Comparison of Attention-based Deep Learning Models for EEG Classification

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Research

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Abstract

Deep Learning (DL) has recently shown promising classification performance in Electroencephalography (EEG) in many different scenarios. However, the complex reasoning of such models often prevent the user to explain their classification abilities. Attention, one of the most recent and influential ideas in DL, allows the models to learn which portions of the data are relevant to the final classification output. In this work, we compared three attention-enhanced DL models, the brand-new InstaGATs , an LSTM with attention and a CNN with attention. We used these models to classify normal and abnormal, including artifactual and pathological, EEG patterns in three different datasets. We achieved the state of the art in all classification problems, regardless the large variability of the datasets and the simple architecture of the attention-enhanced models. Additionally, we proved that, depending on how the attention mechanism is applied and where the attention layer is located in the model, we can alternatively leverage the information contained in the time, frequency or space domain of the EEG dataset. Therefore, attention represents a promising strategy to evaluate the quality of the EEG information, and its relevance for classification, in different real-world scenarios.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

Data preparation (common for all models). (a) An example of a C-channels EEG dataset. (b) Segmentation into 2 s frames (in two representative channels, i.e., channel 1 and 5). (c) The set of T correlation matrices, $r(t)$, obtained from each dataset with T segments.

Figure 2

The architecture of the InstaGATs model (modied from [19]).

Figure 3

The architecture of the LSTM+Att (adapted from [26]).

Figure 4

The architecture of the CNNs+Att model (adapted from [27]).

Figure 5

F1-scores for InstaGATs in cross-validation. (a) TUH EEG Abnormal. (b) TUH EEG Artifact. (c) TUH EEG Seizure.