Evaluation of P300 signal classifiers

BR4IN.IO Hackathon 2023

Introduction

Background

P300 signals are brainwave responses measured using electroencephalography (EEG). They occur around 300 milliseconds after a stimulus is presented to a person, and are associated with cognitive processes like attention, memory, and decision-making. They have vast applications in brain-computer interfaces, as they allow for a computer to interpret the selection of the user through an artificial intelligence (AI) classifier.

Aim

Conduct an evaluation of different machine learning (ML) and deep learning (DL) classifiers for P300 signals in a target vs non-target paradigm.

This project was presented at the VIRTUAL BR41N.IO HACKATHON Spring School 2023. All code was written in Python, using the MNE, Scikit-learn and TensorFlow libraries. You can find more about the project in Github.

Methods

Pre-Processing

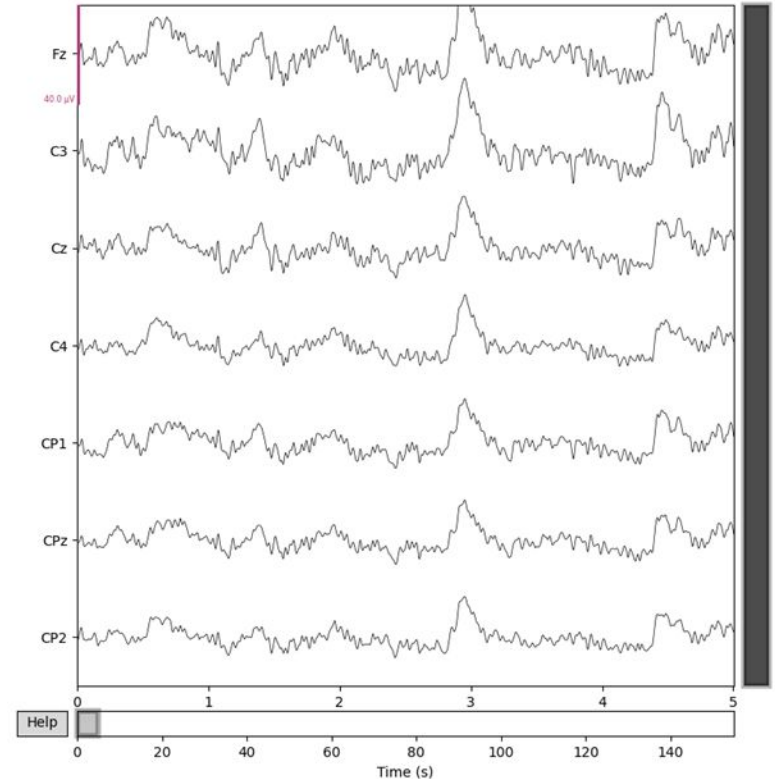Convert units from microvolts to volts

Remove offset through subtracting the mean

High pass filter of 1 Hz

ICA Filter

Segmentation

Normalization

Processing

The pre-processed data is run through the following classifiers:

- Linear Discriminant Analysis (LDA)
- Decission Forrest
- Multi-layer perceptron (MLP)
- Convolutional neural network (CNN)

Processing

All classifiers are evaluated through accuracy.

LDA and decision forrests are also evaluated with confusion matrix, while MLP and CNN are also evaluated with loss.

		Actual values	
		Positive	Negative
Predicted values	Positive	TP = 60	FP = 24
	Negative	FN = 0	TN = 12

Results

Subject	File	LDA	Decision Forrest	MLP	CNN
P1	Low 1	0.75	0.71	0.71	0.76
	Low 2	0.72	0.7	0.7	0.76
	High1	0.75	0.6875	0.69	0.78
	High 2	0.74	0.76	0.74	0.87
P2	Low 1	0.75	0.73	0.81	0.89
	Low 2	0.74	0.78	0.76	0.6
	High 1	0.72	0.79	0.86	0.86
	High 2	0.75	0.81	0.82	0.87

Mean accuracies according to subject
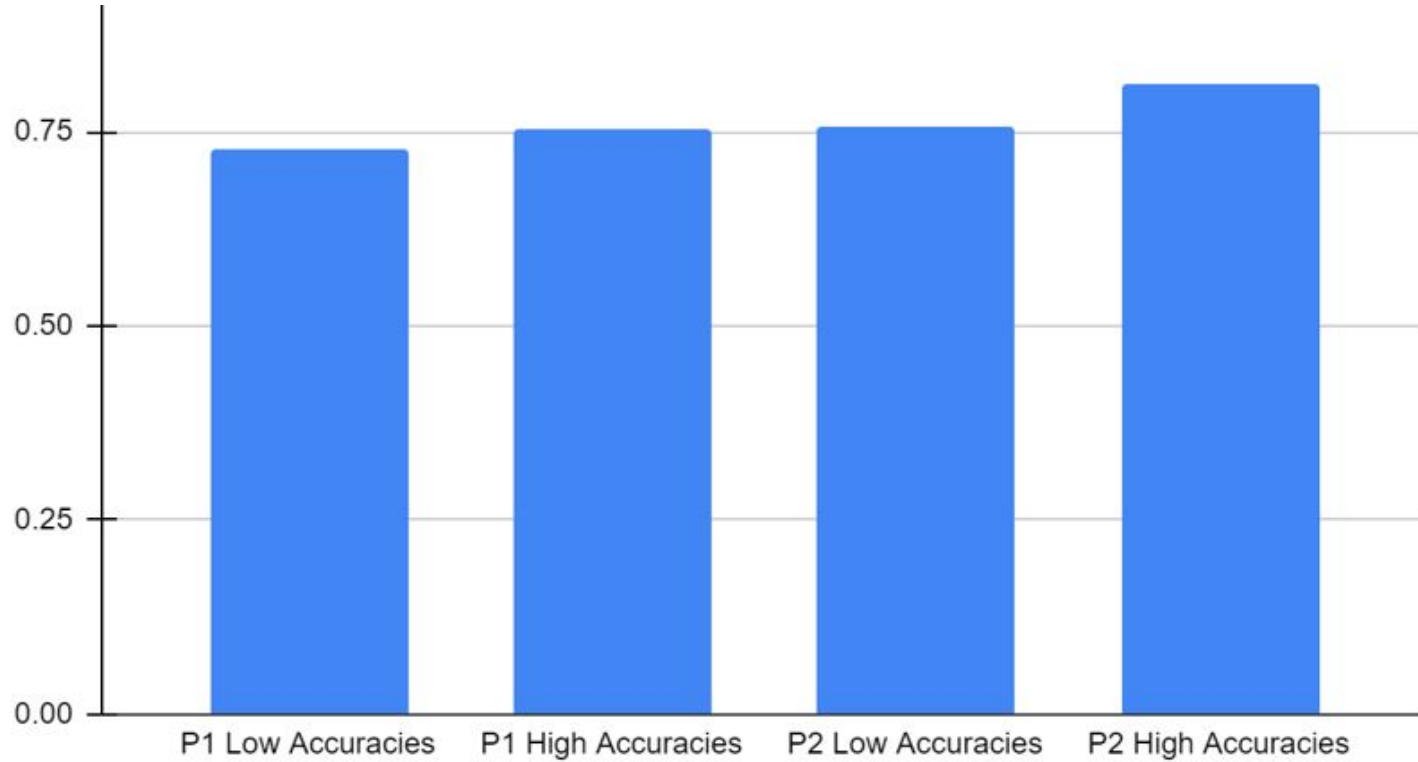
Mean accuracies according to classifier