Mamba-CCA: An Efficient Framework for EEG Emotion Recognition

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Abstract

Emotion recognition from electroencephalogram (EEG) signals is critical for applications in mental health, human-computer interaction, and adaptive systems. However, existing methods struggle with modeling long-term dependencies and addressing the ambiguity between emotion classes. To address these challenges, we propose Mamba-CCA, a novel framework that combines Selective State Space Modeling (SSM) with a Class Confusion-Aware Attention (CCA) mechanism. Mamba-CCA leverages the efficiency of Mamba's linear-time modeling to capture both local and global temporal features in EEG signals while significantly reducing computational costs. The CCA mechanism further enhances classification by dynamically resolving ambiguities between emotional classes. Experimental results on the SEED and SEED-V datasets demonstrate that Mamba-CCA achieves state-of-the-art classification accuracies of 96.02% and 83.54%, respectively, surpassing the previous best model, CSET-CCA, by 0.84% and 1.48%. Additionally, Mamba-CCA reduces inference time by 20.12% and computational cost by 21%, making it highly suitable for real-time applications.

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