

Peer Review

Review of: "STEAM-EEG: Spatiotemporal EEG Analysis with Markov Transfer Fields and Attentive CNNs"

Wellington P. dos Santos¹

1. Biomedical Engineering, Universidade Federal de Pernambuco, Brazil

This work presents STEAM-EEG, a novel framework for enhancing EEG signal analysis by integrating Singular Spectrum Analysis (SSA) for trend-seasonal decomposition, parallel 1D Convolutional Neural Networks (1D-CNNs) with modified attention mechanisms, and Markov Transfer Field (MTF) imaging. This approach effectively captures the complex spatiotemporal dynamics of EEG signals, improving classification accuracy and interpretability. The modified attention mechanism enhances the model's focus on relevant features across multiple EEG channels, while MTF imaging provides informative visual representations of EEG patterns. Overall, STEAM-EEG addresses significant challenges in EEG analysis, offering potential applications in neuroscience research and clinical diagnosis.

The main contributions of the STEAM-EEG framework to EEG signal analysis are as follows:

Integrated Framework: STEAM-EEG synergistically combines Singular Spectrum Analysis (SSA) for trend-seasonal decomposition, parallel 1D Convolutional Neural Networks (1D-CNNs) with modified attention mechanisms, and Markov Transfer Field (MTF) imaging. This unique combination enhances the capture and analysis of complex spatiotemporal dynamics in EEG signals.

Modified Attention Mechanism: The framework introduces a modified attention mechanism specifically designed to capture cross-channel dependencies in parallel 1D-CNNs. This enhancement improves the model's ability to focus on relevant features across multiple EEG channels, thereby increasing the effectiveness of the analysis.

MTF Imaging for Visualization: By leveraging MTF imaging, STEAM-EEG models spatiotemporal dynamics and generates informative visual representations of EEG patterns. This improves both the analysis and interpretability of the results, facilitating better understanding and decision-making in clinical contexts.

Improved Classification Accuracy: Experimental results suggest that STEAM-EEG may offer improvements in classification accuracy compared to existing methods. The SSA decomposition enhances the signal-to-noise ratio, while the MTF imaging captures important spatiotemporal dependencies, contributing to better performance in EEG classification tasks.

Potential for Broader Applications: While the current focus is on specific EEG classification tasks, the STEAM-EEG framework could potentially be adapted for a wider range of biomedical signal processing applications, benefiting both research and clinical practices in neuroscience.

These contributions collectively address the challenges inherent in EEG signal analysis, such as complexity, non-stationarity, and noise artifacts, leading to more effective and interpretable results.

In order to improve the discussion, I just suggest the authors to present the results of ANOVA non-parametric tests over the results presented on Table 1, as well as the box plots and their associated comments, in order to make the comparisons among methods statistically more robust.

Declarations

Potential competing interests: No potential competing interests to declare.