Predict Seizures in Intracranial EEG Recordings

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Introduction

- Epilepsy is a brain disorder in which clusters of nerve cells, or neurons, in the brain sometimes signal abnormally for a brief time, causing strange sensations, emotions, and behavior, or sometimes convulsions, muscle spasms, and loss of consciousness(known as epileptic seizures).
- Every brain is unique and everyone's seizures are different, depending on where the seizures are coming from.
- E.g. Occipital lobe/visual area cause perception of color/shapes/hallucination; Temporal lobe/emotional areas/memory cause emotions like fear, déjà vu, etc.

Cause of Epilepsy

- Epilepsy may develop because of an abnormality in brain wiring, an imbalance of neurotransmitters, or some combination of these factors.
- Some people with epilepsy have an abnormally high level of excitatory neurotransmitters that increase neuronal activity, while others have an abnormally low level of inhibitory neurotransmitters that decrease neuronal activity in the brain.

Epilepsy and Cognition

- Psychiatric, behavioral, and academic problems commonly precede seizures in children AND adults.
- This may suggest an underlying abnormality leading to both problems: problems with thinking and epilepsy.
- People are likely to have a different impact on their cognition based on, including:
  - Etiology
  - Age of onset
  - Seizure type and severity
  - Anti-epileptic medications

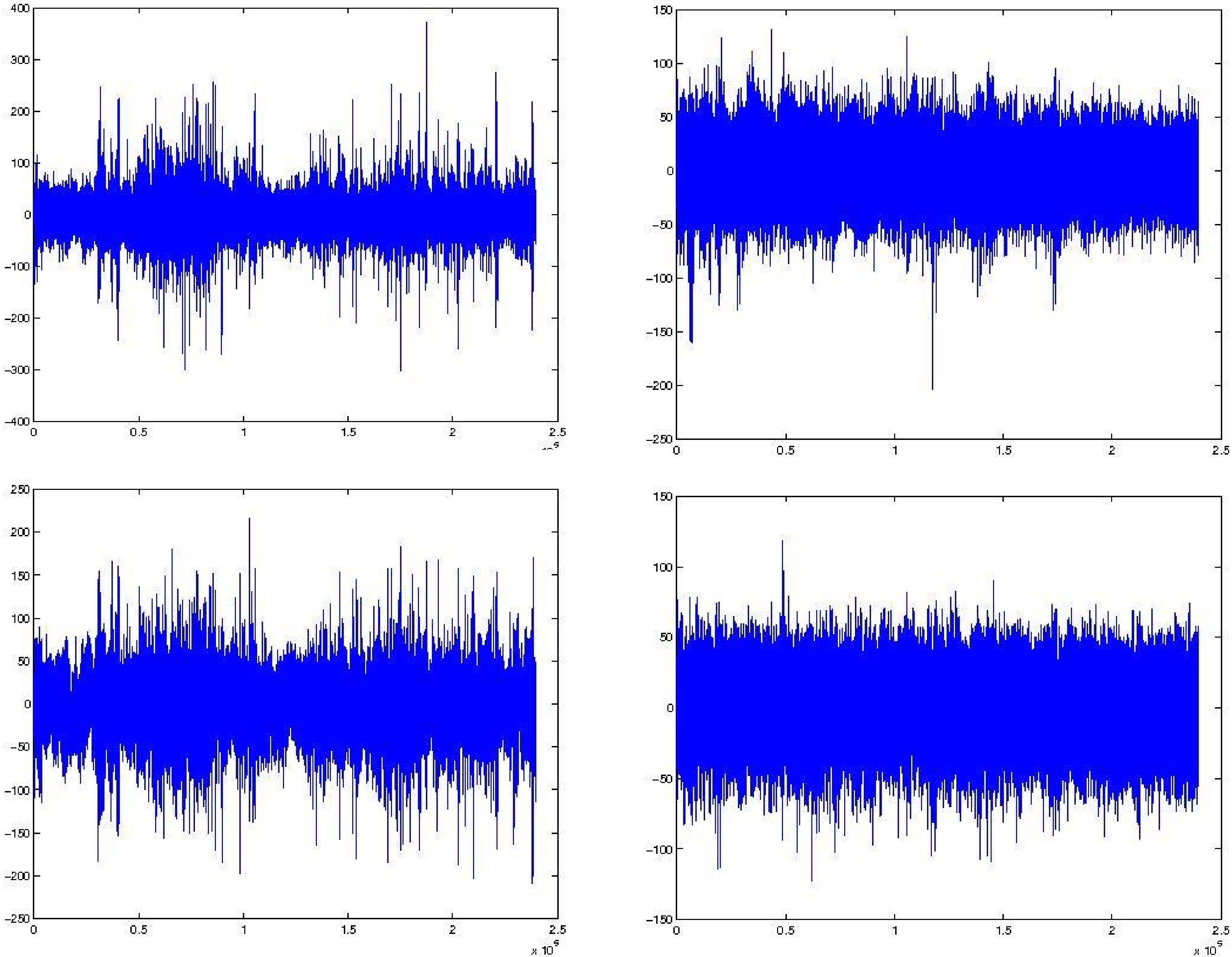
Occurrence of a seizure

- During a seizure, the nerve cells leave their normal activities, and fire in massive, synchronized bursts. Neurons may fire as many as 500 times a second, much faster than normal.
- In some people, this happens only occasionally; for others, it may happen up to hundreds of times a day.
- Histologic studies from both humans and animal models have shown that brain damage primarily affects the hippocampus(spatial memory and navigation), amygdala(processing of memory, decision-making, and emotional reactions), and piriform cortex(olfaction).
- Several MRI imaging studies correlate regional atrophies to seizures.

Predicting Seizures

- The process of seizure can be divided into 4 phases:
  - Interictal: Baseline in-between seizures
  - Preictal : Before Seizure
  - Ictal: Seizure
  - Postictal: After Seizure

- If preictal stage can be detected with some accuracy then patients could be warned about the impending seizure. Further brain damage due to seizure can be avoided.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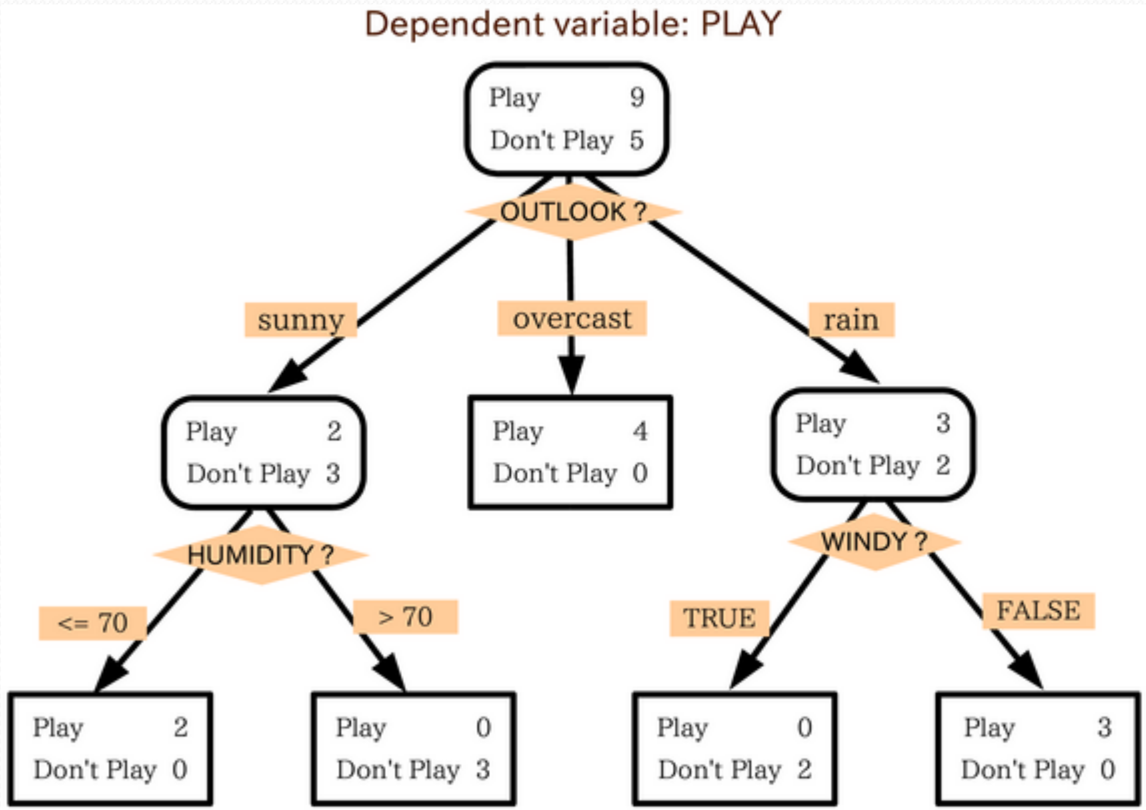
Decision tree



Algorithm

- For each channel , calculate the variance of the channel as well as the Correlation Coefficient between each channel .
- Use this information to generate the Predictor Matrix with the values of the correlation coefficients as the entries for the predictor matrix.
- For each subject train a decision tree using a bagger function .
- Effectively , using a random sample of the data using replacement we train 1000 different decision trees, then for each test set , we give the prediction as the majority of the vote , So this is kinda emulating a vote among 1000 people with 1000 different minds trained on different samples from the same distribution , That's cool .
- Predict on each subject's data from their respective learned decision tree .

Goal Over The Weekend

- Try to use a similar technique but using Random Forests instead of the Tree Bagger because Random Forests include the power of Tree Bagger with the additional benefit of greater accuracy because apart from the random sampling technique , it also uses a random sampling of features which gives better results because some features might be much more highly correlated than the others.

- Also , on an entirely different note as Professor Mukerjee suggested :
- Look at a random projection of the features into a more manageable dimension .
- Initially use a linear Support Vector Machine and look at the results .
- Try using known Kernels along with the Support Vector Machines to see whether we can get better predictions out of the data.

Likely Heuristic

Look at a random projection of the features into a more manageable dimension and use a Hidden Markov Model for predicting the Seizures.

References

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LOONEY TUNES

KEEP CALM

BECAUSE

"'That's All Folks"