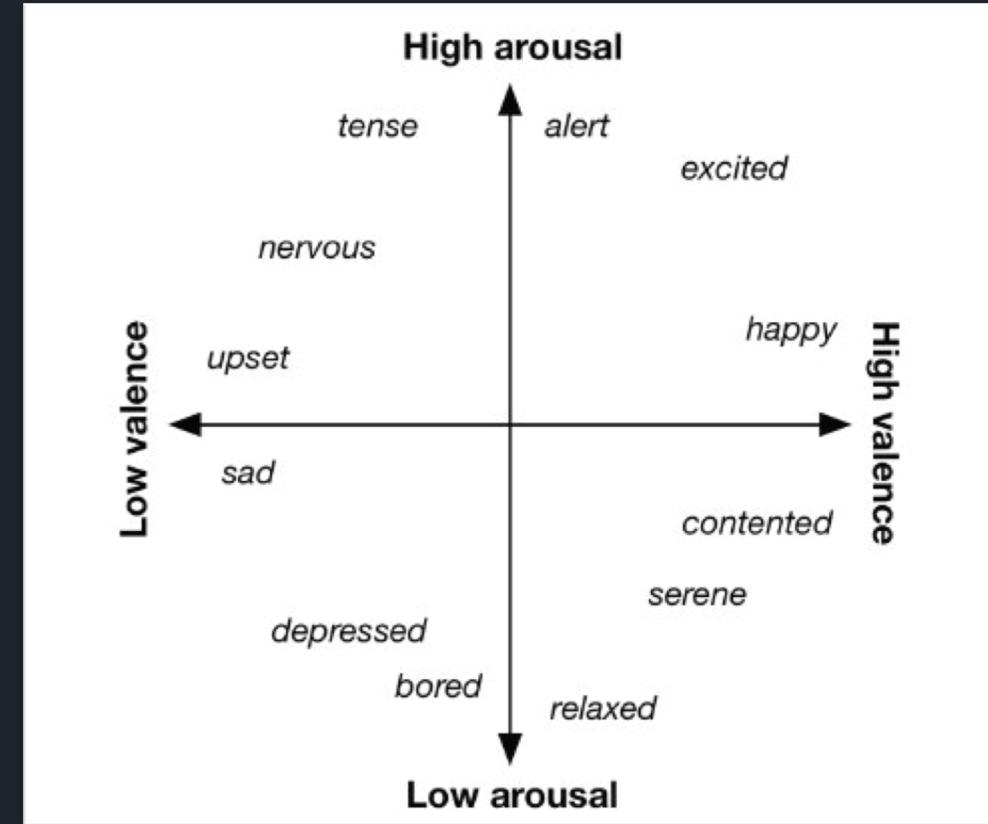


Objective Valence and Arousal Detection Using Extreme Learning Machines on EEG

Prepared by
Matthew DeSilva
Amir ElDesoky

Introduction

- Affective computing and emotion detection
- Valence and Arousal model
- Non-physiological signals vs physiological signals

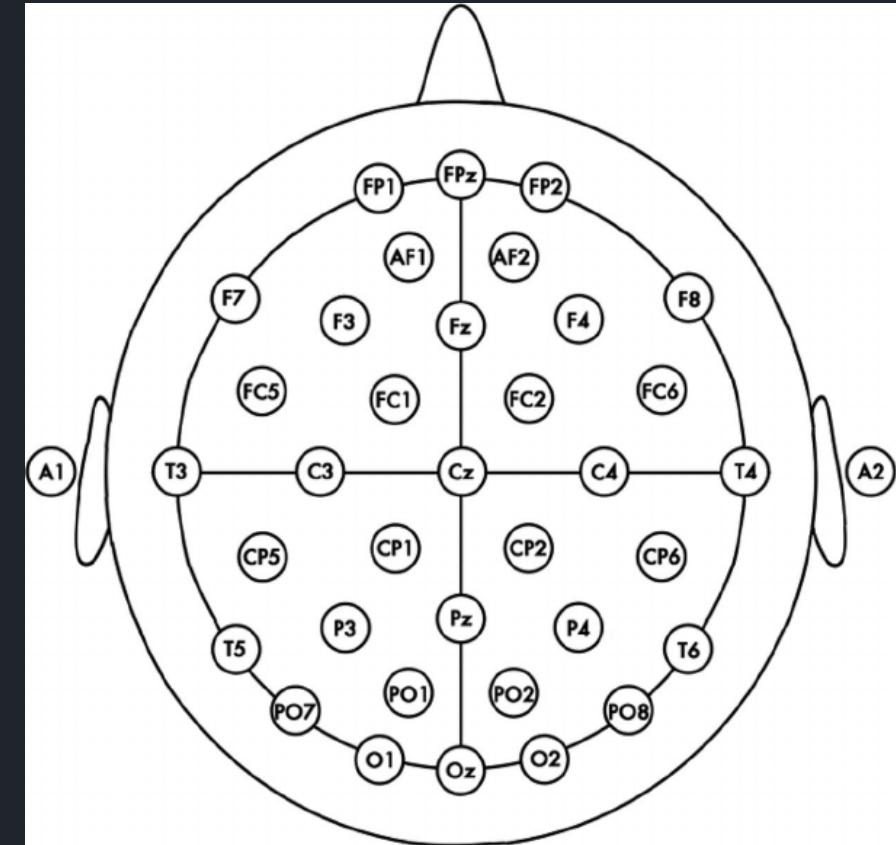


Current Research

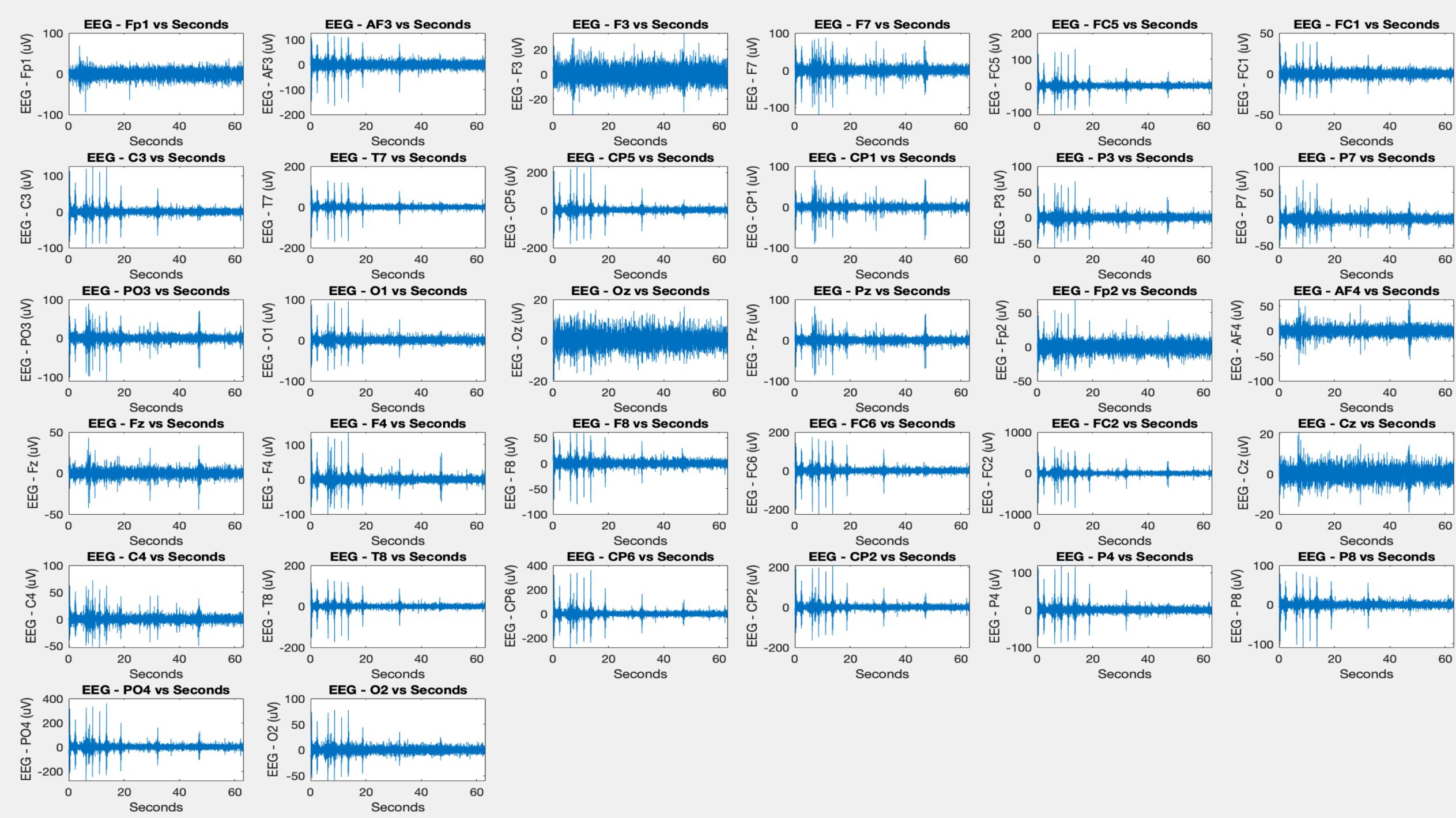
- Statistical supervised methods
 - Fast
 - Low accuracies
- Deep learning approaches
 - High accuracies
 - Slow
- There is a need for a faster classification approach with higher accuracies.

Dataset

- Dataset for Emotion Analysis using EEG, Physiological and Video Signals (DEAP)
- EEG Electrodes placed according to 10-20 system
- Preprocessed data
 - Down sampled to 128 Hz
 - Filtered frequency from 4 to 45 Hz



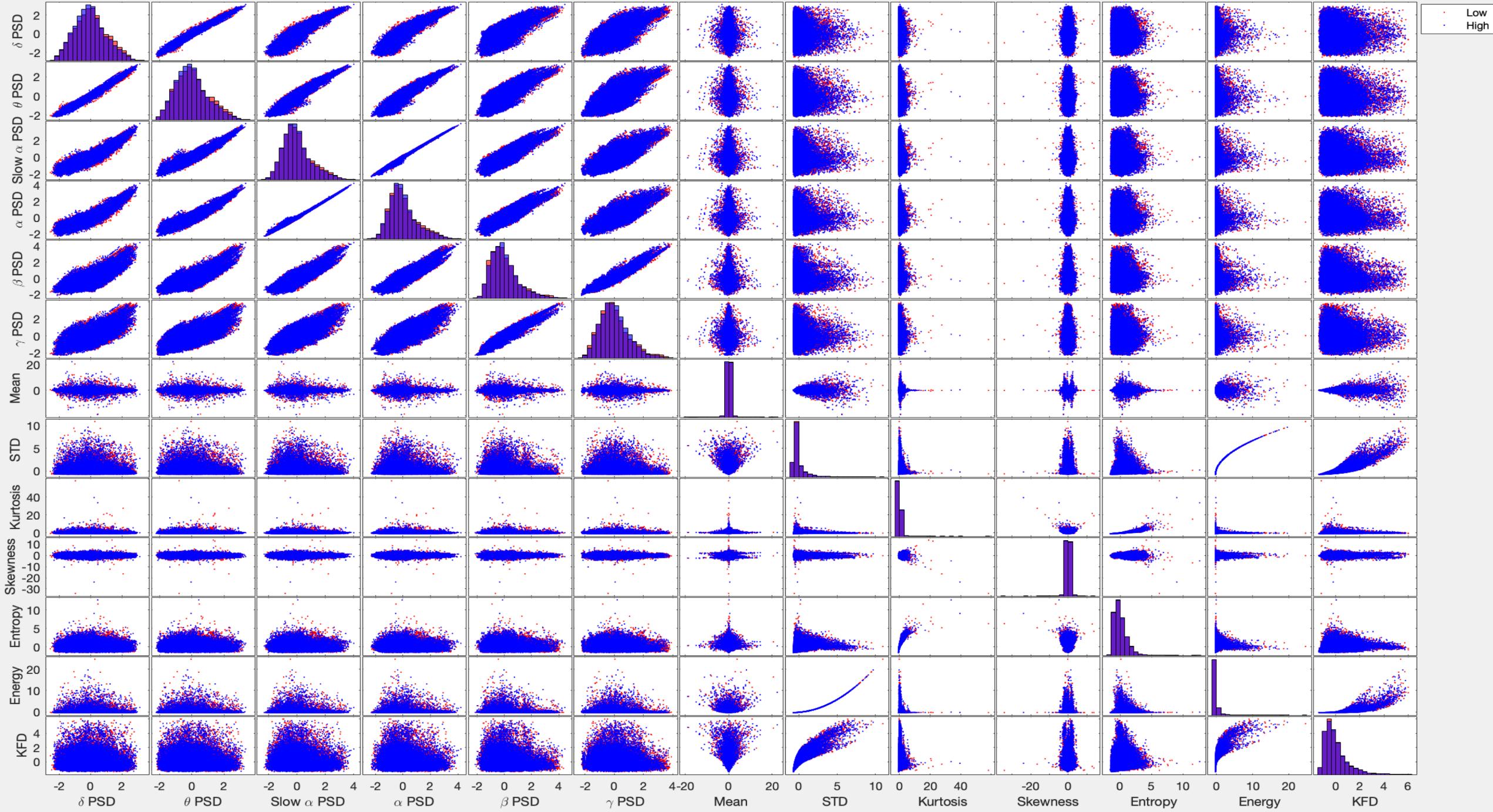
Methods



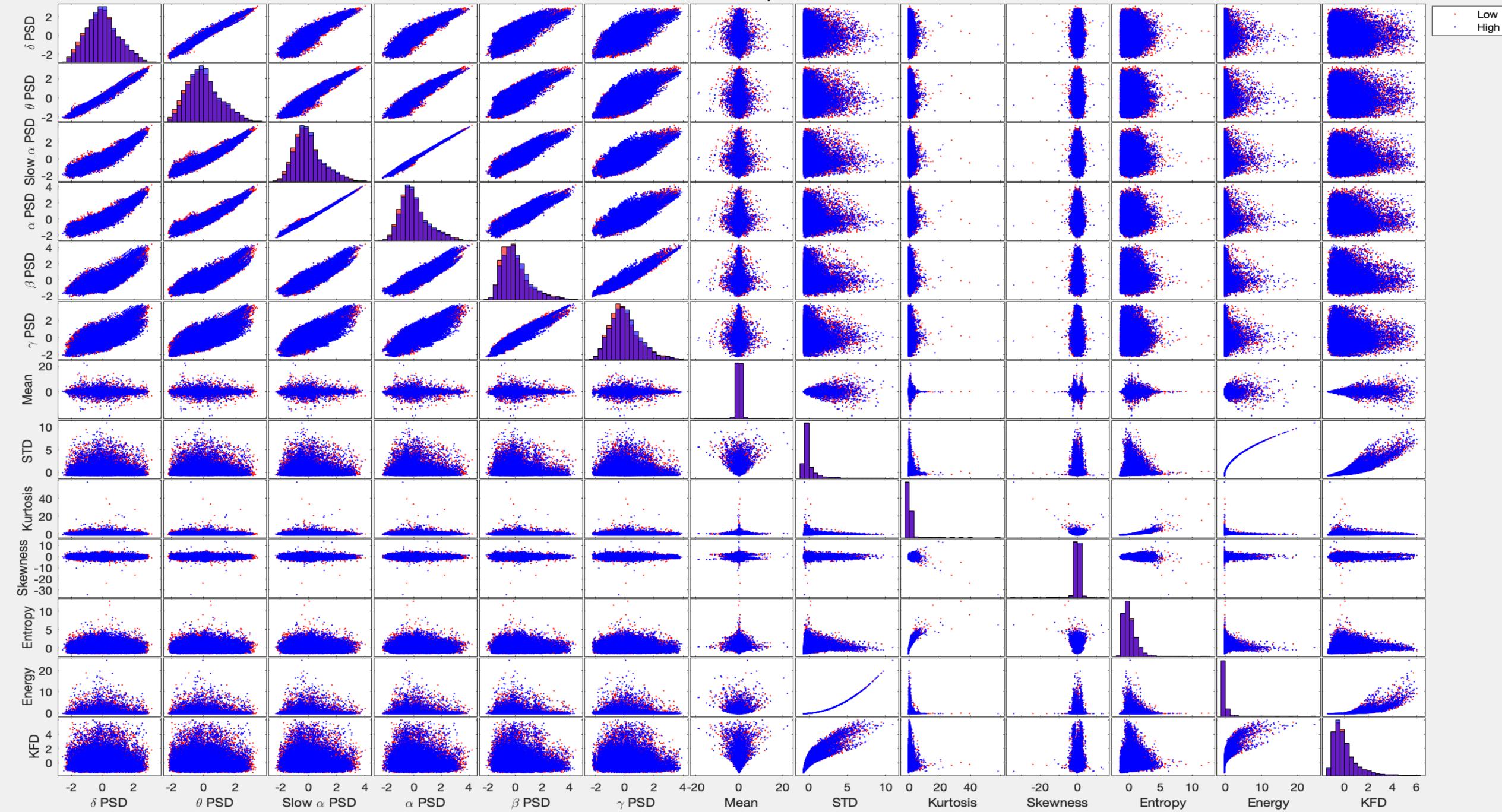
Feature Extraction

- Power Spectral Density
- Statistical Features
 - Mean
 - Standard Deviation
 - Kurtosis
 - Skewness
- Energy
- Entropy
- Fractal Dimension

Matrix of Feature Scatterplots for Valence



Matrix of Feature Scatterplots for Arousal



Feature Selection

```
***** SFS & SBS For Valence *****  
Start forward sequential feature selection:  
Initial columns included: none  
Columns that can not be included: none  
Step 1, added column 9, criterion value 0.457682  
Final columns included: 9  
Start backward sequential feature selection:  
Initial columns included: all  
Columns that must be included: none  
Step 1, used initial columns, criterion value 0.462804  
Step 2, removed column 7, criterion value 0.45612  
Step 3, removed column 12, criterion value 0.450347  
Step 4, removed column 10, criterion value 0.448481  
Step 5, removed column 8, criterion value 0.446832  
Step 6, removed column 5, criterion value 0.444314  
Step 7, removed column 13, criterion value 0.440148  
Final columns included: 1 2 3 4 6 9 11  
>>
```

```
***** SFS & SBS For Arousal *****  
Start forward sequential feature selection:  
Initial columns included: none  
Columns that can not be included: none  
Step 1, added column 9, criterion value 0.441536  
Step 2, added column 11, criterion value 0.438845  
Step 3, added column 2, criterion value 0.436762  
Step 4, added column 4, criterion value 0.434679  
Step 5, added column 3, criterion value 0.42947  
Step 6, added column 8, criterion value 0.428212  
Final columns included: 2 3 4 8 9 11  
Start backward sequential feature selection:  
Initial columns included: all  
Columns that must be included: none  
Step 1, used initial columns, criterion value 0.441536  
Step 2, removed column 12, criterion value 0.432986  
Step 3, removed column 7, criterion value 0.431467  
Step 4, removed column 1, criterion value 0.430773  
Final columns included: 2 3 4 5 6 8 9 10 11 13
```

Feature Selection

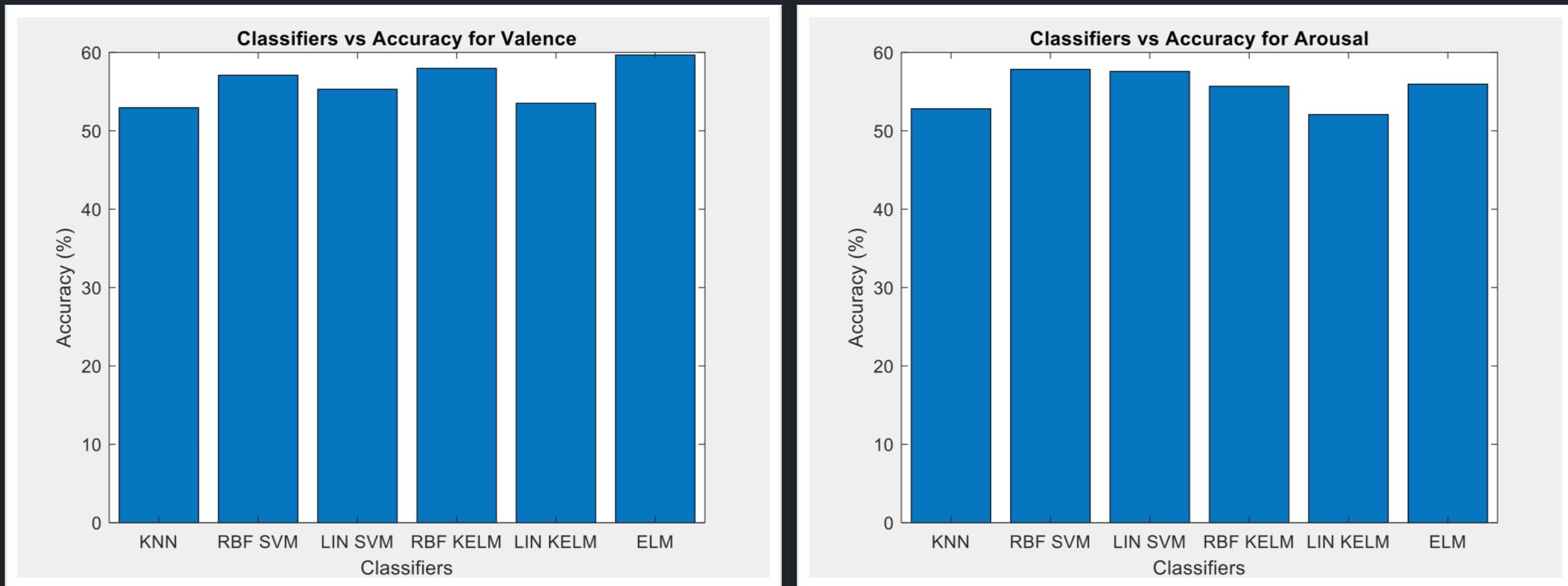
- Valence
 - Delta PSD
 - Theta PSD
 - Slow alpha PSD
 - Alpha PSD
 - Gamma PSD
- Arousal
 - Delta PSD
 - Slow alpha PSD
 - Alpha PSD
 - Kurtosis
 - Skewness
 - Entropy

Classification

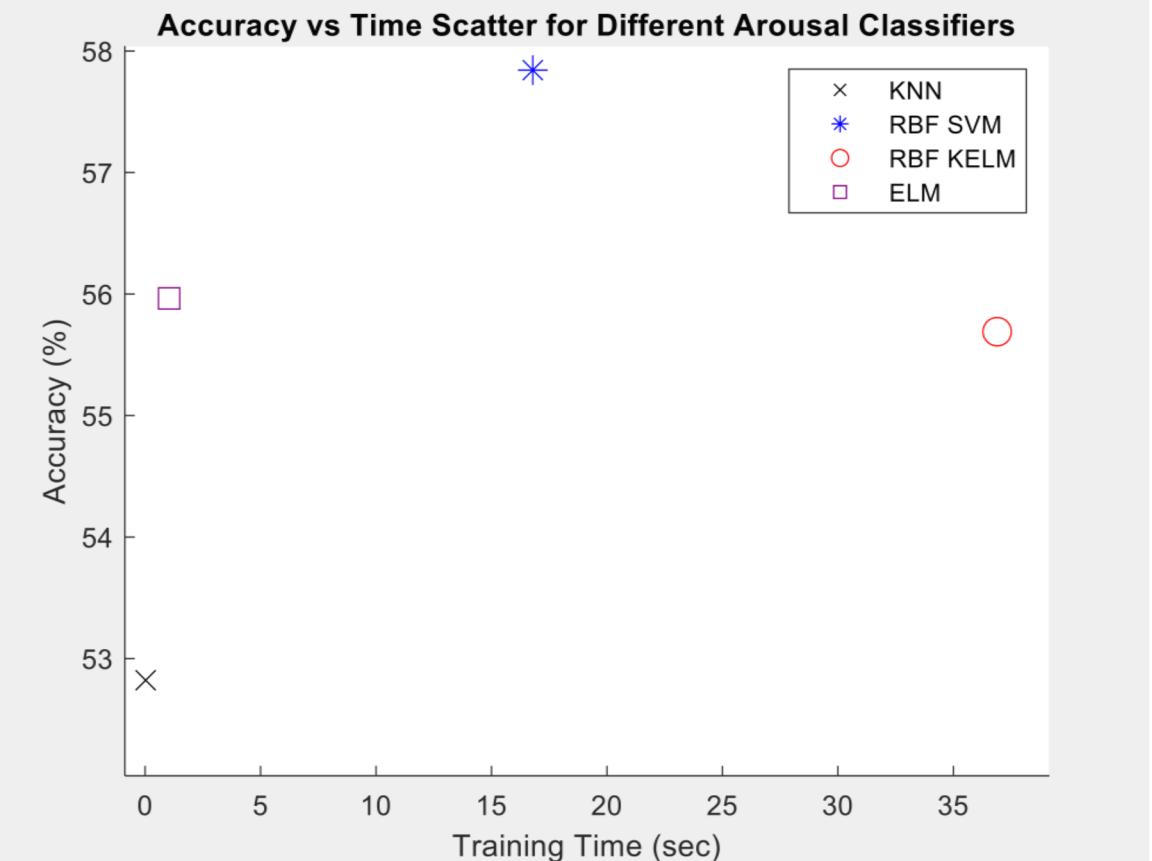
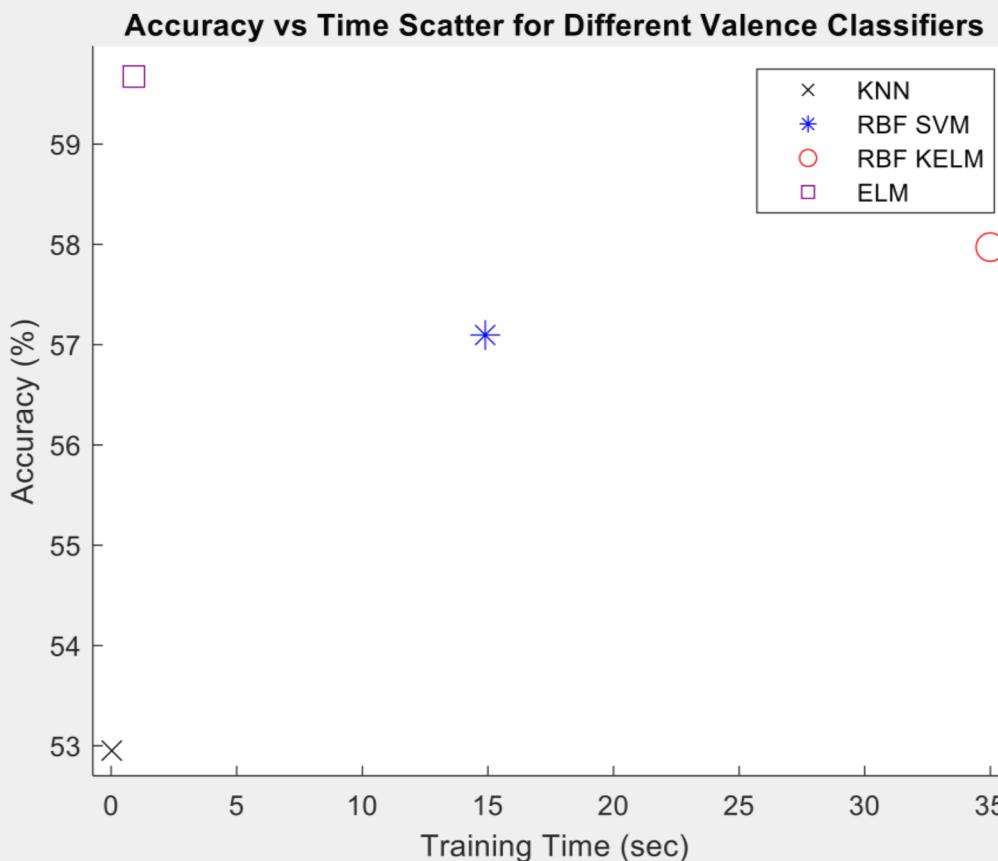
- Found the optimal K value for KNN
- Found the optimal Kernel trick for SVM
- Found the optimal Kernel trick for KELM
- Found the optimal number of hidden neurons for ELM
- Compared accuracy
- Compared training time

Results

Accuracies



Accuracies vs Training Time



Discussion & Conclusion

- Feature extraction
- Preprocessed vs Raw Data
- DEAP dataset acquisition
- TEAP? Not good enough
- ELM outperforms statistical supervised methods
- ELM is promising in emotion recognition

Questions?

Thank you!