Deep Learning Approaches for Predicting Future Cognitive Impairment through Polysomnography

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Aims: This study aims to evaluate deep learning architectures applied to polysomnography recordings (PSG) for predicting the future cognitive impairment (CI) to evaluate whether it is possible to use automated tools for early detection based on sleep biomarkers.

Methods: A balanced dataset of 611 patients (after excluding 5 subjects due to missing .edf files or incomplete channels) was used. Only algorithmic annotations of sleep stages and clinical events were used as input data. While a 1D Convolutional Neural Network (CNN) was the first approach, a hybrid CNN and Long Short-Term Memory (LSTM) architecture is being designed to effectively capture both local features and temporal dynamics. In order to train, optimize and evaluate models a 5-fold balanced cross-validation framework was implemented on 85% of the data, with an isolated 15% test set. Then, after tuning the hyperparameters, a 5-fold unbalanced cross-validation (prevalences between 5-15%) was used to verify the best models' robustness against real scenarios. Hyperparameter optimization was conducted via Bayesian inference (Optuna), using a 3-epoch average validation AUC to ensure the selection of stable models.

Results: The CNN architecture achieved a modest generalization with a test AUC of ~0.60, however, performance decreased to 0.527 on the unofficial test set (UPV Maths team). While first attempts on CNN+LSTM have being made, the next natural step will be to add raw signals and the human annotations as inputs, as well as to implement a transformer architecture to study the performance of the self-attention mechanism, as feature extraction techniques to enrich the input data.

Conclusion: Deep learning applied to PSG has been tested as a predictor of the future onset of CI. Preliminary results show a modest degree of success, highlighting that while CNN+LSTM architectures are highly capable, more techniques and other architectures might be essential to achieve better performance.