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| **Title:** | From Brainwaves to Insights: Leveraging Machine Learning for Real-Time Prediction of Mental States from EEG Data | | | |
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| **Abstract:** | | |  | |
| The detection of mental states with EEG (Electroencephalogram) signals was investigated in this study using supervised and unsupervised machine learning approaches. EEG, a non-invasive tool for measuring brain activity, was utilized to evaluate cognitive and emotional states through various frequency bands, namely Delta, Theta, Alpha, Beta, and Gamma. Supervised classification was performed using Random Forest, while unsupervised analysis was conducted with K-Means clustering in combination with Principal Component Analysis (PCA) for dimensionality reduction. Feature extraction was carried out using wavelet transforms to address the intricate and noisy nature of EEG data. EEG data from channels TP9, AF7, AF8, and TP10 were analyzed in Rest and Focus sets. It was demonstrated that the Random Forest model achieved an accuracy of 67 % with a precision-recall tradeoff, whereas K-Means clustering showed relatively weak differentiation of mental states, as indicated by a cluster silhouette score of 37.76 %. These findings highlight the necessity of further refinement in feature extraction and model tuning to enhance performance in applications such as mental health monitoring, neurofeedback, and human-computer interaction. | | | | |