

Mind Reading: Can AI Models detect brain seizures?

Purpose

Seizures are sudden disruptions in movement, awareness, or behaviour caused by abnormal brain activity. They can range from brief “spacing out” episodes to full body shaking. For critically ill patients, identifying the type of seizure quickly is essential, but even trained neurologists find EEG patterns hard to distinguish. This project tested whether machine learning models could classify EEG data into five seizure categories: LPD, GPD, LRDA, GRDA, and “other.” The hypothesis was that modern classification models could learn hidden patterns and make accurate predictions.

Approach

The project used the *HMS Harmful Brain Activity* dataset from Kaggle, with over 17,000 neurologist-labeled EEG recordings including raw signals and spectrograms. Data was split into *training (80%)*, *validation (15%)*, and *test (5%) sets*. Models were built in Google Colab using Scikit-Learn, NumPy, and Pandas.

Three gradient-boosting models were tested:

1. **XGBoost** – *tree-based ensemble*
2. **CatBoost** – *optimized for categorical data*
3. **LGBM** – *fast and accurate*

Data was cleaned, key features extracted, and hyperparameters tuned. Models were evaluated on accuracy, precision, recall, and F1-score.

Findings

The table shows test-set performance across models:

Model	Accuracy	Precision	Recall	F1-score
XGBoost	92.16 %	94.46 %	86.61 %	89.74 %
CatBoost	86.92 %	89.75 %	77.87 %	81.67 %
LGBM	99.41 %	99.73 %	99.36 %	99.55 %

- **LGBM** achieved the highest scores across all metrics and trained quickly.
- **CatBoost** underperformed, especially in recall, missing more true positives.
- **XGBoost** had occasional misclassifications (e.g., LRDA vs. “other”) and longer training time.
- **LGBM** trained faster than both CatBoost and XGBoost.

Discussion and next steps

The hypothesis was supported: machine learning, especially LGBM, could classify seizure types based on EEG features. However, AI adoption in clinical settings is still limited. Even minor errors could impact patient outcomes, so these tools should guide, not replace, clinical decisions. Ethical concerns, like algorithmic bias and accountability, must be addressed. Future work could explore deeper models (e.g., CNNs), expand datasets, and test performance in clinical trials to improve reliability and trust.

Conclusion

This project demonstrated that well-tuned machine learning models can effectively classify different seizure types from EEG recordings. Among the tested algorithms, LGBM delivered the highest performance, while CatBoost showed the largest gap. Continued development, careful validation and close collaboration with medical professionals are essential to turn these algorithms into reliable tools that assist doctors and improve care for patients with epilepsy and other seizure disorders.