Internship duration: 4-6 months
Host laboratory: Lyon Neuroscience Research Center (CRNL).
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Internship supervisors: Romain QUENTIN, Researcher, romain.quentin@inserm.fr, Pauline Mouches, Postdoctoral researcher
Funding: The intern will be compensated if the intern does not have a scholarship.
Project: Using deep learning to detect epileptic spike from brain activity recordings

Brain neural activity recordings of epilepsy patients contain brief morphologically defined events between seizures, called interictal spikes. Their detection allows the localization of the brain region from which seizure originate[1]. Nevertheless, they are often detected manually by clinicians, which is a time-consuming task.

The data consists of 45 minutes recordings of brain activity in which timing of the spikes were annotated by clinicians. In the current state of the project, the data is cropped into short time windows (200ms) and the problem consists of classifying each window as containing a spike or no.

In this internship, we will explore and develop different methods for automated spike detection using deep learning. Within the team, baseline models using convolutional neural networks and graph convolutional networks have already been developed. The internship project will focus on improving these models and comparing their performances to other model architectures. More precisely, the following aspects could be studied:

- Transformers: Investigate more in depth the value of using transformers for this time-series classification problem[2].
- Semi-supervised learning: Annotations of the interictal spikes in the data are not complete, i.e., all the spikes were not annotated/detected by the clinician. With a supervised approach using all data, these undetected spikes would be considered as “non-spike” and this can deteriorate the model performances. Thus, a semi-supervised approach could be developed[3]. In a such approach, the data is split into fully annotated data and non-annotated data.
- Events detection: Instead of tackling the problem as a classification problem, it could be seen as an event detection problem. This would mean that no short time windows are cropped but the full (or part of the) signal is used and an event detection algorithm (similar to object detection in image) is used to detect spike timings[4].

Challenges encountered with the data will include working with imbalanced data and noisy labels. This internship will allow the intern to gain experience in deep learning and to conduct a project using medical data in collaboration with doctors. Models will be implemented in Python using the Pytorch library.

[1] Jung et al., « The value of magnetoencephalography for seizure-onset zone localization in magnetic resonance imaging-negative partial epilepsy ».
[2] Wen et al., « Transformers in Time Series ».
[3] Goschenhofer et al., « Deep Semi-supervised Learning for Time Series Classification ».
[4] Seeuws et al., « EventNet: Detecting Events in EEG ».