

Lab 10: Patients Physical Activities prediction using Boosting

Name : Annapoornima s (225229101)

Step 1: Understand Data

```
In [6]: import pandas as pd
from sklearn.model_selection import train_test_split
import warnings
warnings.filterwarnings('ignore')
from sklearn.metrics import precision_score, recall_score, accuracy_score, roc_
from sklearn.ensemble import GradientBoostingClassifier, AdaBoostClassifier
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegressionCV
from sklearn.ensemble import RandomForestClassifier, VotingClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import cross_val_score
```

```
In [7]: df = pd.read_csv("Human_Activity_Data.csv")
```

```
In [8]: df.head()
```

```
Out[8]: tBodyAcc-mean()-X tBodyAcc-mean()-Y tBodyAcc-mean()-Z tBodyAcc-std()-X tBodyAcc-std()-Y tBodyAcc-std()-Z tBodyAcc-mad()-X tBodyAcc-mad()-Y
```

0	0.288585	-0.020294	-0.132905	-0.995279	-0.983111	-0.913526	-0.995112	-0.983185
1	0.278419	-0.016411	-0.123520	-0.998245	-0.975300	-0.960322	-0.998807	-0.974914
2	0.279653	-0.019467	-0.113462	-0.995380	-0.967187	-0.978944	-0.996520	-0.963668
3	0.279174	-0.026201	-0.123283	-0.996091	-0.983403	-0.990675	-0.997099	-0.982750
4	0.276629	-0.016570	-0.115362	-0.998139	-0.980817	-0.990482	-0.998321	-0.979672

5 rows × 562 columns

```
In [9]:
```

```
Out[9]: df.shape
```

```
: (151, 562)
```

```
In [10]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 151 entries, 0 to 150
Columns: 562 entries, tBodyAcc-mean()-X to Activity
dtypes: float64(561), object(1)
memory usage: 663.1+ KB
```

```
In [11]: df.columns
```

```
Out[11]: Index(['tBodyAcc-mean()-X', 'tBodyAcc-mean()-Y', 'tBodyAcc-mean()-Z',
       'tBodyAcc-std()-X', 'tBodyAcc-std()-Y', 'tBodyAcc-std()-Z',
       'tBodyAcc-mad()-X', 'tBodyAcc-mad()-Y', 'tBodyAcc-mad()-Z',
       'tBodyAcc-max()-X',
       'fBodyBodyGyroJerkMag-skewness()', 'fBodyBodyGyroJerkMag-kurtosis()', 
       'angle(tBodyAccMean,gravity)', 'angle(tBodyAccJerkMean),gravityMea
n',
       'angle(tBodyGyroMean,gravityMean)',
       'angle(tBodyGyroJerkMean,gravityMean)', 'angle(X,gravityMean)',
       'angle(Y,gravityMean)', 'angle(Z,gravityMean)', 'Activity'],
      dtype='object', length=562)
```

```
In [12]: type(df)
```

```
Out[12]: pandas.core.frame.DataFrame
```

```
In [13]: df['Activity'].value_counts
```

```
Out[13]: <bound method IndexOpsMixin.value_counts of 0           STANDING
          1           STANDING
          2           STANDING
          3           STANDING
          4           STANDING
          ...
          146      WALKING_DOWNSTAIRS
          147      WALKING_DOWNSTAIRS
          148      WALKING_DOWNSTAIRS
          149      WALKING_DOWNSTAIRS
Name: Activity, Length: 151, dtype: object>
```

Step 2: Build a small dataset

```
In [14]: lay = df.loc[df['Activity'] == "LAYING"][:500]
sit = df.loc[df['Activity'] == "SITTING"][:500]
walk = df.loc[df['Activity'] == "WALKING"][:500]
frames = [lay, sit, walk]
df_new = pd.concat(frames)
```

```
In [15]: df_new.shape
```

```
Out[15]: (98, 562)
```

```
In [16]: df_new.to_csv("Human_Activity_sample.csv")
```

```
In [17]: df1=pd.read_csv('Human_Activity_sample.csv')
```

```
In [18]: df1.head()
```

```
Out[18]:
```

	Unnamed: 0	tBodyAcc-mean()-X	tBodyAcc-mean()-Y	tBodyAcc-mean()-Z	tBodyAcc-std()-X	tBodyAcc-std()-Y	tBodyAcc-std()-Z	tBodyAcc-mad()-X
0	51	0.403474	-0.015074	-0.118167	-0.914811	-0.895231	-0.891748	-0.917696
1	52	0.278373	-0.020561	-0.096825	-0.984883	-0.991118	-0.982112	-0.987985
2	53	0.276555	-0.017869	-0.107621	-0.994195	-0.996372	-0.995615	-0.994901
3	54	0.279575	-0.017276	-0.109481	-0.996135	-0.995812	-0.998689	-0.996393
4	55	0.276527	-0.016819	-0.107983	-0.996775	-0.997256	-0.995422	-0.997167

5 rows × 563 columns



```
In [19]: df1.shape
```

```
Out[19]: (98, 563)
```

```
In [20]: df1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 98 entries, 0 to 97
Columns: 563 entries, Unnamed: 0 to Activity
dtypes: float64(561), int64(1), object(1)
memory usage: 431.2+ KB
```

```
In [21]: df1.columns
```

```
Out[21]: Index(['Unnamed: 0', 'tBodyAcc-mean()-X', 'tBodyAcc-mean()-Y',  
   'tBodyAcc-mean()-Z', 'tBodyAcc-std()-X', 'tBodyAcc-std()-Y',  
   'tBodyAcc-std()-Z', 'tBodyAcc-mad()-X', 'tBodyAcc-mad()-Y',  
   'tBodyAcc-mad()-Z',  
   ...  
   'fBodyBodyGyroJerkMag-skewness()', 'fBodyBodyGyroJerkMag-kurtosis()',  
   'angle(tBodyAccMean,gravity)', 'angle(tBodyAccJerkMean),gravityMea  
n)',  
   'angle(tBodyGyroMean,gravityMean)',  
   'angle(tBodyGyroJerkMean,gravityMean)', 'angle(X,gravityMean)',  
   'angle(Y,gravityMean)', 'angle(Z,gravityMean)', 'Activity'],  
  dtype='object', length=563)
```

```
In [22]: type(df1)
```

```
Out[22]: pandas.core.frame.DataFrame
```

```
In [23]: df1["Activity"].value_counts()
```

```
Out[23]: WALKING    47  
LAYING      27  
SITTING     24  
Name: Activity, dtype: int64
```

Step 3: Build GradientBoostingClassifier

```
In [24]: X=df1.drop('Activity',axis=1)  
y=df1.Activity
```

```
In [25]: X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.3,random_stan
```

```
In [26]: model = GradientBoostingClassifier(n_estimators=100,learning_rate=1.0,max_depth=1,random_state=42)  
model.fit(X_train,y_train)
```

```
Out[26]: GradientBoostingClassifier(learning_rate=1.0, max_depth=1, random_state=42)
```

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```
In [27]: y_pred=model.predict(X_test)
```

```
In [28]: accuracy_score(y_test,y_pred)
```

```
Out[28]: 0.9666666666666667
```

```
In [29]: print(classification_report(y_test,y_pred))
```

	precision	recall	f1-score	support
LAYING	1.00	0.90	0.95	10
SITTING	0.89	1.00	0.94	8
WALKING	1.00	1.00	1.00	12
accuracy			0.97	30
macro avg	0.96	0.97	0.96	30
weighted avg	0.97	0.97	0.97	30

Step4. [Find Best no. of trees and Best Learning Rate using Grid Search and Cross Validation]

```
In [30]: classifier = GradientBoostingClassifier()
```

```
In [31]: all_scores = cross_val_score(estimator=classifier, X=X_train, y=y_train, cv=5)
```

```
In [32]: all_scores
```

```
Out[32]: array([1., 1., 1., 1., 1.])
```

To find the average of all the accuracies, simple use the mean() method

```
In [33]: all_scores.mean()
```

```
Out[33]: 1.0
```

```
In [34]: parameter = {'n_estimators': [50, 100, 200, 400], 'learning_rate': [0.1, 0.01]}
```

```
In [35]: model1 = GridSearchCV(estimator=classifier, param_grid=parameter, cv=5, n_jobs=-1)
```

```
In [36]: model1.fit(X_train,y_train)
```

```
Out[36]: GridSearchCV(cv=5, estimator=GradientBoostingClassifier(), n_jobs=-1,  
param_grid={'learning_rate': [0.1, 0.01],  
'n_estimators': [50, 100, 200, 400]})
```

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```
In [41]: y_pred2=model1.predict(X_test)
```

```
In [42]: accuracy_score(y_test,y_pred2)
```

```
Out[42]: 1.0
```

```
In [43]: print(classification_report(y_test,y_pred2))
```

	precision	recall	f1-score	support
LAYING	1.00	1.00	1.00	10
SITTING	1.00	1.00	1.00	8
WALKING	1.00	1.00	1.00	12
accuracy				30
macro avg	1.00	1.00	1.00	30
weighted avg	1.00	1.00	1.00	30

```
In [44]: print(model1.best_estimator_)
```

```
GradientBoostingClassifier(n_estimators=50)
```

Step5. [Build AdaBoostClassifier]

```
In [45]: base = DecisionTreeClassifier()
```

```
In [46]: model2 = AdaBoostClassifier(base_estimator=base,random_state=0)
```

```
In [47]: param_grid = {'n_estimators': [100, 150, 200], 'learning_rate': [0.01, 0.001]}
```

```
In [48]: model3 = GridSearchCV(model2,param_grid,cv=5,n_jobs=-1)
```

```
In [49]: model3.fit(X_train,y_train)
```

```
Out[49]: GridSearchCV(cv=5,
                      estimator=AdaBoostClassifier(base_estimator=DecisionTreeClassifi
ier(),
                                         random_state=0),
                      n_jobs=-1,
                      param_grid={'learning_rate': [0.01, 0.001],
                                  'n_estimators': [100, 150, 200]})
```

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```
In [50]: y_pred3=model3.predict(X_test)
```

```
In [51]: accuracy_score(y_test,y_pred3)
```

```
Out[51]: 1.0
```

```
In [52]: print(classification_report(y_test,y_pred3))
```

	precision	recall	f1-score	support
LAYING	1.00	1.00	1.00	10
SITTING	1.00	1.00	1.00	8
WALKING	1.00	1.00	1.00	12
accuracy			1.00	30
macro avg	1.00	1.00	1.00	30
weighted avg	1.00	1.00	1.00	30

```
In [53]: : print(model3.best_estimator_)
```

```
AdaBoostClassifier(base_estimator=DecisionTreeClassifier(), learning_rate=0.
01,
                   n_estimators=100, random_state=0)
```

Step6. [Build LogisticRegressionCV classifier]

```
In [54]: : model4 = LogisticRegressionCV(cv=4,Cs=5,penalty='l2')
```

```
In [55]: model4.fit(X_train,y_train)
```

Out[55]: LogisticRegressionCV(Cs=5, cv=4)

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```
In [56]: y_pred4=model4.predict(X_test)
```

```
In [57]: accuracy_score(y_test,y_pred4)
```

Out[57]: 1.0

```
In [58]: print(classification_report(y_test,y_pred4))
```

	precision	recall	f1-score	support
LAYING	1.00	1.00	1.00	10
SITTING	1.00	1.00	1.00	8
WALKING	1.00	1.00	1.00	12
accuracy				
macro avg	1.00	1.00	1.00	30
weighted avg	1.00	1.00	1.00	30

Step 7 [Build VotingClassifier]

```
In [59]: model5=VotingClassifier(estimators=[('lr',model4),('gbc',model1)], voting='hard')
```

```
In [60]: model5.fit(X_train,y_train)
```

```
Out[60]: VotingClassifier(estimators=[('lr', LogisticRegressionCV(Cs=5, cv=4)),
                                         ('gbc',
                                          GridSearchCV(cv=5,
                                                       estimator=GradientBoostingClassif
                                         ier(),
                                         n_jobs=-1,
                                         param_grid={'learning_rate': [0.
                                         1,
                                         0.0
                                         1],
                                         'n_estimators': [50,
                                         100,
                                         200,
                                         40
                                         0]}))])
```

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```
In [63]: y_pred5=model5.predict(X_test)
```

```
In [64]: print(classification_report(y_test,y_pred5))
```

	precision	recall	f1-score	support
LAYING	1.00	1.00	1.00	10
SITTING	1.00	1.00	1.00	8
WALKING	1.00	1.00	1.00	12
accuracy			1.00	30
macro avg	1.00	1.00	1.00	30
weighted avg	1.00	1.00	1.00	30

Step8. [Interpret your results]

```
In [65]: print(model1.best_estimator_)
```

```
GradientBoostingClassifier(n_estimators=50)
```

```
In [66]: print(model3.best_estimator_)
```

```
AdaBoostClassifier(base_estimator=DecisionTreeClassifier(), learning_rate=0.01,  
n_estimators=100, random_state=0)
```

GradientBoostingClassifier

GradientBoostingClassifier(n_estimators=50)

```
In [67]: classifierF = GradientBoostingClassifier(n_estimators=50)  
all_scoresF = cross_val_score(estimator=classifier, X=X_train, y=y_train, cv=parameter = {'n_estimators': [50, 100, 200, 400], 'learning_rate': [0.1, 0.01]}
```

```
In [68]: modelGC = GridSearchCV(estimator=classifier, param_grid=parameter, cv=5, n_jobs
```

```
In [69]: modelGC.fit(X_train, y_train)
```

```
Out[69]: GridSearchCV(cv=5, estimator=GradientBoostingClassifier(), n_jobs=-1,  
param_grid={'learning_rate': [0.1, 0.01],  
'n_estimators': [50, 100, 200, 400]})
```

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```
In [71]: y_predGC = model3.predict(X_test)
```

```
In [72]: accuracy_score(y_test, y_predGC)
```

```
Out[72]: 1.0
```

```
In [73]: print(classification_report(y_test, y_predGC))
```

	precision	recall	f1-score	support
LAYING	1.00	1.00	1.00	10
SITTING	1.00	1.00	1.00	8
WALKING	1.00	1.00	1.00	12
accuracy			1.00	30
macro avg	1.00	1.00	1.00	30
weighted avg	1.00	1.00	1.00	30

```
In [74]: ### AdaBoostClassifier
```

```
In [75]: ##### AdaBoostClassifier(base_estimator=DecisionTreeClassifier(), learning_rate=0.01, n_estimators=100)
```

```
In [77]: modelABC = AdaBoostClassifier(base_estimator=DecisionTreeClassifier(), learning_rate=0.01, n_estimators=100)
```

```
In [78]: param_grid = {'n_estimators': [100, 150, 200], 'learning_rate': [0.01, 0.001]}
```

```
In [79]: modelGSCV = GridSearchCV(modelABC, param_grid, cv=5, n_jobs=-1)
modelGSCV.fit(X_train, y_train)
```

```
Out[79]: GridSearchCV(cv=5,
                     estimator=AdaBoostClassifier(base_estimator=DecisionTreeClassifier(),
                     learning_rate=0.01),
                     n_jobs=-1,
                     param_grid={'learning_rate': [0.01, 0.001],
                     'n_estimators': [100, 150, 200]})
```

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```
In [80]: y_predGSCV=model3.predict(X_test)
```

```
In [81]: accuracy_score(y_test,y_predGSCV)
```

```
Out[81]: 1.0
```

```
In [82]: print(classification_report(y_test,y_predGSCV))
```

	precision	recall	f1-score	support
LAYING	1.00	1.00	1.00	10
SITTING	1.00	1.00	1.00	8
WALKING	1.00	1.00	1.00	12
accuracy			1.00	30
macro avg	1.00	1.00	1.00	30
weighted avg	1.00	1.00	1.00	30

