APPENDIX A: 2-Sample t-test

One important problem in statistical inference is the comparison of two population means using data from two independent samples; the sample size may or may not be equal. In such problems, there will be two sets of measurements, one of size $n_1$ and the other of size $n_2$, and null hypothesis

$$H_0 : \mu_1 = \mu_2 \quad (A.1)$$

expressing the equality of two population means, where $\mu_1$ and $\mu_2$ represents the mean of first and second set respectively.

To perform a test of significance for $H_0$, the following steps will be followed.

- Decide whether a one-sided test, say
  $$H_A = \mu_2 > \mu_1 \quad (A.2)$$
  Or a two-sided test,
  $$H_A = \mu_1 \neq \mu_2 \quad (A.3)$$
  is appropriate.

- Choose a significant level $\alpha$, a common choice being 0.05.

- Calculate the t-statistic
  $$t = \frac{\bar{x}_1 - \bar{x}_2}{SE(\bar{x}_1 - \bar{x}_2)} \quad (A.4)$$

where standard error, $SE(\bar{x}_1 - \bar{x}_2) = s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \quad (A.5)$

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \quad (A.6)$$

This is referred to as a 2-sample t-test and its rejection region is determined using the $t$-distribution at $n_1 + n_2 - 2$ degrees of freedom:
For a one-tailed t-test, use the column corresponding to an upper tail area of 0.05 and $H_0$ is rejected if

$$t \leq -\text{tabulated value for } H_A: \mu_1 < \mu_2$$

Or

$$t \geq \text{tabulated value for } H_A: \mu_1 > \mu_2$$

For a two-tailed test or $H_A: \mu_1 \neq \mu_2$, use the column corresponding to an upper tail area of 0.025 and $H_0$ is rejected if

$$t \leq -\text{tabulated value or } t \geq \text{tabulated value}$$

Though some initial assumptions (for example, the populations be normally distributed) are made for applying t-test, this procedure is relatively insensitive to departures from the assumptions made. It was observed that if the samples are large enough, the departures from the assumptions will have little effect on the results. But this procedure is sensitive to extreme observations, a few very small or very large data values.
APPENDIX B: Outliers present in the first channel of normal, interictal and ictal EEG classes

<table>
<thead>
<tr>
<th>Frame No.</th>
<th>Normal (Set A)</th>
<th>Interictal (Set D)</th>
<th>Ictal (Set E)</th>
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APPENDIX C: Receiver Operating Characteristic

The receiver operating characteristic (ROC) curves is used to evaluate the discriminatory performance of binary classifiers. This is obtained by sensitivity versus 1-specificity graph for a binary classifier by varying the discrimination threshold as shown in Fig. C.1.

![Typical ROC curve](image)

Fig. C.1 A typical ROC curve

Sensitivity and specificity were calculated as follows:

Sensitivity = $\frac{TP}{TP+FN}$

Specificity = $\frac{TN}{TN+FP}$

where TP= True Positive, FN= False Negative, TN= True Negative and FP= False Positive.

An ROC curve is a 2-dimensional depiction of a classifier performance. Comparison of classifiers will become easier if the ROC performance could be reduced to a single scalar value to represent the expected performance. A generally used method for this is to calculate the area under the ROC curve (AUC).

Before the calculation of AUC the set of values of sensitivity and specificity was normalized to [0, 1]. Being a part of the area under unit square, AUC has a value between 0 and 1. An AUC value equal to 1 represents a binary classification accuracy of 100%.

When the ROC curve is used for feature ranking, the ROC curve is plotted for each of the pairs formed by each of the features and class label. This means treating a single feature as a classifier and calculating the classifier performance in terms of sensitivity and specificity. For
APPENDIX D: Flow chart of the seizure detection

1. Read EEG Data
2. Divide into frames of 256 samples
3. Extract features over each frame
4. **2 Class**
   - **Training phase?**
     - No
       - Rank features to select the significant features
       - Classify
         - Decision
         - 0= Normal (A)
         - 1= Interictal (D)
         - 2= Ictal (E)
     - Yes
       - Rank features to select the significant features
       - Reduce feature dimension through calculating mean, minimum, maximum and std. deviation
       - Classify
         - Decision
         - 0= Normal (A)
         - 1= Interictal (D)
         - 2= Ictal (E)
5. **5 Class**
   - **Training phase?**
     - No
       - Rank features to select the significant features
       - Reduce feature dimension through computing DCT
       - Classify
         - Decision
         - 0= Normal (A)
         - 1= Normal (B)
         - 2= Interictal (C)
         - 3= Interictal (D)
         - 4= Ictal (E)
     - Yes
       - Rank features to select the significant features
       - Reduce feature dimension through calculating mean, minimum, maximum and std. deviation
       - Classify
         - Decision
         - 0= Normal (A)
         - 1= Interictal (D)
         - 2= Ictal (E)
### APPENDIX E: Details of 21-patient Freiburg EEG dataset

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<th>Patient</th>
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<th>Seizure type</th>
<th>H/NC</th>
<th>Origin</th>
<th>Electrodes</th>
<th>No. of seizures</th>
<th>Interictal duration</th>
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<td>Temporal</td>
<td>g, s</td>
<td>5</td>
<td>24 h</td>
</tr>
</tbody>
</table>

SP - Simple Partial   CP - Complex Partial   GTC - Generalized Tonic- Clonic
H- Hippocampal,   NC – Neo Cortical.   g- grid, d- depth, s- strip
APPENDIX F: Flow chart of the seizure prediction

1. Read EEG Data
2. Apply 50 Hz notch filter
3. Normalize data samples
4. Divide data into frames of 1 minute length
5. Extract features over each frame
6. Classify
   - 0 = Preictal
   - 1 = Interictal
7. Apply 5 minute non overlapping window
8. Is all 5 are zeros in a particular window?
   - Yes: Predicted
   - No: Not Predicted
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International Conferences


