driving_behavior_XGBoost_binary_v4

September 1, 2022

[ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

[ ]:
```
df_training = pd.read_csv("../data_mod/train_motion_data.csv")
df_test = pd.read_csv("../data_mod/test_motion_data.csv")

df_training
```

[ ]:

	AccX	AccY	GyroZ	Class	DiffAccX	DiffAccY	VelX	VelY
0	0.000000	0.000000	0.101938	NORMAL	0.000000	0.000000	0.000000	0.000000
1	0.101741	0.777568	0.054902	NORMAL	-0.636737	1.006023	0.050871	0.388784
2	0.158470	0.345891	0.014584	NORMAL	0.056728	-0.431676	0.079235	0.172946
3	0.308851	0.239022	-0.072769	NORMAL	-0.543828	0.655800	0.154425	0.119511
4	0.163595	0.475107	-0.061163	NORMAL	0.768208	-0.365124	0.081798	0.237554
..	…	…	…	…	…	…	…	…
965	0.872744	0.801287	-0.139964	SLOW	-0.857083	0.085469	0.436372	0.400644
966	1.464669	0.226299	-0.170508	SLOW	0.591925	-0.574988	0.732334	0.113149
967	1.587379	0.583067	-0.196164	SLOW	0.122710	0.356769	0.793690	0.291534
968	0.319258	0.272088	-0.062385	SLOW	-0.383045	1.202910	0.159629	0.136044
969	0.402702	0.432955	0.362167	SLOW	0.083444	0.160867	0.201351	0.216477

[970 rows x 8 columns]

[ ]:
```
df_training.isna().sum()
```

[ ]:
```
AccX        0
AccY        0
GyroZ       0
Class       0
DiffAccX    0
DiffAccY    0
VelX        0
VelY        0
dtype: int64
```

0.1 Change categories to numbers

[ ]:
```
df_training = df_training.replace(
    {"Class": {"NORMAL": 0, "AGGRESSIVE": 1, "SLOW": 2}})
df_test = df_test.replace(
    {"Class": {"NORMAL": 0, "AGGRESSIVE": 1, "SLOW": 2}})
df_training
```

[ ]:
```
          AccX      AccY     GyroZ  Class  DiffAccX  DiffAccY      VelX  \
0     0.000000  0.000000  0.101938      0  0.000000  0.000000  0.000000
1     0.101741  0.777568  0.054902      0 -0.636737  1.006023  0.050871
2     0.158470  0.345891  0.014584      0  0.056728 -0.431676  0.079235
3     0.308851  0.239022 -0.072769      0 -0.543828  0.655800  0.154425
4     0.163595  0.475107 -0.061163      0  0.768208 -0.365124  0.081798
..         …         …         …    …         …         …         …
965   0.872744  0.801287 -0.139964      2 -0.857083  0.085469  0.436372
966   1.464669  0.226299 -0.170508      2  0.591925 -0.574988  0.732334
967   1.587379  0.583067 -0.196164      2  0.122710  0.356769  0.793690
968   0.319258  0.272088 -0.062385      2 -0.383045  1.202910  0.159629
969   0.402702  0.432955  0.362167      2  0.083444  0.160867  0.201351

          VelY
0     0.000000
1     0.388784
2     0.172946
3     0.119511
4     0.237554
..         …
965   0.400644
966   0.113149
967   0.291534
968   0.136044
969   0.216477

[970 rows x 8 columns]
```

0.1.1 Only select normal and aggressive values

[ ]:
```
df_training = df_training.loc[df_training['Class'] != 1]
df_test = df_test.loc[df_test['Class'] != 1]

df_training
```

[ ]:
```
          AccX      AccY     GyroZ  Class  DiffAccX  DiffAccY      VelX  \
0     0.000000  0.000000  0.101938      0  0.000000  0.000000  0.000000
1     0.101741  0.777568  0.054902      0 -0.636737  1.006023  0.050871
2     0.158470  0.345891  0.014584      0  0.056728 -0.431676  0.079235
3     0.308851  0.239022 -0.072769      0 -0.543828  0.655800  0.154425
4     0.163595  0.475107 -0.061163      0  0.768208 -0.365124  0.081798
..         …         …        …    …         …         …         …
965   0.872744  0.801287 -0.139964      2 -0.857083  0.085469  0.436372
966   1.464669  0.226299 -0.170508      2  0.591925 -0.574988  0.732334
967   1.587379  0.583067 -0.196164      2  0.122710  0.356769  0.793690
968   0.319258  0.272088 -0.062385      2 -0.383045  1.202910  0.159629
969   0.402702  0.432955  0.362167      2  0.083444  0.160867  0.201351

          VelY
0     0.000000
1     0.388784
2     0.172946
3     0.119511
4     0.237554
..         …
965   0.400644
966   0.113149
967   0.291534
968   0.136044
969   0.216477

[705 rows x 8 columns]
```

0.2 Normalize the data

[ ]:
```
X_training = df_training.drop(columns=["Class"])
X_training = (X_training - X_training.mean()) / X_training.std() * 100

X_training["Class"] = df_training["Class"]
X_training
```

[ ]:
```
            AccX        AccY       GyroZ    DiffAccX    DiffAccY        VelX  \
0   -122.106111 -116.257157  117.650694  -63.187997  -66.096361 -122.106111
1   -105.031605   25.635205   68.160440 -138.430213   46.047826 -105.031605
2    -95.511253  -53.138133   25.740221  -56.484482 -114.216534  -95.511253
```

```
3    -70.273807  -72.639801  -66.170252 -127.451292    7.007516  -70.273807
4    -94.651012  -29.558503  -53.958370   27.589927 -106.797697  -94.651012
..          …           …           …           …           …           …
965   24.360574   29.963614 -136.870621 -164.468147  -56.568906   24.360574
966  123.699233  -74.961611 -169.007148    6.758805 -130.191905  123.699233
967  144.292810   -9.857655 -196.001833  -48.687551  -26.326386  144.292810
968  -68.527317  -66.605896  -55.243834 -108.451868   67.995301  -68.527317
969  -54.523424  -37.250511  391.453928  -53.327511  -48.164073  -54.523424

           VelY  Class
0   -116.257157      0
1     25.635205      0
2    -53.138133      0
3    -72.639801      0
4    -29.558503      0
..          …    …
965   29.963614      2
966  -74.961611      2
967   -9.857655      2
968  -66.605896      2
969  -37.250511      2

[705 rows x 8 columns]
```

[ ]:
```
X_testing = df_test.drop(columns="Class")
X_testing = (X_testing - X_testing.mean()) / X_testing.std() * 100

X_testing["Class"] = df_test["Class"]
X_testing
```

[ ]:
```
            AccX        AccY       GyroZ    DiffAccX    DiffAccY        VelX  \
814    79.340838   21.963793   38.859198    4.511762   78.994793   79.340838
815   132.192943  569.257650  -11.298662   43.314646  415.888708  132.192943
816   -33.998774   10.843662   -4.956864 -136.351589 -424.416667  -33.998774
817    38.437952   57.366915    1.961463   59.378533   35.317808   38.437952
818   -21.053767    3.156469  -25.711843  -48.833088  -41.236835  -21.053767
…          …           …           …           …           …           …
3079  -95.464081  -76.862781  479.325902  -79.996459   -1.185708  -95.464081
3080  180.478081   51.148641 -645.478582  226.299722   97.246415  180.478081
3081  151.492731 -217.785674 -450.612340  -23.810860 -204.420646  151.492731
3082  105.929590   84.125864  374.398012  -37.408456  229.405378  105.929590
3083  174.027088   32.946129   63.073341   55.819369  -38.933584  174.027088

            VelY  Class
814    21.963793      0
815   569.257650      0
816    10.843662      0
```

```
817    57.366915      0
818     3.156469      0
…           …     …
3079  -76.862781      2
3080   51.148641      2
3081 -217.785674      2
3082   84.125864      2
3083   32.946129      2

[2270 rows x 8 columns]
```

0.3 Train model

[ ]:
```
X_train = X_training.drop(columns="Class")
y_train = X_training.Class

X_test = X_testing.drop(columns="Class")
y_test = X_testing.Class
```

[ ]:
```
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.model_selection import RandomizedSearchCV
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
```

[ ]:
```
xgb = GradientBoostingClassifier()

param_grid = {'n_estimators': np.arange(20, 80, 2), 'learning_rate': np.
 ↪linspace(0.1, 0.8, 20), 'max_depth': np.arange(2, 10), 'max_features':␣
 ↪['sqrt', None], 'max_leaf_nodes': np.arange(2, 30)}

xgb_gscv = RandomizedSearchCV(xgb, param_grid, n_iter=200, cv=10, verbose=10,␣
 ↪n_jobs=10, random_state=0)
xgb_gscv.fit(X_train, y_train)
```

[ ]:
```
best_params = xgb_gscv.best_params_
best_params
```

[ ]:
```
{'n_estimators': 60,
 'max_leaf_nodes': 18,
 'max_features': 'sqrt',
 'max_depth': 9,
 'learning_rate': 0.46842105263157896}
```

[ ]:
```
xgb_gscv.best_score_
```

[ ]:
```
0.5206036217303822
```

0.3.1 Check for overfitting

[ ]:
```
xgb_gscv.score(X_train, y_train)
```

[ ]: 1.0

[ ]:
```
xgb_gscv.score(X_test, y_test)
```

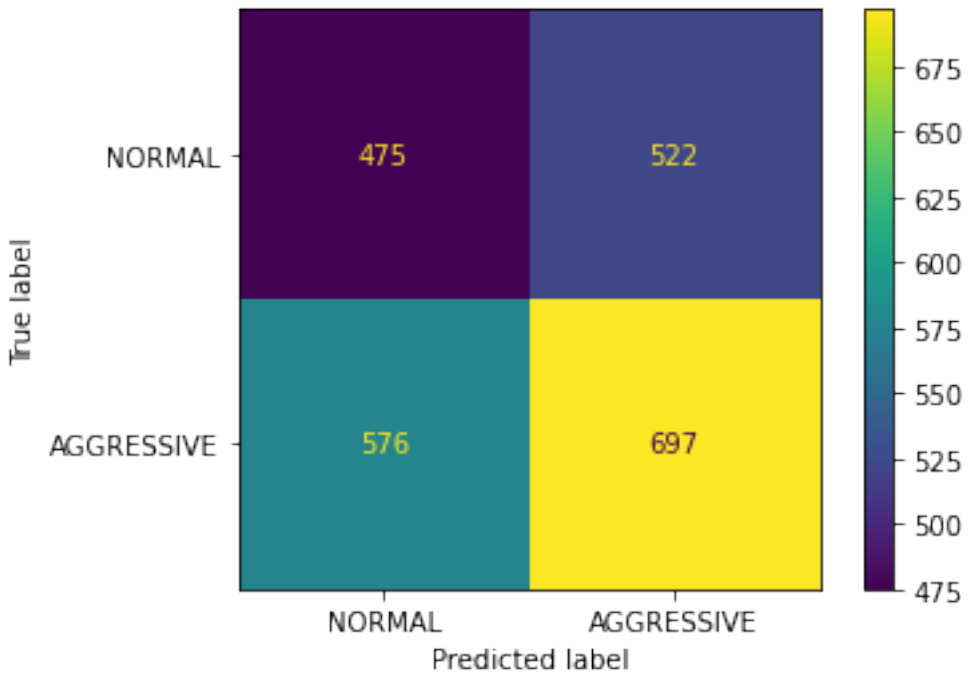
[ ]: 0.5162995594713656

[ ]:
```
classes = ["NORMAL", "AGGRESSIVE"]
```

[ ]:
```
y_pred = xgb_gscv.predict(X_test)

CM = confusion_matrix(y_test, y_pred)
display = ConfusionMatrixDisplay(confusion_matrix=CM,
                         display_labels=classes)
display.plot()
```

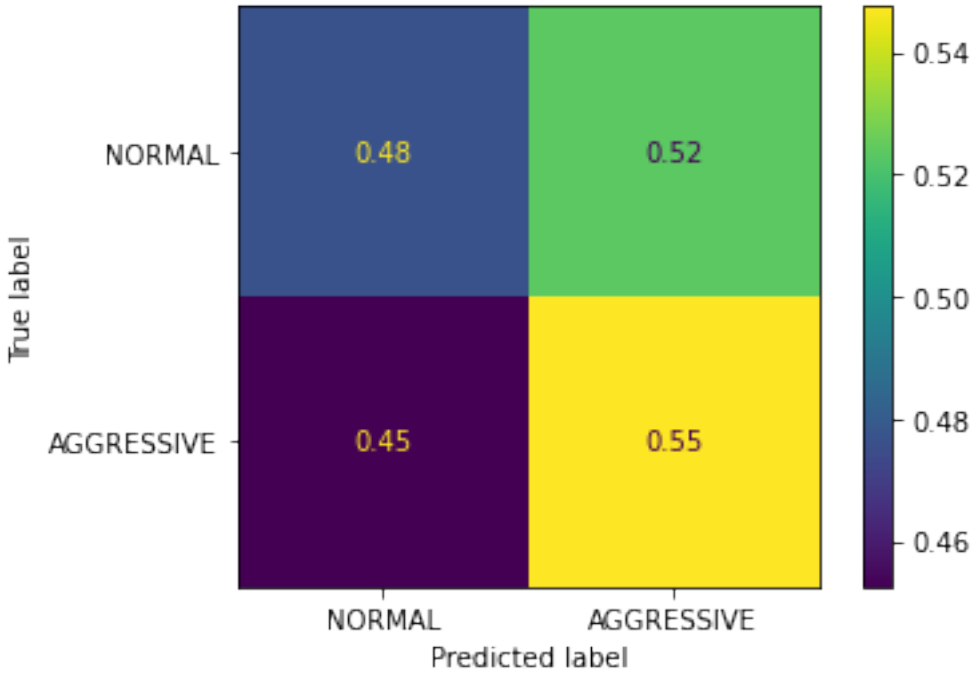
[ ]: <sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7ff062c80cd0>



[ ]:
```
CM_norm = confusion_matrix(y_test, y_pred, normalize="true")
display = ConfusionMatrixDisplay(confusion_matrix=CM_norm,
                         display_labels=classes)
```

```
display.plot()
```

[ ]: <sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7ff073bb2190>



[ ]:
```
def evaluate(model, test_features, test_labels):
    accuracy = model.score(test_features, test_labels)
    print('Model Performance')
    print('Accuracy = {:0.3f}%.'.format(accuracy))

    return accuracy

base_model = GradientBoostingClassifier(n_estimators=100, learning_rate=1.0,␣
 ↪max_depth=1, random_state=0)
base_model.fit(X_train, y_train)
base_accuracy = evaluate(base_model, X_test, y_test)

best_random = xgb_gscv.best_estimator_
random_accuracy = evaluate(best_random, X_test, y_test)

print(f'Improvement of {100 * (random_accuracy - base_accuracy) / base_accuracy:
 ↪.3f}%.')
```

```
Model Performance
Accuracy = 0.531%.
```

```
Model Performance
Accuracy = 0.516%.
Improvement of -2.819%.
```

[ ]: