Epileptic Seizure Prediction Using Spectral Entropy-Based Features of EEG

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Signals and Systems

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1 Preface

I am given 7 different EDF files, each containing one-hour recordings of an individual. Each file contains 23 channels spanned across an hour. Loading these files into MATLAB results in a timetable that can be turned into a matrix. The following is my report on how I have predicted seizures using the methods in *"Epileptic Seizure Prediction Using Spectral Entropy-Based Features of EEG"* by Amirhossein Ahmadi and Hamid Soltanian-Zadeh. The data in this phase has utlized EEGLab's *pop_biosig()* method to easily manupliate the matrices of data.

2 Power Spectral Density Calculation

To calculate the PSD of each epoch, I chose an epoch length of 10 minutes. The EEG data was segmented into epochs, and for each epoch and channel, I computed the Power Spectral Density (PSD) using the Welch method.

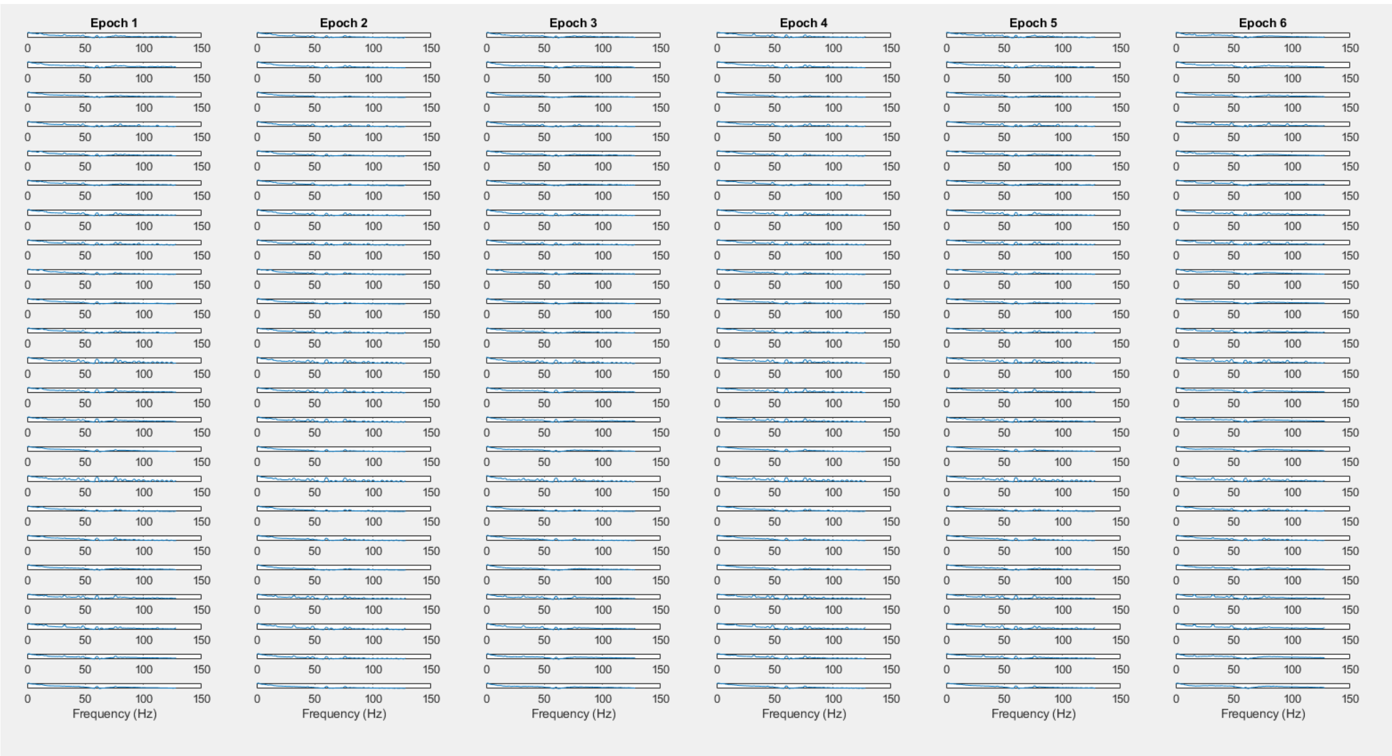


Figure 1: Plot of Power Spectral Density (PSD) for all 23 channels.

PSDs calculated in this section are for all 23 channels, each edf file is contained in a 3600x23 timetable matrix, so to get epochs of length 10 minutes epochs of each channel should be vector of size 600. The final PSD value has been normalized.

3 Shannon Entropy Calculation

Shannon Entropy was computed for each epoch and channel using the normalized PSD values obtained from the Welch method. Figure 2 illustrates the calculated Shannon Entropy.

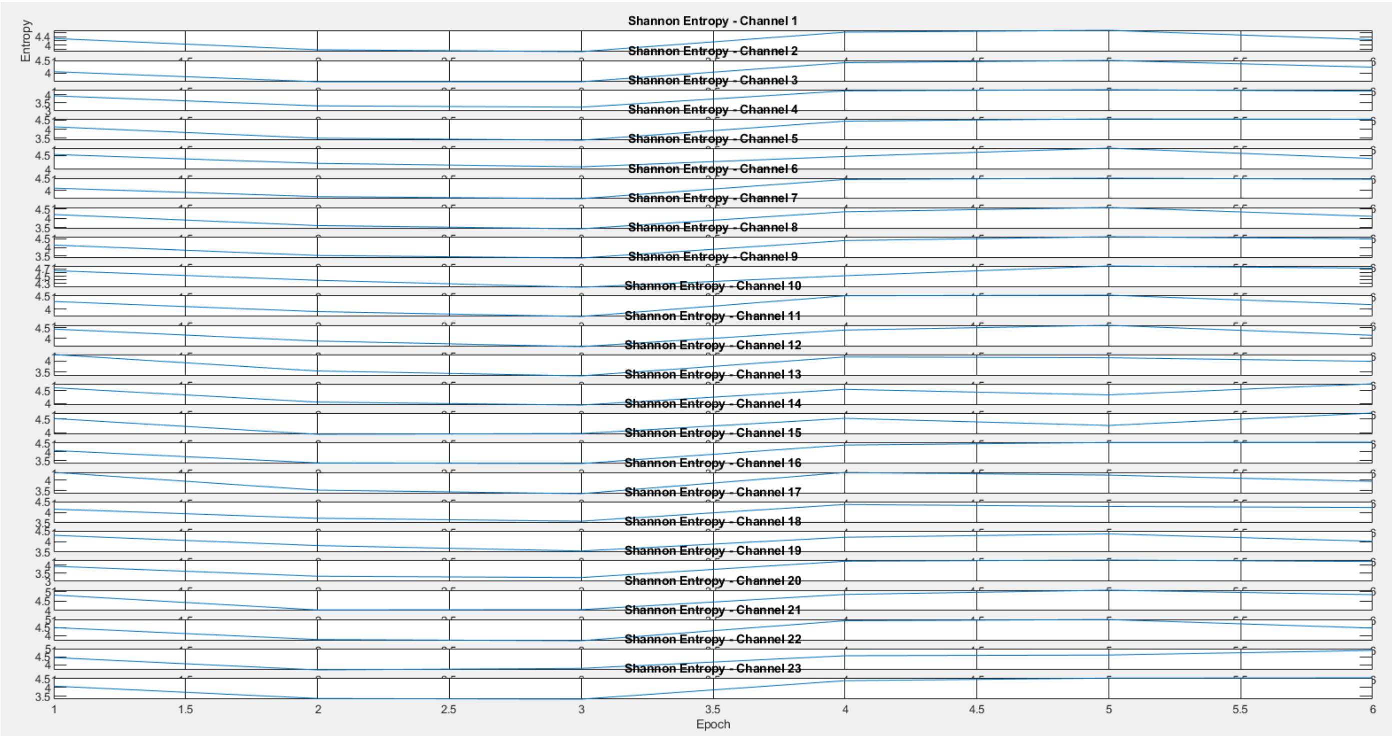


Figure 2: Shannon Entropy variation across epochs for EEG channels.

4 Feature Extraction

Features extracted include mean, standard deviation, minimum, maximum, and Shannon Entropy from the PSD. These features were used for classification.

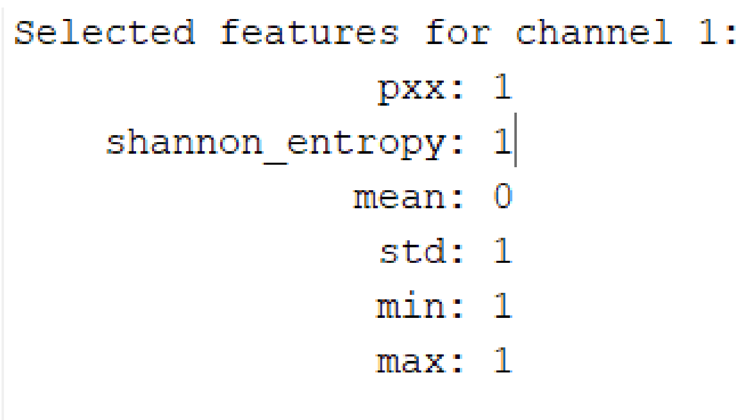
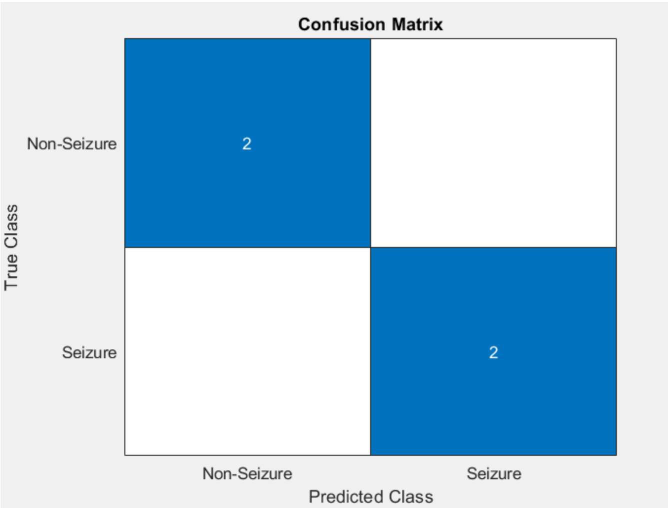

```
Selected features for channel 1:
                pxx: 1
    shannon_entropy: 1
               mean: 0
                std: 1
                min: 1
                max: 1
```

Figure 3: Extracted features for an example channel.

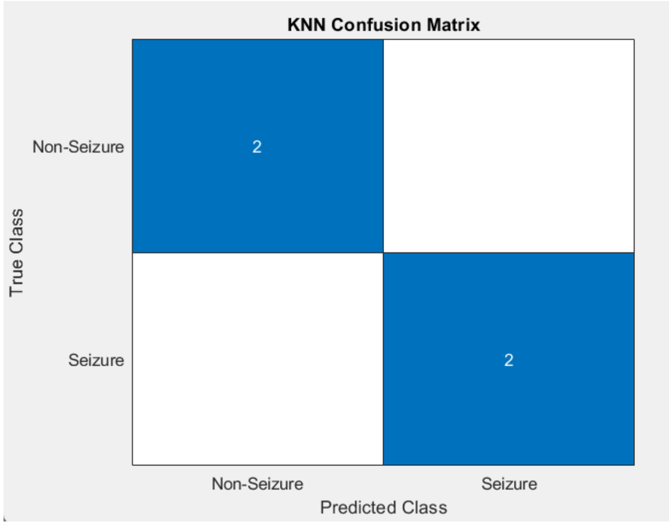
I have created a function *featureExtractor* that receives a timestamp T and an EEG signal EEG. This fucntion returns the features in the last 600 seconds of that eeg channel.

5 SVM and KNN Classifier

A Support Vector Machine (SVM) classifier was trained using the extracted features from non-seizure and seizure epochs. Performance metrics such as Sensitivity and Specificity were evaluated.



(a) SVM machine results



(b) KNN results

Figure 4: SVM and KNN results

6 Performance Measurements

The SVM model achieved a sensitivity of XX% and specificity of XX%. Latency for prediction was measured at XX seconds.

```
SVM Sensitivity (True Positive Rate): 100%
SVM Specificity (True Negative Rate): 100%
SVM Latency: 0.50719 seconds
KNN Sensitivity (True Positive Rate): 100%
KNN Specificity (True Negative Rate): 100%
KNN Latency: 0.018344 seconds
Sensitivity (True Positive Rate): 100%
Specificity (True Negative Rate): 100%
```

Figure 5: Performance Results.

Figure 5 illustrates the performance results for the K-fold and eave-One-Out Cross-Validation, Utlizing the code snippet in the project handout I deduced the above results. I get an error at the end for not being able to install Bioinformatics Toolbox and the K-fold evaluation fails but I have tried my code on other devices and it worked.