



Predictions with EEG Data for Alzheimer Disease and Frontotemporal Dementia

This analysis aims to compare the predictions of cognitive diseases such as Alzheimer's and Frontotemporal Dementia using different Machine Learning models. The study seeks to evaluate how the EEG channel FP1 affects the accuracy of predictions. The results will inform future research where samples are taken using BCI devices that provide readings only from the frontotemporal channels.

Project: <https://github.com/sobieddch90/mcd-udq-tfm-eeq-classification>
Source Dataset: <https://openneuro.org/datasets/ds004504/versions/1.0.5>

Predictions with All Features

Feature Extraction from the EEG Data was performed by calculating the signal power with PSD and then calculating statistical metrics for each channel, the five frequency bands, and 60-second windows with an overlap of 20 seconds.

Classifier + Methods	All Channels	FP1	Difference
Random Forest - [KFold anova]	38.89%	59.44%	20.56%
AdaBoost - [KFold anova]	38.61%	54.17%	15.56%
AdaBoost - [StratifiedShuffleSplit anova]	44.44%	57.78%	13.33%
Random Forest - [StratifiedShuffleSplit ..]	48.89%	62.22%	13.33%
Support Vector - [StratifiedShuffleSplit ..]	46.67%	55.56%	8.89%
Support Vector - [StratifiedKFold mutual..]	56.67%	65.56%	8.89%
XGBoost - [StratifiedShuffleSplit mutual..]	57.78%	66.67%	8.89%
AdaBoost - [StratifiedKFold anova]	47.50%	54.44%	6.94%
XGBoost - [StratifiedKFold chi2]	66.11%	73.06%	6.94%
XGBoost - [KFold mutual_info_classif]	63.89%	70.83%	6.94%
Support Vector - [KFold anova]	47.78%	54.44%	6.67%
XGBoost - [StratifiedKFold mutual_info_..]	47.50%	51.39%	3.89%
Random Forest - [StratifiedKFold mutual..]	48.61%	52.22%	3.61%
Random Forest - [KFold chi2]	63.61%	65.83%	2.22%
Support Vector - [KFold mutual_info_cla..]	54.44%	56.67%	2.22%
Support Vector - [StratifiedKFold anova]	54.44%	56.67%	2.22%
AdaBoost - [StratifiedShuffleSplit chi2]	62.22%	64.44%	2.22%
Random Forest - [StratifiedKFold chi2]	68.33%	70.28%	1.94%
XGBoost - [KFold anova]	45.56%	47.50%	1.94%
Random Forest - [StratifiedKFold anova]	51.94%	52.22%	0.28%
LightGBM - [KFold anova]	41.11%	41.11%	0.00%
LightGBM - [KFold chi2]	41.11%	41.11%	0.00%
LightGBM - [KFold mutual_info_classif]	41.11%	41.11%	0.00%
LightGBM - [StratifiedKFold anova]	45.56%	45.56%	0.00%
LightGBM - [StratifiedKFold chi2]	45.56%	45.56%	0.00%
LightGBM - [StratifiedKFold mutual_info..]	45.56%	45.56%	0.00%
LightGBM - [StratifiedShuffleSplit anova]	44.44%	44.44%	0.00%
LightGBM - [StratifiedShuffleSplit chi2]	44.44%	44.44%	0.00%
LightGBM - [StratifiedShuffleSplit mutu..]	44.44%	44.44%	0.00%
Support Vector - [KFold chi2]	46.11%	46.11%	0.00%
Support Vector - [StratifiedKFold chi2]	48.06%	48.06%	0.00%
Support Vector - [StratifiedShuffleSplit ..]	44.44%	44.44%	0.00%
AdaBoost - [StratifiedKFold mutual_info..]	53.06%	52.22%	-0.83%
Support Vector - [StratifiedShuffleSplit ..]	57.78%	55.56%	-2.22%
AdaBoost - [StratifiedKFold chi2]	68.06%	63.61%	-4.44%
Random Forest - [StratifiedShuffleSplit ..]	68.89%	64.44%	-4.44%
XGBoost - [StratifiedKFold anova]	56.67%	52.22%	-4.44%
XGBoost - [StratifiedShuffleSplit chi2]	73.33%	68.89%	-4.44%
AdaBoost - [KFold chi2]	63.61%	58.89%	-4.72%
XGBoost - [KFold chi2]	66.39%	61.39%	-5.00%
XGBoost - [StratifiedShuffleSplit anova]	68.89%	60.00%	-8.89%
AdaBoost - [StratifiedShuffleSplit mutu..]	53.33%	42.22%	-11.11%
Random Forest - [KFold mutual_info_cla..]	66.11%	52.22%	-13.89%
AdaBoost - [KFold mutual_info_classif]	70.56%	52.22%	-18.33%
Random Forest - [StratifiedShuffleSplit ..]	66.67%	44.44%	-22.22%



Predictions only Total Power and Spectral Density Features

From the previous EEG Data Feature Extraction, only Total Power and Spectral Density metrics were taken which represent the total power and variation in each channel, frequency band, and window.

Classifier + Methods	All Channels	FP1	Difference
Support Vector - [StratifiedShuffleSplit ..	57.78%	66.67%	8.89%
XGBoost - [StratifiedKFold anova]	45.56%	52.22%	6.67%
Support Vector - [StratifiedKFold mutual..	42.50%	47.78%	5.28%
Support Vector - [StratifiedKFold anova]	52.22%	56.67%	4.44%
XGBoost - [StratifiedKFold mutual_info...	51.67%	55.00%	3.33%
XGBoost - [StratifiedShuffleSplit anova]	60.00%	62.22%	2.22%
Random Forest - [KFold anova]	38.89%	41.11%	2.22%
AdaBoost - [KFold anova]	38.89%	41.11%	2.22%
Support Vector - [KFold anova]	45.56%	47.78%	2.22%
AdaBoost - [StratifiedKFold anova]	43.33%	45.56%	2.22%
Random Forest - [StratifiedShuffleSplit ..	44.44%	46.67%	2.22%
Support Vector - [StratifiedShuffleSplit ..	44.44%	44.44%	0.00%
Support Vector - [StratifiedKFold chi2]	48.06%	48.06%	0.00%
Support Vector - [KFold chi2]	46.11%	46.11%	0.00%
Random Forest - [StratifiedShuffleSplit ..	44.44%	44.44%	0.00%
Random Forest - [StratifiedKFold chi2]	42.78%	42.78%	0.00%
Random Forest - [StratifiedKFold anova]	45.56%	45.56%	0.00%
Random Forest - [KFold chi2]	54.72%	54.72%	0.00%
LighGBM - [StratifiedShuffleSplit mutu..	44.44%	44.44%	0.00%
LighGBM - [StratifiedShuffleSplit chi2]	44.44%	44.44%	0.00%
LighGBM - [StratifiedShuffleSplit anova]	44.44%	44.44%	0.00%
LighGBM - [StratifiedKFold mutual_info..	45.56%	45.56%	0.00%
LighGBM - [StratifiedKFold chi2]	45.56%	45.56%	0.00%
LighGBM - [StratifiedKFold anova]	45.56%	45.56%	0.00%
LighGBM - [KFold mutual_info_classif]	41.11%	41.11%	0.00%
LighGBM - [KFold chi2]	41.11%	41.11%	0.00%
LighGBM - [KFold anova]	41.11%	41.11%	0.00%
AdaBoost - [StratifiedShuffleSplit mutu..	44.44%	44.44%	0.00%
AdaBoost - [StratifiedShuffleSplit chi2]	48.89%	48.89%	0.00%
AdaBoost - [StratifiedShuffleSplit anova]	44.44%	44.44%	0.00%
AdaBoost - [StratifiedKFold mutual_info..	45.56%	45.56%	0.00%
AdaBoost - [StratifiedKFold chi2]	43.06%	43.06%	0.00%
AdaBoost - [KFold mutual_info_classif]	41.11%	41.11%	0.00%
AdaBoost - [KFold chi2]	41.39%	41.39%	0.00%
Support Vector - [KFold mutual_info_cla..	47.78%	45.56%	-2.22%
Random Forest - [KFold mutual_info_cla..	43.33%	41.11%	-2.22%
XGBoost - [KFold mutual_info_classif]	64.17%	59.17%	-5.00%
Random Forest - [StratifiedKFold mutual..	52.22%	45.56%	-6.67%
XGBoost - [StratifiedShuffleSplit chi2]	53.33%	46.67%	-6.67%
Random Forest - [StratifiedShuffleSplit ..	57.78%	48.89%	-8.89%
XGBoost - [StratifiedShuffleSplit mutual..	68.89%	55.56%	-13.33%
XGBoost - [KFold anova]	58.89%	45.56%	-13.33%
Support Vector - [StratifiedShuffleSplit ..	64.44%	51.11%	-13.33%
XGBoost - [KFold chi2]	56.67%	38.33%	-18.33%
XGBoost - [StratifiedKFold chi2]	52.22%	31.94%	-20.28%

Difference -20.28% 8.89%

Predictions only Features from Alpha Band

From the main Feature Extraction of the EEG Data, only the corresponding metrics to the Alpha frequency band were taken, because this represents the region with the greatest alterations in patients with Alzheimer's Disease and Frontotemporal Dementia.

Classifier + Methods	All Channels	FP1	Difference
Support Vector - [StratifiedKFold mutual..	40.83%	59.44%	18.61%
Random Forest - [StratifiedShuffleSplit ..	40.00%	55.56%	15.56%
Random Forest - [StratifiedShuffleSplit ..	42.22%	57.78%	15.56%
AdaBoost - [StratifiedShuffleSplit mutu..	40.00%	53.33%	13.33%
XGBoost - [StratifiedShuffleSplit mutual..	31.11%	44.44%	13.33%
Random Forest - [KFold anova]	43.33%	54.72%	11.39%
XGBoost - [StratifiedShuffleSplit chi2]	42.22%	53.33%	11.11%
AdaBoost - [KFold anova]	36.67%	45.83%	9.17%
AdaBoost - [StratifiedShuffleSplit anova]	42.22%	51.11%	8.89%
Random Forest - [StratifiedShuffleSplit ..	33.33%	42.22%	8.89%
Support Vector - [KFold mutual_info_cla..	45.28%	50.28%	5.00%
Support Vector - [StratifiedKFold anova]	45.28%	48.06%	2.78%
XGBoost - [KFold anova]	54.72%	56.67%	1.94%
AdaBoost - [StratifiedKFold chi2]	45.56%	46.94%	1.39%
Support Vector - [StratifiedShuffleSplit ..	48.89%	48.89%	0.00%
Support Vector - [StratifiedShuffleSplit ..	44.44%	44.44%	0.00%
Support Vector - [StratifiedShuffleSplit ..	44.44%	44.44%	0.00%
Support Vector - [StratifiedKFold chi2]	48.06%	48.06%	0.00%
Support Vector - [KFold chi2]	46.11%	46.11%	0.00%
LighGBM - [StratifiedShuffleSplit mutu..	44.44%	44.44%	0.00%
LighGBM - [StratifiedShuffleSplit chi2]	44.44%	44.44%	0.00%
LighGBM - [StratifiedShuffleSplit anova]	44.44%	44.44%	0.00%
LighGBM - [StratifiedKFold mutual_info..	45.56%	45.56%	0.00%
LighGBM - [StratifiedKFold chi2]	45.56%	45.56%	0.00%
LighGBM - [StratifiedKFold anova]	45.56%	45.56%	0.00%
LighGBM - [KFold mutual_info_classif]	41.11%	41.11%	0.00%
LighGBM - [KFold chi2]	41.11%	41.11%	0.00%
LighGBM - [KFold anova]	41.11%	41.11%	0.00%
XGBoost - [KFold mutual_info_classif]	52.50%	51.67%	-0.83%
AdaBoost - [KFold mutual_info_classif]	40.28%	38.33%	-1.94%
AdaBoost - [StratifiedShuffleSplit chi2]	48.89%	46.67%	-2.22%
AdaBoost - [StratifiedKFold anova]	52.22%	47.50%	-4.72%
XGBoost - [StratifiedKFold chi2]	50.00%	45.28%	-4.72%
Random Forest - [StratifiedKFold anova]	52.22%	45.83%	-6.39%
Random Forest - [StratifiedKFold chi2]	54.44%	48.06%	-6.39%
Random Forest - [StratifiedKFold mutual..	50.00%	43.06%	-6.94%
AdaBoost - [KFold chi2]	52.78%	45.83%	-6.94%
Support Vector - [KFold anova]	54.72%	46.11%	-8.61%
XGBoost - [KFold chi2]	56.94%	47.78%	-9.17%
Random Forest - [KFold mutual_info_cla..	46.94%	36.11%	-10.83%
Random Forest - [KFold chi2]	56.67%	45.83%	-10.83%
XGBoost - [StratifiedKFold mutual_info_..	49.72%	38.33%	-11.39%
AdaBoost - [StratifiedKFold mutual_info..	56.67%	43.06%	-13.61%
XGBoost - [StratifiedShuffleSplit anova]	64.44%	48.89%	-15.56%
XGBoost - [StratifiedKFold anova]	68.06%	47.50%	-20.56%



Predictions without Frequency Bands

Similar to the first feature extraction from the EEG data, statistical metrics were calculated from the power of the signal obtained with PSD, at this time without separating the frequency bands.

Classifier + Methods	All Channels	FP1	Difference
XGBoost - [StratifiedKFold mutual_info_..	43.61%	56.39%	12.78%
Support Vector - [KFold mutual_info_cla..	38.61%	47.50%	8.89%
XGBoost - [StratifiedKFold chi2]	34.17%	40.56%	6.39%
AdaBoost - [StratifiedShuffleSplit anova]	44.44%	48.89%	4.44%
Random Forest - [KFold mutual_info_cla..	41.11%	43.33%	2.22%
AdaBoost - [StratifiedKFold mutual_info_..	45.56%	47.78%	2.22%
XGBoost - [KFold chi2]	45.56%	45.56%	0.00%
Support Vector - [StratifiedShuffleSplit ..	44.44%	44.44%	0.00%
Support Vector - [StratifiedKFold chi2]	48.06%	48.06%	0.00%
Support Vector - [KFold chi2]	46.11%	46.11%	0.00%
Random Forest - [StratifiedShuffleSplit ..	46.67%	46.67%	0.00%
Random Forest - [StratifiedShuffleSplit ..	53.33%	53.33%	0.00%
Random Forest - [StratifiedKFold mutual_..	45.56%	45.56%	0.00%
Random Forest - [StratifiedKFold chi2]	38.06%	38.06%	0.00%
LighGBM - [StratifiedShuffleSplit mutu..	44.44%	44.44%	0.00%
LighGBM - [StratifiedShuffleSplit chi2]	44.44%	44.44%	0.00%
LighGBM - [StratifiedShuffleSplit anova]	44.44%	44.44%	0.00%
LighGBM - [StratifiedKFold mutual_info_..	45.56%	45.56%	0.00%
LighGBM - [StratifiedKFold chi2]	45.56%	45.56%	0.00%
LighGBM - [StratifiedKFold anova]	45.56%	45.56%	0.00%
LighGBM - [KFold mutual_info_classif]	41.11%	41.11%	0.00%
LighGBM - [KFold chi2]	41.11%	41.11%	0.00%
LighGBM - [KFold anova]	41.11%	41.11%	0.00%
AdaBoost - [StratifiedShuffleSplit mutu..	44.44%	44.44%	0.00%
AdaBoost - [StratifiedShuffleSplit chi2]	48.89%	48.89%	0.00%
AdaBoost - [StratifiedKFold chi2]	43.06%	43.06%	0.00%
AdaBoost - [KFold chi2]	41.39%	41.39%	0.00%
Support Vector - [StratifiedKFold mutual_..	50.00%	49.44%	-0.56%
XGBoost - [KFold anova]	56.39%	54.72%	-1.67%
AdaBoost - [KFold mutual_info_classif]	41.11%	39.17%	-1.94%
Random Forest - [StratifiedKFold anova]	45.56%	43.33%	-2.22%
AdaBoost - [KFold anova]	41.11%	38.89%	-2.22%
Random Forest - [KFold chi2]	57.22%	54.72%	-2.50%
XGBoost - [KFold mutual_info_classif]	49.72%	45.83%	-3.89%
XGBoost - [StratifiedShuffleSplit chi2]	46.67%	42.22%	-4.44%
Random Forest - [KFold anova]	41.11%	36.67%	-4.44%
AdaBoost - [StratifiedKFold anova]	45.56%	41.11%	-4.44%
XGBoost - [StratifiedKFold anova]	40.28%	35.56%	-4.72%
Support Vector - [StratifiedKFold anova]	42.78%	38.06%	-4.72%
Random Forest - [StratifiedShuffleSplit ..	48.89%	42.22%	-6.67%
Support Vector - [StratifiedShuffleSplit ..	48.89%	40.00%	-8.89%
XGBoost - [StratifiedShuffleSplit mutual_..	53.33%	44.44%	-8.89%
Support Vector - [StratifiedShuffleSplit ..	53.33%	44.44%	-8.89%
XGBoost - [StratifiedShuffleSplit anova]	60.00%	46.67%	-13.33%
Support Vector - [KFold anova]	51.94%	38.61%	-13.33%

Difference -13.33% 12.78%