Predicting Epileptic Seizures from EEG Data

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Objectives

1. To predict **preictal**(just before seizure) and **interictal**(interim periods between seizures) phases from the **EEG** data.
2. Try to figure out the patterns in the data that correspond to **interictal** and **preictal** phases.
3. Use the observed patterns to develop an algorithm to predict seizures based on the EEG data.
4. Try to look at the cognitive aspect of the experts how they perceive the data and draw the inferences about the phase of seizure .

Motivation

Epilepsy is the disorder where an aggregate of Brain Cells start firing synchronously leading to abnormally high levels of brain activity and an eventual seizure .

The ability to predict the occurrence of a seizure is an important problem because it would allow eplileptic people lead more normal lives. If we could warn an epileptic patient of a possible seizure beforehand then appropriate medication will help in combatting it , at the same time reducing the side effects of these **chemical bound** medications.

Algorithm 1

Data: The EEG data
Result: Predict 1(Seizure) or 0(Otherwise)
for *all channels* **do**
  Compute the variance and the correlation between the channels
end
use the Correlation Coefficients to build the Predictor Matrix
while *learning from the training data* **do**
  for *each subject* **do**
    Learn a set of decision trees (Forest) using the Predictor Matrix.
  end
end
while *A new EEG sample is given* **do**
  for *all the decision trees in the subjects Forest* **do**
    Prediction of all trees on this sample
  end
  Output the majority of all Predictions
end

Algorithm 1: Using Random Forests

Algorithm 2

Data: The EEG data
Result: Predict 1(Seizure) or 0(Otherwise)
while *learning from the training data* **do**
  for *each subject* **do**
    for *each data sample X(16*239766)* **do**
      Obtain a Random Projection Matrix RP(239766*2400);
      Compute the inner product of RP*X
      Pred= SVM with Gaussian Kernel to train the classifier.
    end
  end
end
while *A new EEG sample is given* **do**
  use RP to preject the data into the low dimensional space
  use Pred matrix and data to compute the Prediction
end

Algorithm 2: Using Support Vector Machines

Observations

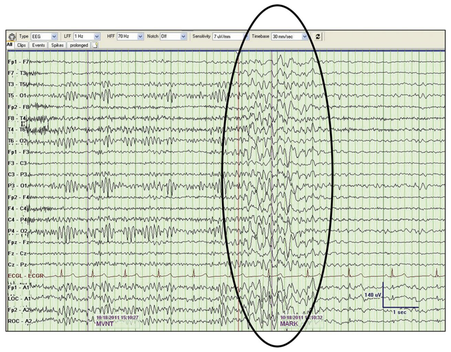


Figure 1: How experts perceive epileptic behavior from EEG data

Observation 1 Some of the channels , particularly those near the Hippocampus face excessive amount of brain activity.
Generally it is seen that during a seizure, the signals of the brain work in a constructive interference pattern and reaches very high levels , ultimately culminating in a seizure. We used this observation to model the SVM and to tune the parameters for better prediction.

Observation 2 Not all channels are equally excited in the case of a seizure.

This is because a seizure generally doesn't impact the whole of the brain but rather concentrated around the Hippocampus , hence we cannot treat the data for all the channels as equivalent . Hence we find out the correlation among the various channels and use it as the Predictor Matrix for the Training of the Decision Trees of the Forest .

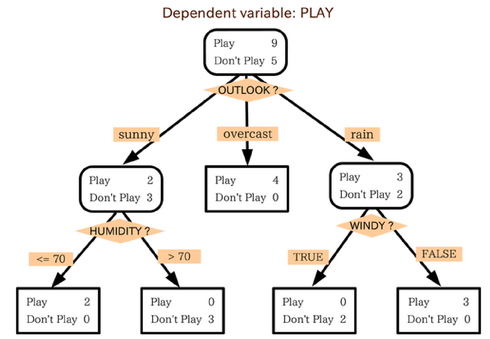
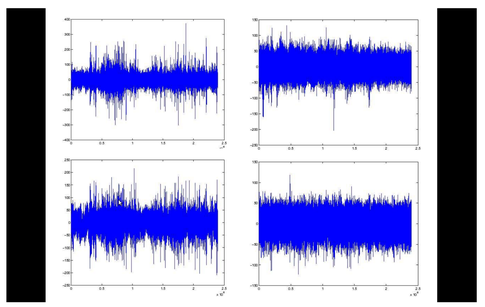


Figure 2: Decision Tree

Results



Algorithm	F1 Score
Random Forest	61%
Random Forest (Gaussian Kernel)	65%
SVM (no kernel)	70%
SVM (Gaussian kernel)	72%

References

[1] Stead SM et al Howbert JJ, Patterson EE. Forecasting seizures in dogs with naturally occurring epilepsy. 13(21):1–21, March 2014.

[2] Chicharro D Andrzejak RG. Seizure prediction: Any better than chance? pages 1–12, July 2009.

Conclusion AND Future Research

The methods we tried to apply proved good enough results but it is still far from state of the art. We have to look at slightly different mechanisms trying to exploit the time series component of the EEG data.

If experts well versed in this field can be consulted and understand their perception of the data detection of anomalies using their instinct , we could try some more fancy neural networks and deep learning techniques to solve this problem.

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