Integration of multiparametric data by machine learning for the development of an imaging biomarker in epilepsy

Context

In drug-resistant epilepsy patients who can benefit from surgical resection, mislocalization of the epileptogenic zone (EZ) can lead to neurological sequelae. We have recently developed, in a mouse model of focal epilepsy, two new approaches to detect the EZ non-invasively: the first is based on GABA NMR spectroscopy [1] and the second on quantitative multiparametric imaging [2]. We hypothesize that the combination of these two methods can help to detect EZ more accurately in animals and eventually in humans. To do this, we need to:

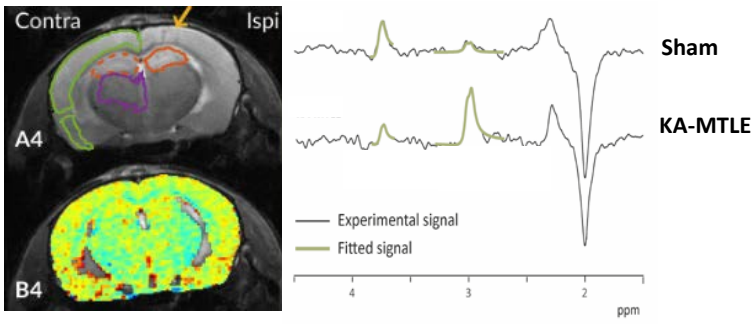

Figure 1. Example of imaging and spectroscopy data collected at 9.4T in mice [1], [2]. Imaging: anatomical (top) and mean diffusivity map (bottom). Spectroscopy: GABA-edited spectra of a sham (top) and of an epileptic mouse (bottom).

- Integrate measurements obtained by the two methods, which have different spatial resolutions, using mathematical approaches to obtain a multiparametric representation at the anatomical image scale [3];
- Implement automatic anomaly detection to automatically delineate the EZ in epileptic animals using reference data obtained in healthy animals, based on previous work from the lab [4];
- Quantify the impact of anti-epileptic drugs on the measured parameters and take this impact into account in the automatic detection of anomalies.

Workplan

The thesis work will consist in developing machine learning based solutions to classify and integrate multiparametric MRI and spectroscopy data. The PhD student will also participate, for a small fraction of his time, in the acquisition of preclinical data to characterize the effect of anti-epileptic drugs on the proposed imaging and spectroscopic metrics. For the preclinical studies, the animals will be taken care of by an engineer with a background in biology.

The PhD student will use software for image registration and analysis, spectroscopic data analysis (Matlab, Python), statistics and machine learning (classification in particular). He/She will work in a multidisciplinary team (physics, applied mathematics, biology, medicine), associated with MIAI (https://miai.univ-grenoble-alpes.fr/), the center for artificial intelligence in Grenoble, and in collaboration with Inria (Team Statify). This project is funded by the ANR.

Background: Master 2 or Engineer. Initial training in physics or applied mathematics / statistics. An experience in imaging will be appreciated.

Supervision/Contact : Team "Functional Neuroimaging and Brain Perfusion" at GIN : Emmanuel Barbier (emmanuel.barbier@univ-grenoble-alpes.fr) and Florence Fauvelle (florence.fauvelle@univ-grenoble-alpes.fr)

Workplace: Grenoble Institut des Neurosciences : https://neurosciences.univ-grenoble-alpes.fr

Start date: Fall 2022

How to apply: Email a CV and a motivation letter to the two supervisors. Interviews of the selected applicants will be done on an ongoing basis. Applications will be accepted until end of June.

References: [1] Hamelin et al., Epilepsia (2021) ; [2] Boux et al., Epilepsia (2021) ; [3] Jain et al., Front Neurosci. 2017 ; [4] Arnaud et al., IEEE-TMI, 2018