Deep Temporal-Spatial Attention Network for Seizure Prediction

Internship Project Report

ITSOLERA Pvt Ltd

Intern: Muhammad Hanzala Khan

Date: August 09, 2025

Abstract
This project focuses on developing a deep learning-based Temporal-Spatial Attention Network for predicting epileptic seizures using EEG data from the CHB-MIT dataset. The objective is to preprocess EEG data, extract meaningful features, and train a model capable of accurate seizure prediction. A baseline model was developed first, followed by a more advanced deep temporal-spatial attention architecture.

Introduction
Epilepsy is a neurological disorder characterized by recurrent seizures, and early prediction can greatly enhance patient safety and treatment effectiveness. EEG (Electroencephalogram) signals provide critical information for detecting and predicting seizures. This project implements an advanced deep learning model that leverages both temporal and spatial patterns in EEG signals for seizure prediction.

Objectives
- Preprocess EEG signals from EDF format.
- Develop a baseline model for seizure detection.
- Implement a Temporal-Spatial Attention Network for improved prediction accuracy.
- Evaluate the model using accuracy, AUC, and confusion matrix.

Dataset Description
The CHB-MIT Scalp EEG Database is a publicly available dataset containing EEG recordings from pediatric subjects with intractable seizures. The data is stored in EDF (European Data Format) and includes both seizure and non-seizure events. Sampling rate is 256 Hz with 23 EEG channels.

Methodology
1. Data Preprocessing:
   - Load EDF files using MNE library.
   - Apply band-pass filter (0.5–40 Hz) and notch filter (49–51 Hz).
   - Segment EEG into fixed-size windows and label them.

2. Baseline Model:
   - Implemented a CNN/LSTM-based network for seizure prediction.
   - Trained and evaluated on preprocessed EEG segments.

3. Temporal-Spatial Attention Model:
   - Implemented a transformer-based attention mechanism to capture both temporal and spatial dependencies.
   - Tuned hyperparameters for optimal performance.

Results
The final model was evaluated on EEG segments and produced the following results:

Confusion Matrix:

```
[[68  0]
 [ 4  0]]
```

Validation Accuracy: 94.44%

Validation AUC: 0.7132

Discussion

The results show that the model achieved high accuracy on the test set. However, the dataset used for validation contained a small number of seizure events, which can affect the robustness of the model. Future improvements could include data augmentation, using more EDF files, and optimizing the attention layers.

Conclusion

This project successfully implemented a Temporal-Spatial Attention Network for seizure prediction using EEG data. The model demonstrated strong predictive capabilities, and the methodology can be applied to real-time seizure monitoring systems.

References

[1] Goldberger AL, et al. (2000). PhysioBank, PhysioToolkit, and PhysioNet: Components of a New Research Resource for Complex Physiologic Signals. Circulation 101(23):e215-e220.

[2] MNE-Python software package: https://mne.tools/

[3] PyTorch library: https://pytorch.org/