A Deep Semi-Supervised Domain Generalization Approach for Epileptic Seizure Prediction Using Electroencephalography (EEG)

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According to the WHO, nearly 50 million people suffer from epilepsy, one of the most common neurological diseases. Deaths caused by epilepsy have doubled over the past decade. Epilepsy is characterized by abnormal brain activity, leading to recurrent seizures. Each seizure manifests as sudden, uncontrolled bursts of electrical activity in the brain, and the injuries and restrictions on daily life underscores the urgency of finding effective methods for epileptic seizure prediction. Electroencephalogram (EEG) devices that output brain activity as waves are used for detection. This project aims to use deep learning techniques for the early prediction of epileptic seizures, an unsolved problem. Previous models have two limitations: being biased on specific datasets and devices used for training, and being sensitive to noise. A semi-supervised-based domain generalization method was developed to create a seizure prediction model that solves these problems. It consists of two phases: representation learning and transfer learning phase. To achieve high precision, the proposed method utilizes a representation learning approach. Here, a feature-swapping mechanism that effectively disentangles seizure-related EEG features is introduced, proved by the t-SNE feature maps visualization. During transfer learning, the pre-trained network is trained to output the probability if the input EEG indicates a seizure. The proposed model achieves exceptional performance, with an accuracy of 90.53% and 94.88% on the NICU and Epileptic Seizure Recognition datasets respectively in within-dataset evaluations. It outperforms the previous methods on average by 19.35% in cross-dataset evaluations. This robust improvement opens up promising possibilities for real-world clinical applications.