Detecting OSAS and Depression in OSAS Patients with ECG and EEG Signals Using Machine Learning without Feature Processing

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Abstract

Obstructive Sleep Apnea Syndrome (OSAS) and Major Depressive Disorder (MDD) are both prevalent conditions in the modern world that are associated with many comorbidities. Feature processing associated with electrophysiological signals adds time and computational cost to automated detection systems. In addition, automated systems that do not require feature extraction, such as deep learning techniques, require significantly larger amounts of data, which can be a hindrance due to lack of availability or the computational cost of augmenting data, not to mention training itself. Therefore, we aim to train classic machine learning models with which to first automatically classify sleep stages and these two conditions directly, then classify OSAS and MDD for each sleep stage. Classification input comprises features derived from electrocardiogram (ECG) and electroencephalogram (EEG) recordings taken from polysomnography studies, with no additional feature processing. We gather data from 118 subjects and use 89 for training and the remaining 29 for testing with 10-fold cross-validation. Sleep stage classification was best done with AdaBoosted trees without feature selection, yielding an accuracy of 70.52 %, F1-Score of 70.07 %, Cohen's κ of 0.34, and an AUC of 0.78. The best classification performance of OSAS happened with deep sleep with features selected via the ReliefF algorithm and subspace discriminant. It has yielded an accuracy of 98.36 %, F1-Score of 98.82 %, Cohen's κ Coefficient of 0.96, and an area under receiver operating characteristics curve (area under ROC, or AUC) of 1.00. All sleep stages without feature selection and RUSBoosted trees for classification yielded an accuracy of 72.24 %, F1-Score of 71.53 %, Cohen's κ of 0.45 and an AUC of 0.71 for classification of depression in OSAS patients. These results show that minimal feature processing may not be a hindrance in detecting OSAS and depression in OSAS patients.

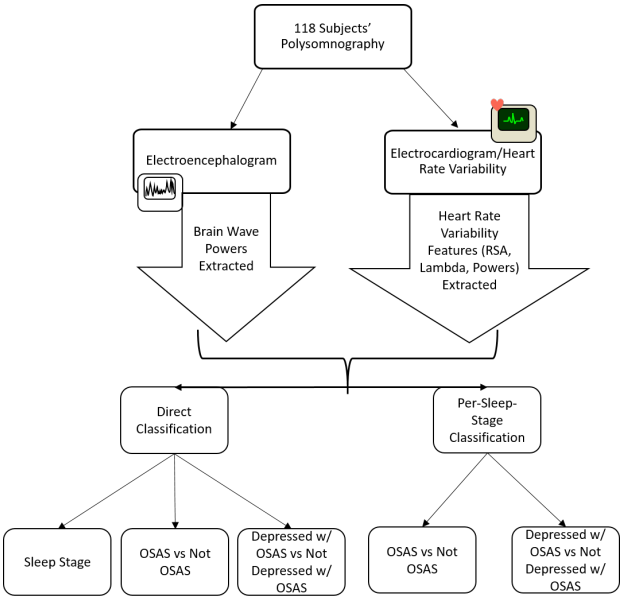

Figure 1. Graphical Abstract.

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