specificity. Indeed, the extracted features that are sensitive to AD or PD may well reflect common neurodegenerative processes, therefore lacking specificity for the disease-related physiopathology at the individual level. Integrating simultaneously these modalities could yield a powerful tool, to expand the knowledge of our brain and to exhibit robust biomarkers of AD and PD, more sensitive to pathophysiological changes.

Assignment

Location:

The recruited person will work at Inria/IRISA, UMR CNRS 6074, among the Empenn U1228 team. The work will be in close link with Pierre-Yves Jonin, neuropsychologist in CHU Rennes and Neurologists working on Alzheimer's and Parkinson's diseases.

IRISA/Inria is a French laboratory for research and innovation in digital science and technology. Successful candidates will also benefits of annual paid holidays and social insurance.

Main activities

The major scientific objective for this postdoc is to develop innovative machine learning methods, adapted for innovative multimodal features, that will allow to discover accurate specific biomarkers of each AD and PD stage by analyzing cerebral connectomes. Instead of using traditional comparison between healthy control and patient groups, the proposed approach consists in developing multi-class classification models to differentiate among the different disease stages of AD and PD (noted WP2 on the figure below). The postdoc will apply the developed approach on two large patients' cohorts and, then, assess the effectiveness of candidate disease-specific biomarkers on a new innovative local multimodal cohort including patients with and without cognitive impairment, at various stages of the diseases.

The proposed project is an part of a long-term project, funded by the French research agency (ANR). A PhD student is currently working on the integration of functional and structural neuroimaging data, using the multilayer networks [8].

[1] G. M. McKhann *et al.*, « The diagnosis of dementia due to Alzheimer's disease: recommendations from the National Institute on Aging?Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease », *Alzheimer's & dementia*, vol. 7, nº 3. p. 263?269, 2011.

[2] I. Liepelt-Scarfone, A. Ophey, et E. Kalbe, « Cognition in prodromal Parkinson's disease », *Progress in brain research*, vol. 269, nº 1. p. 93?111, 2022.

[3] R. Brookmeyer, S. Gray, et C. Kawas, « Projections of Alzheimer's disease in the United States and the public health impact of delaying disease onset », *American journal of public health*, vol. 88, nº 9. p. 1337?1342, 1998.

[4] C. Hohenfeld, C. J. Werner, et K. Reetz, « Resting-state connectivity in neurodegenerative disorders: Is there potential for an imaging biomarker? », *NeuroImage: Clinical*, vol. 18. p. 849?870, 2018.

[5] A. Fornito, A. Zalesky, et M. Breakspear, « The connectomics of brain disorders », *Nature Reviews Neuroscience*, vol. 16, nº 3. p. 159?172, 2015.

[6] E. Bullmore et O. Sporns, « Complex brain networks: graph theoretical analysis of structural and functional systems », *Nature Reviews Neuroscience*, vol. 10, nº 3. p. 186?198, 2009.

[7] A. W. Toga, K. A. Clark, P. M. Thompson, D. W. Shattuck, et J. D. Van Horn, « Mapping the human connectome », *Neurosurgery*, vol. 71, nº 1. p. 1?5, 2012.

[8] Z. Hammoud et F. Kramer, « Multilayer networks: aspects, implementations, and application in biomedicine », *Big Data Anal.*, vol. 5, nº 1, p. 2, déc. 2020, doi: 10.1186/s41044-020-00046-0.

Skills

We are seeking highly motivated candidates passionate about engaging research topics in machine learning, neuroimaging, clinical applications, and magnetic resonance imaging (MRI).

We look for candidates with a PhD in biomedical imaging, neuroimaging or machine learning. Basic knowledge in image processing would be a plus. Good knowledge of computer science aspects is also mandatory, especially in Python and Matlab.

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
- Social security coverage

Remuneration

Monthly gross salary amounting to 2788 euros.

General Information

- **Theme/Domain :** Computational Neuroscience and Medicine
- **Town/city :** Rennes
- **Inria Center :** Centre Inria de l'Université de Rennes
- **Starting date :** 2025-09-01
- **Duration of contract :** 5 months
- **Deadline to apply :** 2025-08-25

Contacts

- **Inria Team :** EMPENN
- **Recruiter :**
  Cologner Julie / julie.cologner@irisa.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

How to apply?

Please send us the following information and documents:

- Updated CV

- Your grades and ranking of your master degree

- A motivation letter

- A recommendation letter, or the contact of a PhD supervisor who could recommend your application.

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.