Classification of early stage Parkinson's Disease based on EEG feature set

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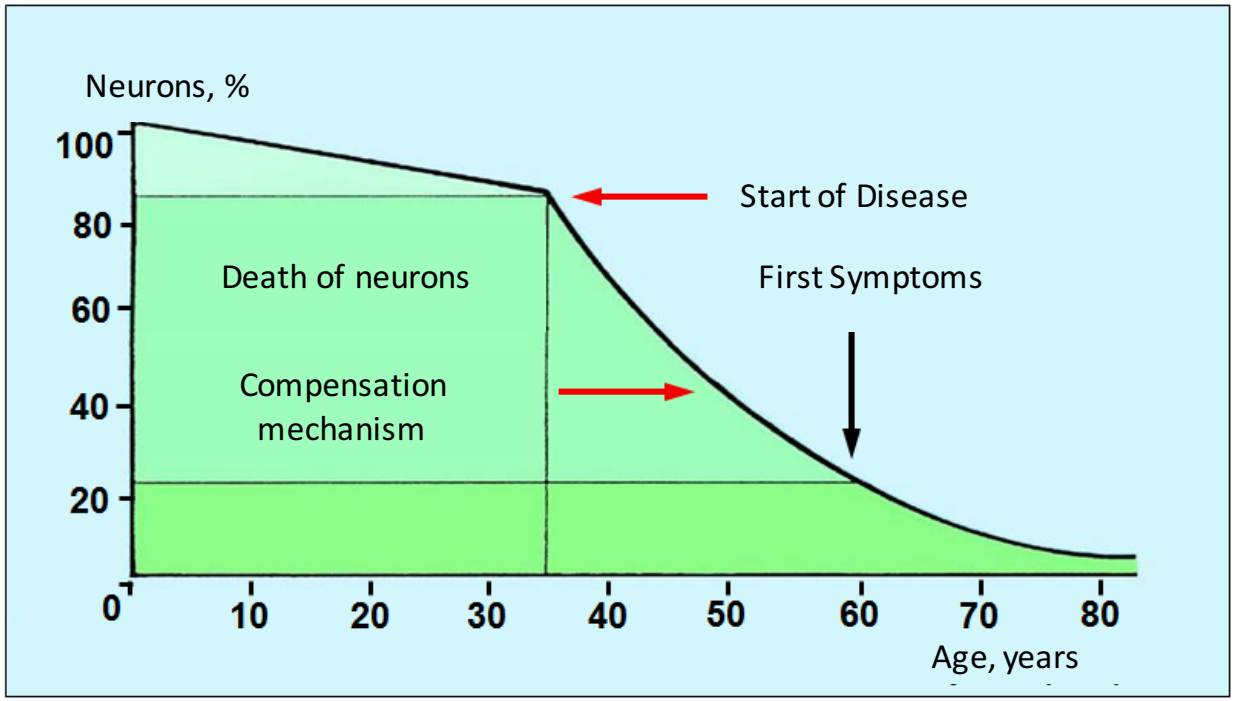
Presentation Plan

- Parkinson's Disease and its electrophysiological features
- Experiment Design
- EEG data transformation
- Features of Parkinson’s Disease
- Classification model
- Accuracy results

Parkinson's Disease



Patients without symptoms

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Group of Risk

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Positron-Emission Tomography

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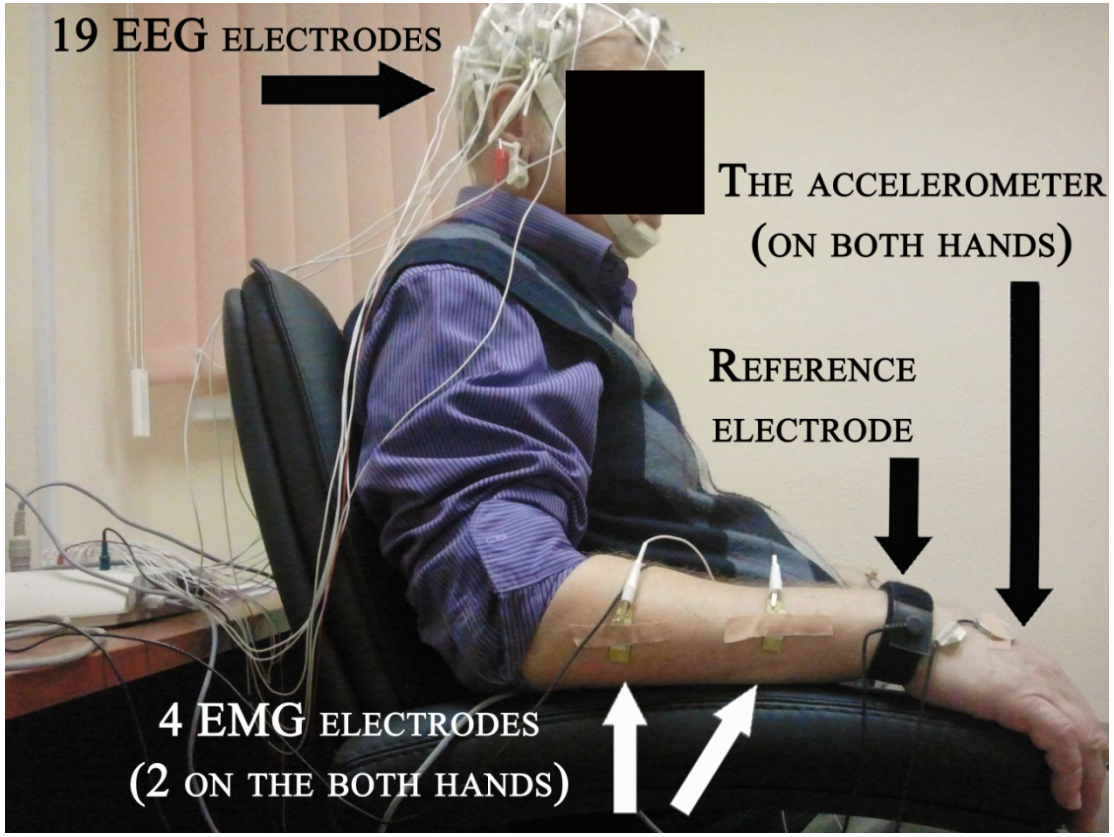
Prevention Treatment

Diagnostics of Parkinson's Disease on pre-clinical stage based on electrophysiological features

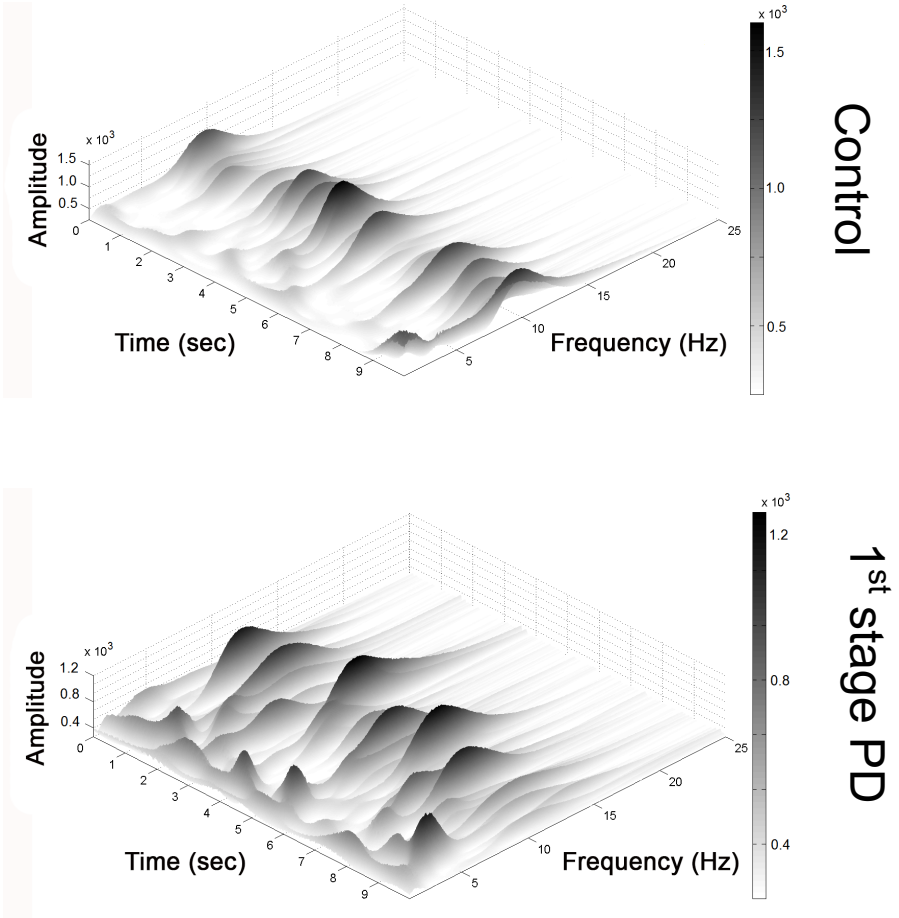
Experiment Design



31 non treated 1st stage PD patients & 18 control

EEG symmetrical electrodes:
(Fp1,Fp2), (F7,F8), (F3,F4), (T3,T4), (C3,C4), (P3,P4), (T5,T6) and (O1,O2)

Wavelet transform of EEG signals



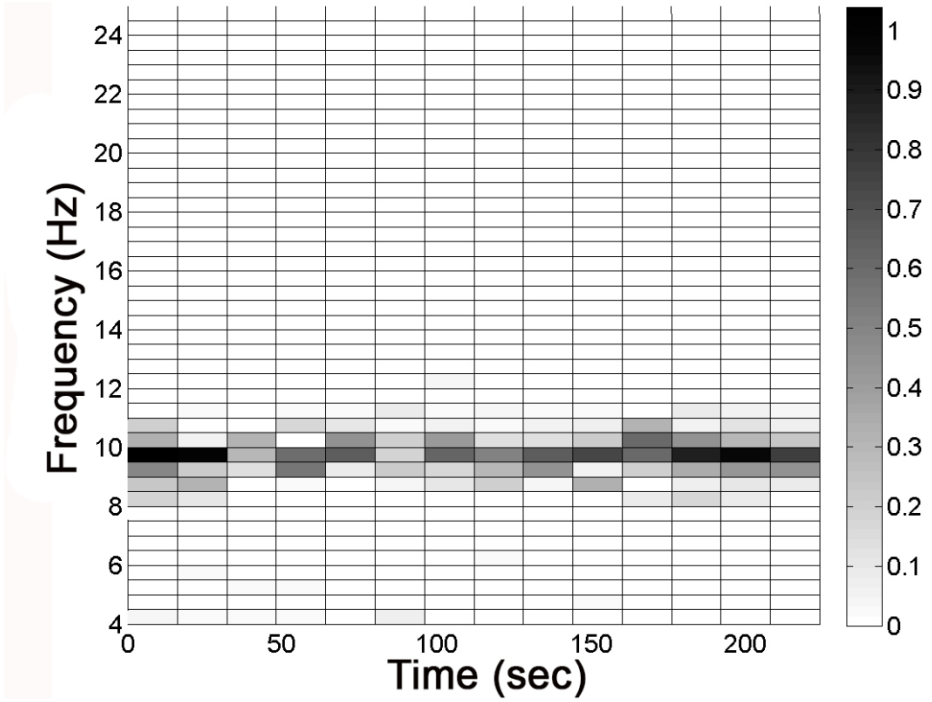
$$W(\tau,T)=\frac{1}{\sqrt{T}}\int x(t)\Psi^{*}\left(\frac{t-\tau}{T}\right)dt,$$

$$\Psi(\eta)=\frac{1}{\sqrt{\pi F_b}}e^{2i\pi F_c\eta}e^{-\frac{\eta^2}{F_b}}$$

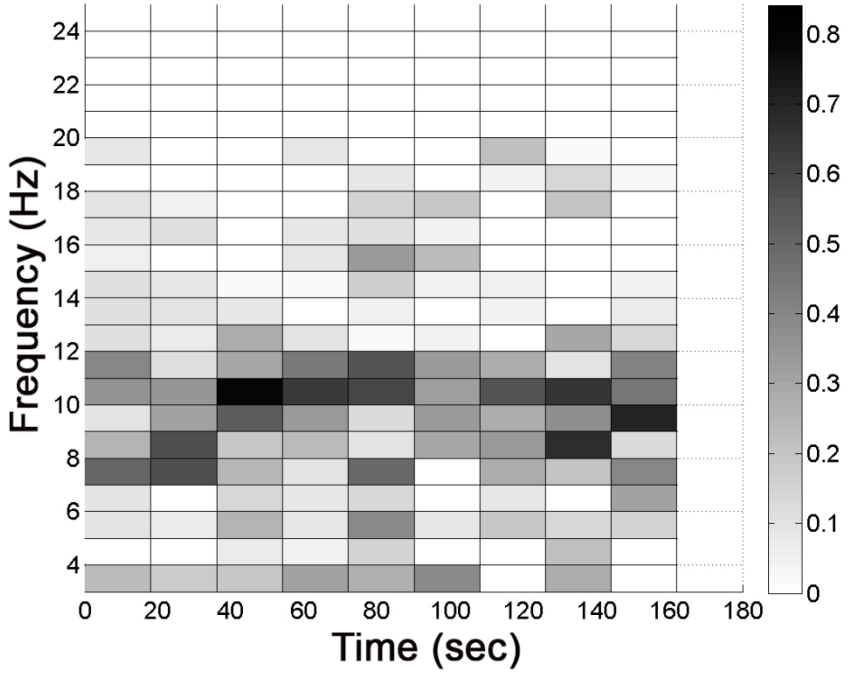
$$S(\tau,f)=|W(\tau,f)|^2,$$

Dynamical histograms of wavelet spectrogram

Control

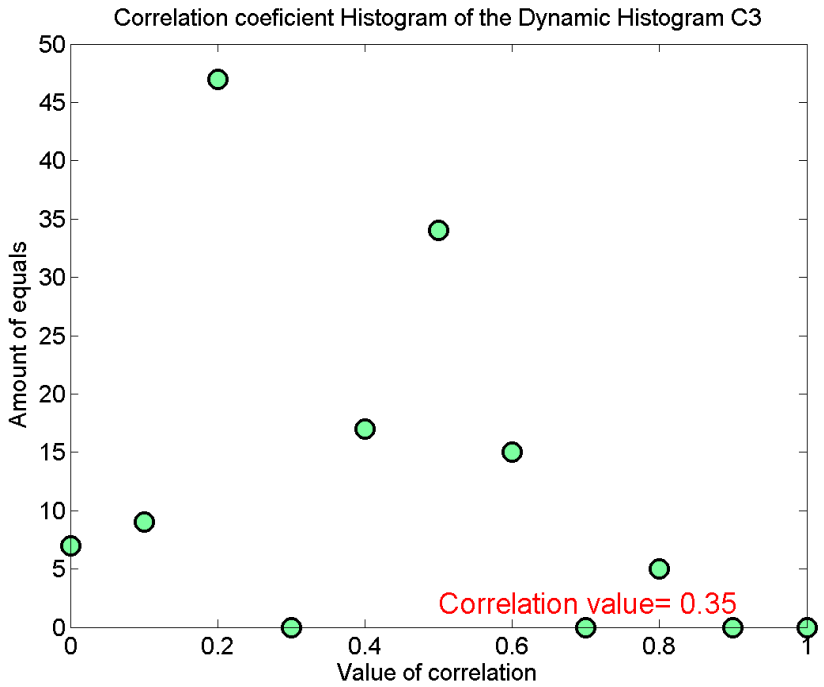


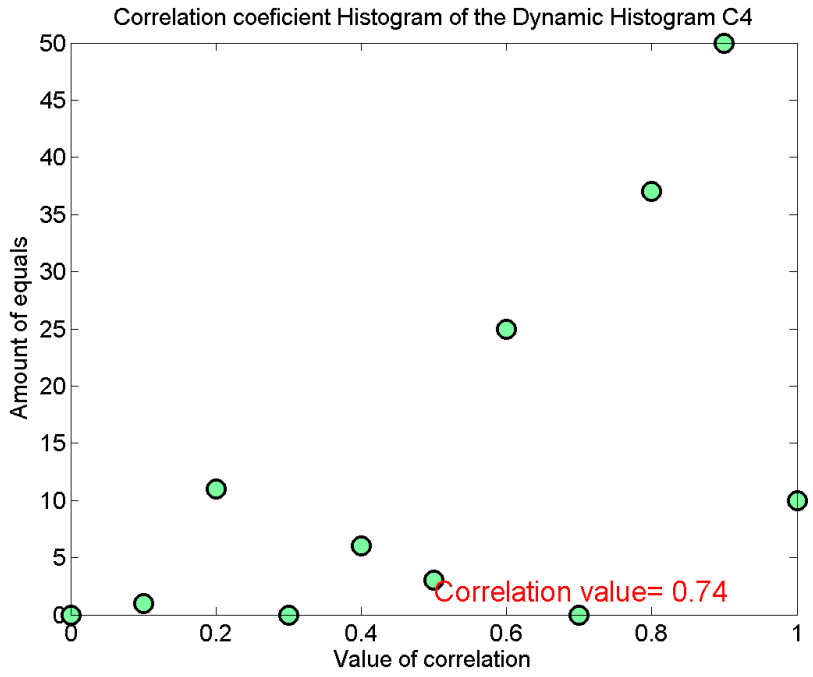
1st stage PD



$A_\theta/A\alpha$ (j), $A_\theta/A\alpha$ (j*) can be considered as features of PD

Correlation matrices of wavelet spectrogram





C3 1st stage PD patient C4

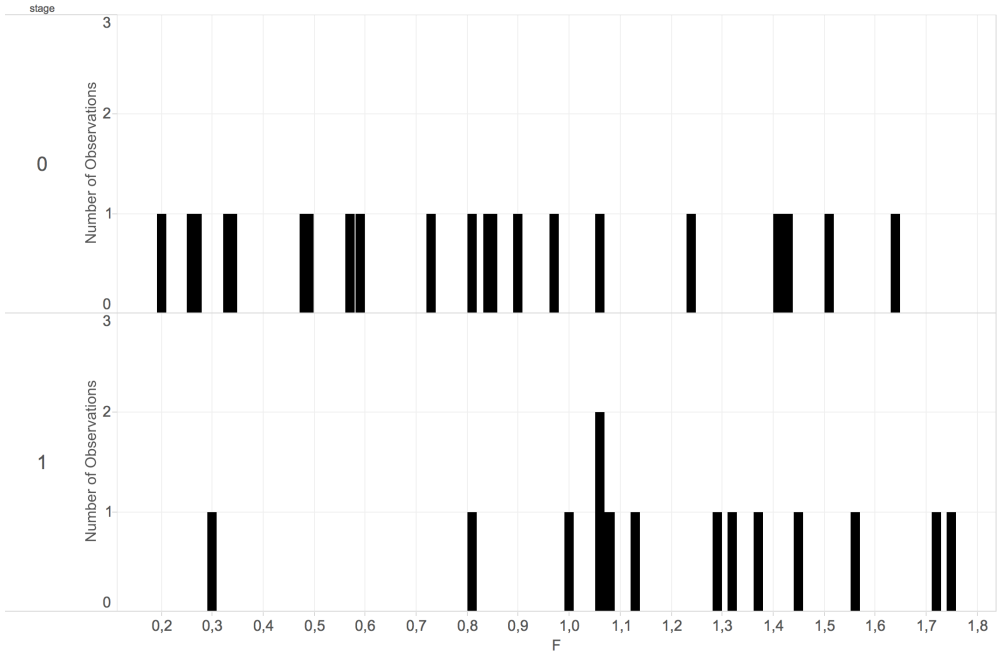
Mean correlations r(j), r(j*) and sd σ(j), σ(j*) can be considered as features of PD

Logistic regression model

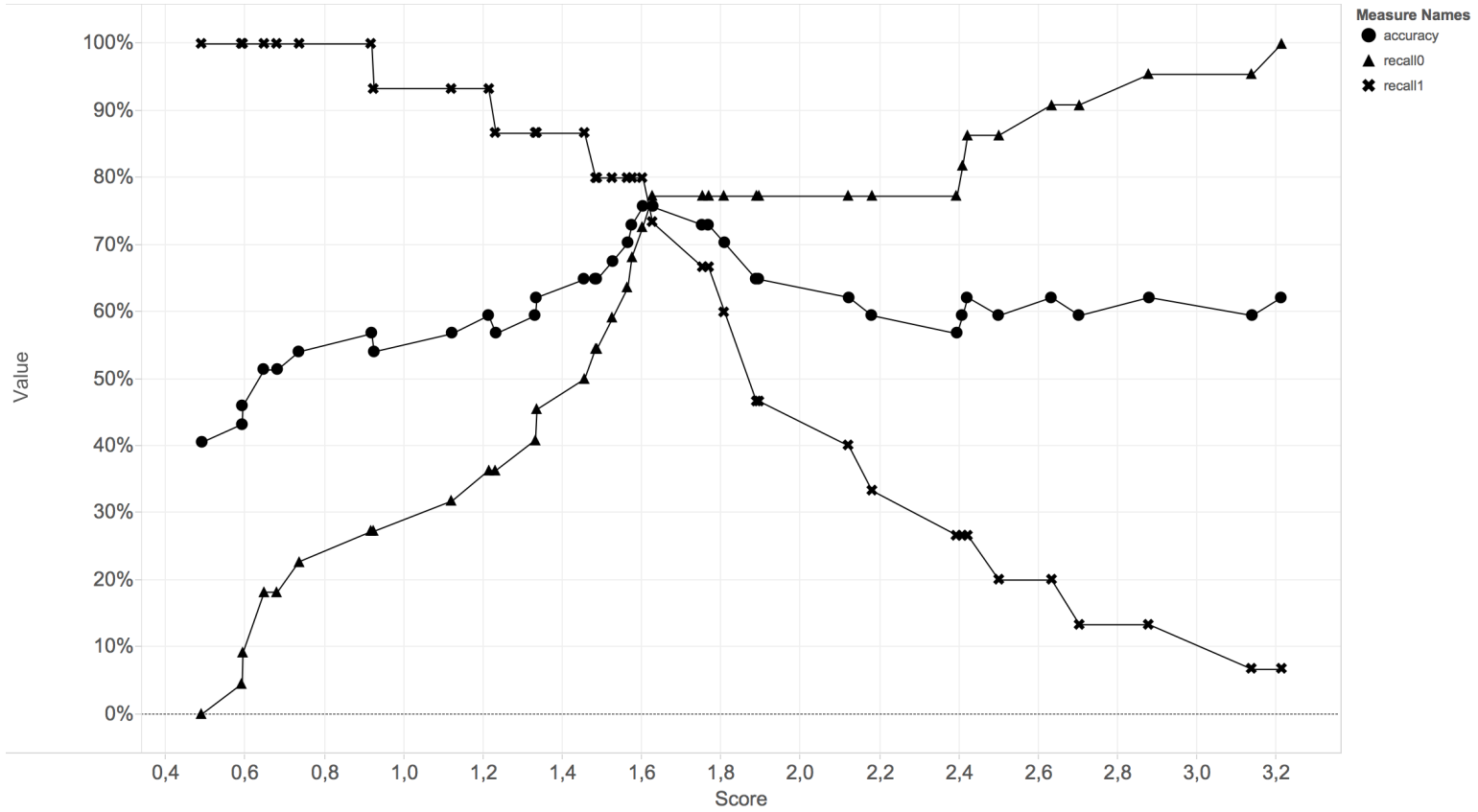
- Feature space: $x_i \in \{A_\vartheta/A_\alpha\,(j),\ A_\vartheta/A_\alpha\,(j^*),\ r(j),\ r(j^*),\ \sigma(j),\ \sigma(j^*)\}$
- EEG channels: *(j,j*) ϵ {(Fp1,Fp2), (F7,F8), (F3,F4), (T3,T4), (C3,C4), P3,P4), (T5,T6), (O1,O2)}*
- Logistic function: $f(z) = \frac{1}{1+\exp(-z)}$
- Polynomial function: $Z(j,j^*) = a_1x_1+\ldots+a_nx_n$

Probability of PD aggregation

- Aggregation of PD probabilities: $F = \sum_i |P(i) - 0.5| * AUC(i,j)$
- AUC measured on train data, P(i) calculated on new dataset



Model Results



Recall of clinical and EEG diagnosis for control (▲), PD patients (*), and accuracy of classification (●)

Summary

- Time-frequency analysis of EEG for 31 1st stage PD patients and 18 control volunteers was done.
- PD features were extracted and used for binary classification model training.
- Logistic Regression model was used for evaluation of probability the 1st PD stages in 16 EEG channels. Aggregation was performed in accordance with AUC results.
- Proposed cut-off value leads to Accuracy of 1st stage PD prediction approx. 75%

Thank you for your attention!