Multi Channel Sleep Stage Classification

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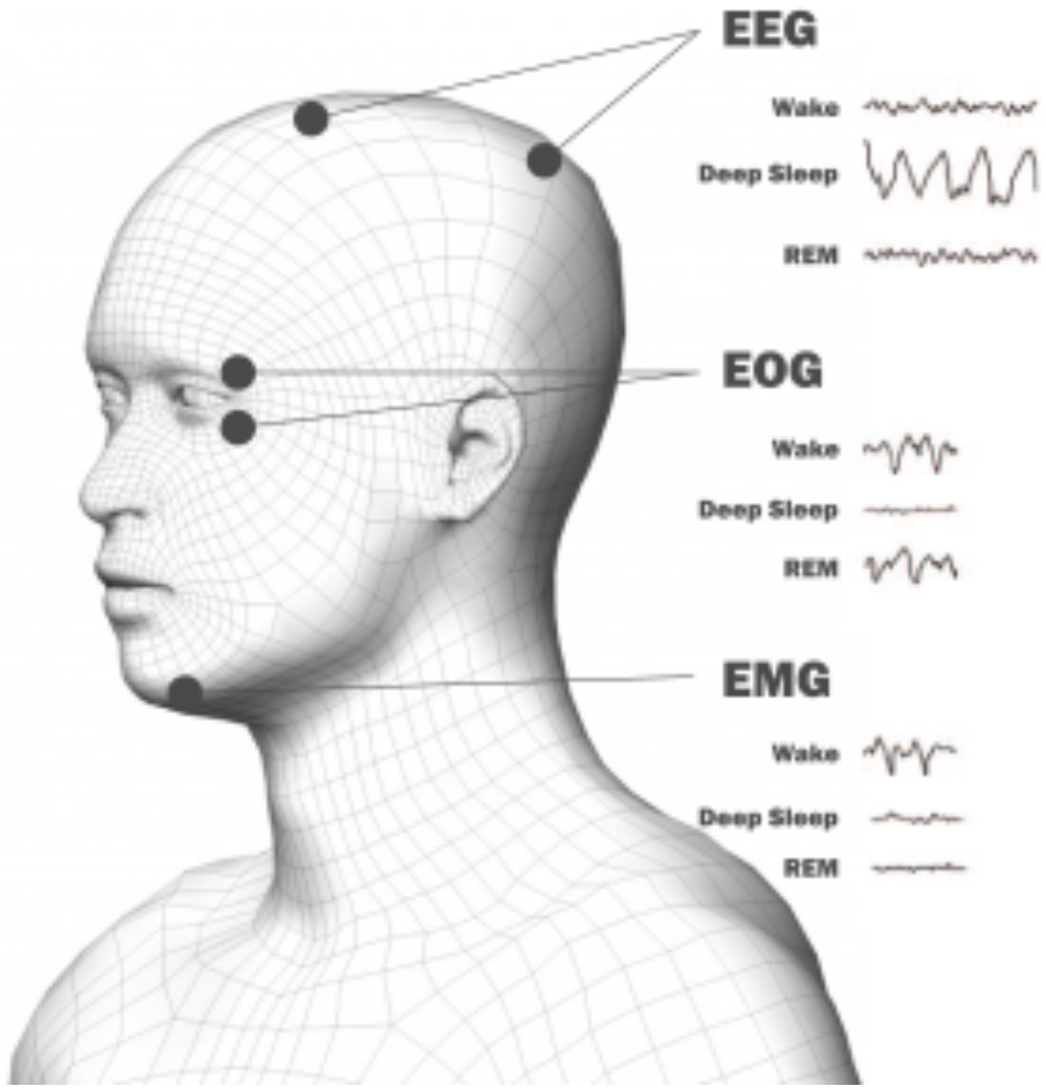
Objective

The objective of the research is to improve the accuracy of the sleep stage classification by using multiple channels of different EEG, EOG, EMG, and respiratory signals and using popular Deep Learning approaches.

Most of the time researchers focus on EEG data only, there are only a few papers that have combined different types of channels together.

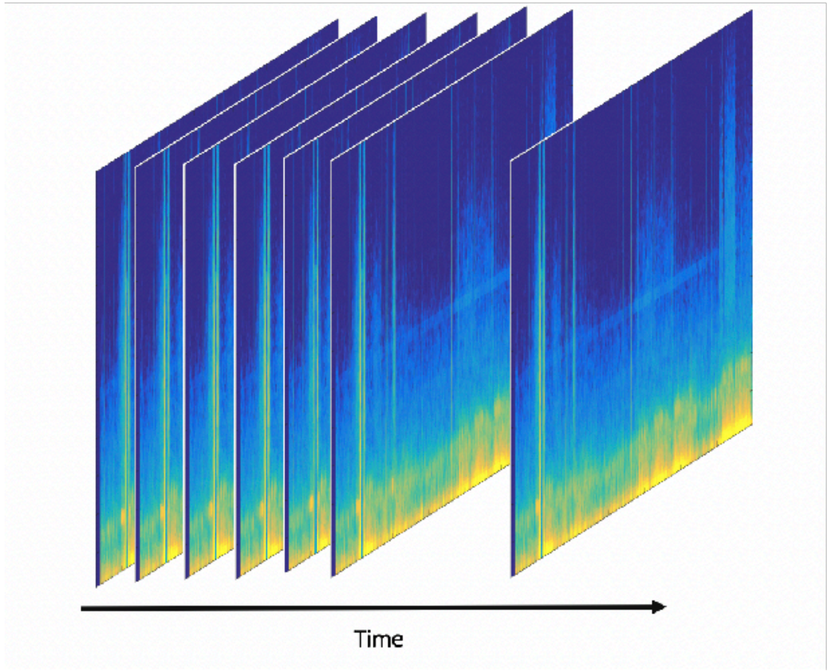


Related Work

- Learning Representations from EEG with Deep Recurrent Convolutional Neural Networks by Bashivan, 2016
- SLEEPNET: Automated Sleep Staging System via Deep Learning by Biswal, 2017
- DeepSleepNet: a Model for Automatic Sleep Stage; Scoring based on Raw Single-Channel EEG by Supratak, 2017
- A deep learning architecture for temporal sleep stage classification using multivariate and multimodal time series by Chambon, 2017

SLEEPNET: Automated Sleep Staging System via Deep Learning by Biswal, 2017

Another approach to working with EEG data is transforming the raw signal into **Spectrograms**. The approach is to use created models of image classification algorithms (such as ImageNet, Inception) as a base model and perform transfer learning to classify the spectrograms.

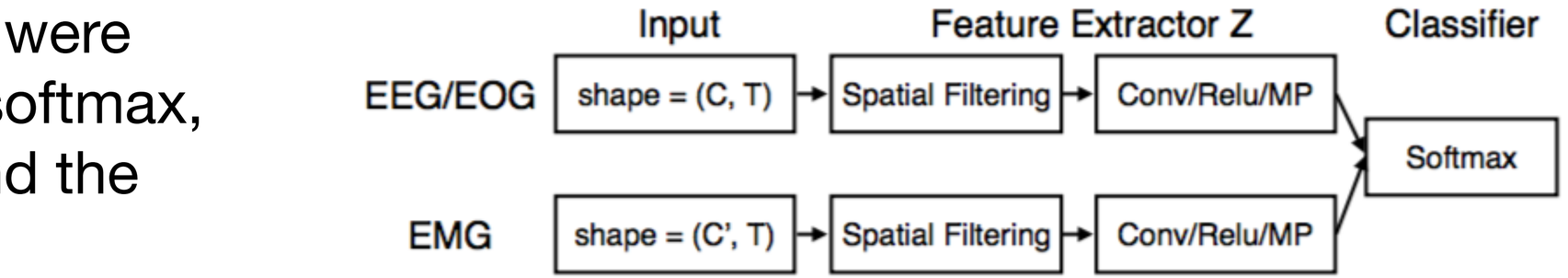


DeepSleepNet: a Model for Automatic Sleep Stage; Scoring based on Raw Single-Channel EEG by Supratak, 2017

The best results were shown in approaches that used **raw EEG data**. The paper by Supratak showed 86.2% of the accuracy. A Convolutional Neural Network with LSTM memory cell is implemented.

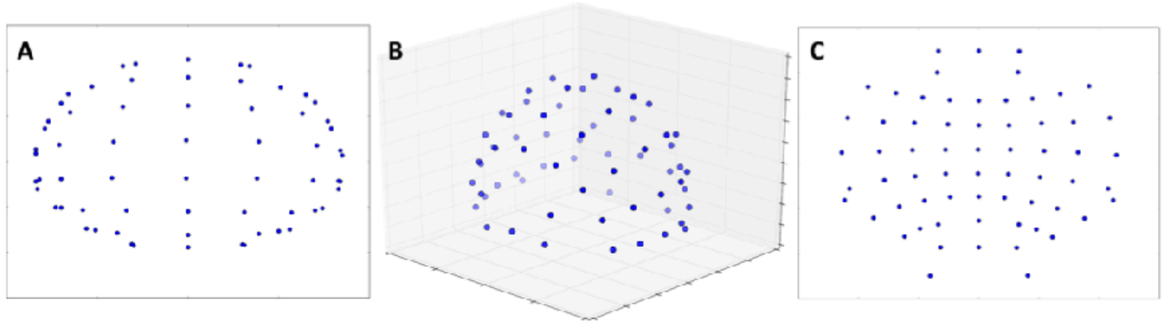
A deep learning architecture for temporal sleep stage classification using multivariate and multimodal time series by Chambon, 2017

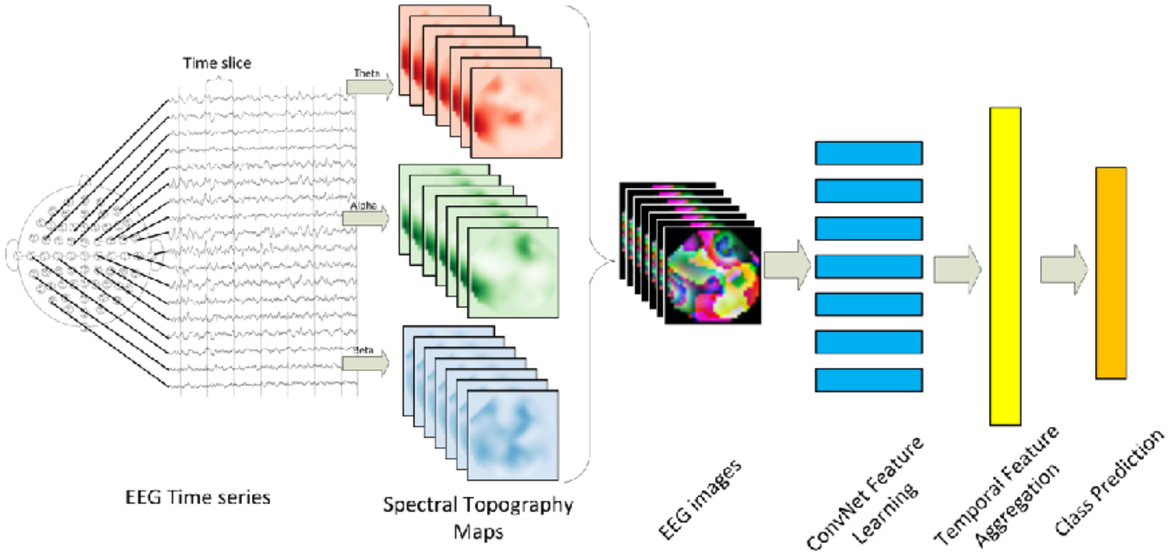
2 Convolutional Networks were utilised and combined at softmax, one for EEG/EOG data, and the second one for EMG.



Learning Representations from EEG with Deep Recurrent Convolutional Neural Networks by Bashivan, 2016

There has been work done in creating a novel approach to work with EEG data by Bashivan in 2016. His research team has worked with Classification of the Memory Task Load. They have turned the raw EEG data into an **image**, using FFT and Polar Projection. Later they fed the images into a Convolutional Neural Network with LSTM memory cells, that gave them a test error of 8.89%





Proposed Approach

- Determining the Sleep Stage is mainly done through EEG, however there are other data channels that are being recorded. EMG and EOG signals can help determining the sleep stage more accurately.

- The difficulty is the difference of the signals features, therefore combing them is difficult, that is the reason that paper by Chambon used 2 networks.

Datasets:

- The Sleep-EDF Database by Kemp, 2000:
  - consists of 61 polysomnograms with 4 channels:
    - EEG Fpz-Cz
    - EEG Pz-Oz
    - EOG horizontal
    - submental chin EMG
- MASS Dataset by O’Reilly, 2014:
  - consists of 200 participants with 20 channels
  - requires an irb

Work Completed:

- We have redesigned the input shapes of the network DeepSleepNet created by Supratak, and ran the model with an input of a multi dimensional vector consisting of raw EEG, EEG, EOG and EMG data.

- While performing k fold validation the average accuracy of the model was at 49%, with fold 7 at around 74% accuracy.

Ongoing Work

- Since combination of the raw EEG Fpz-Cz, EEG Pz-Oz, EOG and EMG data have given low results, the approach of Bashivan was taken.

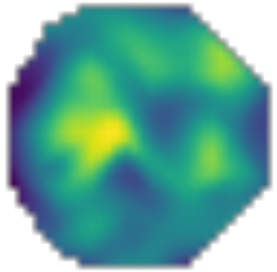
- The team is working on extracting FFT of power spectrum domain for EEG and EOG data and looking at the ways multiple types of channels could be combined into an image.

- With the images generated like Bashivans, there will be 3 types of networks implemented:

    - Convolutional Neural Network with LSTM cell with Self Representation layers

    - A Convolutional Neural Network with LSTM without Self Representation layers

    - Transfer Learning from either Inception V3 or VGG 16 model



Bashivan generated image

Questions?