Project: Deep Learning (DL) Enabled EEG Artifact Removal Algorithms for Real-World BCI Applications

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Removing Noise From Brain Signals with AI to Improve Brain-Computer Interface (BCI) Tasks

Background

Typical BCI workflow

Signal Acquisition → Feature Extraction → Device Interface

Accuracy of the BCI task is affected by the amount of noise in the EEG signal

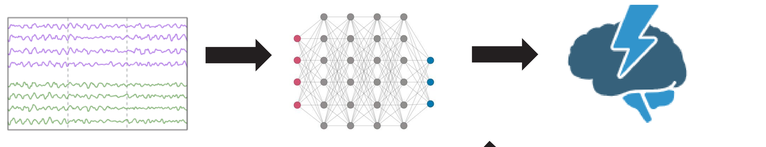
Objective

Does EEG noise removal using DL techniques improve performance of real world BCI tasks?

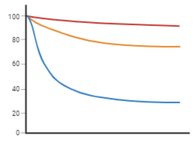
Methods

DL Pipeline for BCI Validation

Open-access dataset (*EEGdenoiseNet* [1]) → Deep Learning Model → BCI Task Validation [2]

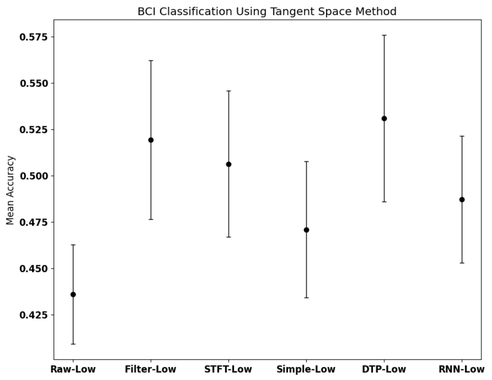


Model Evaluation



Baseline and state-of-the-art models from literature, as well as a novel Short-time Fourier Transform based CNN model were compared.

Results



Model	Accuracy	Model Size
SimpleCNN	0.47 ± 0.04	10.5M
RNN	0.49 ± 0.03	788k
DTPNet	0.53 ± 0.04	40M
Our model (STFT)	0.51 ± 0.04	16M

Conclusion

- Overall, DL models improved the performance of the classification task.
- Results from DL models were comparable with bandpass filtering, a traditional noise removal technique.
- Our novel CNN is the second-best performing model amongst all the DL algorithms.

Next Steps

1. Evaluate level of noise in validation dataset
2. Further analyze properties of BCI data
3. Experiment with other BCI datasets

Relevance

Development of novel EEG artifact removal techniques will enhance BCI usability in real-world environments, extending benefits children with severe motor disabilities.

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References: [1] Zhang, H., Zhao, M., Wei, C., Mantini, D., Li, Z., and Liu, Q. (2021b). EEGdenoiseNet: a benchmark dataset for deep learning solutions of EEG denoising. *J. Neural Eng*. 18:056057. doi: 10.1088/1741-2552/ac2bf8
[2] Goldberger, A., Amaral, L., Glass, L., Hausdorff, J., Ivanov, P. C., Mark, R., ... & Stanley, H. E. (2000). PhysioBank, PhysioToolkit, and PhysioNet: Components of a new research resource for complex physiologic signals. Circulation [Online]. 101 (23), pp. e215–e220.