Predicting Epileptic Seizures Using Discrete Wavelet Transform and Machine Learning

Kwon, Daye (School: Arkansas School for Mathematics, Sciences and the Arts)

Epilepsy is one of the most common neurological disorders worldwide, and the unpredictable nature of epileptic seizures makes life challenging for many patients. The objective of this study was to develop generalized and patient-specific machine learning models that are able to predict seizures by identifying the preictal state. A five level discrete wavelet transform with the Daubechies 4 wavelet was applied to preictal and interictal EEG segments. Energy, Shannon entropy, and absolute mean were extracted from each subband as features. Variance Decomposition Proportions were analyzed to detect multicollinearity and remove redundant features. Four machine learning algorithms- Decision Tree, K-Nearest Neighbors, Logistic Regression, and Support Vector Machine- were trained using 5-fold cross validation and tested on the corresponding validation sets. The decision tree algorithm had the best performance as a generalized predictor, achieving a specificity of 95.2%, a sensitivity of 84.8% and an accuracy of 88.4%. The best-performing patient-specific models all achieved a sensitivity of at least 75% and specificity of at least 80%. In a clinical context, the algorithm would be able to detect the onset of a preictal state within 25 seconds with a 99.97% probability. If implemented in wearable devices, such machine learning based seizure predictors can greatly improve the quality of life for people with epilepsy. Further research in this field includes exploring different types of features, applying different machine learning algorithms, and using data from a larger number of patients.

Awards Won: