Uncovering the Epileptogenic Brain Networks With Independent Component Analysis and Deep Learning: A Novel and Comprehensive Framework for Scalable and Generalizable Seizure Prediction With Unimodal Neuroimaging Data in Pediatric Patients

Singhal, Bliss (School: Issaquah High School)

Epilepsy is a prevalent neurological disorder affecting 50 million individuals worldwide and 3.4 million Americans. There exist millions of pediatric patients with intractable epilepsy, a condition in which seizures fail to come under control. The occurrence of seizures can result in physical injury, disorientation, unconsciousness, and additional symptoms that could impede children's ability to participate in everyday tasks. Predicting seizures can help parents and healthcare providers take precautions, prevent risky situations, and mentally prepare children to minimize anxiety and nervousness associated with the uncertainty of a seizure. This research proposes a novel and comprehensive framework to predict seizures in pediatric patients by evaluating machine learning algorithms on unimodal neuroimaging data consisting of electroencephalogram signals. The bandpass filtering and independent component analysis proved to be effective in reducing the noise and artifacts from the dataset. Various machine learning algorithms' performance is evaluated on important metrics such as accuracy, precision, recall, specificity, sensitivity, F1 score, and MCC. The results show that the deep learning algorithms are more successful in predicting seizures than logistic Regression, and k nearest neighbors. The recurrent neural network (RNN) gave the highest precision and F1 Score, long short-term memory (LSTM) outperformed RNN in accuracy and convolutional neural network (CNN) resulted in the highest Specificity. This research has significant implications for healthcare providers in proactively managing seizure occurrence in pediatric patients, potentially transforming clinical practices, and improving pediatric care.

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