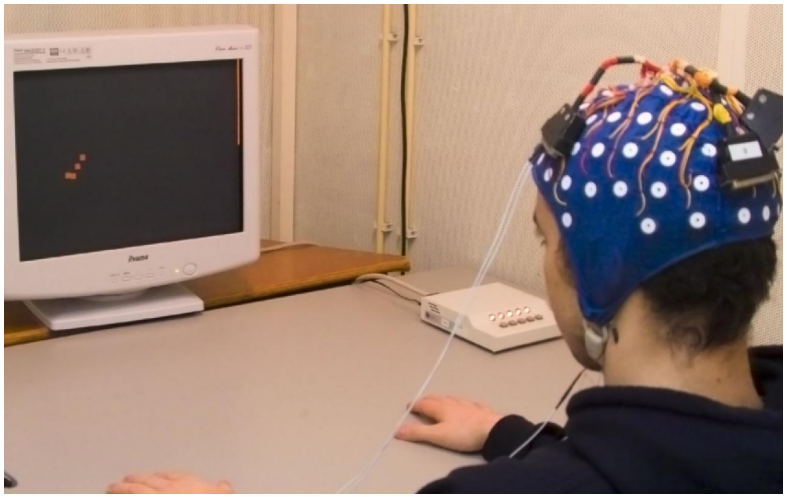
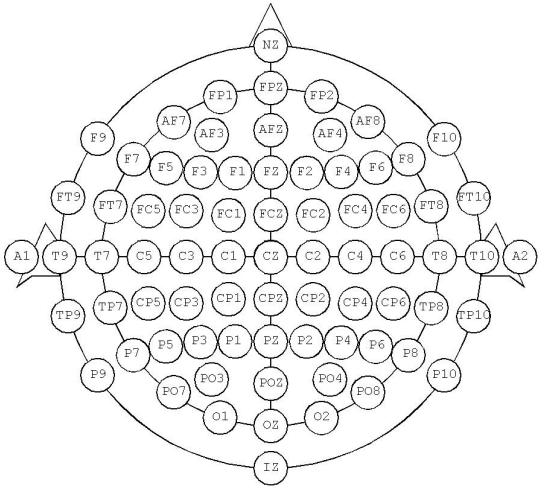
An emotionally aware P300 speller

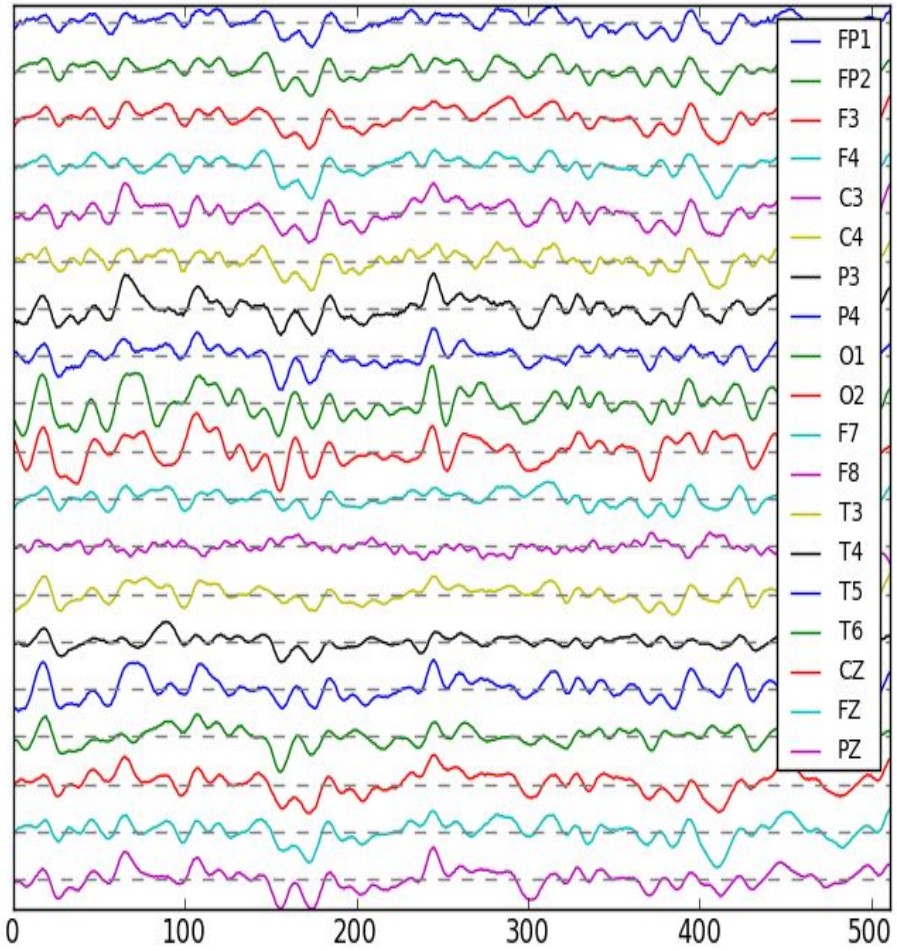
Andreas De Lille

Brain Computer Interfaces

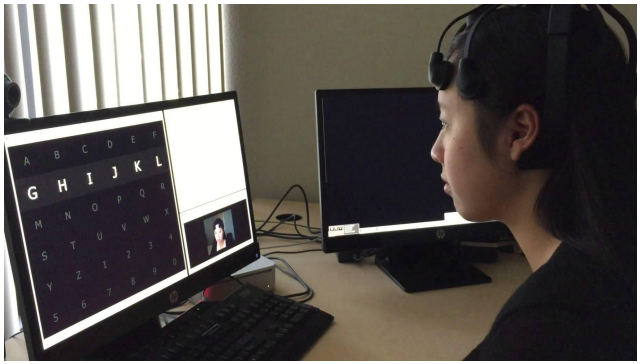


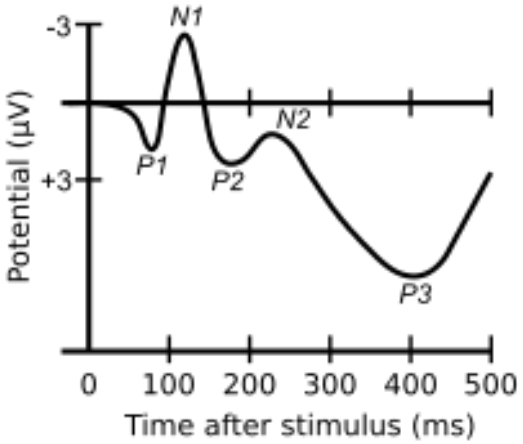
Measure brain activity



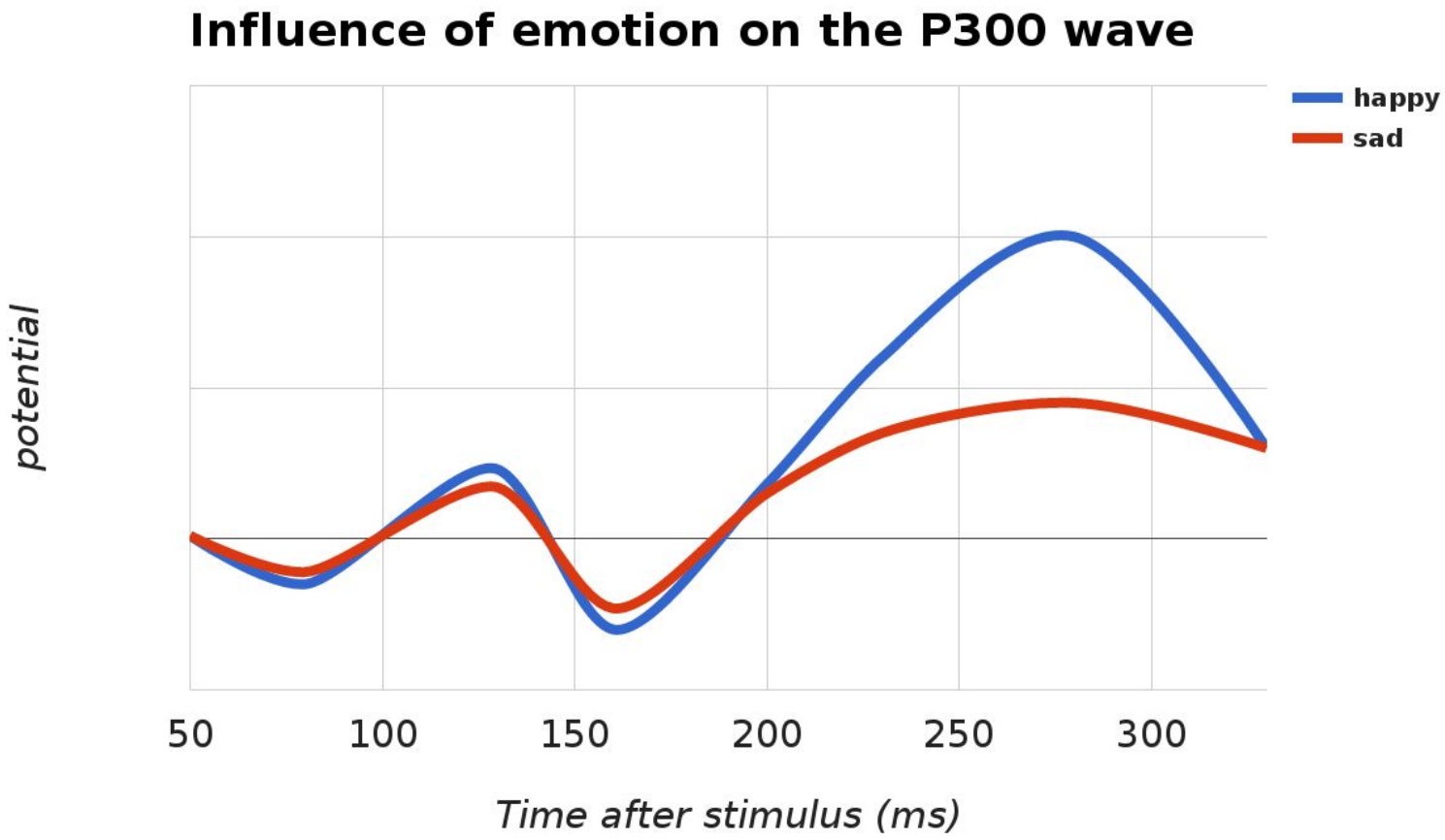


BCI application: P300 Speller

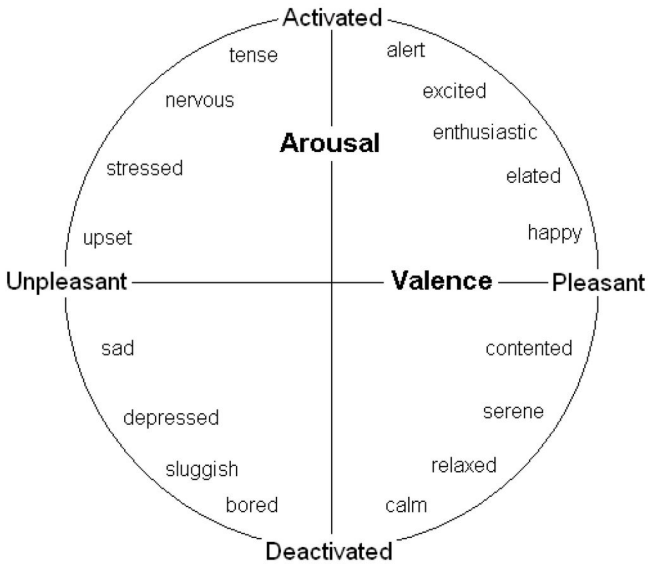


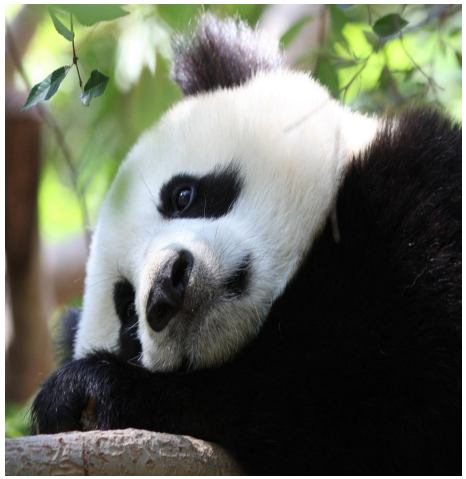


BCI for emotion Recognition



Emotion


Activated
tense
alert
nervous
excited
Arousal
enthusiastic
stressed
elated
upset
happy
Unpleasant
Valence
Pleasant
sad
contented
depressed
serene
sluggish
relaxed
bored
calm
Deactivated



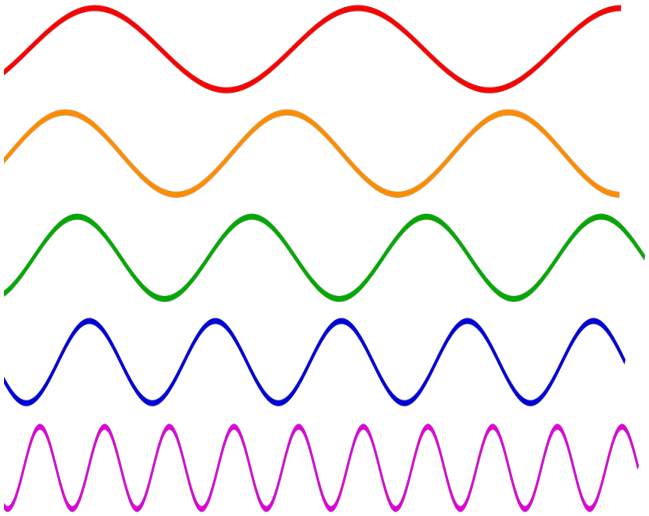
Emotion

Expression

Physiological

Emotion in the brain

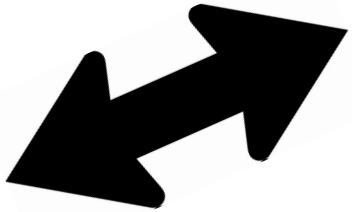
Emotion in the brain

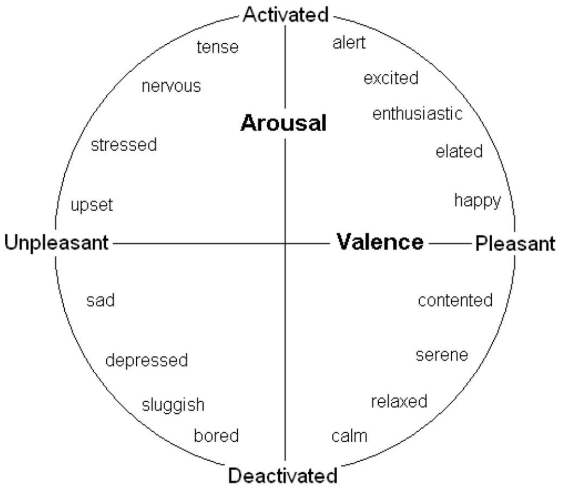


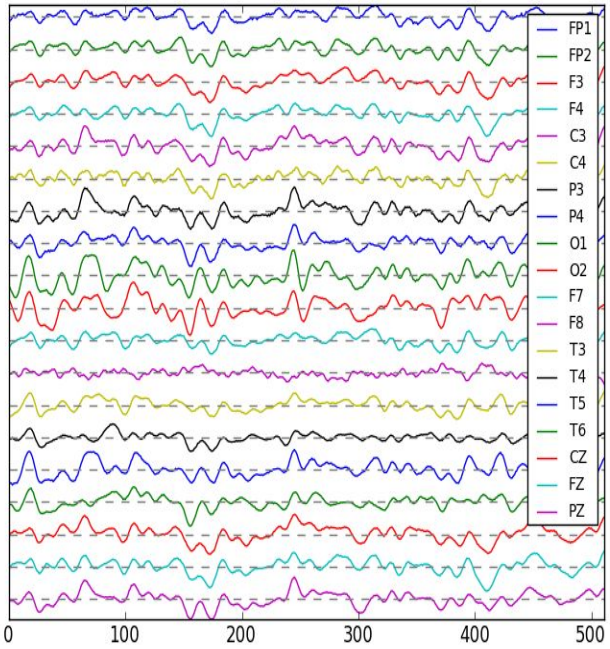
Delta	0 - 4
Theta	4 - 8
Alpha	8 - 13
Beta	13-30
Gamma	30-50

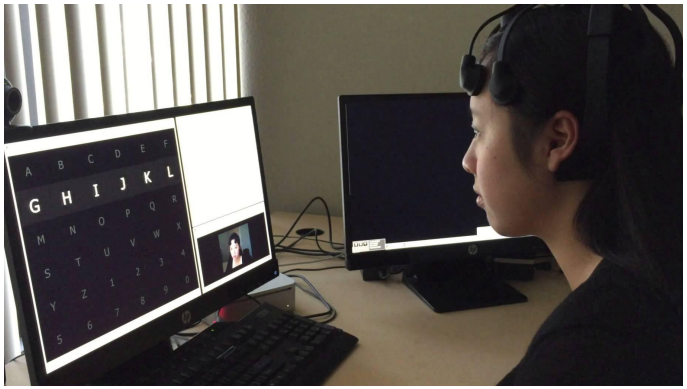
picture from http://imotions.com/blog/frontal-asymmetry-101-get-insights-motivation-emotions-eeg/

Quick Summary

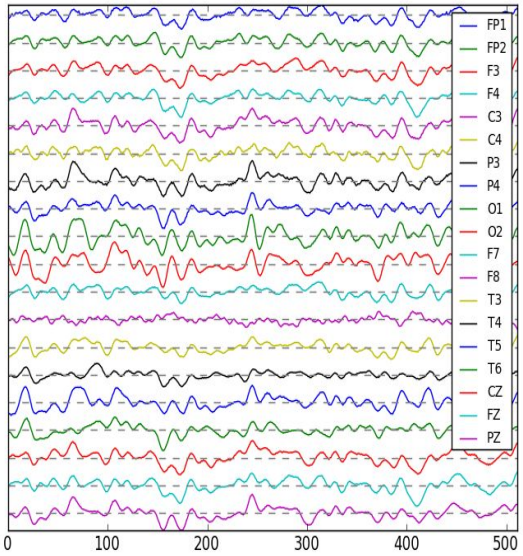


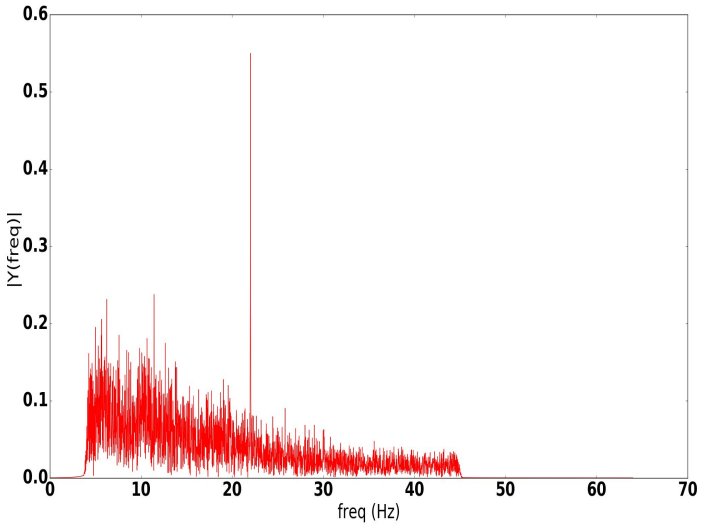


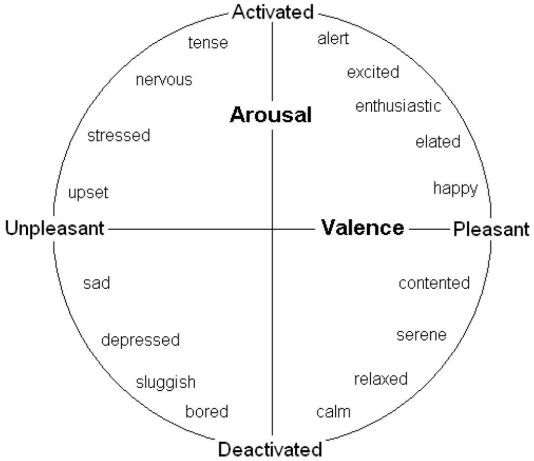




How ?





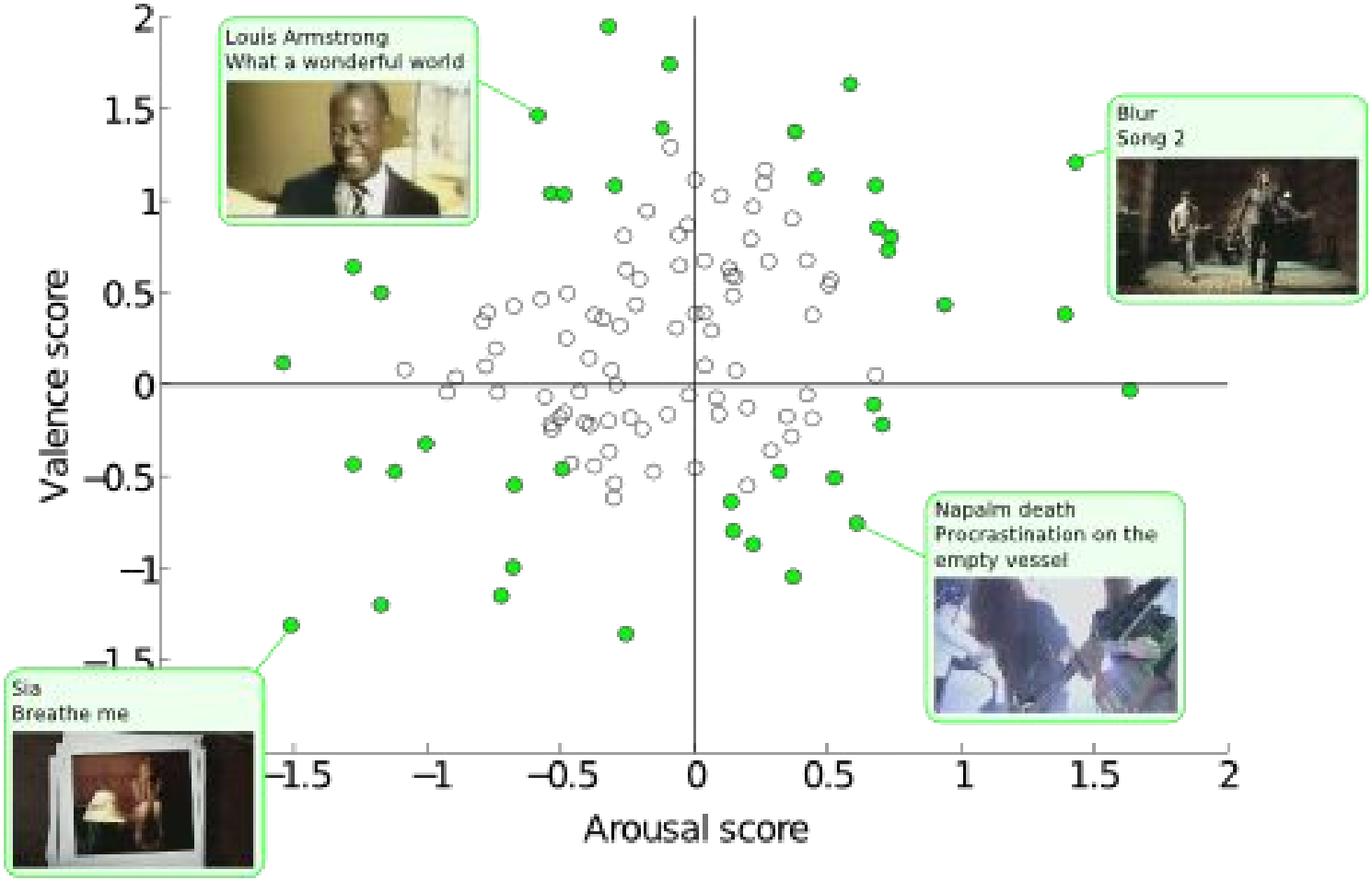


Input: brain waves

Feature Extraction and Machine Learning

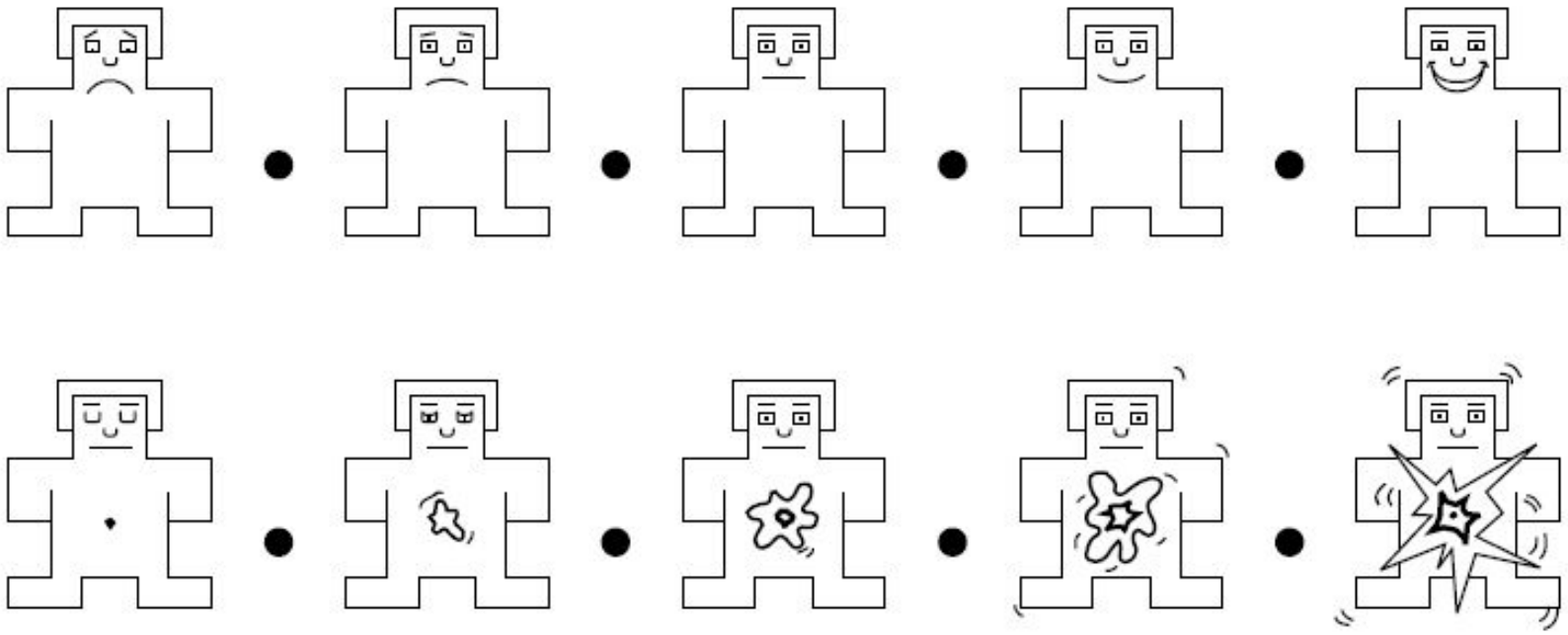
Output: valence/arousal

Machine learning requires samples



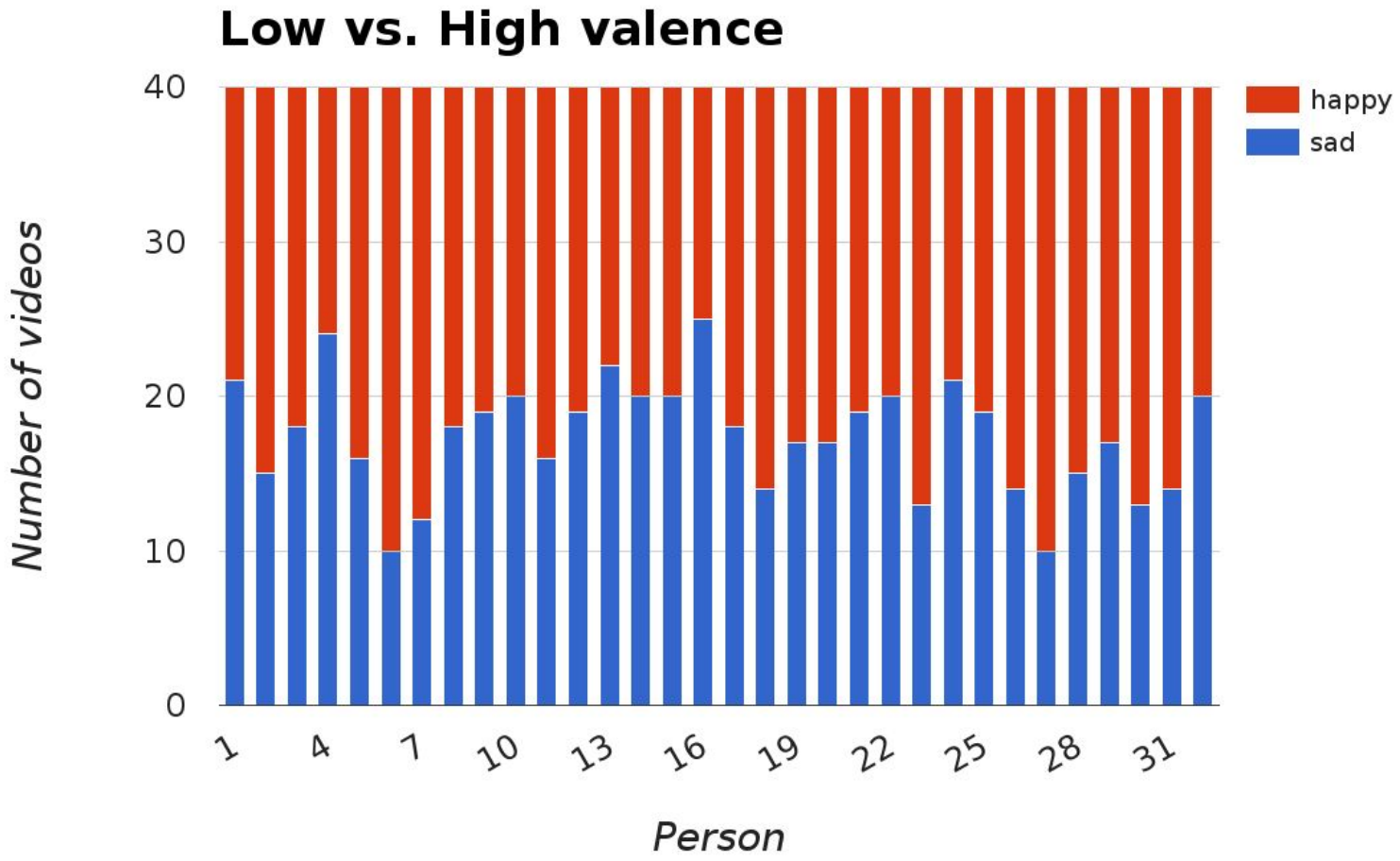
picture from http://www.eecs.qmul.ac.uk/mmv/datasets/deap/

Problem - Labels via survey

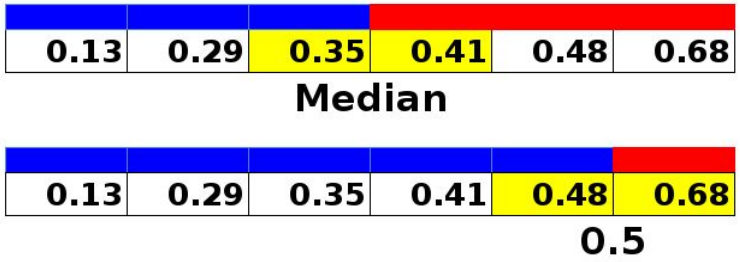


http://www.eecs.qmul.ac.uk/mmv/datasets/deap/doc/tac_special_issue_2011.pdf

Problem - Data unbalance



Very first trial: SVM



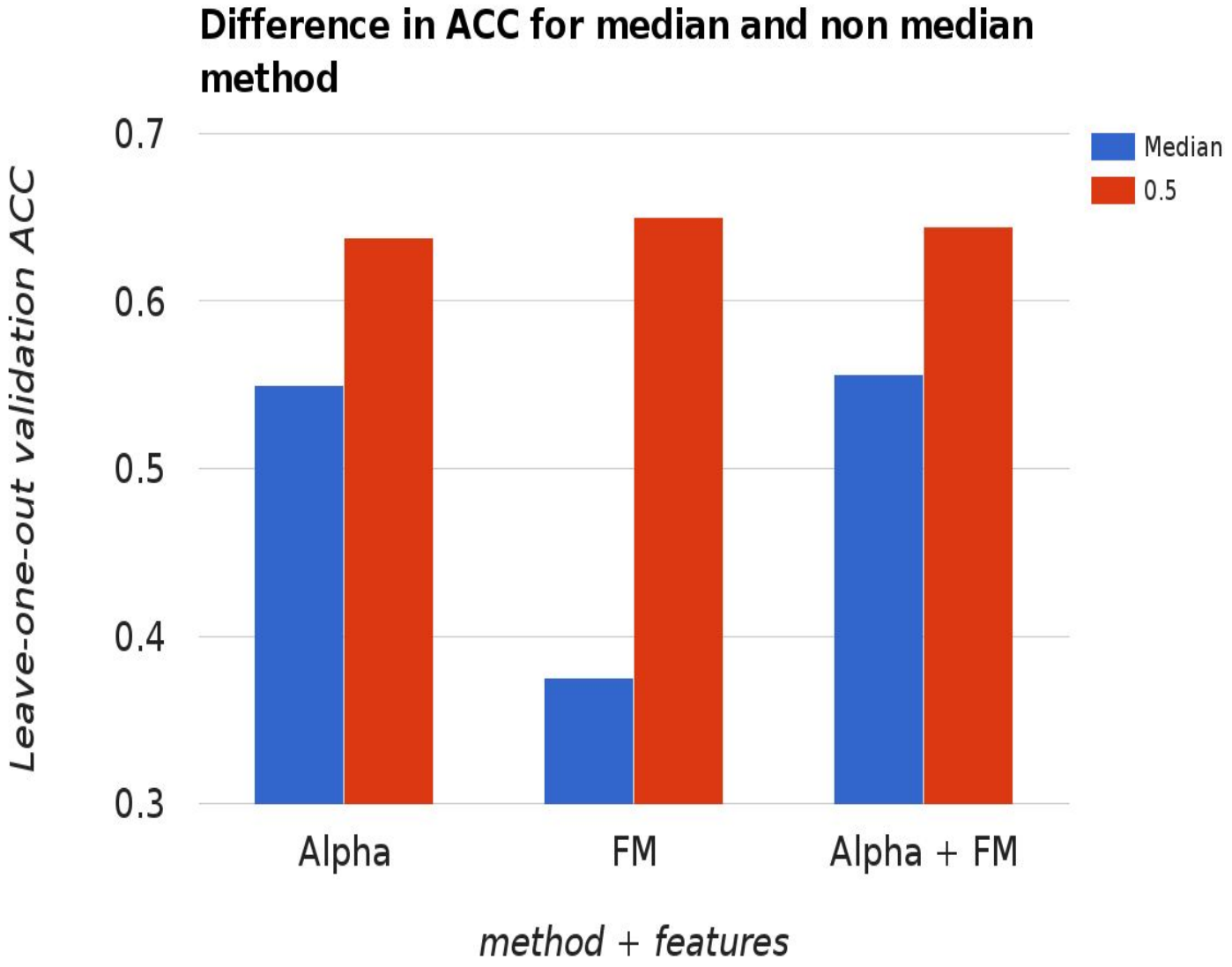
Split dataset in low / high valence

Feature extraction

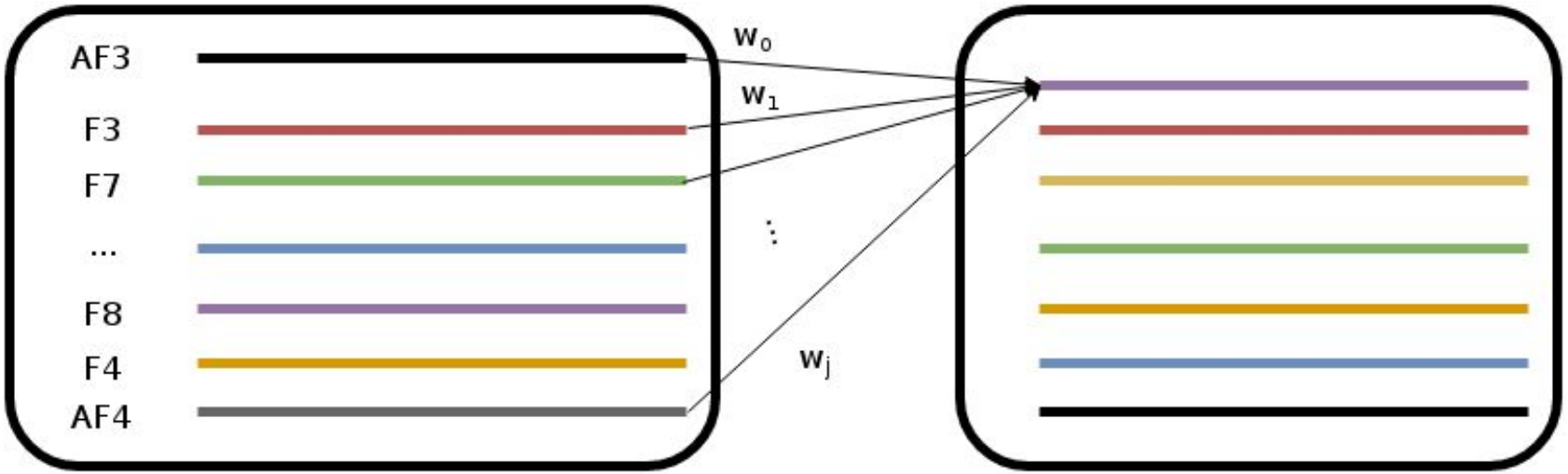
Video 1	Video 2	Video 3	Video 4
Video 1	Video 2	Video 3	Video 4
Video 1	Video 2	Video 3	Video 4
Video 1	Video 2	Video 3	Video 4

Leave-one-out validation

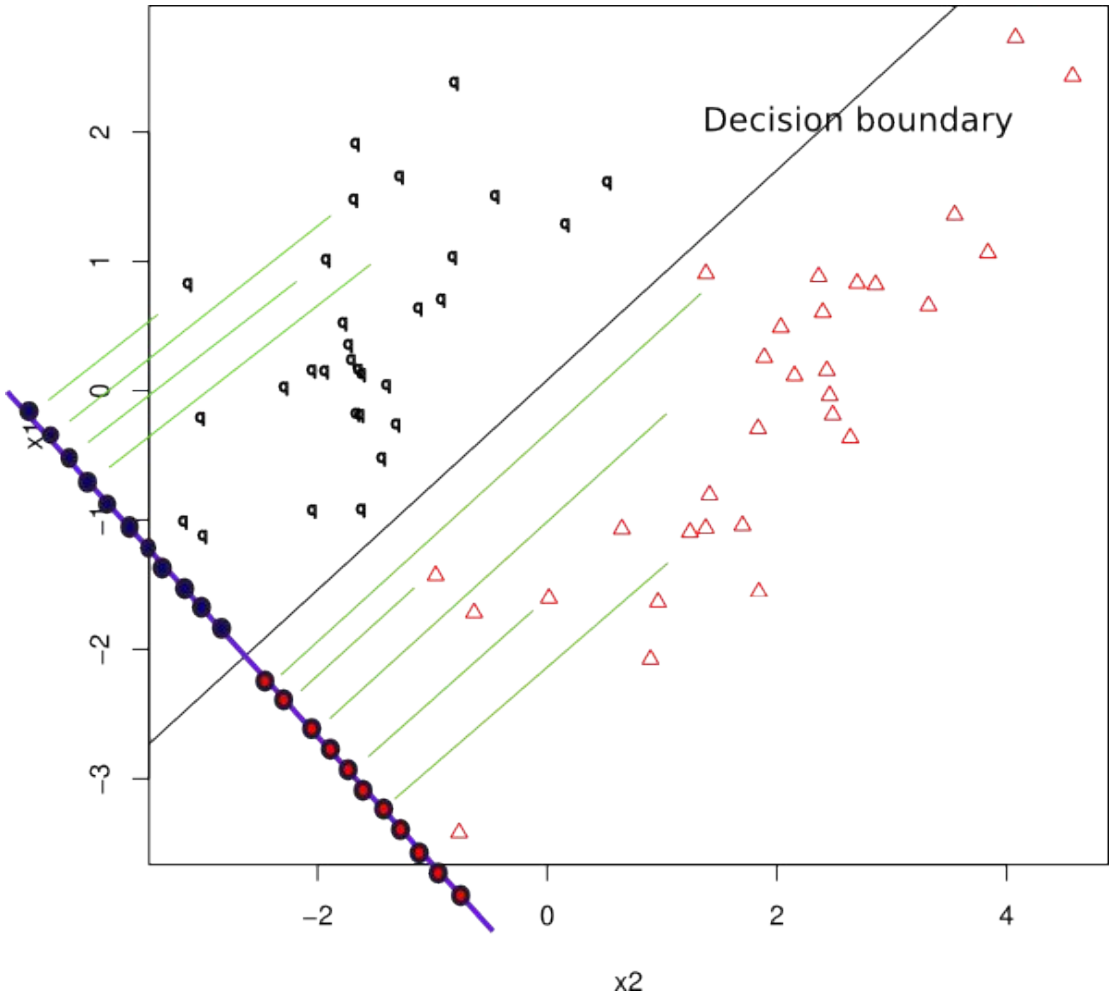
Results


Difference in ACC for median and non median method
Leave-one-out validation ACC
0.7
0.6
0.5
0.4
0.3
Median
0.5
Alpha
FM
Alpha + FM
method + features

Common Spatial Patterns (CSP)



Linear Discriminant Analysis (LDA)



CSP + LDA

0.13	0.29	0.35	0.41	0.48	0.68

0.5

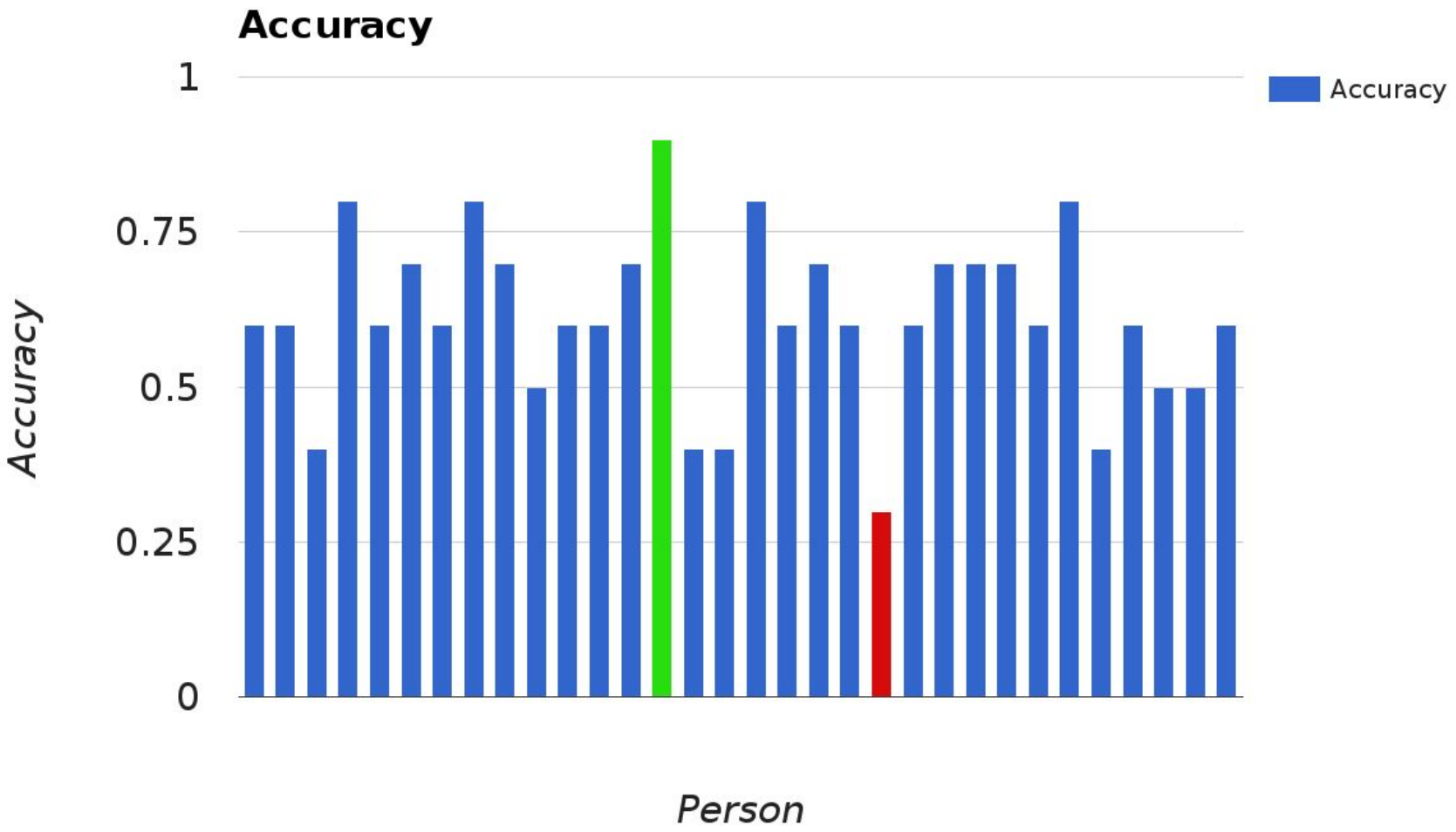
Split dataset in low / high valence

Feature extraction

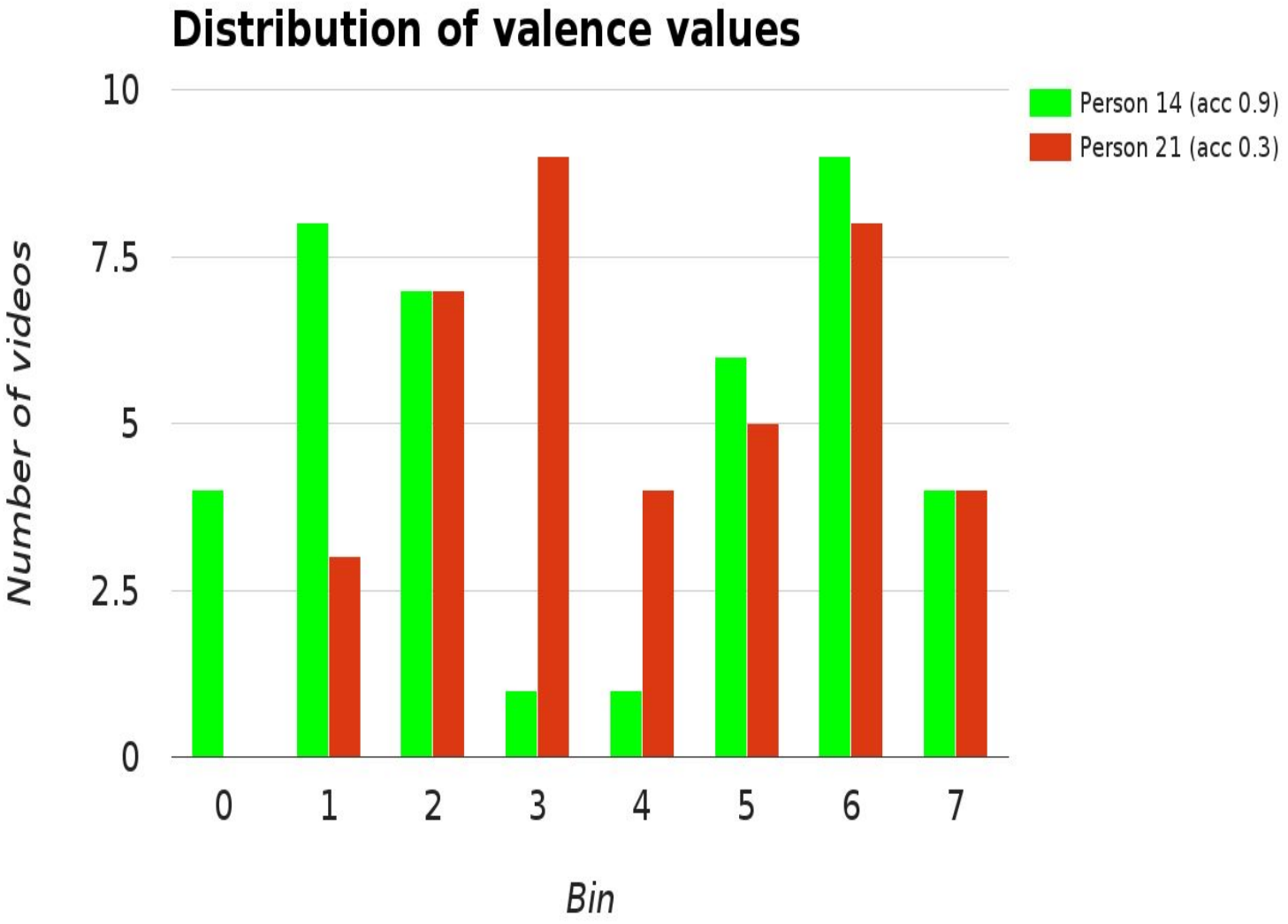
Video 1	Video 2	Video 3	Test set
Video 1	Video 2	Video 3	Test set
Video 1	Video 2	Video 3	Test set

Leave-one-out validation + test set

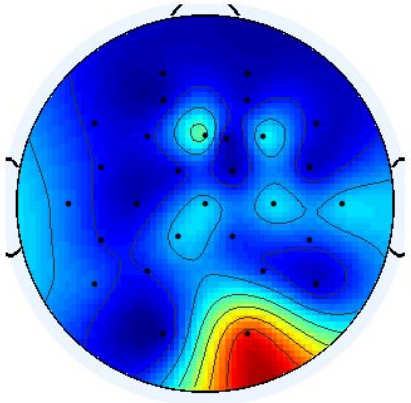
Results



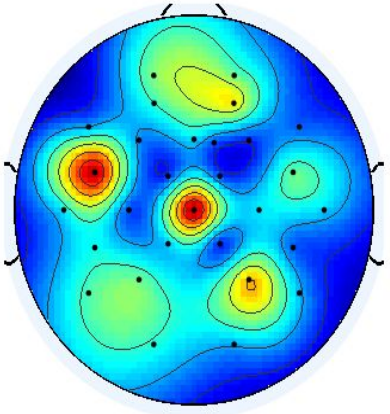
Results


Distribution of valence values
Person 14 (acc 0.9)
Person 21 (acc 0.3)
Number of videos
10
7.5
5
2.5
0
0
1
2
3
4
5
6
7
Bin

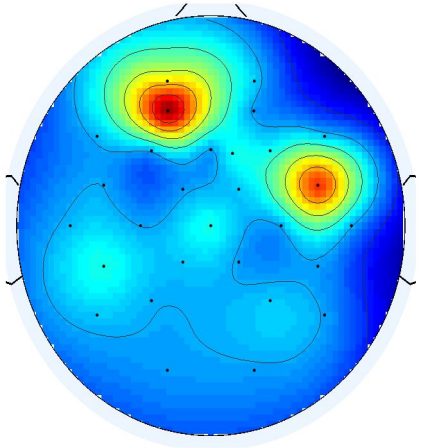
Results



Person 14
accuracy of 90%



Person 21
accuracy of 30%



Person 2
accuracy of 60%

Similar research

Model	**Features**	**# Emotions**	**# Persons**	**Accuracy**
SVM	EEG + HR + BP	5 emotions	12	58.2%
FDA	EEG + BP + RSP + HR	3 levels of arousal	4	50-72 %
SVM	EEG	3 emotions + 1 neutral state	4	87.5 %
Deep neural nets	EEG	3 states, negative, positive, neutral	15	avg: 86% std: 8.34%

Further steps

- Improve Accuracy
  - only use important channels
  - epochs of 6 seconds with 5 seconds overlap
  - Use additional wavebands
- Classify different arousal levels
- Classify videos from other persons
- Unsupervised
- Improve accuracy of P300 speller

Questions