Idea1

MOTOR IMAGERY BASED PHOTO VIEWER.

Team ID: SC_37

Team Members:

الاسم	رقم الجلوس
منة الله محمد السيد احمد لاشين	20201701205
مايان محمد حلمي سيد	20201700646
مارينا نادي شحاتة عوض	20201700636
عبدالرحمن طارق سيد احمد	20201700441

Data Preparation

- The dataset consists of EEG data from 9 subjects.

- The data was recorded using 22 EEG channels and 3 EOG channels. For this analysis, we focused on the EEG data from subject number 1.

Data Preparation

- The data is read from GDF files using **mne.io.read_raw_gdf**

- The EOG channels are dropped and EEG data is re-referenced.

- Epochs are created based on events with event IDs 7 and 8 which are left and right-hand classes.

- The features (EEG data) and labels (events) are extracted

Data preparation(cont.)

Identifying Event Indices for Left and Right Hand Classes from EEG Event Annotations:

The relevant indices for left hand and right-hand classes are derived from the **events** array, which contains event information. Specifically, the left-hand class (class 1) corresponds to index 7, and the right-hand class (class 2) corresponds to index 8, as indicated by the event codes 769 and 770 respectively.

Code	Description	Event
1023	Rejected trial	event1
1072	Eye movements	event2
276	(eyes open)	event3
277	(eyes closed)	event4
32766	Start of a new run	event5
768	Start of a trial	event6
769	left (class 1)	event7
770	right (class 2)	event8
771	foot (class 3)	event9
772	tongue (class 4)	event10

Data preprocessing

- **Common Average Referencing (CAR)**: Averages the signals and subtracts the average from each channel.
- **Z-Score Normalization**: Standardizes the data by removing the mean and scaling to unit variance.
- **Filter Bank Bandpass Filter:** The filter is applied iteratively over the specified frequency band with an interval step of 2 Hz. This creates a filter bank covering the entire range from 4 Hz to 40 Hz

Feature Extraction

Common Spatial Pattern (CSP) Analysis:

Usage: Common Spatial Pattern (CSP) enhances the discriminative power of EEG signals by finding spatial filters that maximize variance for one class and minimize it for another. This technique is especially useful in Brain-Computer Interface (BCI) applications, helping to distinguish between different mental states, such as imagining moving the left hand versus the right hand

- CSP is applied to the normalized, bandpass-filtered data to extract features. These features are transformed using CSP for each frequency band.
- The parameter n_components=2 in CSP specifies extracting the two most discriminative spatial filters to enhance class separation and reduce dimensionality in EEG data

Feature Extraction(cont.)

Common Spatial Pattern (CSP) Analysis:

Shape of features before csp (144, 3872)
Shape of features after csp (144,36)

Explanation: Since the EEG data undergoes decomposition into 18 distinct frequency bands using a filter bank bandpass filter . each containing spatially filtered features of shape (144, 2). After concatenating the spatially filtered features from each band, the resulted feature array is reshaped to (144, 36)

Classification Models

1-Data Splitting and Preprocessing:

- Map class 7 to 0 and class 8 to 1
- Utilize train_test_split function to split the dataset into training and testing sets.

2-Model Selection and Hyperparameter Tuning:

•Perform hyperparameter tuning using grid search with cross-validation for several classification models: Logistic Regression, Support Vector Machine (SVM), Multinomial Naive Bayes, Random Forest, XGBoost.

Classification Models(cont.)

Best Hyperparameters for each model:

- Logistic regression:{'C': 0.01}
- SVM :{'C': 0.1, 'kernel': ‘poly’}
- Multinominal Naïve Bayes:{'alpha': 0.1}
- Random Forest:{'max_depth’: 50, 'min_samples_leaf’: 4, 'min_samples_split': 2, 'n_estimators': 50}
- Xgboost:{'learning_rate': 0.03, 'max_depth': 5, 'n_estimators': 100, 'subsample': 0.5}

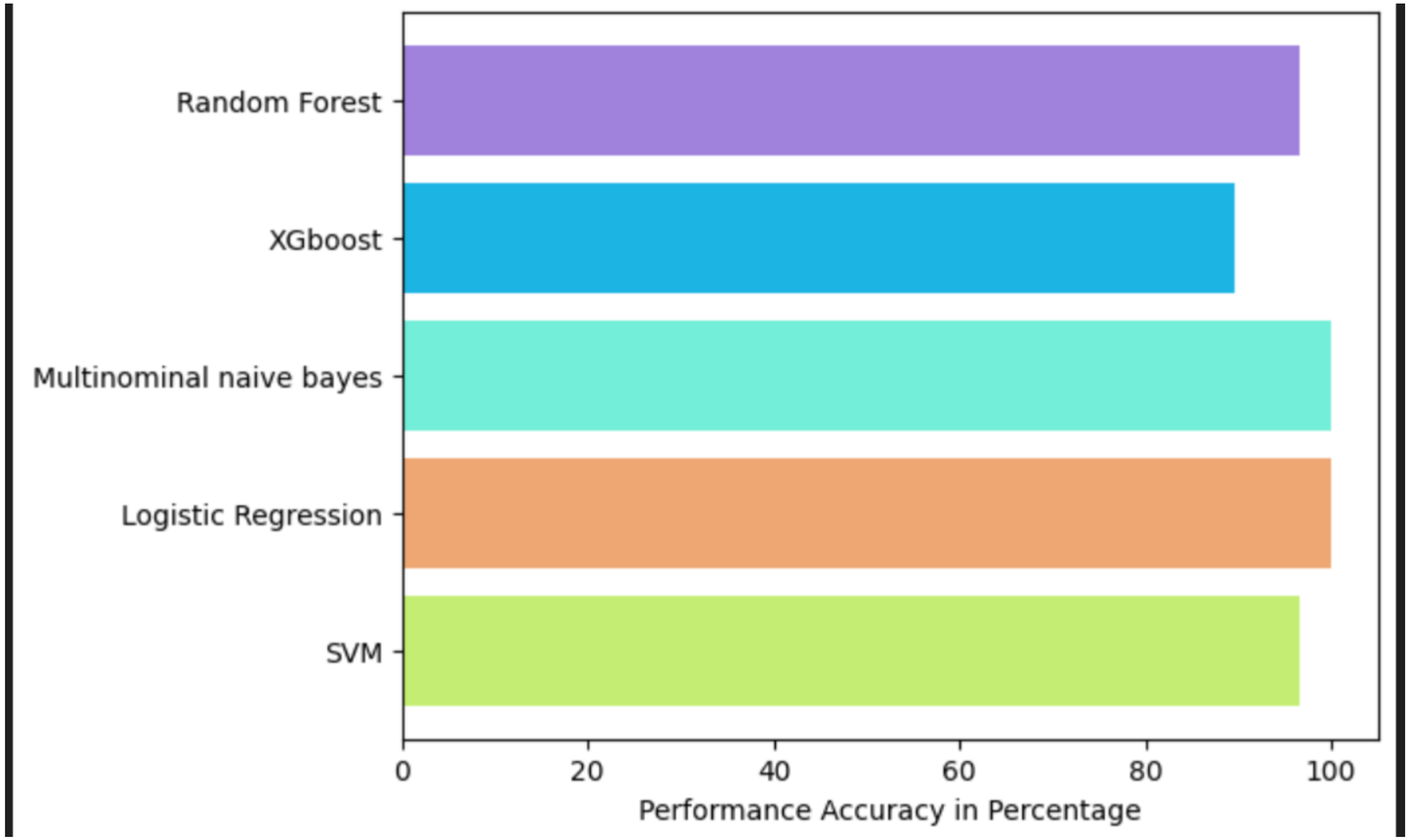
Classification Models(cont.)

Training and testing accuracies of models:

Model	Training Accuracy (%)	Testing Accuracy (%)
Logistic Regression	98.26	100.0
Support Vector Machine (SVM)	100.0	96.55
Multinomial Naive Bayes	99.13	100.0
Random Forest	100.0	100.0
XGBoost	100.0	89.66

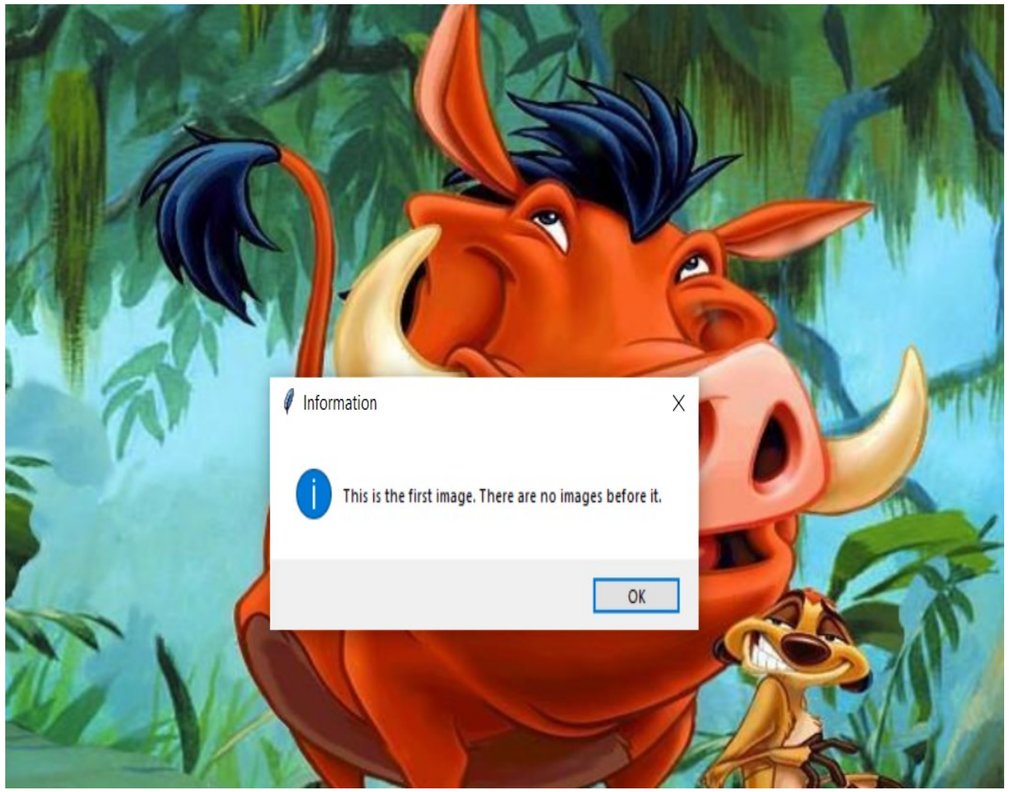
Classification Models(cont.)

Graph for Training and testing accuracies of models:



Graphical User Interface

Screenshots from GUI:



THANK YOU