

Report Evaluating the Machine Learning Models

Data: Human pose skeletal key points data generated from sign videos generated by group 20 and also sample key points csv data provided by the professor.

Approach and Feature Engineering part:

- As the data consists of the key points data of the videos, the first task is to scale the data so that the data would be in a standard scale to perform any analysis.

Scaling:

- From the data points for scaling we checked for the constant point to subtract. As it is a human video data focusing on the upper body, we assumed that nose key point would be the standard for the scaling part.
- So, we subtracted Nose X coordinated from the other key points x coordinate values and Nose y coordinate value from other key points y coordinate values.
- After performing this step, all the data would be perfectly scaled and the next step would be to normalize the data.

Normalization:

- Vertical Normalization: We divide the data fields with the torso length for normalizing. Torso length is obtained by nose coordinated from the middle of the hip coordinated.
- Horizontal Normalization: We divide the data field with the shoulder length for horizontal normalization. We obtained shoulder length by subtracting left shoulder coordinated from the right shoulder coordinates.

Adjusting the no of frames:

- we adjusted the no of frame to be 120 because most of the files used for training were in that range as described by pandas. Describe ()
- while doing so we first made all the files to be of the same length as of the maximum framed file in our case it was 292
- later we truncated the list to 120 length
- this is done to prevent the bias of the models to categories of lower frames.

FFT (Fast Fourier Transform):

- To the normalized data we perform Fast Fourier transform to extract the important feature set. And then we pass this data to our machine learning models to generate models which would predict the human sign video key points data.

4 Machine Learning Models Used:

- 1) Decision Tree:** It uses a tree or graph-based classifier which would take all possible outcomes and make that into a tree/ graph format and predicts the target class. It is very easy to interpret and explain. We mainly used this method because of its non-parametric classification which makes It best to handle outliers and no need to worry about linear separability feature. So, we used this classifier.
- 2) Random Forest:** It is an ensemble algorithm which assembles multiple decision trees and predicting the target label my mean prediction of the individual trees. We mainly used this classifier to make use of all

the advantages of the decision tree but to avoid its disadvantage of easily overfitting and multiply the effect as it makes use of multiple forests and considers the results from all of them and make a prediction that is much more reliable. Hence, we used this classifier model.

- 3) **kNN (k Nearest Neighbors):** It is a supervised classification algorithm which would take k closest data points around a target data point and classify it according to those k points. We used this model for classification because this model is mainly dependent on the feature similarity. That is how closely the testing data points resemble our training data samples. As the actions we need to classify mostly relates with the coordinates of the key points this would help us to classify the sign actions using this classifier.
- 4) **Logistic Regression:** It is a statistical model, which would make use of the logit function and model the probability of a class from the given set of target classes. We used this model for classification for this dataset because there are a lot of features in our feature space and we don't need to worry about the correlation factor and lot of methods to regularize the data. Also, it takes the probabilistic approach so if we want to include further data in our model, we can easily do that.

Training, Validation and Testing:

We used K-fold validation with 5 splits and since in the preprocessing phase we made every file to be of 120 length we counted the maximum votes for a class while computing the accuracy, confusion, recall and precision.

Results: [Metrics Used: Accuracy, Precision, Recall, F1 Score, Confusion Matrix]

present fold 0

Random Forest Classifier Started

Results of random_forest_classifier classifier

Accuracy score is: 0.8780487804878049

Precision score is: 0.8780487804878049

Recall score is: 0.8780487804878049

F1 score is: 0.8780487804878049

-----Confusion Matirx-----

```
[[16 0 0 0 0 0]
```

```
[ 0 7 0 0 0 0]
```

```
[ 2 0 18 0 1 0]
```

```
[ 0 0 0 11 0 0]
```

```
[ 0 0 3 0 11 3]
```

```
[ 1 0 0 0 0 9]]
```

Decision tree started

Results of decision_tree_classifier classifier

Accuracy score is: 0.7682926829268293

Precision score is: 0.7682926829268293

Recall score is: 0.7682926829268293

F1 score is: 0.7682926829268293

-----Confusion Matirx-----

```
[[14 2 0 0 0 0]
```

```
[ 0 7 0 0 0 0]
```

```
[ 3 0 16 1 1 0]
```

```
[ 0 0 0 11 0 0]
```

```
[ 0 0 4 1 8 4]
```

```
[ 0 1 2 0 0 7]]
```

Logistic regression Started

Results of logistic_regression_classifier classifier

Accuracy score is: 0.6951219512195121

Precision score is: 0.6951219512195121

Recall score is: 0.6951219512195121

F1 score is: 0.6951219512195121

-----Confusion Matirx-----

```
[[13 0 1 2 0 0]
```

```
[ 0 7 0 0 0 0]
```

```
[ 3 0 14 0 2 2]
```

```
[ 0 0 1 8 0 2]
```

```
[ 0 1 1 0 7 8]
```

```
[ 1 1 0 0 0 8]]
```

K-nearest neighbours

Results of K-nearest neighbours classifier

Accuracy score is: 0.7560975609756098

Precision score is: 0.7560975609756098

Recall score is: 0.7560975609756098

F1 score is: 0.7560975609756099

-----Confusion Matirx-----

[[14 0 1 0 1 0]

[0 7 0 0 0 0]

[2 0 15 0 1 3]

[0 1 1 9 0 0]

[0 0 4 0 10 3]

[2 0 0 0 1 7]]

present fold 1

Random Forest Classifier Started

Results of random_forest_classifier classifier

Accuracy score is: 0.7926829268292683

Precision score is: 0.7926829268292683

Recall score is: 0.7926829268292683

F1 score is: 0.7926829268292683

-----Confusion Matirx-----

[[11 1 1 0 0 0]

[1 12 0 0 0 0]

[0 3 7 0 1 3]

[0 0 0 14 0 0]

[0 0 1 0 9 4]

[0 0 1 0 1 12]]

Decision tree started

Results of decision_tree_classifier classifier

Accuracy score is: 0.6463414634146342

Precision score is: 0.6463414634146342

Recall score is: 0.6463414634146342

F1 score is: 0.6463414634146342

-----Confusion Matirx-----

[[11 1 1 0 0 0]

[0 11 1 0 1 0]

[2 0 7 0 2 3]

[0 0 0 13 0 1]

[0 2 2 0 6 4]

[0 1 2 0 6 5]]

Logistic regression Started

Results of logistic_regression_classifier classifier

Accuracy score is: 0.7439024390243902

Precision score is: 0.7439024390243902

Recall score is: 0.7439024390243902

F1 score is: 0.7439024390243903

-----Confusion Matirx-----

[[8 3 1 0 0 1]

[1 11 0 1 0 0]

[0 0 11 2 0 1]

[0 0 0 14 0 0]

[0 2 0 0 11 1]

[1 0 1 0 6 6]]

K-nearest neighbours

Results of K-nearest neighbours classifier

Accuracy score is: 0.7682926829268293

Precision score is: 0.7682926829268293

Recall score is: 0.7682926829268293

F1 score is: 0.7682926829268293

-----Confusion Matirx-----

```
[[11 1 1 0 0 0]
 [ 0 12 0 0 1 0]
 [ 0 3 6 0 2 3]
 [ 0 0 0 14 0 0]
 [ 0 0 5 0 9 0]
 [ 0 0 3 0 0 11]]
```

present fold 2

Random Forest Classifier Started

Results of random_forest_classifier classifier

Accuracy score is: 0.8658536585365854

Precision score is: 0.8658536585365854

Recall score is: 0.8658536585365854

F1 score is: 0.8658536585365854

-----Confusion Matirx-----

```
[[11 0 0 0 0 0]
 [ 0 18 0 0 1 0]
 [ 0 0 12 0 0 1]
 [ 1 0 0 11 0 0]
 [ 0 0 1 0 6 3]
 [ 0 1 3 0 0 13]]
```

Decision tree started

Results of decision_tree_classifier classifier

Accuracy score is: 0.7682926829268293

Precision score is: 0.7682926829268293

Recall score is: 0.7682926829268293

F1 score is: 0.7682926829268293

-----Confusion Matirx-----

```
[[10 0 1 0 0 0]
 [ 0 14 0 3 2 0]
 [ 1 0 8 1 0 3]
 [ 0 0 0 10 0 2]
 [ 0 0 0 0 9 1]
 [ 2 0 2 0 1 12]]
```

Logistic regression Started

Results of logistic_regression_classifier classifier "of iterations.", ConvergenceWarning)

Accuracy score is: 0.6951219512195121

Precision score is: 0.6951219512195121

Recall score is: 0.6951219512195121

F1 score is: 0.6951219512195121

-----Confusion Matirx-----

```
[[10 0 0 0 0 1]
 [ 1 15 1 0 0 2]
 [ 1 0 9 0 2 1]
 [ 0 0 1 10 0 1]
 [ 0 1 0 0 8 1]
 [ 2 1 2 0 7 5]]
```

K-nearest neighbours

Results of K-nearest neighbours classifier

Accuracy score is: 0.7317073170731707

Precision score is: 0.7317073170731707

Recall score is: 0.7317073170731707

F1 score is: 0.7317073170731707

-----Confusion Matirx-----

```
[[11 0 0 0 0 0]
```

```
[ 2 13 0 1 2 1]
[ 0 0 10 0 1 2]
[ 0 1 0 11 0 0]
[ 0 0 3 0 4 3]
[ 0 1 2 2 1 11]]
```

present fold 3

Random Forest Classifier Started

Results of random_forest_classifier classifier

Accuracy score is: 0.7682926829268293

Precision score is: 0.7682926829268293

Recall score is: 0.7682926829268293

F1 score is: 0.7682926829268293

-----Confusion Matirx-----

```
[[13 0 1 0 0 0]
 [ 1 7 0 0 0 0]
 [ 0 0 13 0 0 0]
 [ 0 0 0 15 0 1]
 [ 0 0 3 0 5 3]
 [ 2 1 4 0 3 10]]
```

Decision tree started

Results of decision_tree_classifier classifier

Accuracy score is: 0.7560975609756098

Precision score is: 0.7560975609756098

Recall score is: 0.7560975609756098

F1 score is: 0.7560975609756099

-----Confusion Matirx-----


```
[[13 0 1 0 0 0]
 [ 1 7 0 0 0 0]
 [ 1 1 10 0 0 1]
 [ 1 1 0 13 0 1]
 [ 0 1 2 0 6 2]
 [ 1 0 5 0 1 13]]
```

Logistic regression Started

Results of logistic_regression_classifier classifier

Accuracy score is: 0.6951219512195121

Precision score is: 0.6951219512195121

Recall score is: 0.6951219512195121

F1 score is: 0.6951219512195121

-----Confusion Matirx-----

```
[[12 0 1 0 0 1]
 [ 1 7 0 0 0 0]
 [ 1 1 10 0 1 0]
 [ 0 0 1 14 0 1]
 [ 0 0 2 0 9 0]
 [ 0 3 2 0 10 5]]
```

K-nearest neighbours

Results of K-nearest neighbours classifier

Accuracy score is: 0.7073170731707317

Precision score is: 0.7073170731707317

Recall score is: 0.7073170731707317

F1 score is: 0.7073170731707317

-----Confusion Matirx-----

```
[[13 0 1 0 0 0]
 [ 0 8 0 0 0 0]
```

```
[ 1 0 8 0 1 3]
[ 1 0 0 15 0 0]
[ 0 0 3 0 4 4]
[ 1 1 4 0 4 10]]
```

present fold 4

Random Forest Classifier Started

Results of random_forest_classifier classifier

Accuracy score is: 0.8271604938271605

Precision score is: 0.8271604938271605

Recall score is: 0.8271604938271605

F1 score is: 0.8271604938271605

-----Confusion Matirx-----

```
[[14 2 0 0 0 1]
 [ 1 16 1 0 0 0]
 [ 0 0 8 0 0 1]
 [ 0 0 0 14 0 1]
 [ 0 1 2 0 6 4]
 [ 0 0 0 0 0 9]]
```

Decision tree started

Results of decision_tree_classifier classifier

Accuracy score is: 0.7407407407407407

Precision score is: 0.7407407407407407

Recall score is: 0.7407407407407407

F1 score is: 0.7407407407407407

-----Confusion Matirx-----

```
[[14 1 0 1 0 1]
```

```
[ 3 12 2 1 0 0]
[ 0 0 8 0 1 0]
[ 0 1 0 14 0 0]
[ 0 1 1 0 6 5]
[ 0 0 1 0 2 6]]
```

Logistic regression Started

Results of logistic_regression_classifier classifier "of iterations.", ConvergenceWarning)

Accuracy score is: 0.7530864197530864

Precision score is: 0.7530864197530864

Recall score is: 0.7530864197530864

F1 score is: 0.7530864197530863

-----Confusion Matirx-----

```
[[11 3 0 1 1 1]
 [ 2 16 0 0 0 0]
 [ 0 0 8 0 0 1]
 [ 0 1 1 13 0 0]
 [ 0 1 0 1 8 3]
 [ 0 1 1 0 2 5]]
```

K-nearest neighbours

Results of K-nearest neighbours classifier

Accuracy score is: 0.7530864197530864

Precision score is: 0.7530864197530864

Recall score is: 0.7530864197530864

F1 score is: 0.7530864197530863

-----Confusion Matirx-----

```
[[14 0 2 0 0 1]
 [ 1 15 1 0 0 1]
 [ 0 0 7 0 1 1]
```

[0 1 0 14 0 0]

[0 1 3 0 5 4]

[0 0 1 1 1 6]]

Process finished with exit code 0

Conclusion:

Based on our results, we acquired maximum accuracy of 87 percent in a fold where 82 files were used for testing with the random forest with 1000 trees.