Proposition: Charting the human brain with fMRI

Type de contrat : CDD
Niveau de diplôme exigé : Thèse ou équivalent
Fonction : Chercheur contractuel

A propos du centre ou de la direction fonctionnelle

Located at the heart of the main national research and higher education cluster, member of the University Paris Saclay, a French research institution (IDEX, LabEx, IRT, EqipeX) and partner of the main establishments present on the plateau, the centre is particularly active in three major areas: data and knowledge, safety, security and reliability, modelling, simulation and optimisation (with 100 researchers and engineers and its partners who work in the research centre’s 28 teams, the 60 research support staff members, the high-level equipment at their disposal (image walls, high-performance computing clusters, sensor networks), and the privileged relationships with prestigious industrial partners, all make Inria Saclay Île-de-France a key research centre in the local landscape and one that is oriented towards Europe and the world.

Contexte et atouts du poste

Working at Inria

Established in 1967, Inria is the only public research body fully dedicated to computational sciences. Combining computer sciences with mathematics, Inria’s 3,500 researchers strive to invent the digital technologies of the future. Educated at leading international universities, they creatively integrate basic research with applied research and dedicate themselves to solving real problems, collaborating with the main players in public and private research in France and abroad and transferring the fruits of their work to innovative companies.

The researchers at Inria published over 4,500 articles in 2019. They are behind over 300 active patents and 120 start-ups. The 172 project teams are distributed in eight research centers located throughout France.

Working with Parietal team

Besides permanent researchers, the developer will be in contact with PhD students that do software development as part of their PhD contract, and with the developer team that contributes to skict-learn and Joblib, supported by the skict-learn consortium. He or she will also be in contact with cognitive and clinical neuroscientists at NeuroSpin.

Parietal researchers use English as a common language for their activities (daily interactions, weekly meetings, yearly retreats).

Context: Large-scale functional atlasing

Having a working model of brain organization has been a historical and major goal in neuroscience. With the advent of cognitive neuroimaging, it has become clearer that functional specificity is both a prominent marker of architectural differences in the brain and the most natural way to characterize the differences between brain regions [2]. To this end, many brain atlases have been inferred and released, based on various imaging modalities and experimental procedures. However, their justification has been weakened by the absence of concomitant release of data that backs up the available atlas, and by the large inter-subject variability that unavoidably blurs population models. Advances will be made possible by:

1. Acquiring a large number of functional protocols that probe as many cognitive processes as possible on a fixed group of subjects, so that each putative brain region (area or module) can be characterized unambiguously through a unique functional signature and position in individual brains.

2. Making the data and ensuing processing steps available to the community, so that the results of this mapping can be easily reproduced and compared to other data.

The Human Brain Project (HBP, http://www.humanbrainproject.eu) aims to develop a model of human brain organization; a bottom-up approach that consists of building a brain by going all the way from molecular to system-level organization. This needs to be informed by high-level constraints that shape the macroscopic organisation of the brain.

Individual brain charting (IBC, https://project.inria.fr/IBC) is a part of the HBP and consists of repeatedly scanning a limited number of subjects with a large and varied set of functional protocols (retinotopic, tonotopic, somatotopic, visual categories, space and number, language, social cognition, resting state…) together with high-resolution anatomical and diffusion-weighted scans. The project was launched at the end of 2013 and data acquisition started in mid-2014. The project has recently output an impressive number of high-resolution brain maps (http://neurovault.org/collections/6618), that provide an objective basis to inform the definition of brain regions. The richness of the dataset resides in the variety of cognitive functions probed.

Mission confiée

The engineer will be in charge of adapting a set of protocols and running them on the existing pool of 12 subjects. These protocols will be provided by the community, potentially from inhouse developments, and are meant to cover a diverse array of cognitive processes (in the sense of Figure 1: IBC project principle: High resolution brain images on a fixed cohort make it possible to accurately map brain regions). The accumulation of these data lead to a much more complete description of the functional organization of the brain.

(http://www.cognitiveatlas.org). The validation, necessary adaptations, and implementations of these protocols will be carried out in close collaboration with the Unicog lab at Neurospin (http://www.unicog.org).

The engineer will participate in the acquisitions conducted on the Neurospin 3T (and, possibly later, the 7T) scanner. The data are acquired at high resolution (1.5mm) and will be analyzed.
using a pipeline provided by the lab. S/he will be involved in the improvement of this pipeline and will obtain activation maps related to the various contrasts, with support from technical experts. The data will be analyzed both at the volume level and on the cortical surface. Detailed reports will be provided to assess the quality of the data, motivate the participants and document the content of the database.

The data will also systematically be compared with existing resources (Openneuro, NeuroVault, Neurosynth, Human Connectome Project). The methodological aspects will be developed in close collaboration with the Parietal team at Neurospin (http://team.inria.fr/parietal), that has recently developed specific techniques to perform brain parcellation effectively [4, 1] and to discriminate between distributed activation patterns [3]. The engineer will also re-use the existing pipeline and quality checking tools of the Parietal team.

**Principales activités**

All the raw and processed data, stimuli, as well as the functional atlases inferred from the data will be made available on the EBRains (http://kg.ebrains.eu/search), Neurovault (http://neurovault.org) and Openneuro (http://openneuro.org) platforms to become a reference for the neuroimaging community, together with exhaustive documentation on the acquisition and processing parameters. The engineer will have a role in the decisions pertaining to the choice of functional localizer experiments that are undertaken to ensure completeness and accuracy of the functional brain atlas.

**Compétences**

- Mandatory: Experience designing/adapting, running and analyzing an fMRI protocol, in particular localization-related protocols (retinotopy, tonotopy, somatotopy etc.).
- Mandatory: Training in cognitive neuroscience.
- Desired: Experience working/programming in Python, Matlab.
- Desired: Experience with experiment-building tools like E-Prime, Presentation.
- Mandatory: The candidate should be willing to work in a multi-disciplinary environment (cognitive neuroscience, MRI acquisition, computer science).

**Avantages**

- 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

**Rémunération**

Salary in regard to professional experiences