
EEG Signals, Machine Learning, and Optimization Techniques for Automatic Dream Detection during REM and NREM Sleep

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Our research aims to make a step forward towards creating new approaches for automatic dream detection using electroencephalographic (EEG) signals and machine learning (ML). Our study demonstrates the feasibility of using high-density EEG signals to train ML models that accurately identify dream experiences (DE) and no experiences (NE) during non-rapid eye movement (NREM, N2) and rapid eye movement (REM) sleep.

We explored various feature extraction techniques, including Common Spatial Patterns (CSP) and the Discrete Wavelet Transform (DWT), and employed multiple ML models. Permutation-based channel selection methods and the non-dominated sorting genetic algorithm II (NSGA-II) were utilized to identify the most informative EEG channels.

Our results, evaluated in two public datasets, achieved high classification performance in both NREM/REM or only NREM data, with accuracies up to 0.94, F1-score, precision, recall, and area under the receiver operating characteristic (AUROC) of 0.975, and a kappa coefficient of 0.88. It is worth noting that as few as 8-10 EEG channels could still yield accuracies greater than 0.85, and the removal of strategic channels from the occipital area slightly enhanced performance. Furthermore, our models showed an accuracy of 0.70 even when subjects reported dreams without recall during the N2 sleep stage.

Our work highlights the feasibility of automatic dream detection across NREM and REM stages using ML techniques and the potential to develop low-cost portable EEG devices for real-life applications. However, challenges in generalizing ML models to unseen subjects were identified, emphasizing the need for more research to improve model robustness and adaptability.
