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Autoencoder Empowered EEG Data Classification: A Self-Supervised Learning Approach

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Electroencephalogram (EEG) analysis plays a crucial role in understanding brain activity and diagnosing neurological conditions. Traditional methods often struggle with the complexity and high dimensionality of EEG data. This study analysed these challenges by developing a novel framework that leverages generative self-supervised learning and autoencoder architecture to enhance EEG data analysis. The primary problem lies in the accurate and efficient extraction of meaningful features from EEG signals, which are inherently noisy and complex. The objectives of this research study were to improve feature extraction from EEG data using an autoencoder and accurately predict sleep stages using advanced machine learning techniques. The methodology involveds pre-processing the EEG data, segmenting it into 30-second epochs, and annotating it according to standard scoring guidelines. An autoencoder was used for feature extraction, followed by the application of Synthetic Minority Over-sampling Technique to address the class imbalance. The encoded features were then classified using a robust machine learning model within a TensorFlow environment. Results demonstrate a high average F1-score of 0.97, indicating the effectiveness of the proposed framework. High evaluation metrics, such as Area Under the Curve, Cohen's Kappa Coefficient, and Matthews Correlation Coefficient, further validate the model's performance. This study presents an effective framework for EEG data analysis, combining generative self-supervised learning and autoencoder techniques. Future work will focus on enhancing the autoencoder architecture and applying transfer learning to diverse datasets.

Keywords: *machine learning, TensorFlow, EEG classification, neural networks, generative self-supervised learning.*