Paper Title:
Interpretable Emotion Recognition Using EEG Signals

Paper Link:
https://ieeexplore.ieee.org/document/8762129

1 Summary

1.1 Motivation
Most studies on EEG-based emotion recognition prioritize achieving high classification accuracy rather than exploring the interpretability of emotion progression. Conventional research often overlooks the intricacies of when and how emotions are stimulated during experiments, underscoring the necessity for an innovative approach to fill this gap.

1.2 Contribution
This method introduces an interpretable approach to emotion recognition using EEG signals, with a specific focus on understanding the progression and stimulation of emotions. By employing autoencoders, it extracts abstract features from EEG signals, thereby boosting the discriminative power of these features. Critically, it addresses a gap in current research by placing a strong emphasis on the interpretability of emotion progression within EEG-based emotion recognition studies.

1.3 Methodology
The research proposed a method for understanding emotional activation mechanisms based on EEG signals and machine learning, comprising preprocessing, feature extraction, and classification stages. It employed a coefficients-based approach for emotion recognition from EEG signals, with a dual focus on improving interpretability and accuracy.

1.4 Conclusion
The proposed method showcased enhanced classification accuracy relative to existing benchmark algorithms through the utilization of weight coefficients derived from correlation and entropy analyses. The interpretability of the method was underscored via correlation and entropy curves, illustrating alignment with the documented progressive activation process of emotions in existing literature.

2 Limitations

2.1 First Limitation
The discussion on the generalization of the proposed method to other EEG datasets was brief.

2.2 Second Limitation
The absence of comparisons with newer state-of-the-art algorithms in EEG-based emotion recognition was noted.

3 Synthesis
The paper's proposed method showcased enhanced classification accuracy by incorporating weight coefficients derived from correlation and entropy coefficients. Additionally, the interpretability of the method was underscored through correlation and entropy curves, aligning well with the documented progressive activation process of emotion in the literature. However, limitations of the study include insufficient discussion regarding the method's applicability to other EEG datasets and a failure to compare it with more recent state-of-the-art algorithms in EEG-based emotion recognition.

Paper Title:
Multi-Domain Feature Fusion for Emotion Classification Using DEAP Dataset

Paper Link:
https://ieeexplore.ieee.org/document/9321314

1 Summary

1.1 Motivation
The paper seeks to enhance emotion classification models utilizing EEG data by pinpointing stable features well-suited for this task. Motivated by the imperative to cultivate emotion recognition systems employing EEG signals with heightened ecological validity and a broader spectrum of emotion classes, the study embarks on an innovative journey. This innovative approach involves extracting multi-domain features from wavelet, time, and frequency domains, driven by the overarching aim of attaining notable accuracy in emotion classification for applications in affective computing.

1.2 Contribution

The study introduces an emotion recognition technique employing the DEAP dataset, where selected channels are utilized, and features are extracted from time, frequency, and wavelet domains. It identifies stable features and frequency bands crucial for emotion classification, achieving an average accuracy ranging from 65.72% to 65.92% across nine emotional states. Leveraging SVM and cross-validation techniques, the proposed method demonstrates its efficacy. By harnessing multi-domain features from wavelet, time, and frequency domains, it aims to bolster emotion classification accuracy, catering to diverse applications in affective computing.

1.3 Methodology

A machine learning framework was applied for emotion classification utilizing the DEAP dataset, integrating multi-domain features both independently and in combination. The study encompassed preprocessing steps for EEG data refinement, feature selection, and feature-level fusion to pinpoint stable features conducive to emotion classification.

Entropy and energy values were computed via Discrete Wavelet Transform (DWT) across alpha, beta, and gamma bands, with differential entropy calculations employed for wavelet-based features. Moreover, a grid search technique was adopted to identify significant electrodes, complemented by EEG signal preprocessing methods such as down-sampling, band-pass filtering, and artifact removal.

1.4 Conclusion

The paper introduced an emotion recognition model leveraging EEG data, incorporating multi-domain features from wavelet, time, and frequency domains for emotion classification. It attained notable accuracy in classifying nine emotion states through SVM and cross-validation methodologies. Notably, entropy features within the wavelet domain, specifically across three frequency sub-bands, emerged as the top performers among other features.

2 Limitations

2.1 First Limitation

Difficulties arise when attempting to extend methods exhibiting higher accuracy to encompass a broader spectrum of emotional states and a larger pool of participants.

2.2 Second Limitation

Possible constraints may arise from the selection of features and electrodes for emotion classification utilizing EEG data.

3 Synthesis

The study presented a model for emotion classification utilizing EEG signals from the DEAP dataset, achieving an average accuracy of 65.92%. Multi-domain features encompassing wavelet, time, and frequency domains were employed for emotion classification. Significantly, entropy features within the wavelet domain were identified as crucial for accurate emotion classification. Additionally, EEG signal preprocessing was conducted, incorporating band-pass filtering and artifact removal techniques.

Paper Title:
EEG based Emotion Recognition using SVM and PSO

Paper Link:
https://ieeexplore.ieee.org/document/8342809

1 Summary

1.1 Motivation
The paper's objective is to employ EEG signals to classify human emotions into four distinct states: happy, sad, angry, and relaxed, with the aim of enhancing machine empathy towards users. The study utilizes spectral and statistical features derived from discrete wavelet transform, coupled with an SVM classifier optimized through the PSO algorithm, achieving an overall emotional accuracy of 80.625%. Notably, EEG spectral analysis, with a focus on Power Spectral Density (PSD) features, is underscored as pivotal for delineating variations in EEG signals and enhancing classifier efficacy.

1.2 Contribution
The research utilizes EEG signals for the classification of human emotions into distinct states, aiming to enhance machine empathy. It implements feature extraction and classification techniques through MATLAB, with a specific focus on power spectral density and coherence estimates for emotional recognition. By incorporating Russell's Circumplex model, the study represents emotional space, thereby enabling the inference of emotions such as happiness, sadness, anger, and relaxation based on valence and arousal levels.

1.3 Methodology
The study utilizes preprocessed EEG signals sourced from the DEAP dataset for emotion classification, with feature extraction and classification conducted using MATLAB. Extracted features encompass Power Spectral Density (PSD), Magnitude Squared Coherence Estimate (MSCE), Energy, and Entropy, with Particle Swarm Optimization (PSO) employed for feature selection. A Support Vector Machine (SVM) classifier with an RBF kernel is utilized for classification. The process of feature extraction, selection, and classification is iterated across various channel combinations.

1.4 Conclusion
The study attained an overall emotional accuracy of 80.625% by classifying EEG signals into happy, sad, angry, and relaxed states. Feature extraction techniques such as Power Spectral Density (PSD) and Magnitude Squared Coherence Estimate (MSCE) played pivotal roles in emotional recognition. Furthermore, the SVM classifier with an RBF kernel exhibited a robust learning capacity for emotion classification.

2 Limitations

2.1 First Limitation
The paper concentrated on a limited set of emotional states (happy, sad, angry, relaxed) and did not explore a broader spectrum of emotions.

2.2 Second Limitation
The paper did not compare the performance of the SVM classifier with other machine learning algorithms for emotion recognition.

3 Synthesis
The research underscored the pivotal role of machine learning techniques in advancing affective computing and fostering empathetic machine interactions. It emphasized the significance of feature selection and optimization through the PSO algorithm to enhance classification accuracy. Furthermore, the study advocated for exploring a wider array of emotions beyond the typical happy, sad, angry, and relaxed states for emotion recognition using EEG signals.

In addition, the study conducted a comparative analysis, evaluating the performance of the SVM classifier against other machine learning algorithms for emotion recognition using EEG signals.