Using a Machine Learning Model to Prevent Misdiagnosis of Narcolepsy

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BACKGROUND

Sleep cycles and phases

- There are 4-6 sleep cycles per night in a healthy individual (Suni & Singh, 2023)
- Sleep consists of rapid eye movement (REM) and non-rapid eye movement (NREM) phases
- Furthermore, NREM can be divided into stages N1 through N3 (Hussain et al., 2022).
- Each stage has different purposes

Sleep disorders

- Sleep disorders affect an individual's ability to sleep or their experiences while asleep
- Some common sleep disorders are insomnia, sleep apnea, and sleepwalking

Misdiagnosis

- Since cataplexy can appear similar to a seizure, narcolepsy can be misdiagnosed as epilepsy (Diukova et al., 2021)

Narcolepsy

- Narcolepsy is a rare chronic sleep disorder in which people experience excessive daytime sleepiness (EDS)
- Cataplexy, sudden weakness in the muscles triggered by strong emotions, is characteristic of T1 narcolepsy
- The condition comes from the deficiency of hypocretin, a neuropeptide that stimulates wakefulness (Liblau et al., 2015)

ML Algorithms

- Machine learning (ML) models can be used to help classify different conditions and help with diagnosis
- Convolutional neural networks (CNNs) are effective at image and feature recognition
- Random forests are ensemble models that use the classes of multiple decision trees to finalize an output

Problem Statement

Narcolepsy is a sleep disorder that involves sudden sleep attacks during the day. A key characteristic of Type 1 narcolepsy is cataplexy, a sudden weakness in the muscles that can appear as a seizure. As a result, narcolepsy can be misdiagnosed as epilepsy, which leads to increased time for proper diagnosis and treatment of the condition

Objective

The overall aim of this project is to combat the misdiagnosis of narcolepsy with epileptic seizures by developing a machine learning classification model that uses EEG data from patients with both conditions. This project hypothesizes that the implementation of such a model in clinical practice can greatly aid in the proper diagnosis of the two conditions and reduce the time needed.

Project Methodology

1. Datasets

Datasets for epilepsy, narcolepsy, and a healthy control group without either condition were obtained online.

2. Split data

The data was split at random into a training and testing group, following a 70/30 train-test split.

3. Algorithms

Different models were implemented in order to return results such as accuracy, precision, and F1 score.

4. Conclusions

Results were analyzed and compared between models for classification accuracy.

Results

Figure 1

Confusion Matrix for InceptionV3

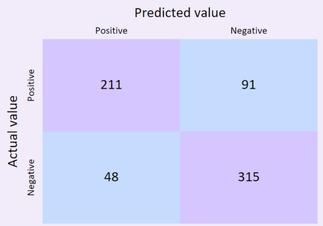

Figure 2

Confusion Matrix for Random Forest

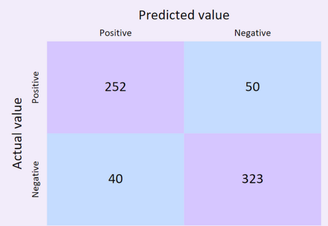

Table 1

Accuracy, precision, recall, and F1 score for InceptionV3

Accuracy	0.790977418422699
Precision	0.6986754966887417
Recall	0.8146718146718147
F1 Score	0.7522281639928698

Table 2

Accuracy, precision, recall, and F1 score for Random Forest

Accuracy	0.8646616541353384
Precision	0.863013698630137
Recall	0.8484848484848485
F1 Score	0.8344370860927153

Analysis

- Accuracy - how accurately outcomes are predicted
- Recall [TP / (TP + FN)] - proportion of correctly identified positives
- Precision [TP / (TP + FP)] - proportion of true positives/all positives
- F1 score comparison (75.2% on InceptionV3 vs 83.4% on Random Forest)
- Despite narcolepsy data not fitting well and limiting the study, the metrics shown by these two models suggest that a multiclass classification with narcolepsy is possible

Conclusion

- Objective
  - Create a machine learning model that could help classify narcolepsy and epilepsy from EEG recordings to help prevent misdiagnosis
- Methods
  - Preprocessed narcolepsy and epilepsy datasets
  - Split into train and test sets
  - Evaluated accuracy, precision, recall, F1 score
- While the narcolepsy dataset was not able to be effectively preprocessed, this model includes a binary classification model for epilepsy and healthy patients

Future Work

- Using larger datasets to train and test
  - Provides more data for the machine to work with
- Include narcolepsy data that is more easily compatible with the epilepsy dataset
- Fine-tuning the model to notice biomarkers in EEG recordings
  - Can aid as a diagnostic tool along with clinician evaluation