Automatic Sleep Arousal Detection using Multimodal Biosignal Analysis

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Objective: Sleep arousals include a wide spectrum of clinical features ranging from the elevation of blood pressure to nocturnal awakenings. The mechanism of sleep arousals can be considered as an unconscious reflex to respiratory and non-respiratory stimuli such as ventilator obstruction. Thus, accurate detection of such events can lead to revealing the underlying causes and consequently increasing the treatment outcome. While arousals are simply defined as an abrupt shift of EEG frequency, high within-arousal variations and class imbalance make automatic arousal detection a challenging task. The aim of this study is to develop a method to detect sleep arousals using polysomnographic recordings.

Methods: In total, 600 hand-crafted features are extracted from time, frequency, time-frequency, and phase space representation of polysomnography signals, including EEG, EOG, EMG, SaO2, and ECG. The top 50 ranked features are selected using a random forest classifier. The selected features are then fed into a hybrid classification algorithm, which combines sequential and non-sequential machine learning methods. The proposed algorithm is an ensemble of base-learners such as linear discriminant analysis, boosted decision tree, random forest, and hidden Markov model. The base-learners classify the polysomnography signals into arousal and non-arousal events. Finally, the decisions of the base-learners are further processed using a meta-learner to increase the overall performance.

Results: In the unofficial phase, the proposed method is evaluated over the PhysioNet/CinC 2018 Challenge training dataset. So far, using 5-fold cross-validation scheme, we have achieved an average area under the precision-recall and ROC curves of 0.1096 and 0.6446, respectively. As a future work, we plan to enhance our approach by extracting more informative features and modeling within-patient variations. (Username in Physionet website: snooze.team2018@gmail.com)