Research Engineer / Post-Doc position:

Automated assessment of MRI metrics and uncertainties for multiple sclerosis follow-up

Deadline for application: December 10st, 2019

Research teams: Empenn Team / Neurinfo Platform, IRISA Rennes (http://www.irisa.fr/)

Associate Supervisors:
benoit.combes@inria.fr
anne.kerbat@chu-rennes.fr

Keywords: Deep learning, Personalized medicine, Image segmentation, Multiple sclerosis, Magnetic Resonance Imaging.

Context:
The question of prognosis in multiple sclerosis (MS) is of paramount interest at the beginning of the disease in order to inform the patient on his estimated risk of disability and to guide the choice of disease modifying treatment. Recent works have demonstrated the high prognosis value of complementary brain and spinal cord MRI biomarkers (Brownlee et al., 2019):
- Baseline T2 and gadolinium positive lesion volume and number in the brain and spinal cord.
- Annual lesion volume and number change in the brain and cord during the first years of MS.
- Brain and spinal cord atrophy.
Several prerequisites are now available to transfer such quantitative MRI metrics to clinical practice. Firstly, standardisation of clinical MRI protocols in MS patients and infrastructure development supported in France by the OFSEP initiative (Cotton et al., 2015) have allowed to gather large datasets from which to learn and extract metrics. Secondly, infrastructures have been developed, aiming to bring the brain imaging biomarkers to the clinics. Locally an ongoing research project named MUSIC (Multiple Sclerosis Imaging Check Out), promoted by Rennes University hospital, was funded to develop in 5 pilot centers an infrastructure able to collect, store and process standardized MRI data from MS patients. Finally, a first processing pipeline consisting of the automated identification of lesions from brain MRIs using a deep neural network (Galassi et al., 2019) was deployed and tested.

Project description:
The aim of this project is to improve the current processing pipeline through three major improvements:

1) Spinal cord data: While the MUSIC project initially focused on brain lesions, spinal cord lesions have also been shown to have a great prognostic value on the MS disease course. We thus propose to extend the processing pipeline to spinal cord imaging. This method will rely on the method for spinal cord lesion identification developed at Neuropoly (Gros et al., 2019) and will be assessed with clinical MRI already available in the project.
ii) **Margin of errors**: Then, substantial efforts have to be made on the estimation of margins of errors associated with estimated lesion measurements (in the spinal cord as well as in the brain). Indeed, such quantities are mandatory for precision medicine purpose and to date, only a few works have investigated these fields. Two alternative research directions will be led. First, margins of errors will be assessed directly from output probability lesion masks. Second, more sophisticated approaches relying on a Bayesian neural network formulation (Gal 2016) of the segmentation problem will be investigated. Obtained intervals will be evaluated using available already segmented data.

iii) **Atrophy**: Additionally to lesion measurements, brain and spinal cord tissue loss from one time step to another (known as atrophy) has a high pronostic value. The generalized boundary shift integral (GBSI) method is the state-of-the-art method for assessing this tissue atrophy (Prados 2015). GBSI is a registration-based approach using two timepoints to estimate directly tissue loss with a subvoxel resolution. This method must be deployed and assessed in the case of multiple sclerosis follow-up in the spinal cord as well as in the brain. Moreover, the development of methods to assess the associated margin of errors is still needed.

**Skills and applicant profile:**

The ideal applicant should have a strong background in computational sciences and image and signal processing. A very good practice in programming, especially in C++ and/or Python is required. The position is opened for an initial period of 12 months with a range of gross salary starting from 2100€ per month, according to experience.

**Application package:**

Applicants should send their complete application package by email. It will include:

- Motivation letter
- Complete CV
- Recommendation letters

Incomplete applications will not be processed.

**Bibliography:**


