Postdoctoral position

Network-based biomarker discovery of neurodegenerative diseases using multimodal connectivity

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Scientific environnent: Empenn U1228, IRISA, Campus de Beaulieu, Rennes - https://team.inria.fr/empenn/

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Keywords : Neuroimaging, Neuroinformatic, Graph, Functional MRI, Diffusion MRI, tractography, Graph signal processing.

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].

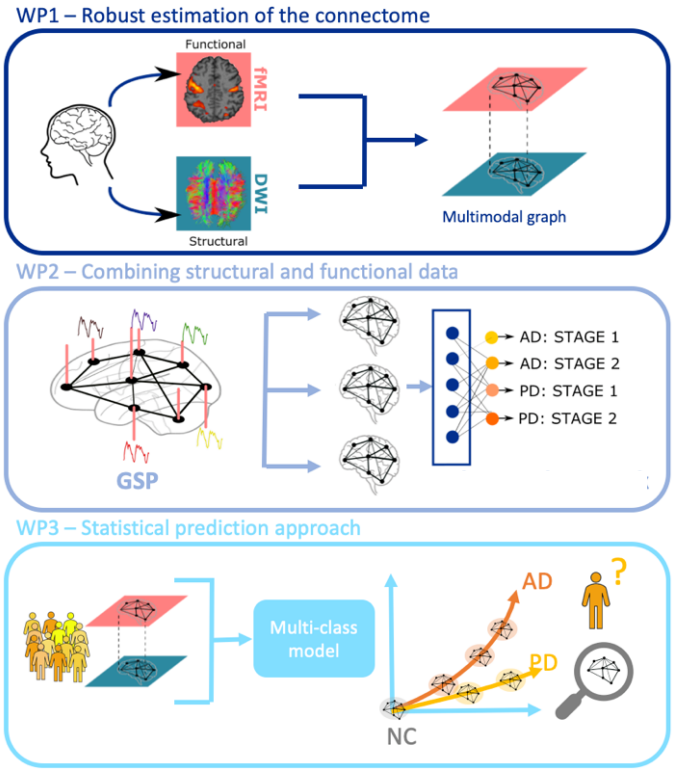
In the search for those biomarkers, the introduction of non-invasive imaging techniques, such as functional magnetic resonance imaging (fMRI) and diffusion weighted imaging (DWI), prompted important discoveries to provide a comprehensive map of neural connections, known as the connectome. The field of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

Scientific objectives of the project :

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].



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

Requirements:
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.

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.

References :

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