A Machine Learning approach for Recognizing Intellectual Development Disorder using EEG

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Introduction

- Intellectual developmental disorder
  - malfunctioning of brain area
  - functional and mental limitations
- Symptoms
  - Slow learning
- Causes
  - Genetic conditions.
  - Problems during pregnancy
  - Problems during childbirth
  - Illness or injury.
  - Unknown

Motivation

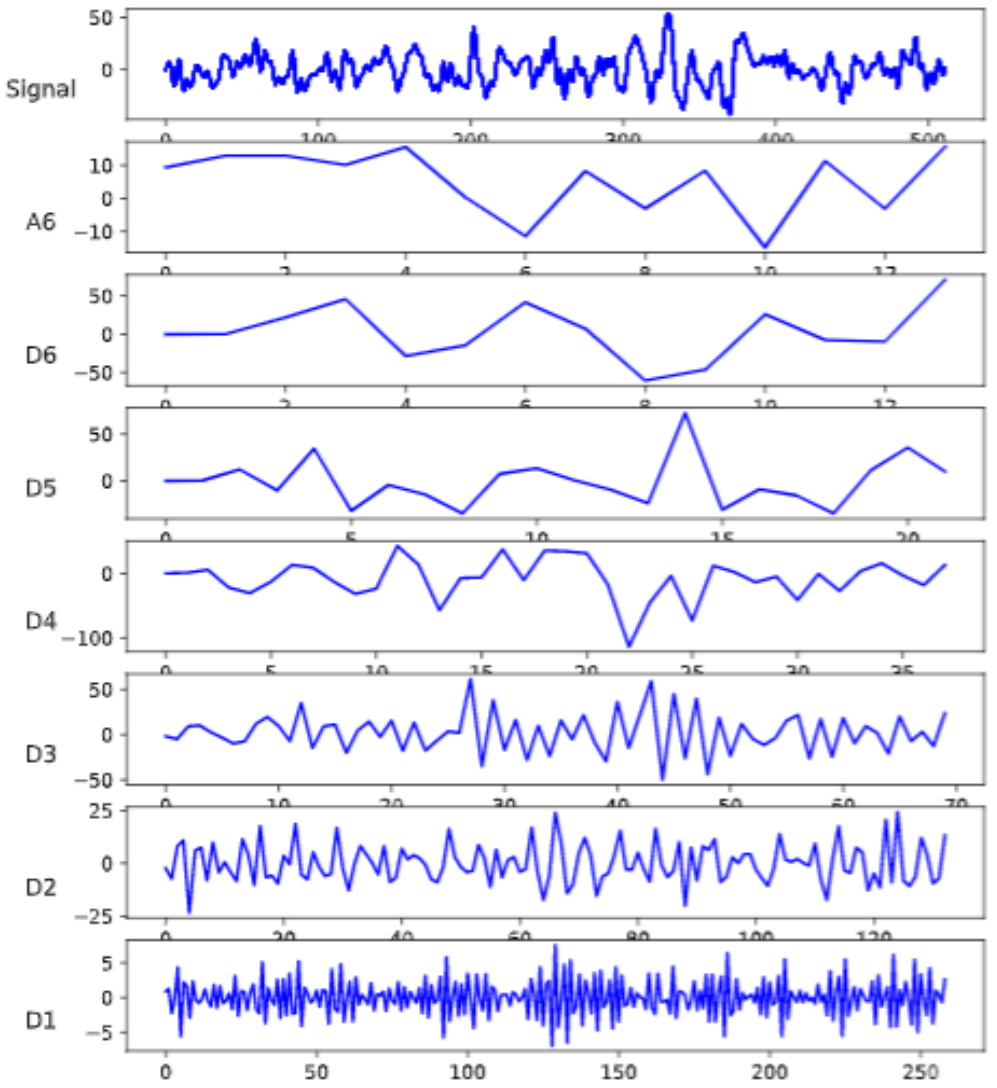
- Population of IDD
  - United state and other developed countries have 2.5-5 severe cases per 1000 children and 2-30 mild cases per 1000 children[1]
  - India has around 10.5/1000 cases of intellectual disability.[2]
  - Pakistan has the highest reported rate of intellectual disabilities in the world with an estimated 19/1000 [3]
- Diagnosis
  - Physical abnormalities can be identified easily

Objective

- Propose an approach that can identify Intellectual development disorder using electroencephalogram with the help of machine learning.

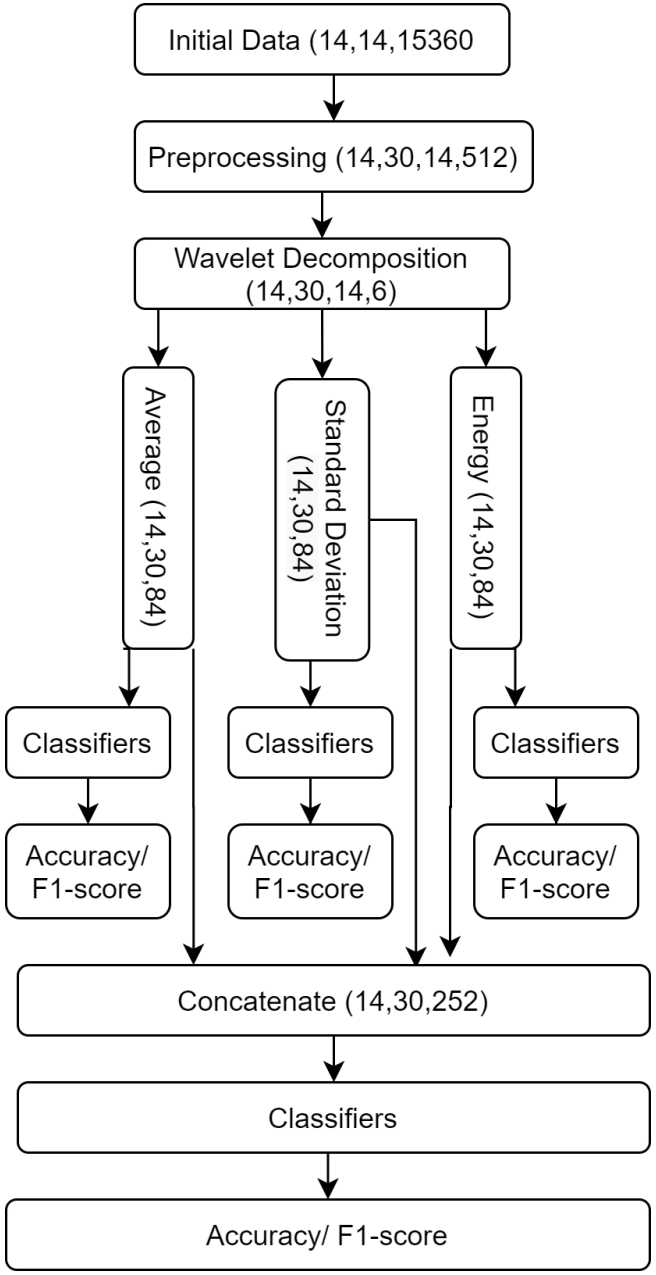
Methodology

- Dataset
  - 7 Healthy 7 Patients
  - Collected using Emotiv EPOCH+
  - Data duration is 2 minute, under rest and music stimuli
- Preprocessing
  - Band pass filter 1-30 Hz
  - Segmented into 4 second
- Feature Selection
  - Discrete Wavelet Transform
  - Fourth-order Daubechies wavelet
  - Average, Standard Deviation, Energy
  - Combined all three

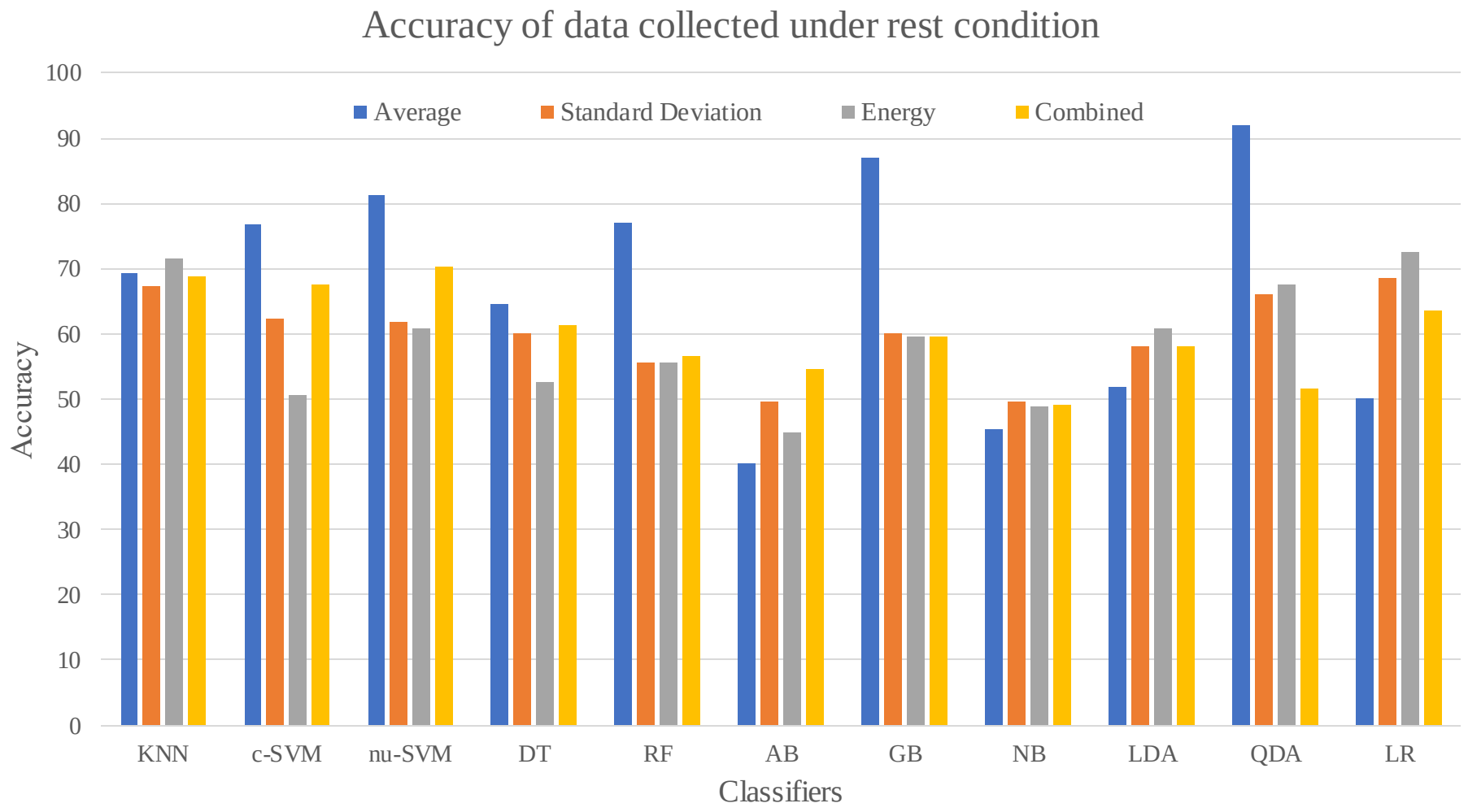


Methodology

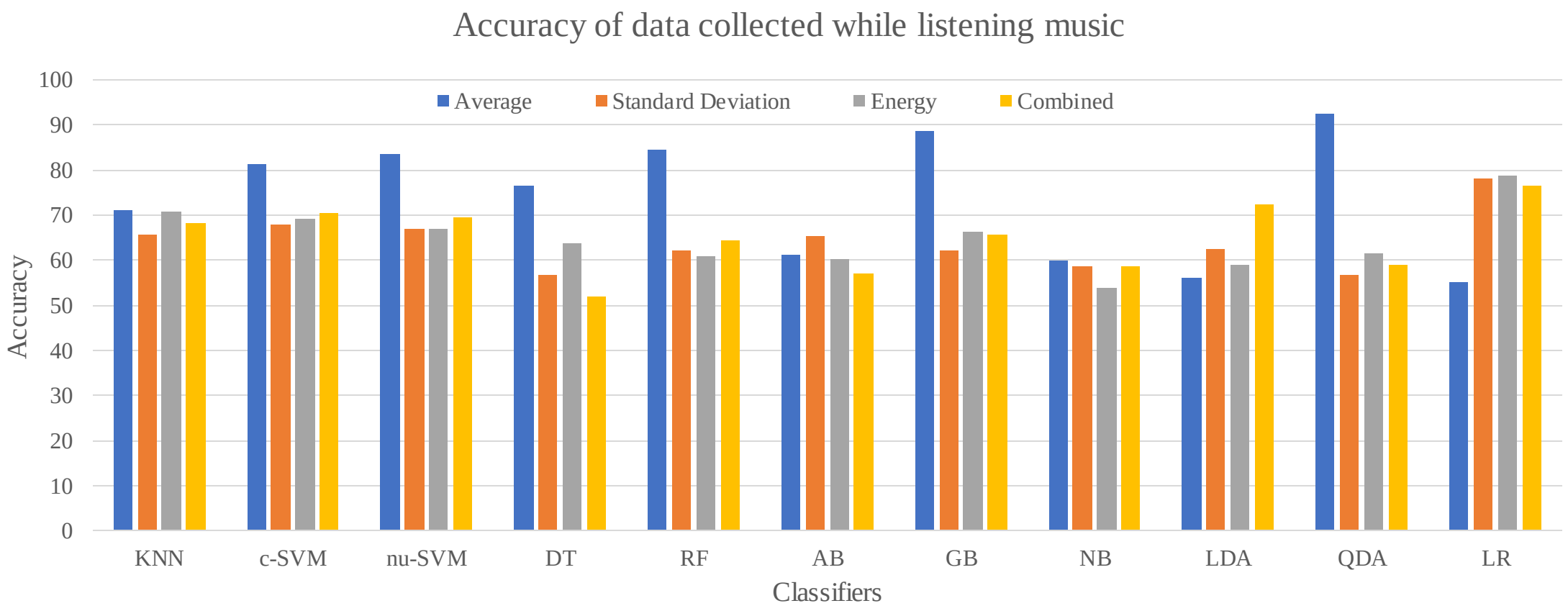
- Classification
  - K-Nearest Neighbor (KNN)
  - Logistic Regression (LR)
  - Support Vector Machine
  - Decision Tree Classifier (DT)
  - Random Forest Classifier (RF)
  - AdaBoost Classifier (AB)
  - Gradient Boosting Classifier (GB)
  - Naive Bayes (NB)
  - Linear Discriminant Analysis (LDA)
  - Quadratic Discriminant Analysis (QDA)



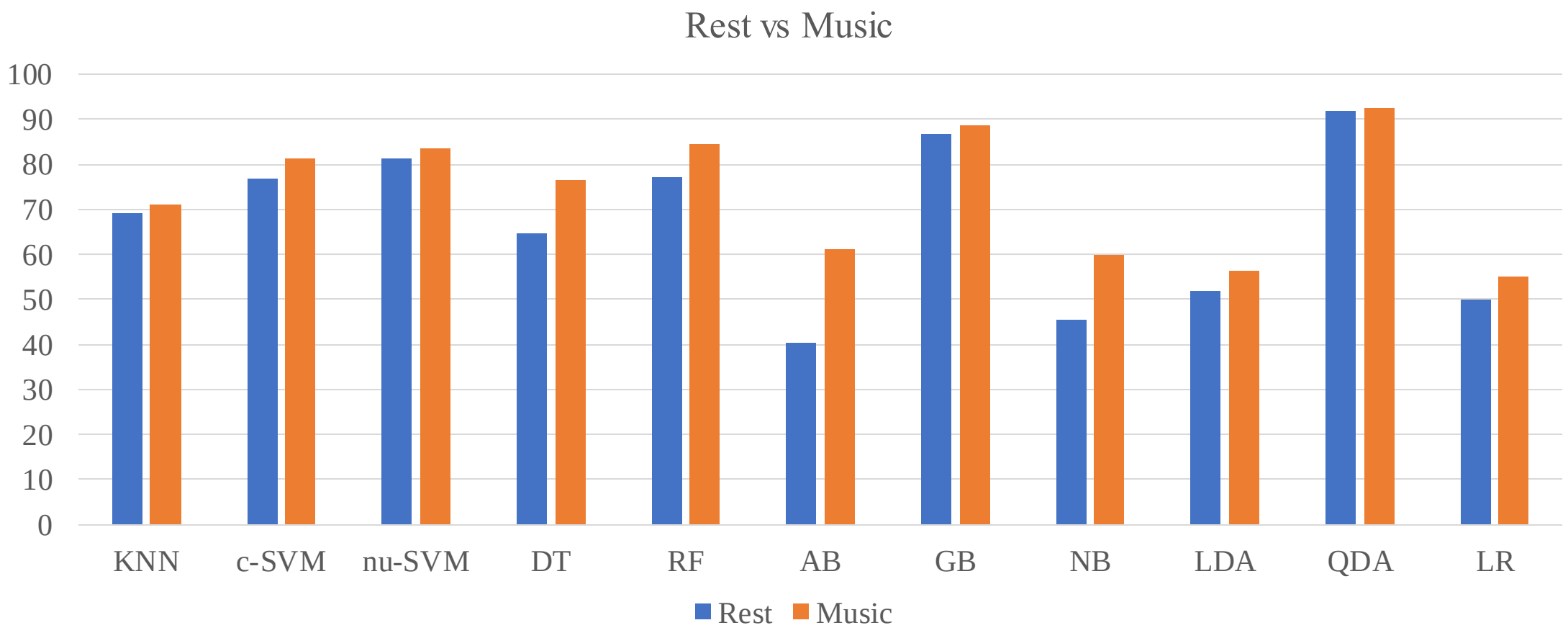
Results


Accuracy of data collected under rest condition
Average
Standard Deviation
Energy
Combined
Accuracy
100
90
80
70
60
50
40
30
20
10
0
KNN
c-SVM
nu-SVM
DT
RF
AB
GB
NB
LDA
QDA
LR
Classifiers

Results


Accuracy of data collected while listening music
Average
Standard Deviation
Energy
Combined
Accuracy
100
90
80
70
60
50
40
30
20
10
0
KNN
c-SVM
nu-SVM
DT
RF
AB
GB
NB
LDA
QDA
LR
Classifiers

Results


Rest vs Music
100
90
80
70
60
50
40
30
20
10
0
KNN
c-SVM
nu-SVM
DT
RF
AB
GB
NB
LDA
QDA
LR
Rest
Music

Result

Rest condition

	Average		Std		Energy		Combined	
	Acc	F1	Acc	F1	Acc	F1	Acc	F1
KNN	69.3	77.0	67.3	74.3	71.6	77.4	68.8	76.8
c-SVM	76.9	76.8	62.3	65.5	50.7	35.7	67.6	66.2
nu-SVM	81.4	81.2	61.9	62.4	60.9	61.2	70.2	68.6
DT	64.7	64.4	60.2	58.3	52.6	55.2	61.4	57.6
RF	77.16	76.4	55.7	51.9	55.7	54.1	56.6	57.2
AB	40.24	39.7	49.7	48.4	45.0	44.7	54.7	54.0
GB	86.9	88.0	60.0	65.0	59.5	63.2	59.7	64.0
NB	45.5	8.8	49.5	10.8	48.8	10.5	49.0	10.9
LDA	51.9	54.2	58.1	60.8	60.9	65.1	58.1	59.4
QDA	**91.9**	**89.9**	66.1	38.8	67.6	44.7	51.6	60.1
LR	50.0	53.0	68.5	72.6	67.3	69.8	63.5	63.7

Listening to Music

	Average		Std		Energy		Combined	
	Acc	F1	Acc	F1	Acc	F1	Acc	F1
KNN	71.2	78.1	65.7	74.4	70.7	77.0	68.1	75.8
c-SVM	81.2	80.4	67.8	71.3	69.2	69.5	70.4	70.5
nu-SVM	83.6	83.2	67.1	67.4	67.1	67.0	69.5	68.4
DT	76.4	76.7	56.6	62.6	63.8	67.9	51.9	59.2
RF	84.5	85.2	62.3	66.4	60.9	66.8	64.5	69.1
AB	61.2	62.8	65.4	67.5	60.2	68.2	57.1	61.8
GB	88.6	89.9	62.1	65.9	66.4	68.4	65.7	68.6
NB	60	56.7	58.8	54.7	54.0	43.5	58.8	52.4
LDA	56.2	58.9	62.6	67.7	59.0	66.3	72.3	77.2
QDA	**92.6**	**91.3**	56.9	28.9	61.4	36.6	59.0	55.7
LR	55.0	57.3	78.3	80.8	78.8	81.5	76.6	79.3

Conclusion

- Machine learning can be used to diagnose IDD using EEG signal.
- Performance can be improved by increasing features and tuning the classifiers.

References

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