A Multiresolution Data Augmentation in Transformer Architecture: Neurological Predictors from EEG for Comatose Recovery

Simanto Saha, Andrea Samore, Andrew Goodwin, Collin Anderson, Michael Loong-Siong Wong, Raquib-ul Alam and Alistair McEwan
The University of Sydney, NSW, Australia

Aims: In an intensive care unit (ICU), an accurate prognosis of comatose patients' recovery is critical for ongoing medical interventions. Patient prognosis guides decisions around continuation of care. Literature suggests that patients may recover from a coma despite poor initial prognoses; thus, more reliable predictors for recovery are needed. Electroencephalogram (EEG)-based neurological markers may complement the current prognosis of comatose recovery.

Methods: The Physionet Challenge 2023 includes a dataset of 18-channel bipolar EEG and clinical data from a total of 1020 adult patients in ICUs that remained in a coma after cardiac arrest, 607 of whom were dedicated to algorithmic training. Based on the transformer architecture, we conceptualized a multiresolution data augmentation method for preparing temporal EEG signals as input to a 2-dimensional deep learning model. A wavelet transform analysis was used to capture the spatiotemporal features of the EEGs with data augmentation. Heartbeat artefacts were identified in the EEG signals and used to calculate additional HRV features. The proposed method assumed that the transformer architecture's nonlinearity potentially learns EEGs' inherent nonstationarities and that the HRV manifests cardiac arrest-associated characteristics. Figure 1 illustrates a typical block diagram of our proposed algorithm. We initially developed a Welch periodogram and a random forest classifier-based algorithm. The true positive rate (TPR) was the scoring metric with a false positive rate of ≤ 0.05 at the 72nd hour.

Results: Our algorithm achieved a TPR of 0.33 on the validation set, implicating reconstruction of the algorithm that captures the spatiotemporal dynamics of EEG contributing to the clinical prognosis of comatose patients' recovery.

Conclusion: Nonlinearity in transformer architecture with multiresolution wavelet analysis may integrate the nonstationarities of EEGs, promoting EEG-based neurological markers for comatose recovery.

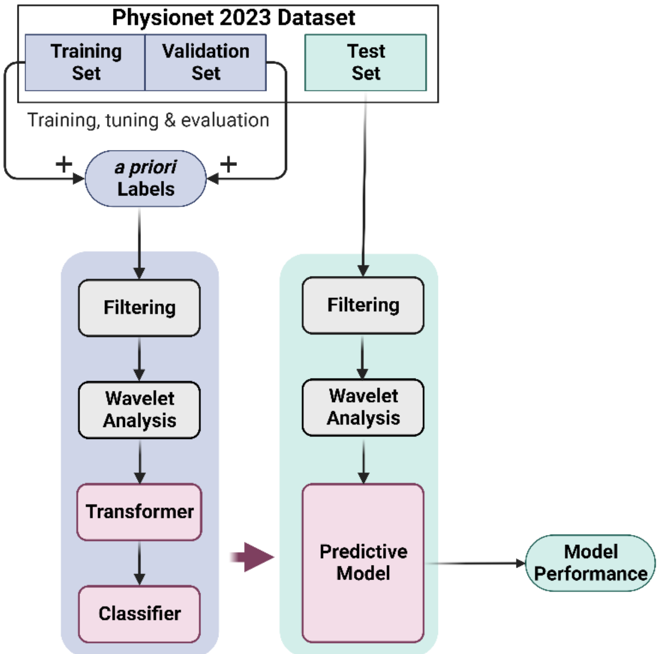

Figure 1: The overview of the proposed algorithm.