EEG + Text: Sentiment Analysis and Cognitive State Evaluation

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Introduction: Why EEG + Text?

- • EEG signals capture brain activity related to emotions and cognitive states.
- • Text analysis helps in understanding sentiment and user intent.
- • Combining EEG and Text enhances sentiment analysis for improved accuracy in mental health, BCI, and emotion recognition applications.

Research Motivation

- • Recent studies show EEG signals can detect emotions effectively.
- • Text-based sentiment analysis is widely used, but lacks physiological validation.
- • EEG + Text fusion improves accuracy in predicting cognitive states.
- • Applications in mental health, brain-computer interfaces, and human-computer interaction.

Datasets Used

- • EEG Datasets:
- - DEAP (Emotion Recognition)
- - SEED (Sentiment EEG Database)
- - PhysioNet EEG (Cognitive States)
- Text Datasets:
- - IMDB Movie Reviews (Sentiment Analysis)
- - Twitter Sentiment Dataset
- - Reddit Mental Health Text Data

Preprocessing Techniques

- • EEG Data Preprocessing:
- - Noise removal (Independent Component Analysis, Bandpass Filtering)
- - Extracting frequency bands (Delta, Theta, Alpha, Beta, Gamma)
- • Text Data Preprocessing:
- - Tokenization, stopword removal, stemming
- - Word embedding (Word2Vec, GloVe, BERT)

Feature Extraction

- • EEG Feature Extraction:
- - Time-domain (Mean, Variance, Skewness)
- - Frequency-domain (Power Spectral Density, FFT)
- - Wavelet Transform (Signal Decomposition)
- • Text Feature Extraction:
- - TF-IDF, Bag-of-Words (BoW)
- - Deep Learning Embeddings (BERT, FastText)

Model Selection

- • Machine Learning Models:
- - SVM, Random Forest, KNN

- • Deep Learning Models:
- - CNN for EEG Feature Extraction
- - LSTM for Text Processing
- - Hybrid CNN + LSTM for EEG + Text Fusion

Results & Performance Metrics

- • Accuracy, Precision, Recall, F1-score
- • Confusion Matrix for model evaluation
- • Ablation study comparing EEG-only, Text-only, and EEG+Text models
- • Performance comparison with state-of-the-art methods

Future Scope & Conclusion

- • Extend the model to real-time applications (Mental Health Monitoring, BCI)
- • Enhance EEG signal quality using advanced filtering techniques
- • Train larger models with more diverse datasets
- • Deploy the system using Flask/FastAPI for real-time sentiment analysis

References

- 1. Koelstra et al. (2012) - DEAP: A database for emotion analysis using EEG.
- 2. Zheng et al. (2015) - SEED: A sentiment EEG dataset for emotion research.
- 3. Li et al. (2020) - EEG-based emotion recognition using deep learning.
- 4. Research papers on sentiment analysis and BCI applications.