MACHINE LEARNING METHOD TO FORECAST EPILEPTIC SEIZURES FROM BRAIN CONNECTIVITY

Supervising staff

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Context

This project will be performed in collaboration and with the help of the Department of Neurology at the CUB Hôpital Erasme.

Epilepsy is a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures and by the neurobiologic, cognitive, psychological, and social consequences of this condition (Fisher et al., 2005). Epilepsy has variable etiologies, may affect both children and adults, and has an annual incidence of 4–8/1000. In about a third of epileptic patients, seizures do not respond to conventional anti-epileptic drugs.

Management of epileptic patients in the Intensive Care Unit (ICU) is challenging. The ability to anticipate an upcoming seizure would be valuable both for patient management and as a predictor of treatment adequacy.

Recently, a technique has gradually gained prominence in forecasting epileptic seizures: the investigation of brain connectivity, characterizing how highly specialized brain regions communicate with each other (Ismail and Karwowski 2020). Indeed, epilepsy is widely believed to result from disrupting healthy brain network properties (van Mierlo et al. 2014). By modeling the brain as a connectivity graph, the interactions between its regions can be studied formally, allowing quantitative characterization and interpretation of the specific patterns observed (Farahani, Karwowski, and Lighthall 2019; van Diessen et al. 2015).

Machine learning techniques are often used on EEG data to accurately and automatically predict a patient's condition, such as at risk of seizure or not for ICU patients. However, research using machine learning techniques to analyze connectivity parameters extracted from connectivity graphs or even directly analyze connectivity networks has been much less explored.

In addition to exploring the potential of machine learning in analyzing connectivity networks, it would be valuable to compare its performance to more traditional classification methods. This would help determine whether machine learning techniques can provide more accurate predictions. Another important aspect to consider is the trade-off between model complexity and interpretability. While more complex models may offer higher performance, they can also be more difficult to explain and interpret. Understanding this correlation and finding a balance between accuracy and interpretability is crucial in ensuring that these models are reliable and can be used effectively in clinical settings.

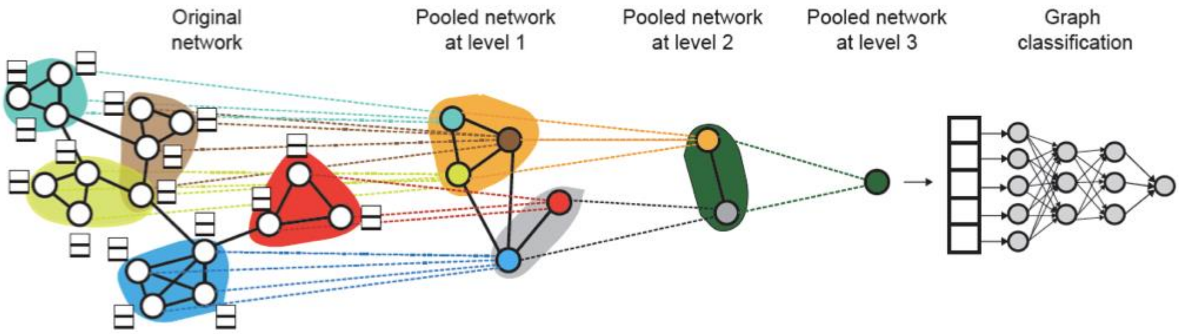

Figure 1. Graph Neural Network (Hamilton 2020). *Deep learning technique for topological data such as graphs.*

Work

This work aims to design, implement and assess a machine-learning method to predict subsequent seizures based on brain connectivity. Recording of electroencephalographic signals (EEG) from patients in the Intensive Care Unit (ICU) will be provided.

Bibliography

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