Comparison of various methods in the detection of respiratory effort related arousals using polysomnographic sleep studies

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Polysomnography is a test conducted to study sleep and diagnose a variety of sleep disorders. Often associated with breathing issues causing arousals, these disorders are excellent predictors of sleep quality. Some of them such as apnoea have definitive characteristics making them easier to detect. Respiratory effort related arousals(RERA-s) possess much weaker identifiers.

As part of an international challenge we were able to access the night long polysomnogram of 1893 subjects. Half of this data set was annotated with arousal locations and sleep stages making it possible to train on. The subjects had plenty of physiological signals recorded including: electroencephalography, electrooculography, electromyography, electrocardiology and oxygen saturation. Six channels of EEG were collected.

For the first part of the data processing 20 second long windows were obtained with their center point being the start of an arousal. For regions not containing any arousals, the same amount of segments were collected. Feature assessment was done with two main approaches. A first set of features was used to describe main differences between RERA and non arousal regions. The rest was determined to characterize the rate of change. The latter was described by earlier studies as great predictors of the start of an arousal. From a large pool of 222 features 32 were selected with feature selection techniques, maintaining the same ROC-AUC result.

A random decision forest(RF) was used as an initial learning method. Considering the nature of RERA-s, four stages: non-arousal, start, middle and end was distinguished. Then the RF learning was combined with a Hidden Markov Model(HMM) to enforce the sequence mentioned above. Finally the Viterbi algorithm was implemented to predict the right order of the stages. As a state of the art solution deep neural networks were also tried for the same task.

In conclusion the strength of the features lie in their predictive power of detecting the beginning and the end of arousals, making HMM a more than viable solution.