Predicting Cognitive Impairment from Polysomnography Using Deep Learning Techniques

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Early detection of cognitive impairment is critical for timely intervention. This study explores the predictive value of polysomnography (PSG) signals in identifying future cognitive decline as part of the George B. Moody PhysioNet Challenge 2026.

Preliminary analysis comparing automated CAISR sleep staging against human annotations revealed high discordance in N1 stages (24%). Furthermore, we observed that CAISR confidence scores were significantly lower during periods of human-AI disagreement. Based on these findings and prior research identifying REM sleep as a sensitive indicator of neurodegeneration, our unofficial phase approach focuses exclusively on REM epochs.

We implemented a three-stage 1D CNN integrated with Squeeze-and-Excitation (SE) blocks. The model processes nine PSG channels (six EEG, two EOG, and one chin EMG). Each stage utilizes convolutions and SE blocks to perform channel-wise recalibration, allowing the network to emphasize informative physiological features across varying levels of abstraction. Patient-level risk is determined by averaging sigmoid probabilities across all identified REM epochs. We evaluated more complex architectures using multi-scale depthwise filterbanks with alternating cross-channel and temporal transformer attention layers, but found the SE-CNN to be more effective given the current training set size.

Using patient-level group shuffle split cross-validation on 622 recordings, our method achieved a cross-validated AUROC of 0.600. On the official Challenge hidden test set, our entry (Team: NeuroUc3m) achieved an AUROC of 0.666, currently ranked 20/244.

In the upcoming official phase, we will incorporate demographic metadata and handcrafted sleep architecture ratios. To expand beyond REM-only analysis, we plan to integrate all sleep stages by filtering for high-confidence segments based on CAISR probability outputs. We also intend to explore pre-trained transformer encoders and an in-house VQ-VAE model for ECG latent representation to improve feature extraction and generalizability.