An Optimization Approach to EEG Feature Extraction for the Prediction of Neurological Outcome

Allan R Moser*, Jackie Le, Lys Kang

Swarthmore College, Swarthmore, PA, USA

Aim: The goal of the 2023 PhysioNet Challenge is to develop a machine learning method using hourly EEG data to predict neurological outcome for comatose patients post cardiac arrest. For patients who have been resuscitated, but remain comatose after a cardiac arrest, the underlying cause of death and disability is hypoxic-ischemic brain injury caused by the interruption of blood circulation to the brain. However, since the direct cause of death for these patients is generally withdrawal of life-sustaining treatment, the prediction method must yield a very low false positive rate.

Method: Many features can be extracted from EEG data to classify neurological outcome. Additionally, some, all, or a combination of the 18 electrode channels can be used. The SwarthBeat team's approach was to treat the selection of EEG features, channels, and patient information as an optimization problem with the objective being to select a subset that maximizes the true positive rate given a false positive rate of less than 5%. EEG signal features from which this subset was drawn include attributes from the time (standard deviation, entropy), frequency (power spectral density, frequency-band total power and band-power ratios, cross-spectral density, coherence, spectral entropy), and wavelet (phase synchronization) domains. To avoid overfitting, ensemble tree methods were used for classification. In addition, a parameter-number based penalty was applied in the optimization search procedure.

Results: This strategy proved successful in the unofficial phase of the PhysioNet Challenge where we achieved an official score of 0.612 which is in the top 10% of ranked scores. Using the PhysioNet Challenge scoring metric with training data, we obtained the following results:

Cross-Validation Results for Training Data

	Outcome				CPC	
Score	AUROC	AUPRC	Accuracy	F-measure	MSE	MAE
0.667	0.835	0.901	0.750	0.744	2.229	1.240