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Motor Imagery EEG signal Classification

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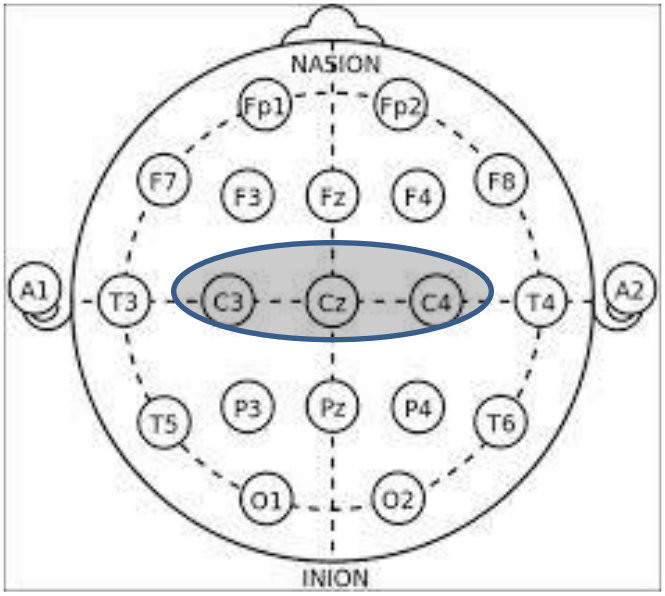
MI EEG signal

Motor imagery is a mental process by which an individual rehearses or simulates a given action. An EEG signal is produced in this action.



Task Overview

- Efficiently classify a two class motor imagery based EEG data
- Different Classification procedures were studied, implemented and compared in order to find a procedure to suite the particular data
- The algorithms were tested

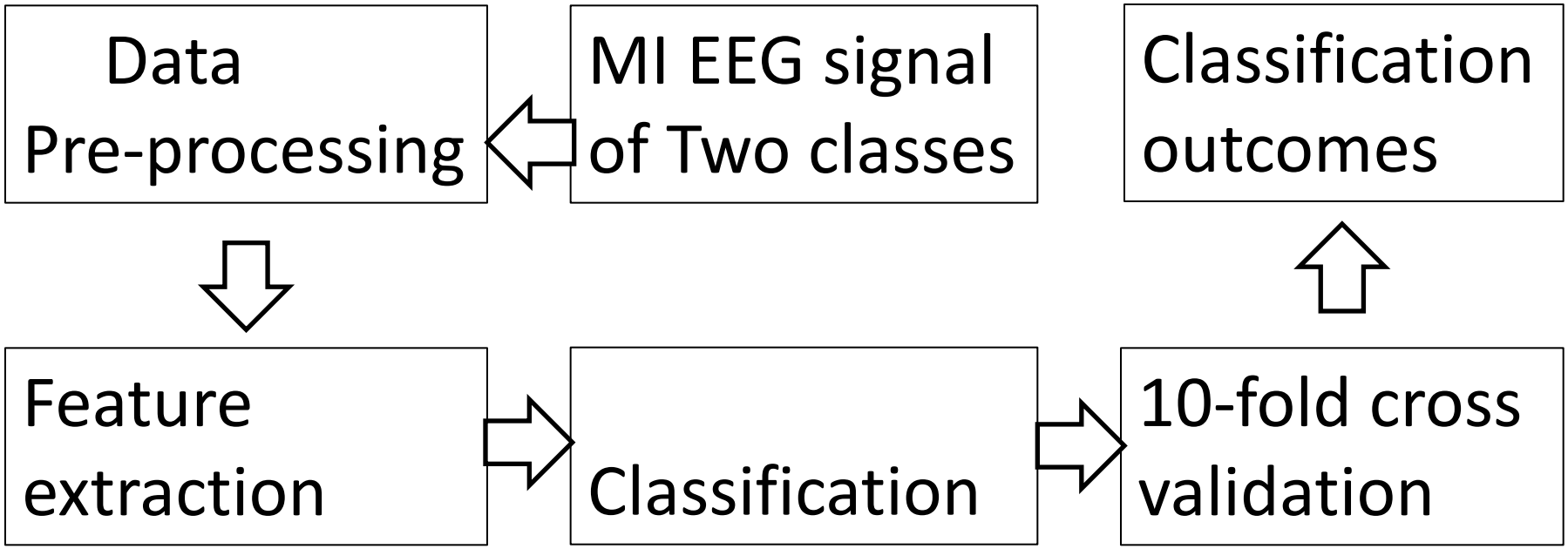
– On a standard dataset (BCI competition III)

– On experimental data collected using "emotiv".

Outline

- Overview of classification procedure
- Data format and Processing
- Feature extraction techniques
  - Cross-Correlation
  - Discrete Wavelet Transform
- Classification Algorithms
- Experiment using “emotiv”

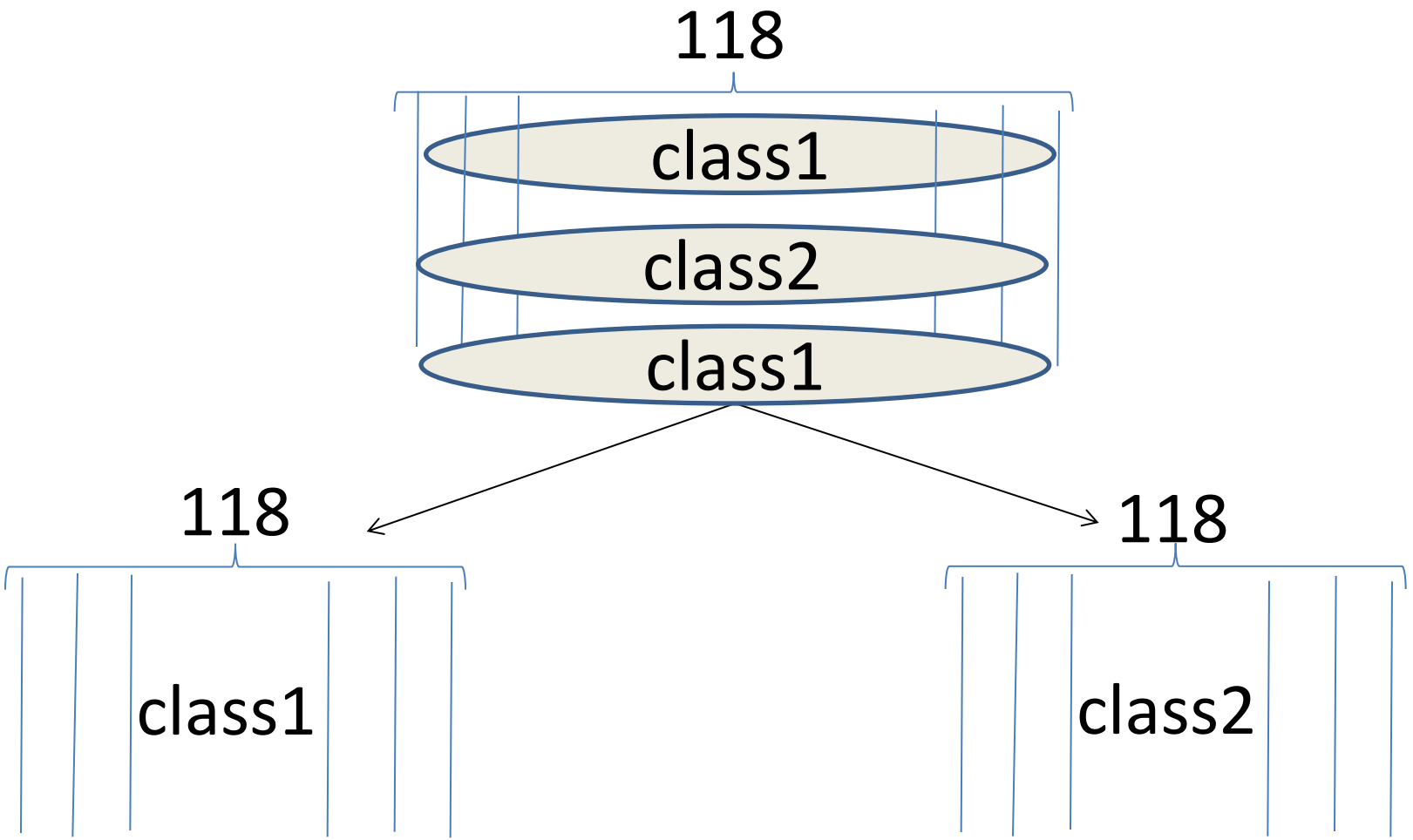
Overview of a classification procedure



Data format and Processing

- The data is a Matrix of 118 columns where each column represents a signal obtained from a particular channel
- Each of the 118 columns has data from both the classes. The matrix was divided into two matrices of 118 columns where each matrix would represent a single class.
- In machine learning terms there are 118 training examples or samples for each class.

Data format and Processing



Evaluation

- 10-fold cross-validation method has been used for assessing the performance of classifier.
- This procedure divides the feature vector sets into ten approximately equal-sized distinct partitions.
- One partition is then used for testing, while other partitions are used for training the model.

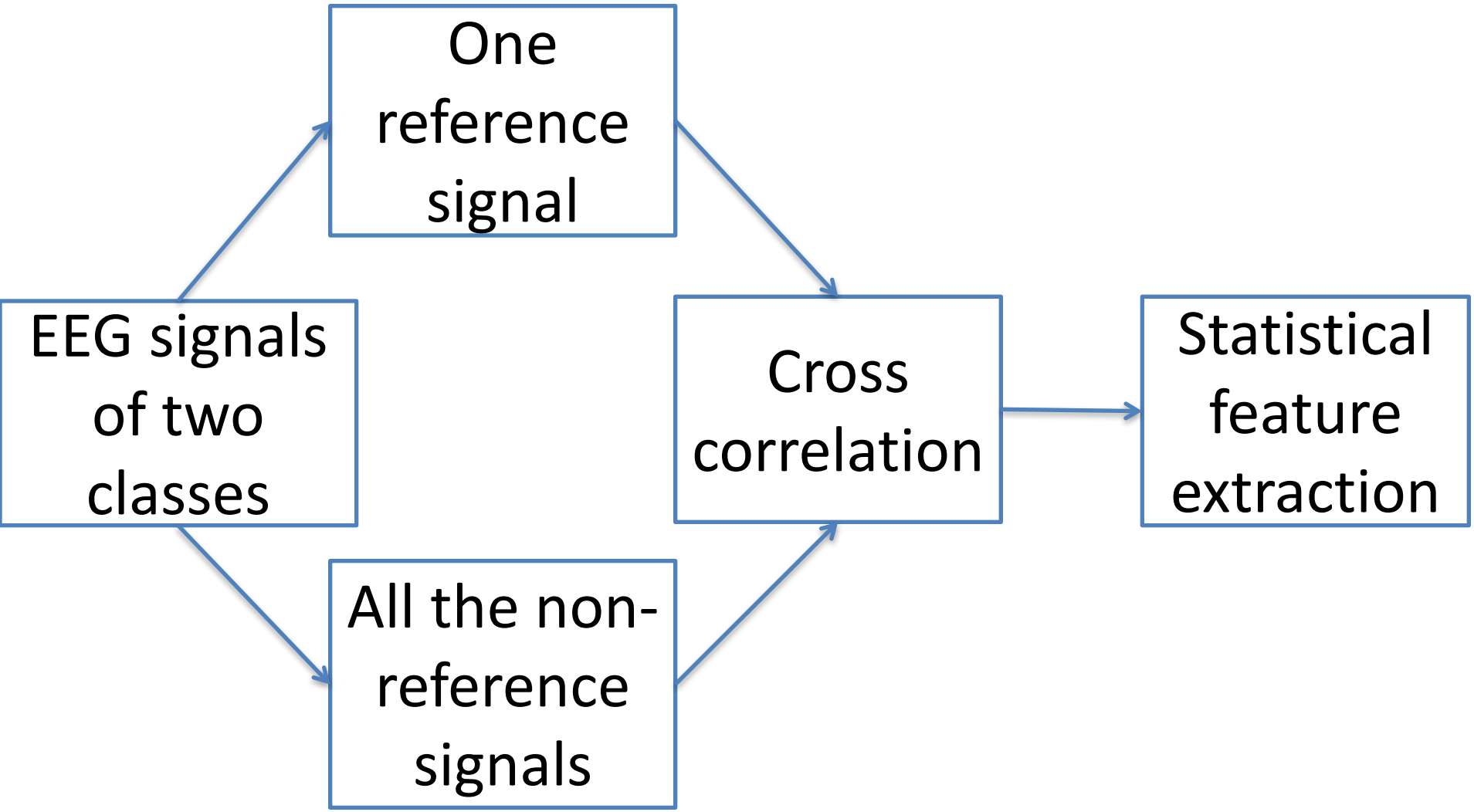
Evaluation

- To further improve the estimate, the procedure is repeated ten times and all accuracies over these ten runs are averaged.
- The average accuracy over the ten runs obtained from the test data is taken as the performance evaluation criteria in this study

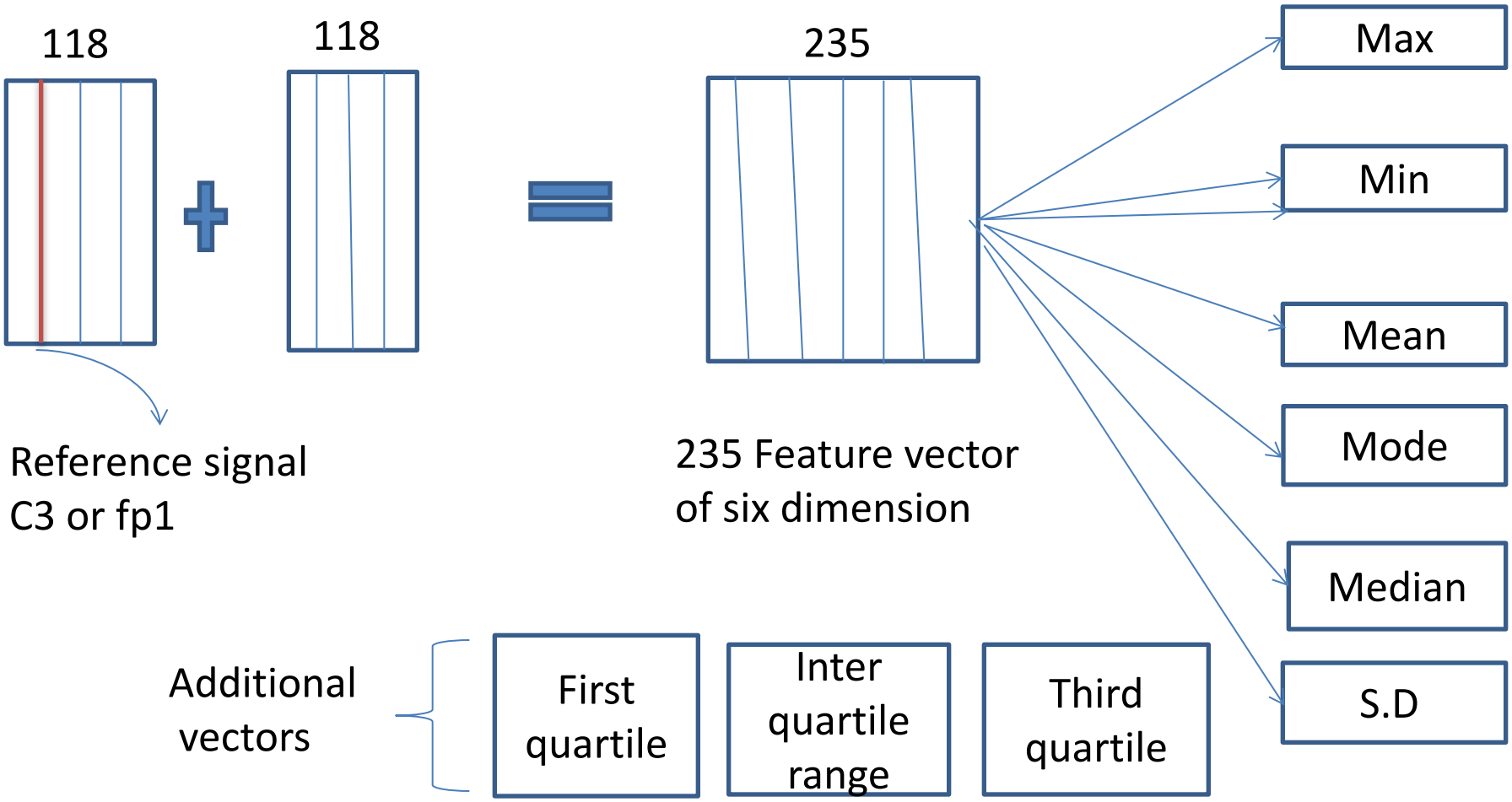
Techniques used for feature extraction

- Cross-Correlation
- Discrete Wavelet Transform
- Cross-Correlation + Discrete Wavelet Transform

Cross-correlation

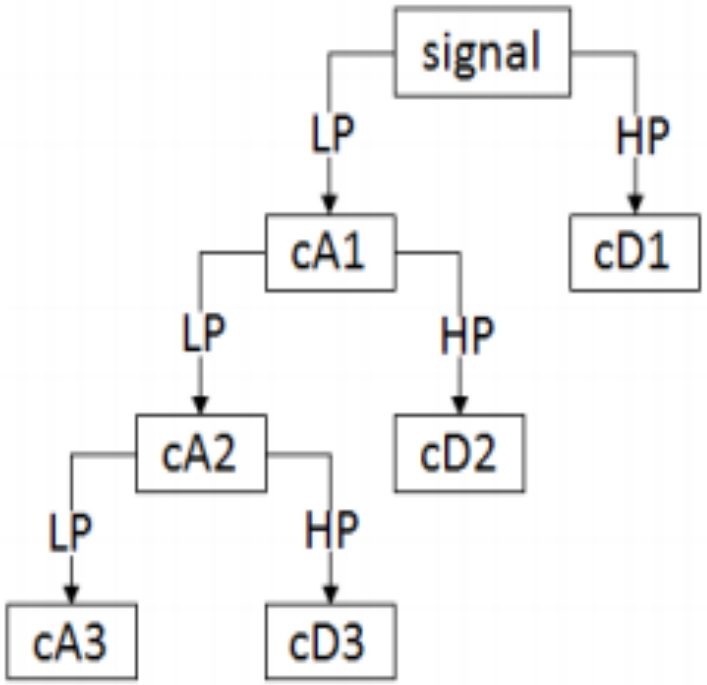


Cross-correlation



Discrete Wavelet Transform

- Daubechies-4 (db4) decomposition filter
- Nine features are to be extracted from these coefficients.



Discrete Wavelet Transform

- The first three are variances of the detail coefficients at level 1, 2 and 3. Detail coefficients at level 4, 5 and 6 have been auto correlated. Variance of them was then calculated to give the next three features.
- The last three features were found by taking the absolute mean of smoothened versions of detail coefficients at level 1, 2 and 3

Techniques used for classification

- Least Square support Vector Machine (LSSVM)
- Logistic Regression
- Kernel Logistic Regression
- Multilayer Perceptron
- Probabilistic Neural Network

Experiments

Case	Feature extraction Technique	Reference Signal	Feature vector size
1	Cross correlation	Fp1	6
2	Cross correlation	C3	6
3	Cross correlation	Fp1	9
4	Cross correlation	C3	9

Experiments

Case	Feature extraction Technique	Reference Signal	Feature vector size
5	**Discrete Wavelet Transform**	**-**	**9**
6	CC+DWT	Fp1	9
7	CC+DWT	C3	9

Observations

- Feature extraction technique

  Discrete Wavelet transform

- Classification technique

  LSSVM

- Slight improvement in accuracy upon increasing the feature vectors

Observations

- Feature extraction technique

  Discrete Wavelet transform

- Classification technique

  LSSVM

- Slight improvement in accuracy upon increasing the feature vectors

Data Acquisition Using Emotiv

- An experimental cue was set up in which for first 20 secs the person had to imagine a particular task say right hand movement.

- This was followed by a 5 sec delay and then for next 20 secs subject had to imagine another task say right leg movement.

Data Acquisition Using Emotiv

Conclusion

- A comparative study of five classification methods and three feature extraction
- Evaluation using 10-fold cross validation technique under common ground conditions.
- feature extraction techniques => DWT and classification algorithms => LSSVM
- Overall, a combination of DWT and LSSVM seems to be a good procedure for classifying two class MI based EEG signals