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Low Dimensional EEG Classification for Alzheimer's Disease Recognition

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EEG vs fMRI and PET

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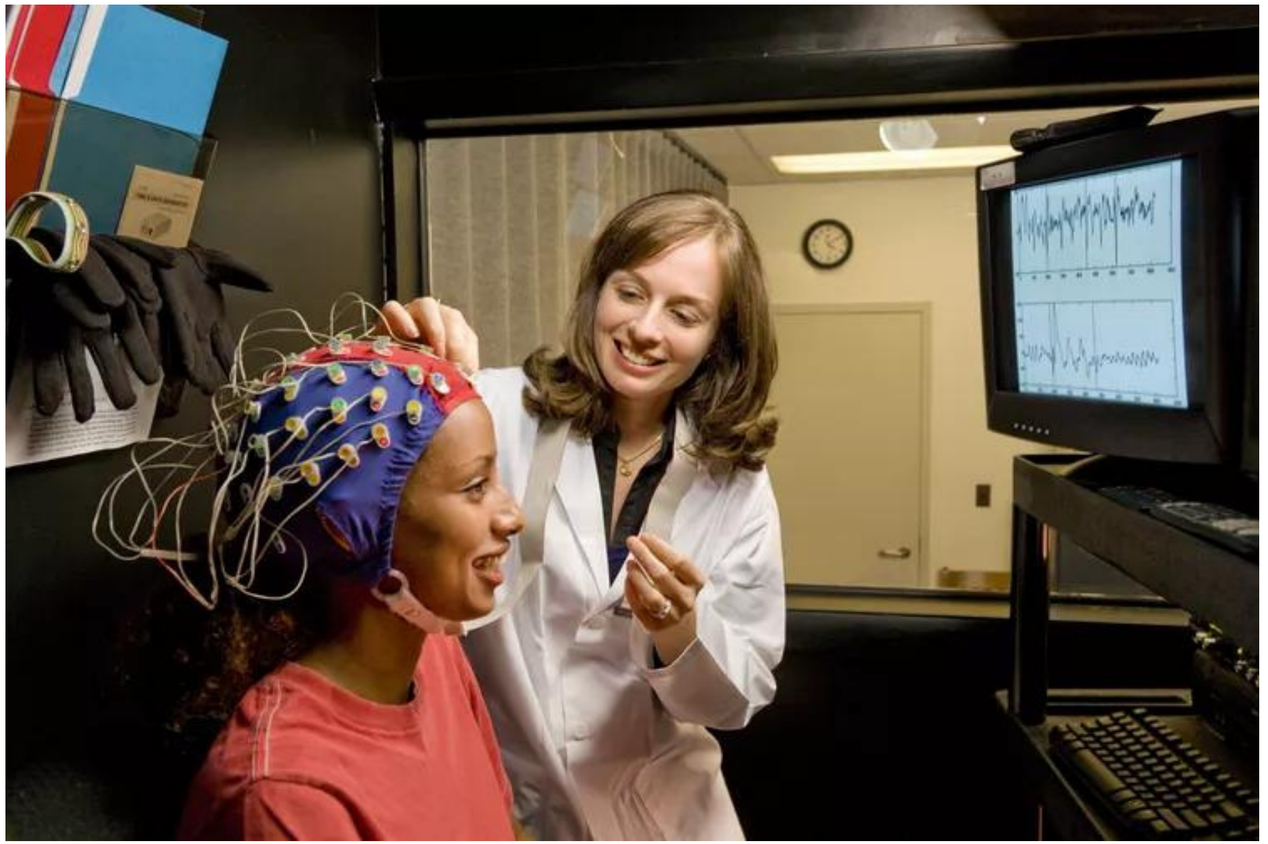

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... but taking into account the advantages of EEG - price, availability, non-invasiveness and high temporal resolution, this approach is chosen.

Performance - Interpretability trade-off

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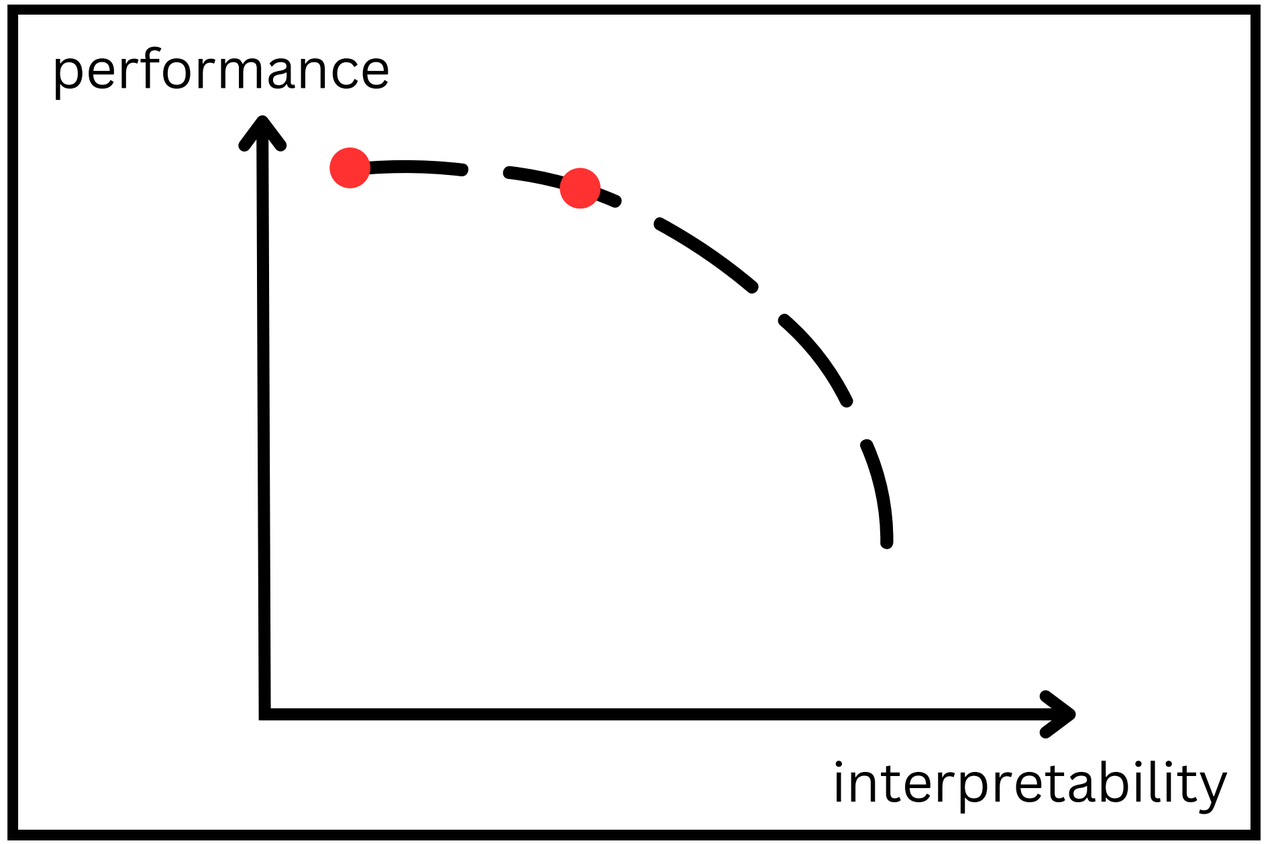

We propose a framework that trades off some performance to significantly increase model interpretability.

The block diagram of the proposed analysis

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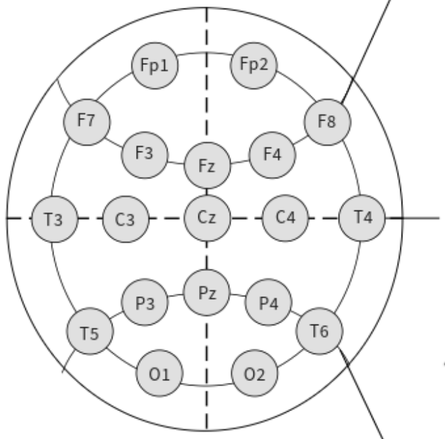
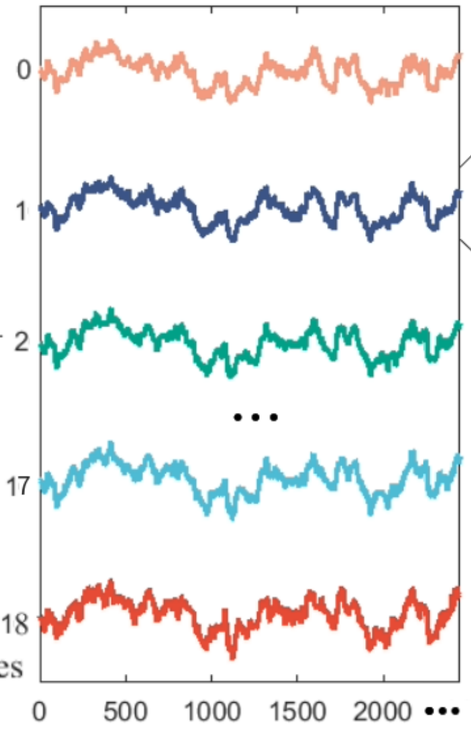
database

65 subjects
- 36 Alzheimer's disease (AD)
- 29 healthy subjects (CN)



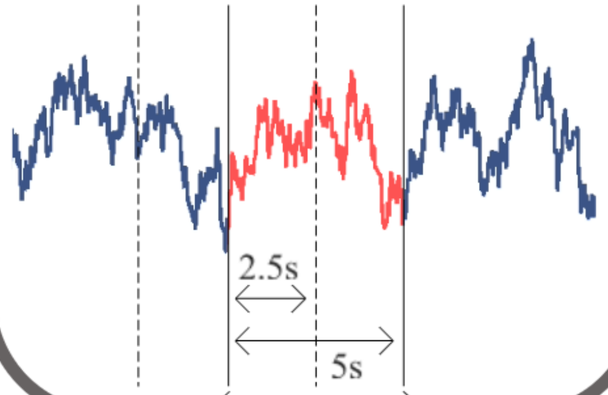


19 electrodes

preprocessing

brain waves: α, β, γ, δ, θ

windowing + overlap

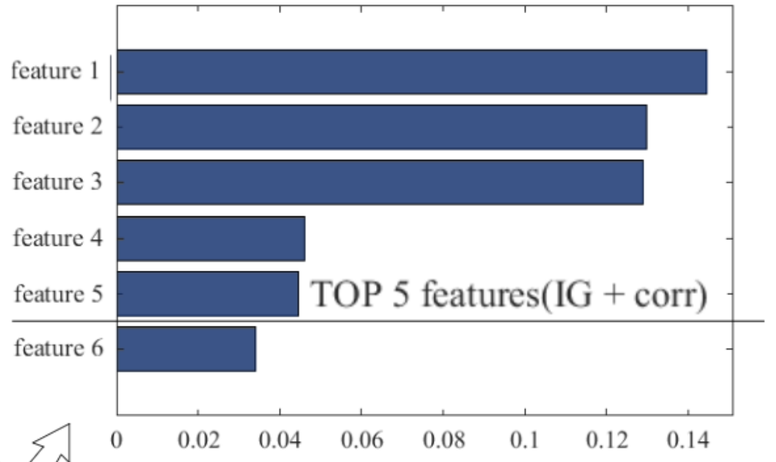


feature extraction

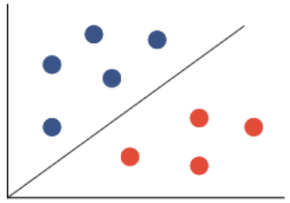
- hjorth parameters
- skewness
- kurtosis

19ch * 5wav * 5feat = 475 features

feature selection



ML based classification



prognosis

AD CN

Dataset description

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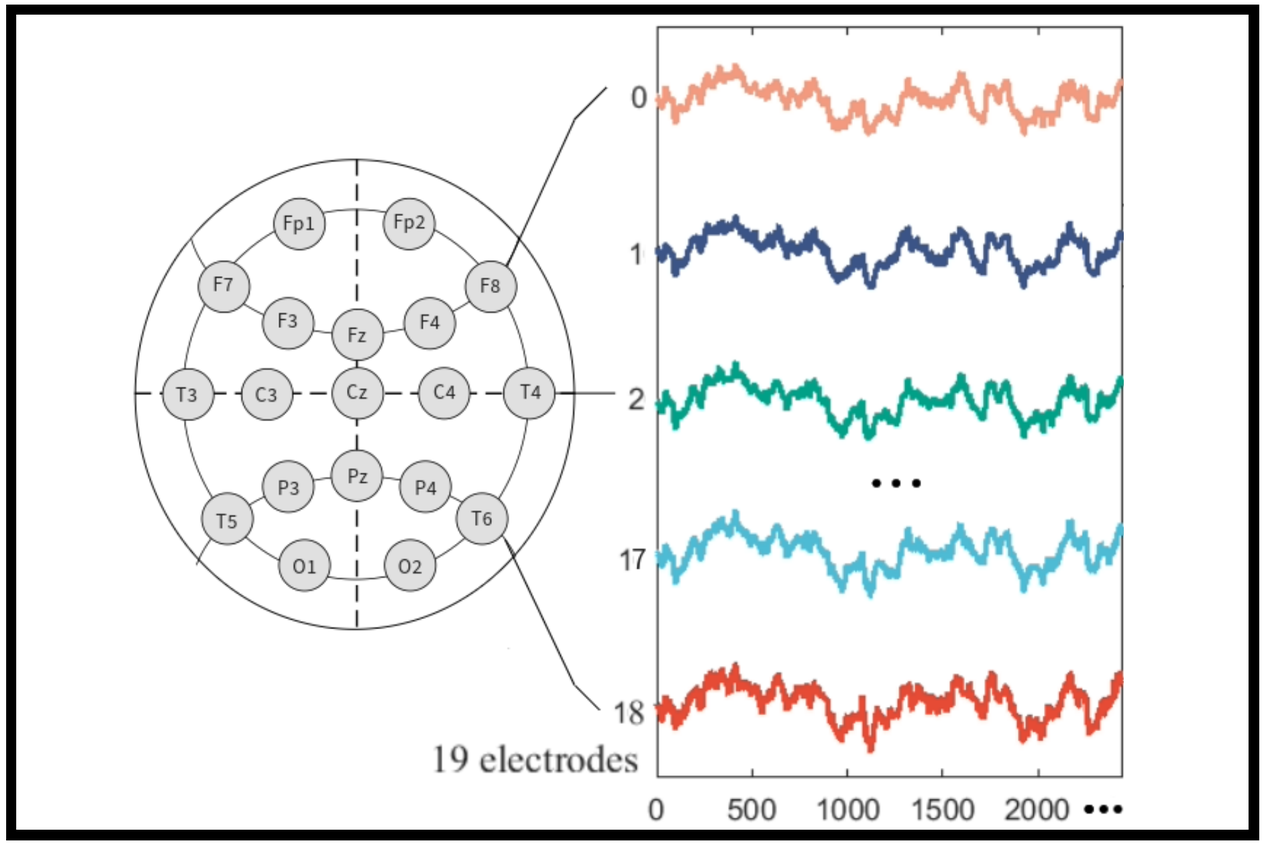

Our dataset consists of previously preprocessed EEG signals of 65 patients (36 AD + 29 CN). Available at: https://openneuro.org/datasets/ds004504/versions/1.0.5

Data preprocessing and feature extraction

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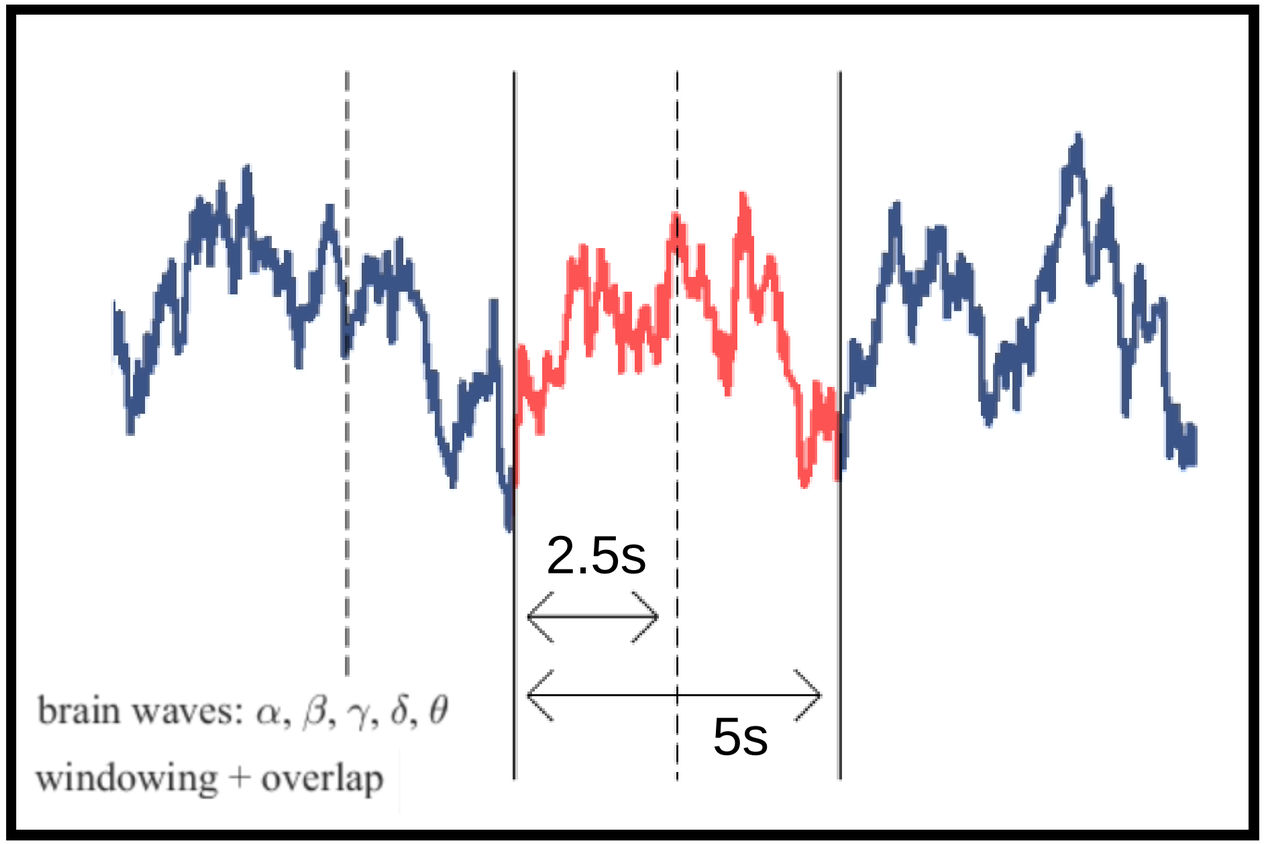

From each signal, 5 brain waves were extracted and divided into 5s epoch intervals with 2.5s overlap.

Data preprocessing and feature extraction

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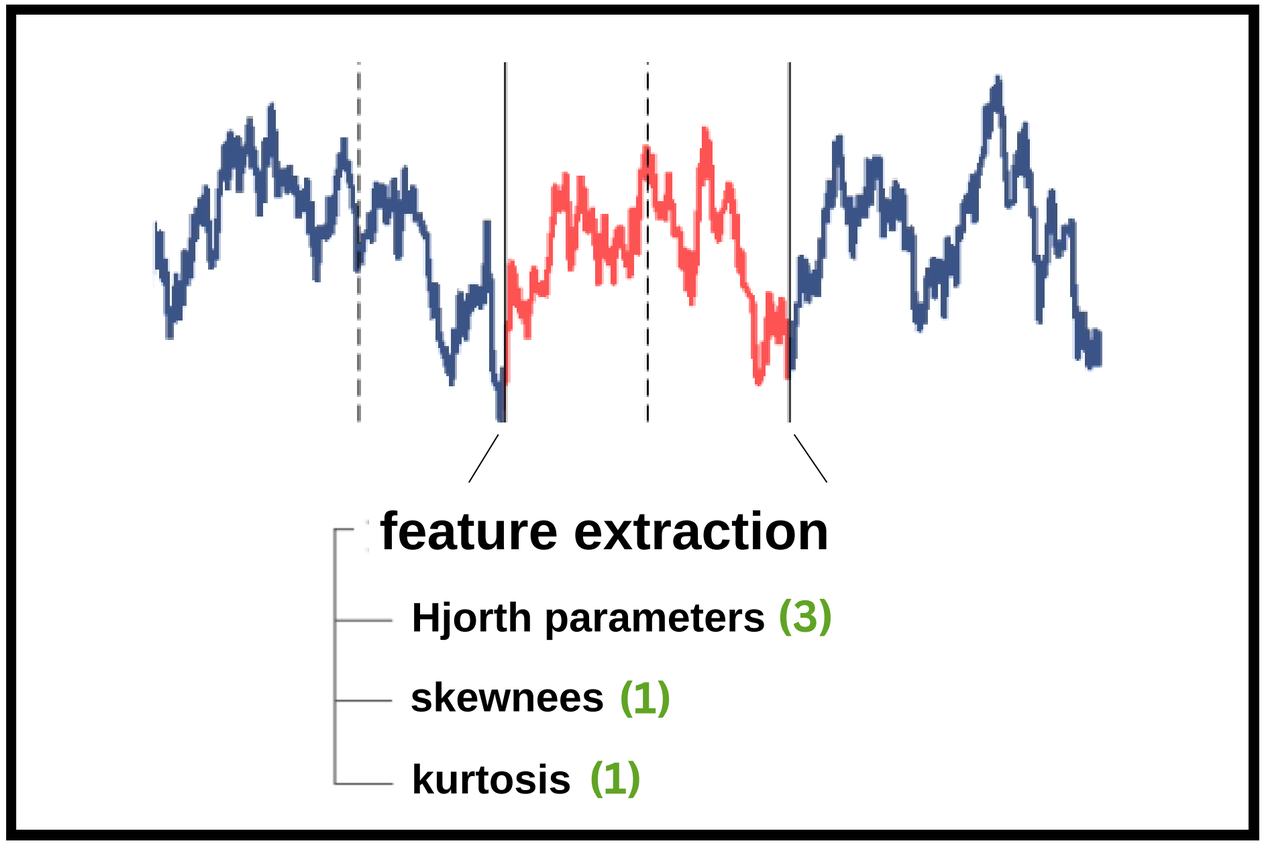

For each of the 19 EEG channels, for each of the 5 brain waves, 5 features were extracted, resulting in 19 * 5 * 5 = 475 features.

Feature selection

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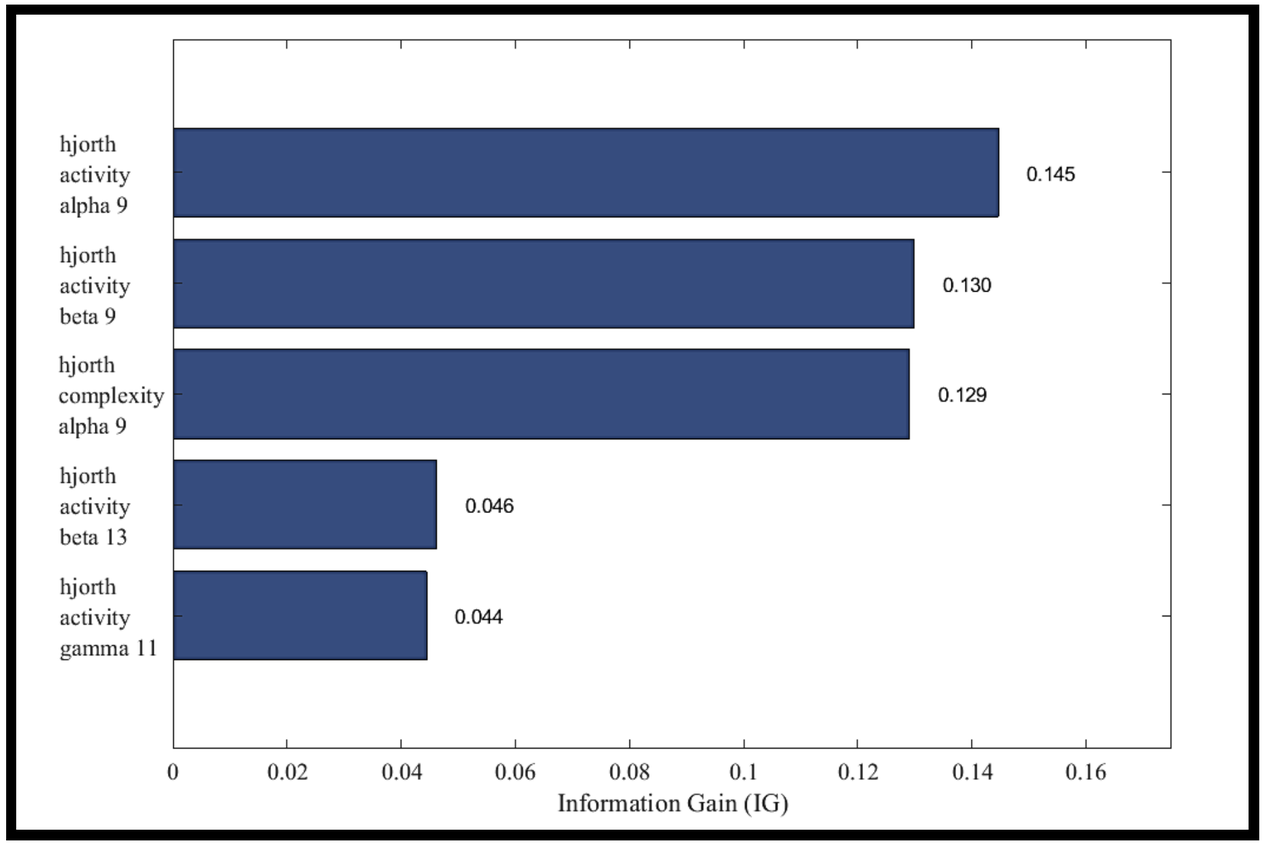

The top 5 features with the highest information gain, while also having Pearson cross-correlation less than 0.5 were selected.

Classification

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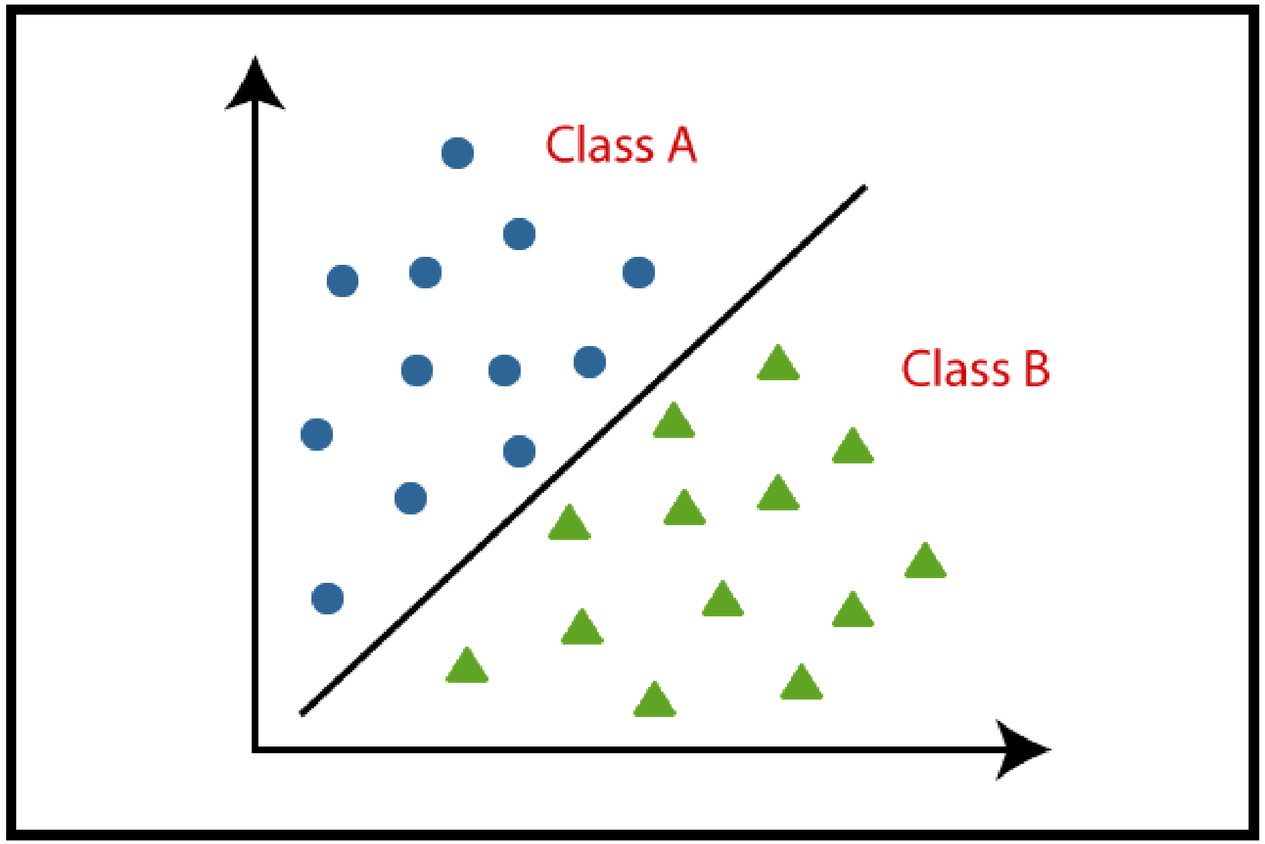

Classifiers kNN, Random Forest, XGBoost, SVM and Logistic Regression were implemented and evaluated with a modified cross-validation technique.

Boxplot representation of 5 best features

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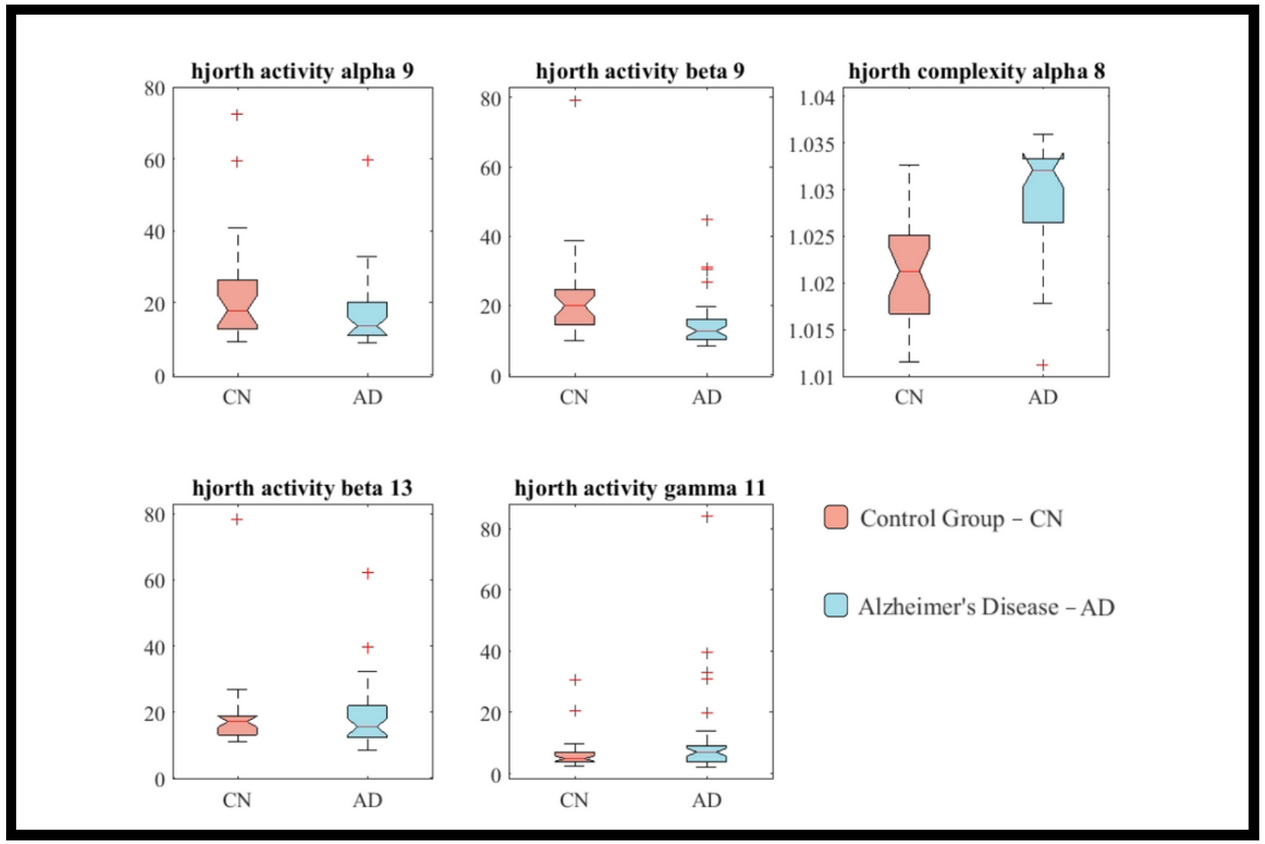

Hjorth activity of the alpha wave of the 9th channel turns out to be the best feature.

Comparison of the results

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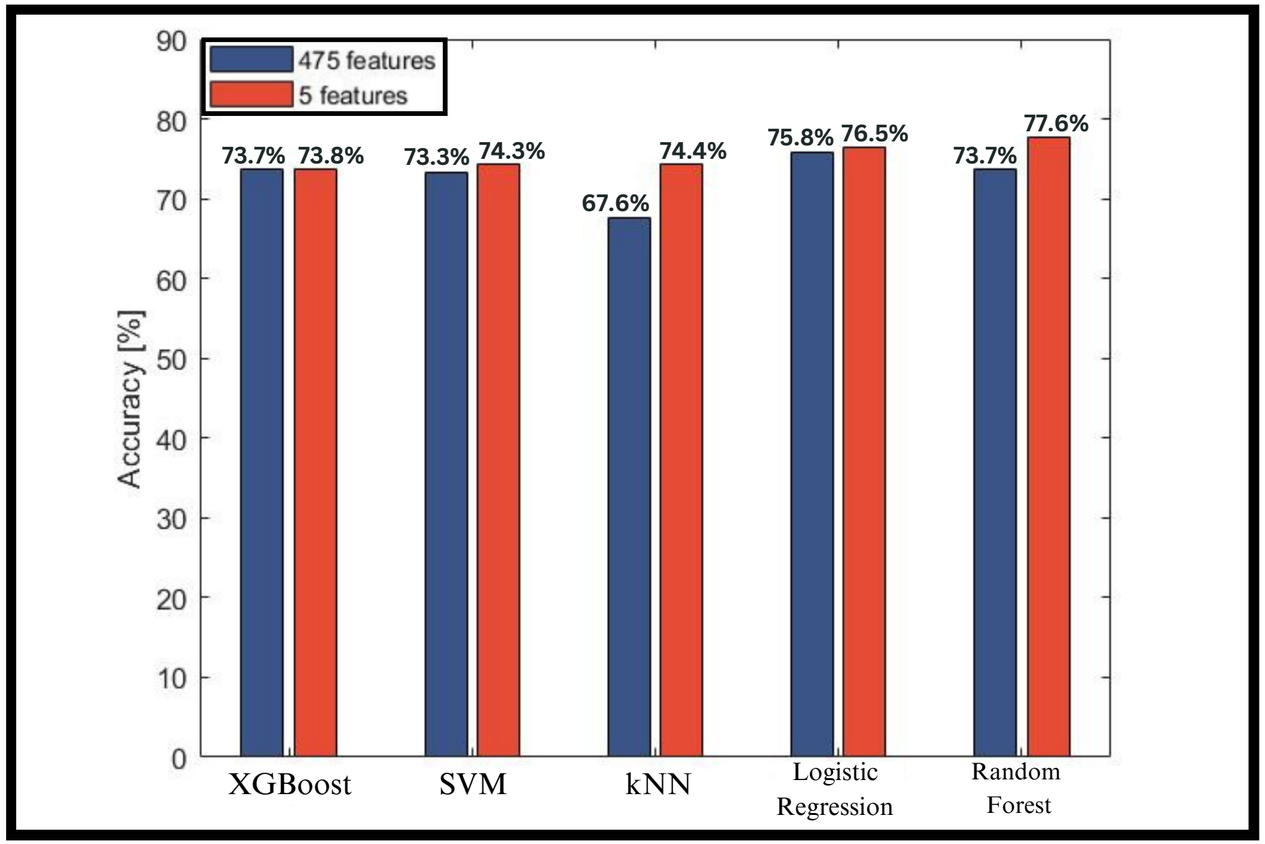

All models show higher accuracies on reduced feature set;
Random Forest is best overall with accuracy of 77.6%.

Comparison of the results

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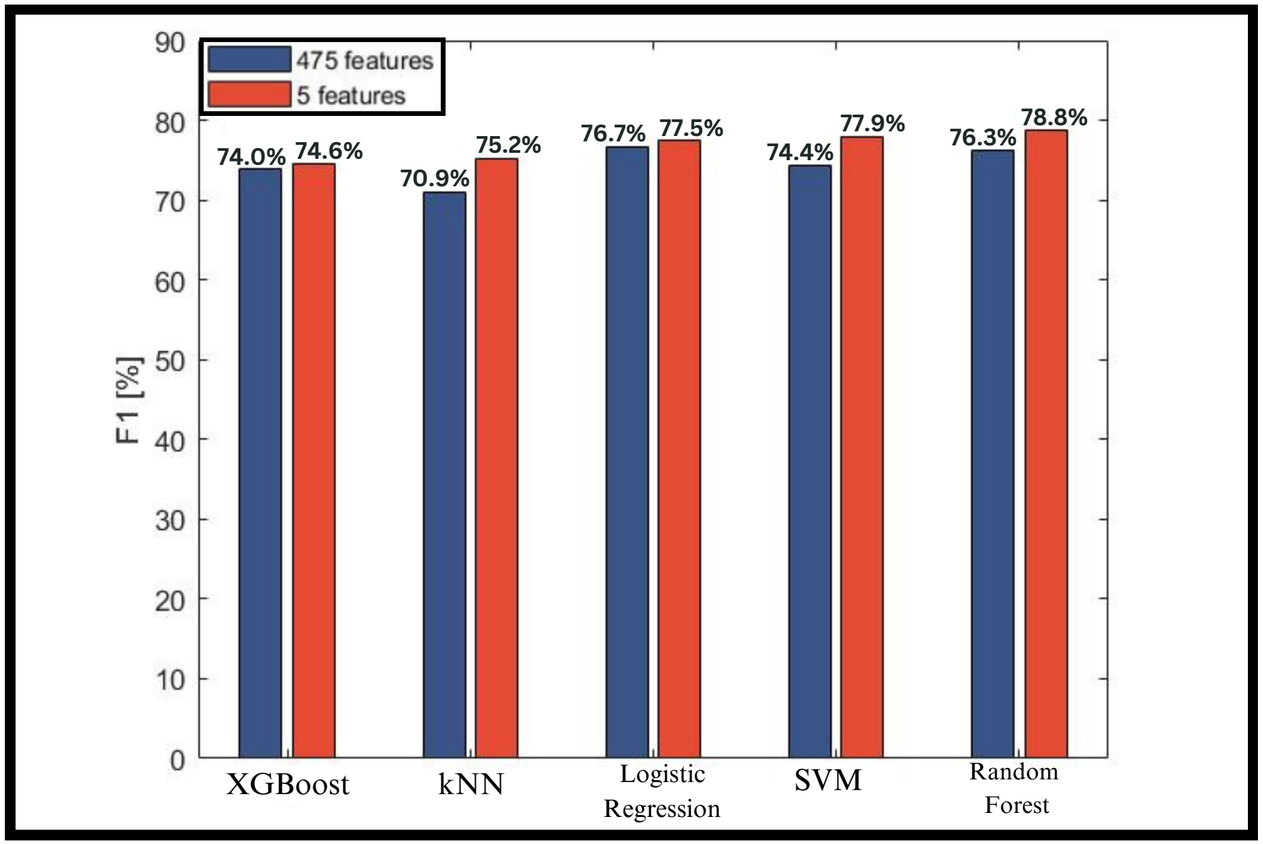

Also, all models achieve higher F1 score on the reduced feature set; Random Forest is again best overall with F1 of 78.8%.

Comparison to relevant research

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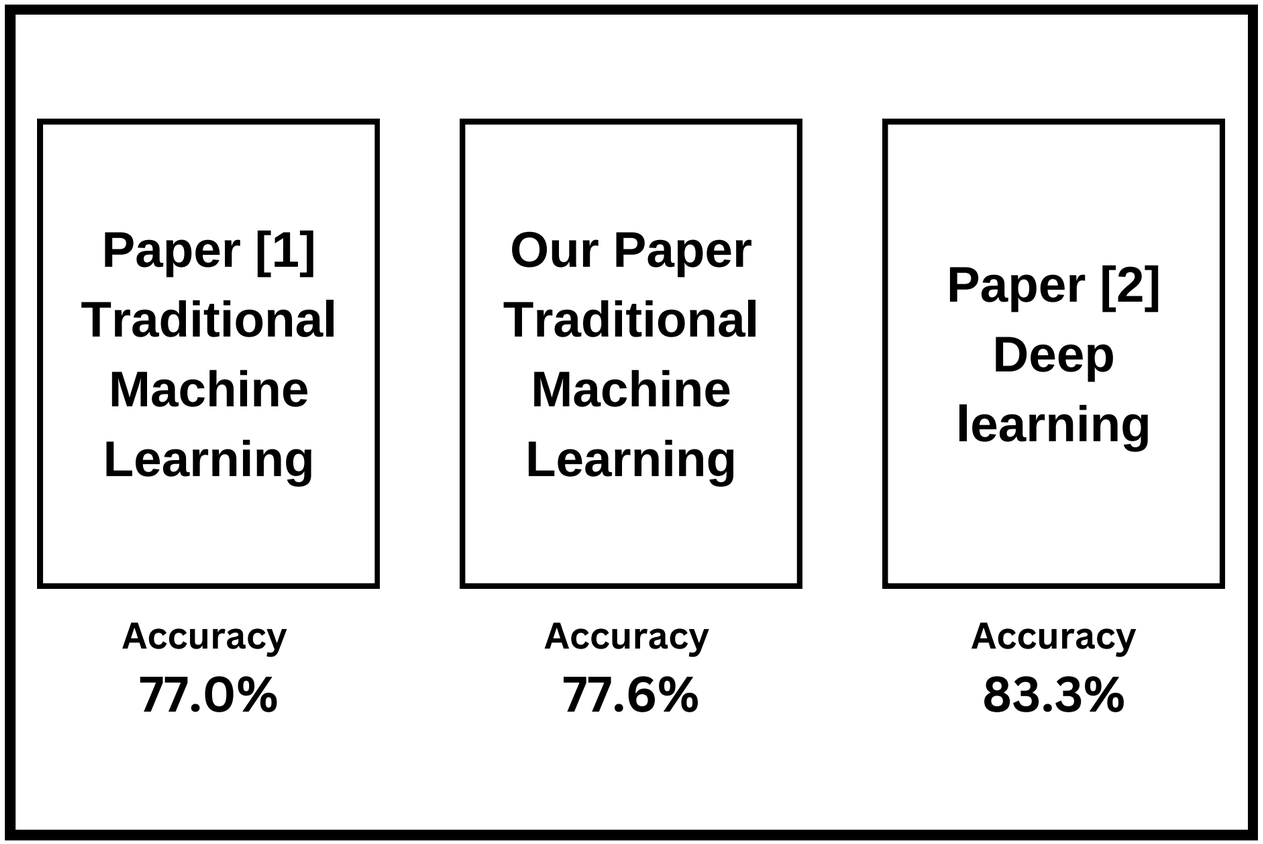

[1] A. Miltiadous et al., “A dataset of scalp EEG recordings of Alzheimer's disease, frontotemporal dementia and healthy subjects from routine EEG” Data, vol. 8, no. 6, p. 95, 2023.

[2] A. Miltiadous et al., “Dice-net: A novel convolution-transformer architecture for alzheimer detection in eeg signals,” IEEE Access, 2023.

Conclusion

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Our method achieved 77.6% accuracy using 5 features without deep learning

Possible improvements of future work include a bigger and more diverse dataset as well as better features

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Thank you for your attention!