Autoencoder Artefact Removal for Brain Signals and Impact on Classification Performance

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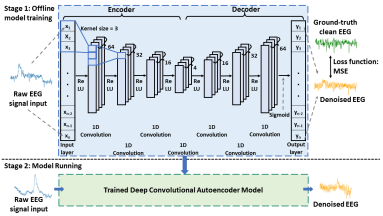
Electroencephalography (EEG) signals, as used in this year's Challenge, are small and very sensitive to noise and interference. In standard analysis pipelines Independent Component Analysis (ICA) is used to remove artefacts. However the numerical condition means ICA requires a large number of channels for good performance, and so is not best suited for the 18 channel data in the Challenge, nor for use in the ICU where a reduced number of channels can help with setup time and ease of use. We hypothesized that an autoencoder machine learning approach may allow a channel count independent artefact removal approach, giving cleaned EEG, and hopefully improved true positive rate, while naturally complementing machine learning based classification used for the main Challenge problem.

Our autoencoder architecture is shown below. It is trained on publicly available non-Challenge data which provides both raw and cleaned EEG signals (e.g. cleaned via ICA). Our main Challenge classifier is 2D-CNN based, using the Short-Time Fourier Transform to obtain an image representation of the EEG. It uses a customised loss function wherein output probabilities instead of predicted labels are utilised to provide differentiable loss for gradient calculation and weight update, and severely penalises for False Positive Rates (FPR) > 0.05, as required by the challenge.



Proposed autoencoder architecture.

To date, the autoencoder and CNN are working, but are yet to be combined to assess the impact on Challenge performance. Using raw, non-cleaned, EEG data as the baseline comparison case, we randomly split 10 patients into a hold-out test set, and used the rest for 5-fold class-stratified cross validation with metrics of FPR and recall for optimal model selection. Two trials were conducted on different test data and the average challenge scores are 0.6115, 0.4725, 0.3335 and 0.8055 for12, 24, 48 and 72 hours respectively.