Signal Processing Techniques to Improve Feature Space for EEG-based Epileptic Seizure Detection

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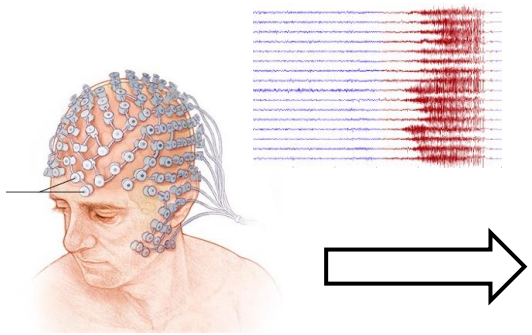
Overview

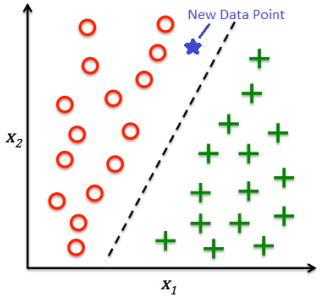


Data Acquisition
(EEG)

Data
Preprocessing

Feature
Engineering

Feature
Dimensionality
Reduction



Classifier
(Seizure Detection)

- Random Forest
- SVM

The Epileptologie Database

Alternative: CHB-MIT Scalp EEG Database

OBJECTIVES

- Explore Signal Processing Algorithms on EEG Signals that improves the seizure detection accuracy
- Identify the most useful features extracted by signal processing algorithms that improves seizure detection

Operations to be performed

Data Preprocessing

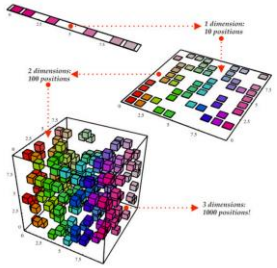
- ❖ Signal Detrending
  - Mean reduction
  - Scaling to unit variance
- ❖ Spatial Filtering / Denoising
  - Windowed FIR Filters
  - Windowed IIR Filters

Alternative: *Blind Source Separation*

1. Principal Component Analysis
2. Independent Components Analysis

Feature Engineering

- ❖ Time Domain Features
  - Linear Signal Analysis (Enforcing stationarity locally)
  - Alternative: *Non-Linear Signal Analysis*
- ❖ Frequency Domain Features
  - PSD-based features using Welch Method
  - Alternative: *FFT*
- ❖ Time - Frequency Domain Features
  - Wavelet Transformation
  - Alternatives: *empirical mode decomposition, matching pursuit*



Feature Dimensionality Reduction

- ❖ Correlation Matrix
- ❖ Feature Selection
  - Variance Thresholding
  - Mutual Information Estimation
  - ANOVA
  - Alternative: *Model specific feature selectors (Embedded/Wrapper Methods)*
- ❖ Feature Extraction
  - PCV
  - T-SNE
  - Alternative: *Uniform Manifold Approximation and Projection (UMAP)*

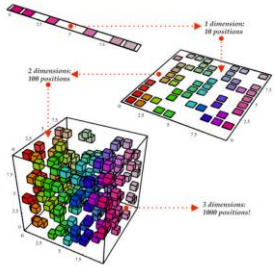
Parameters to Consider

Data Preprocessing

- Window size
- Cut-off frequencies of filter
- Type of filters
- Padding criteria for edge effect removal
- Number of Principal Components to select

Feature Engineering

- Window size to apply linear signal analysis
- Window size for Welch Method (depends on lowest frequency of interest)
- Welch scaling option
- Mother wavelet function



Feature Dimensionality Reduction

- Number of principal components
- Variance Threshold value

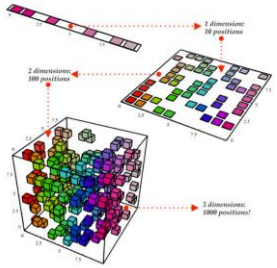
Evaluation Methods and Metrics

Data Preprocessing

- SNR
- Detection Accuracy
- Sensitivity
- Precision
- F1 Score
- AUC

Feature Engineering

- Sparsity
- Detection Accuracy
- Sensitivity
- Precision
- False Detection Rate (FDR/h)
- F1 Score
- AUC



Feature Dimensionality Reduction

- Detection Accuracy
- Sensitivity
- Precision
- FDR/h
- F1 Score
- AUC
- Computation Time/Complexity