Sleep stages classification using EEG signals

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Motivation

Sleep-wake classification is important for measuring the sleep quality as it significantly affects the quality of daily life and it helps in finding out sleep disorders. A lot of studies have been made in this field but most of them used hand-crafted features extraction which may lead to less accurate classification results and longer processing time. However, some new deep learning models can also be deployed to achieve better accuracy and faster results.

Previous work

Starting with Tsinalis et.al[1], a time-frequency analysis with complex Morlet wavelets is used for features extraction and autoencoder for classifications. This depends heavily on domain knowledge experience. In[2], authors developed a 14-layers CNN followed by one or two fully-connected layers and a softmax regression layer that outputs class probabilities. Similarly, Yildirim et.al[3] developed a 1-D convolutional neural network for the classification of sleep stages based on both EEG and EOG signals. In[4], authors used a network consisting of convolutional layers for local features extraction followed by an LSTM to capture temporal dependencies. Finally, in DeepSleepNet[5], a convolutional neural networks is used to extract time-invariant features then a bidirectional-long short-term memory is used to learn transition rules among sleep stages automatically from EEG epochs. However, class imbalance problem has not been addressed in their study.

Proposed work

Our effort in this project will start by exploring and exploiting a public sleep EEG dataset, Physionet, which can be downloaded from Physionet website. The dataset contains 197 whole-night EEG data and the corresponding hypnograms (sleep patterns). These patterns consist of classes: W, R, 1, 2, 3, 4, M (Movement time) and ? (not scored).

Next, we will start building our model and apply the following:
- Using 1D CNN for features extraction,
- Setup a base line and try to outperform it,
- Apply different RNN algorithms (LSTM, GRU, BiRNN) and compare the results,
- Use dropout on RNN and see if there are improvements,
- Stack many RNN layers and see if there are improvements,
- Address imbalanced data problem by oversampling techniques,
- Consider adding an attention layer and building seq-to-seq model.

Suggested Milestones

- Cleaning and preparing dataset,
- Features extraction,
- building and testing models,
- Analyzing results,
- prepare slides and notebook report.

References

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