Automatic Sleep Stage Scoring Using Deep Convolutional Neural Networks

Abstract

According to the feature of the sleep EEG, we developed a deep learning methodology of automatic sleep stage scoring.

We used class-balanced random sampling across sleep stages for each model in the ensemble to avoid skewed performance in favor of the most represented sleep stages, and addressed the problem of misclassification errors due to class imbalance while significantly improving worst-stage classification.

We used an openly available dataset from 39 healthy young adults for evaluation.

Our method has both high overall accuracy (86.2%), and high mean F1-score (86.5%) and mean accuracy across individual sleep stages (XX%) over all subjects.

1. Introduction

After the PSG is recorded, it is divided into 30-s intervals, called epochs. According to the epoch feature, we develop a methodology combined spectrogram and deep learning.

为什么打分？以及为什么要把N3和N4融合在一起。

Following the recent development of deep neural networks, methods have been proposed to learn feature representation from EEG data. Recently, a method was proposed to learn an EEG representation by converting the signal into an image using the location of electrodes and applying deep a CNN to the image (Bashivan et al., 2015). Convolutional neural networks have also been applied to hand-chosen features for epileptic seizure recognition (Mirowski et al., 2008). Compact CNNs have been proposed to learn representation of EEG for brain computer interface tasks (Lawhern et al., 2016). These successful applications to EEG data suggest that deep learning methods have potential for analyzing EEG data from PSGs to extract efficient representations for automatic sleep-wake stage annotation.

1. Materials and Methods
2. Results
3. Discussion

This is a novel deep neural network which can be extended to other types of EEG annotation and classification tasks.

Table 1: Confusion matrix from cross-validation using the PzOz electrode.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | W (algorithm) | N1 (algorithm) | N2 (algorithm) | N3 (algorithm) | REM (algorithm) |
| W (expert) | 1305 | 21 | 3 | 2 | 4 |
| N1 (expert) | 98 | 649 | 117 | 9 | 213 |
| N2 (expert) | 6 | 33 | 1240 | 45 | 46 |
| N3 (expert) | 0 | 0 | 16 | 1281 | 1 |
| REM (expert) | 21 | 159 | 93 | 4 | 1072 |