NeuroHero: A Novel QEEG and HRV Based Neural Network for Explainable Post-Anoxic Coma Prognosis

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Annually, 4.8 million people enter a post-anoxic coma following cardiac arrest, presenting a critical need for early recovery prognosis using Electroencephalogram (EEG) and Electrocardiogram (ECG) data. The shortage of neurologists and cardiologists that are needed to analyze this data, especially in rural areas, has led to incorrect prognoses and unnecessary deaths of patients who lack access to these physicians. The best machine learning models that aim to address this issue use raw EEG data, which lacks model interpretability, leaving it with little clinical utility. This research aims to solve this issue through a novel model that leverages Quantitative Electroencephalogram (QEEG) and Heart Rate Variability (HRV) feature extraction for comprehensive physiological analysis, enhancing model interpretability and clinical applicability. Utilizing the I-CARE database, EEG and ECG data was wrangled and pre-processed through industry-standard resampling, normalizing, and filtering to reduce data size and remove noise. Next, QEEG features from the Frequency and Time Domains and HRV features from the Frequency and Time Domains, Poincaré plot, HR Asymmetry and Fragmentation, Complexity, and Fractal Physiology were extracted. Finally, various QEEG and HRV feature set combinations were trained on six machine learning classifiers (Logistic Regression, LDA, CART, NB, SVM, and Neural Network). The novel Neural Network model integrating QEEG and HRV features achieved superior performance with a PR-AUC of 0.95 and ROC-AUC of 0.83, outperforming some state-of-the-art models using raw EEG data by 19%! This research reveals the significance of QEEG and HRV features in post-anoxic coma prognosis to prioritize model explainability for greater clinical utility.

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