```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score
import matplotlib.pyplot as plt
from sklearn import datasets
```

```
pip install datawig
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/
Requirement already satisfied: datawig in /usr/local/lib/python3.7/dist-packages (0.
Requirement already satisfied: typing==3.6.6 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: mxnet==1.4.0 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: scikit-learn[alldeps]==0.22.1 in /usr/local/lib/pytho
Requirement already satisfied: pandas==0.25.3 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: numpy<1.15.0,>=1.8.2 in /usr/local/lib/python3.7/dist
Requirement already satisfied: graphviz<0.9.0,>=0.8.1 in /usr/local/lib/python3.7/di
Requirement already satisfied: requests>=2.20.0 in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: python-dateutil>=2.6.1 in /usr/local/lib/python3.7/di
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: scipy>=0.17.0 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages (f
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-package
```

```
import datawig
```

```
path = "/content/app_data.csv"
```

```
df = pd.read_csv(path)
df
```

	Age	BMI	Sex	Height	Weight	AlvaradoScore	PediatricAppendiciti
0	12.531143	16.494601	male	159.0	41.7	7	
1	12.410678	12.595222	female	152.0	29.1	8	
2	10.537988	15.991247	male	133.5	28.5	3	
3	10.425736	16.185025	male	146.0	34.5	4	
4	13.270363	20.449137	female	164.0	55.0	2	
...	...	...	...	...	...	...	

✓ 0s completed at 10:24 PM ● ×

```
426  12.528405  29.316297    male  152.3  68.0          7
427  12.013689  28.906250    male  160.0  74.0          5
428   7.739904  22.038188  female  120.5  32.0          5
429  10.157426  21.017920  female  142.2  42.5          9

430 rows × 41 columns
```

```
#df.info()
```

```
#column dropping considering y3= AppendicitisComplications
df.drop(['AppendicitisComplications','TreatmentGroupBinar'],axis=1,inplace=True)
```

```
#df.info()
```

```
df_numerical = df.filter(['Age','BMI','Height','Weight','AlvaradoScore','PediatricAppendic
                    'AppendixDiameter','BodyTemp','WBCCount','NeutrophilPerc','CRPEntry'],
```

```
#df_numerical.info()
```

```
df_categorical = df.filter(['Sex','KetonesInUrine','ErythrocytesInUrine','WBCInUrine',
                           'Peritonitis','AppendixWallLayers','TissuePerfusion'],axis=1).c
```

```
#df_categorical.info()
```

```
#df_categorical.head()
```

```
df_boolean = df.filter(['AppendixOnSono','MigratoryPain','LowerAbdominalPainRight','Reboun
                    'Nausea','AppetiteLoss','Dysuria','FreeFluids','Kokarde',
                    'SurroundingTissueReaction','PathLymphNodes','MesentricLymphadenitis',
                    'FecalImpaction','Meteorism','Enteritis','DiagnosisByCriteria',
                     'PsoasSign','Stool'],axis=1).copy()
```

```
#df_boolean.info()
```

```
#df_boolean.sample(10)
```

```
#pandas profiling
#from pandas_profiling import ProfileReport
```

```
#profile = ProfileReport(df)
#profile.to_file(output_file = "AppendicitisComplications_profiling.html")
```

```
#perform label Encoding for categorical data

from sklearn.preprocessing import LabelEncoder
from pandas import Series
df_categorical = df_categorical.apply(lambda series:pd.Series(
      LabelEncoder().fit_transform(series[series.notnull()]),
      index = series[series.notnull()].index
   ))
```

```
#df_categorical.info()
```

```
#df_categorical.head()
```

```
#concatanation two dataframe
df_new = pd.concat([df_numerical,df_categorical],axis=1)
```

```
#df_new.info()
```

```
# Datawig imputation

from datawig import SimpleImputer
```

```
# impute missing values using Datawig
df_dw_imputed = datawig.SimpleImputer.complete(df_new)
```

```
#df_dw_imputed.head()
```

```
df_dw_imputed.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 430 entries, 0 to 429
Data columns (total 18 columns):
Age                             430 non-null float64
BMI                             430 non-null float64
Height                          430 non-null float64
Weight                          430 non-null float64
AlvaradoScore                   430 non-null float64
PediatricAppendicitisScore      430 non-null float64
```

```
     AppendixDiameter              430 non-null float64
     BodyTemp                      430 non-null float64
     WBCCount                      430 non-null float64
     NeutrophilPerc                430 non-null float64
     CRPEntry                      430 non-null float64
     Sex                           430 non-null float64
     KetonesInUrine                430 non-null float64
     ErythrocytesInUrine           430 non-null float64
     WBCInUrine                    430 non-null float64
     Peritonitis                   430 non-null float64
     AppendixWallLayers            430 non-null float64
     TissuePerfusion               430 non-null float64
     dtypes: float64(18)
     memory usage: 60.6 KB
```

```
#df_dw_imputed.isnull()
```

```
#perform labelEncoding for Boolean data
df_boolean = df_boolean.apply(lambda series:pd.Series(
      LabelEncoder().fit_transform(series[series.notnull()]),
      index = series[series.notnull()].index
   ))
```

```
#df_boolean.head()
```

```
df_boolean = df_boolean.fillna(df_boolean.mode().iloc[0])
```

```
#df_boolean.sample(20)
```

```
#df_boolean.info()
```

```
#concatanation two dataframe
df_final = pd.concat([df_dw_imputed,df_boolean],axis=1)
```

```
df_final.info()
```

```
     <class 'pandas.core.frame.DataFrame'>
     RangeIndex: 430 entries, 0 to 429
     Data columns (total 39 columns):
     Age                           430 non-null float64
     BMI                           430 non-null float64
     Height                        430 non-null float64
     Weight                        430 non-null float64
     AlvaradoScore                 430 non-null float64
     PediatricAppendicitisScore    430 non-null float64
     AppendixDiameter              430 non-null float64
     BodyTemp                      430 non-null float64
     WBCCount                      430 non-null float64
```

```
WBCCount                      430 non-null float64
NeutrophilPerc                430 non-null float64
CRPEntry                      430 non-null float64
Sex                           430 non-null float64
KetonesInUrine                430 non-null float64
ErythrocytesInUrine           430 non-null float64
WBCInUrine                    430 non-null float64
Peritonitis                   430 non-null float64
AppendixWallLayers            430 non-null float64
TissuePerfusion               430 non-null float64
AppendixOnSono                430 non-null float64
MigratoryPain                 430 non-null int64
LowerAbdominalPainRight       430 non-null float64
ReboundTenderness             430 non-null float64
CoughingPain                  430 non-null float64
Nausea                        430 non-null int64
AppetiteLoss                  430 non-null float64
Dysuria                       430 non-null float64
FreeFluids                    430 non-null float64
Kokarde                       430 non-null float64
SurroundingTissueReaction     430 non-null float64
PathLymphNodes                430 non-null float64
MesentricLymphadenitis        430 non-null float64
BowelWallThick                430 non-null float64
Ileus                         430 non-null float64
FecalImpaction                430 non-null float64
Meteorism                     430 non-null float64
Enteritis                     430 non-null float64
DiagnosisByCriteria           430 non-null int64
PsoasSign                     430 non-null float64
Stool                         430 non-null float64
dtypes: float64(36), int64(3)
memory usage: 131.1 KB
```

```
#correlation and pvalue

from scipy import stats
corr_df=pd.DataFrame(columns=['r','p'])

for col in df_final:
    print(col)
    if pd.api.types.is_numeric_dtype(df_final[col]):
        r,p = stats.pearsonr(df_final.DiagnosisByCriteria,df_final[col])
        corr_df.loc[col]=[round(r,3),round(p,3)]

corr_df
```

```
Age
BMI
Height
Weight
AlvaradoScore
PediatricAppendicitisScore
AppendixDiameter
```

```
AppendixDiameter
BodyTemp
WBCCount
NeutrophilPerc
CRPEntry
Sex
KetonesInUrine
ErythrocytesInUrine
WBCInUrine
Peritonitis
AppendixWallLayers
TissuePerfusion
AppendixOnSono
MigratoryPain
LowerAbdominalPainRight
ReboundTenderness
CoughingPain
Nausea
AppetiteLoss
Dysuria
FreeFluids
Kokarde
SurroundingTissueReaction
PathLymphNodes
MesentricLymphadenitis
BowelWallThick
Ileus
FecalImpaction
Meteorism
Enteritis
DiagnosisByCriteria
PsoasSign
Stool
```

	r	p
Age	0.073	0.129
BMI	0.109	0.024
Height	0.050	0.301
Weight	0.094	0.051
AlvaradoScore	-0.439	0.000
PediatricAppendicitisScore	-0.373	0.000
AppendixDiameter	-0.502	0.000
BodyTemp	-0.196	0.000
WBCCount	-0.410	0.000
NeutrophilPerc	-0.446	0.000
CRPEntry	-0.260	0.000

Sex	-0.102	0.034
KetonesInUrine	0.090	0.062
ErythrocytesInUrine	0.057	0.235
WBCInUrine	-0.026	0.595
Peritonitis	0.529	0.000
AppendixWallLayers	0.252	0.000
TissuePerfusion	0.263	0.000
AppendixOnSono	-0.531	0.000
MigratoryPain	-0.141	0.003
LowerAbdominalPainRight	-0.067	0.166
ReboundTenderness	-0.158	0.001
CoughingPain	-0.144	0.003
Nausea	-0.138	0.004
AppetiteLoss	-0.067	0.164
Dysuria	0.098	0.043
FreeFluids	-0.191	0.000
Kokarde	-0.314	0.000
SurroundingTissueReaction	-0.133	0.006
PathLymphNodes	0.018	0.709
MesentricLymphadenitis	-0.047	0.327
BowelWallThick	-0.143	0.003
Ileus	-0.133	0.006
FecalImpaction	0.038	0.426
Meteorism	0.064	0.186
Enteritis	0.180	0.000
DiagnosisByCriteria	1.000	0.000
PsoasSign	0.080	0.097
Stool	0.071	0.144

```
df_final.shape
```

```
(430, 39)
```

```
df_final['DiagnosisByCriteria'].value_counts()
```

```
     0    246
     1    184
     Name: DiagnosisByCriteria, dtype: int64
```

1 = yes, 0 = NO

```
no = df_final[df_final.DiagnosisByCriteria==0]
yes = df_final[df_final.DiagnosisByCriteria==1]
```

```
print(no.shape)
print(yes.shape)
```

```
     (246, 39)
     (184, 39)
```

```
#spliting the data for training and testing

X=df_final.drop(columns='DiagnosisByCriteria',axis=1)
Y=df_final['DiagnosisByCriteria']
```

```
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=.2, stratify=Y, random
```

```
print(X.shape)
print(X_train.shape)
print(X_test.shape)
```

```
     (430, 38)
     (344, 38)
     (86, 38)
```

```
print(Y.shape)
print(Y_train.shape)
print(Y_test.shape)
```

```
     (430,)
     (344,)
     (86,)
```

Logistic Regression

```
# model training using logistic regression
from sklearn.linear_model import LogisticRegression
model = LogisticRegression()
model.fit(X_train, Y_train)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:940: Conver
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  extra_warning_msg=_LOGISTIC_SOLVER_CONVERGENCE_MSG)
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=100,
                   multi_class='auto', n_jobs=None, penalty='l2',
                   random_state=None, solver='lbfgs', tol=0.0001, verbose=0,
                   warm_start=False)
```

```
# accuracy score for training data and testing data
X_train_prediction=model.predict(X_train)
X_training_accuracy=accuracy_score(X_train_prediction,Y_train)

X_test_prediction=model.predict(X_test)
X_testing_accuracy=accuracy_score(X_test_prediction,Y_test)


print('Accuracy score for training data: ',X_training_accuracy)
print('Accuracy score for testing data: ',X_testing_accuracy)
```

```
Accuracy score for training data:  0.9098837209302325
Accuracy score for testing data:  0.9302325581395349
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(model , X_train, Y_train, cv = kf)
result
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:940: Conver
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/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:940: Conver
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
Avg accuracy: 0.8576470588235294
Avg accuracy: 0.8576470588235294
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(model , X_test, Y_test, cv = kf)
result
```

```
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```

```
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/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:940: Conver
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```
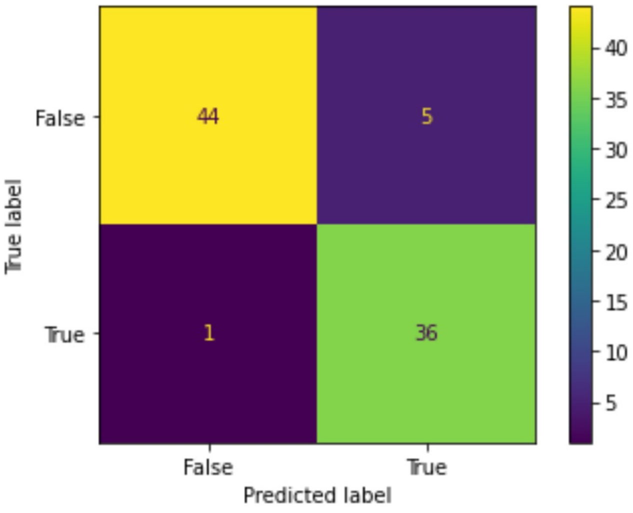

```
print("Avg accuracy: {}".format(result.mean()))
```

```
Avg accuracy: 0.8583333333333332
```

```
from sklearn import metrics
import matplotlib.pyplot as plt

# make predictions
predicted = model.predict(X_test)
from sklearn.metrics import accuracy_score, confusion_matrix
confusion_matrix = metrics.confusion_matrix(Y_test,predicted)

cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_matrix, display_l
cm_display.plot()
plt.show()
```



```
TN = confusion_matrix[0][0]
FN = confusion_matrix[1][0]
TP = confusion_matrix[1][1]
FP = confusion_matrix[0][1]
FP = confusion_matrix[0][1]

sensitivity = (TP / float(TP + FN))
specificity = (TN / float(TN + FP))
ppv = (TP / float(TP + FP))
npv = (TN / float(TN + FN))

print("Sensitivity: ",sensitivity)
print("specificity: ",specificity)
print("PPV: ",ppv)
print("NPV: ",npv)
```

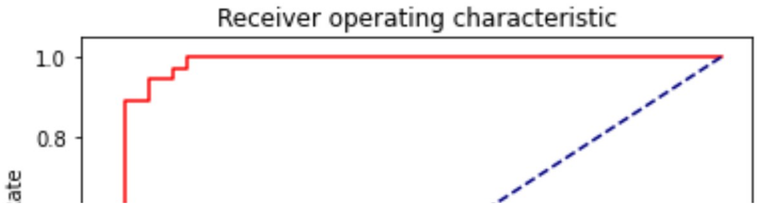
```
     Sensitivity:  0.972972972972973
     specificity:  0.8979591836734694
     PPV:  0.8780487804878049
     NPV:  0.9777777777777777
```

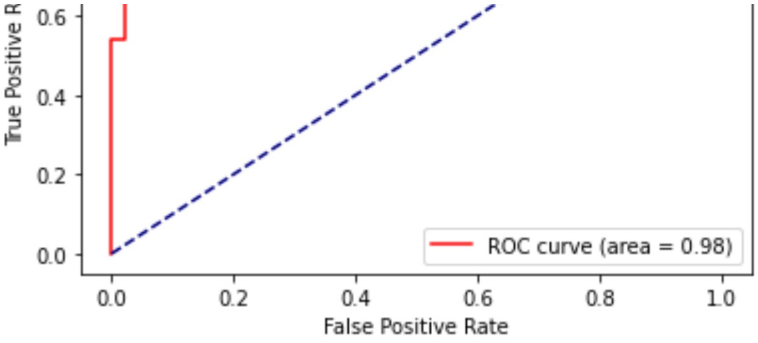
```
# AUROC and AUPR value
from sklearn.metrics import auc, roc_curve, precision_recall_curve

y_predictProb = model.predict_proba(X_test)

fpr, tpr, thresholds = roc_curve(Y_test, y_predictProb[::,1])
roc_auc = auc(fpr, tpr)

precision, recall, thresholds = precision_recall_curve(Y_test, y_predictProb[::,1])
area = auc(recall, precision)

print("AUROC:",roc_auc)
print("AUPR:",area)
```

```
     AUROC: 0.9834528405956977
     AUPR: 0.9754365410231702
```

```
# AURoc graph

plt.plot(fpr, tpr, color='red', label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

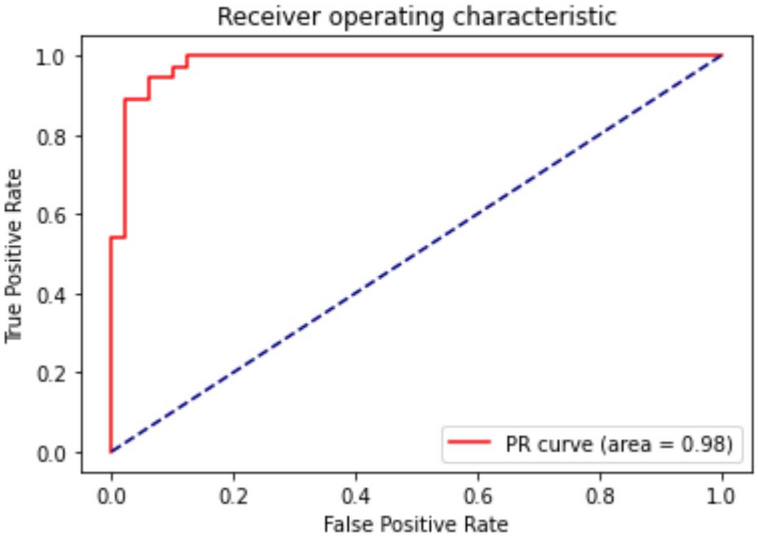
```
     <function matplotlib.pyplot.show(*args, **kw)>
```





```
# AUPR graph

plt.plot(fpr, tpr, color='red', label='PR curve (area = %0.2f)' % area)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
<function matplotlib.pyplot.show(*args, **kw)>
```



Random Forest

```
# model training Using random forest
from sklearn.ensemble import RandomForestClassifier
forest = RandomForestClassifier(random_state = 1, n_estimators = 10, min_samples_split = 2
forest.fit(X_train, Y_train)
```

```
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                       criterion='gini', max_depth=None, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=10,
                       n_jobs=None, oob_score=False, random_state=1, verbose=0,
                       warm_start=False)
```

```
# accuracy score for training data and testing data
X_train_prediction=forest.predict(X_train)
X_training_accuracy=accuracy_score(X_train_prediction,Y_train)

X_test_prediction=forest.predict(X_test)
X_testing_accuracy=accuracy_score(X_test_prediction,Y_test)


print('Accuracy score for training data: ',X_training_accuracy)
print('Accuracy score for testing data: ',X_testing_accuracy)
```

```
    Accuracy score for training data:  0.9941860465116279
    Accuracy score for testing data:  0.9302325581395349
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(forest , X_train, Y_train, cv = kf)
result
```

```
    array([0.88571429, 0.8       , 0.71428571, 0.88571429, 0.91176471,
           0.88235294, 0.91176471, 0.79411765, 0.82352941, 0.76470588])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

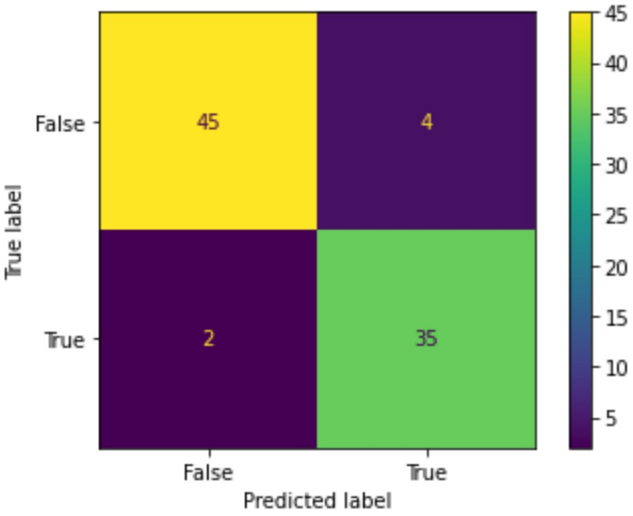
```
    Avg accuracy: 0.8373949579831933
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(forest , X_test, Y_test, cv = kf)
result
```

```
    array([0.88888889, 0.77777778, 0.88888889, 0.88888889, 1.        ,
           0.77777778, 0.875     , 0.625     , 0.625     , 0.75      ])
```

```
print("Avg accuracy: {}".format(result.mean()))

     Avg accuracy: 0.8097222222222221
```

```
# make predictions
predicted = forest.predict(X_test)
from sklearn.metrics import accuracy_score, confusion_matrix
confusion_matrix = metrics.confusion_matrix(Y_test,predicted)

cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_matrix, display_l
cm_display.plot()
plt.show()
```



```
TN = confusion_matrix[0][0]
FN = confusion_matrix[1][0]
TP = confusion_matrix[1][1]
FP = confusion_matrix[0][1]

sensitivity = (TP / float(TP + FN))
specificity = (TN / float(TN + FP))
ppv = (TP / float(TP + FP))
npv = (TN / float(TN + FN))

print("Sensitivity: ",sensitivity)
print("specificity: ",specificity)
print("PPV: ",ppv)
print("NPV: ",npv)

     Sensitivity:  0.9459459459459459
     specificity:  0.9183673469387755
     PPV:  0.8974358974358975
     NPV:  0.9574468085106383
```

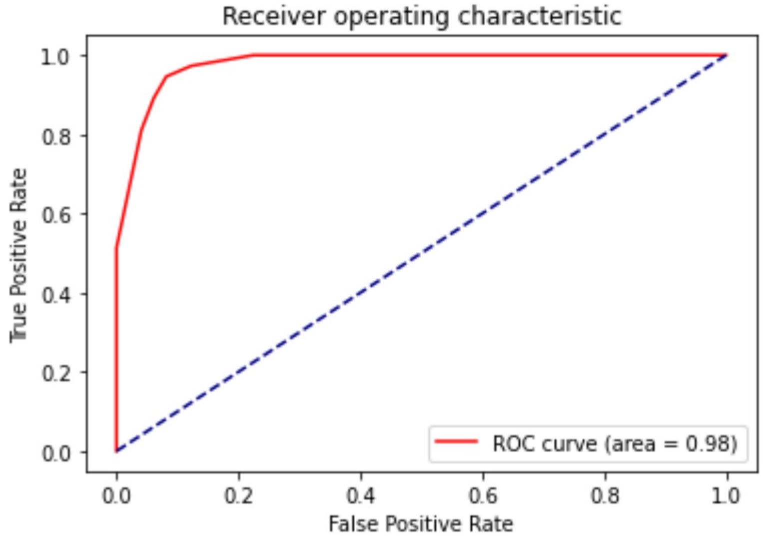
```
y_predictProb = forest.predict_proba(X_test)
```

```
fpr, tpr, thresholds = roc_curve(Y_test, y_predictProb[::,1])
roc_auc = auc(fpr, tpr)

precision, recall, thresholds = precision_recall_curve(Y_test, y_predictProb[::,1])
area = auc(recall, precision)

print("AUROC:",roc_auc)
print("AUPR:",area)
```

```
AUROC: 0.9784886927744071
AUPR: 0.9714291901791903
```

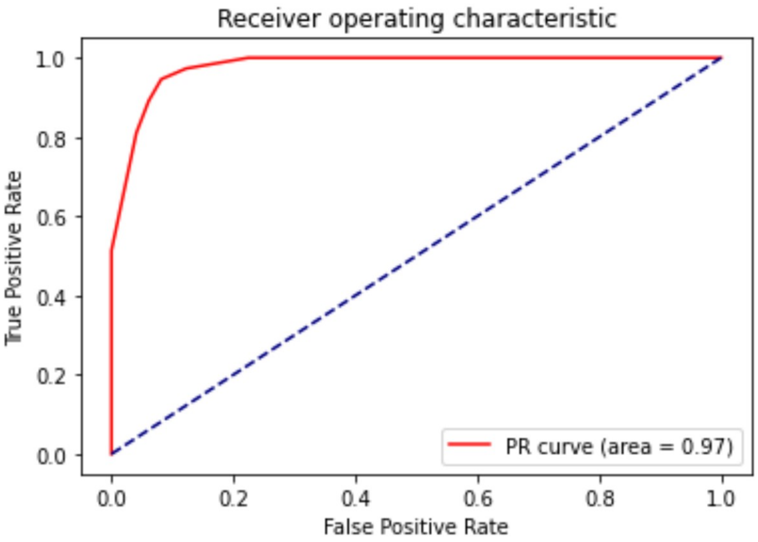
```
# AURoc graph

plt.plot(fpr, tpr, color='red', label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
<function matplotlib.pyplot.show(*args, **kw)>
```



```
# AUPR graph

plt.plot(fpr, tpr, color='red', label='PR curve (area = %0.2f)' % area)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
    <function matplotlib.pyplot.show(*args, **kw)>
```



Decision Tree

```
# using decisin tree
from sklearn.tree import DecisionTreeClassifier
dclf = DecisionTreeClassifier()
dclf.fit(X_train,Y_train)

     DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None, criterion='gini',
                            max_depth=None, max_features=None, max_leaf_nodes=None,
                            min_impurity_decrease=0.0, min_impurity_split=None,
                            min_samples_leaf=1, min_samples_split=2,
                            min_weight_fraction_leaf=0.0, presort='deprecated',
                            random_state=None, splitter='best')
```

```
# accuracy score for training data and testing data
X_train_prediction=dclf.predict(X_train)
X_training_accuracy=accuracy_score(X_train_prediction,Y_train)

X_test_prediction=dclf.predict(X_test)
X_testing_accuracy=accuracy_score(X_test_prediction,Y_test)


print('Accuracy score for training data: ',X_training_accuracy)
print('Accuracy score for testing data: ',X_testing_accuracy)

     Accuracy score for training data:  1.0
     Accuracy score for testing data:  0.9069767441860465
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(dclf , X_train, Y_train, cv = kf)
result
```

```
array([0.82857143, 0.68571429, 0.77142857, 0.8       , 0.91176471,
       0.91176471, 0.85294118, 0.79411765, 0.76470588, 0.88235294])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
Avg accuracy: 0.8203361344537814
```

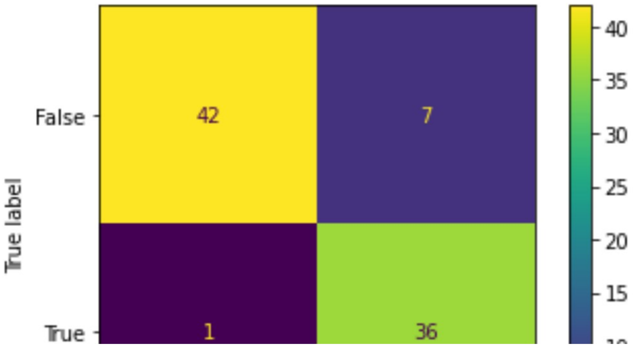
```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(dclf , X_test, Y_test, cv = kf)
result
```

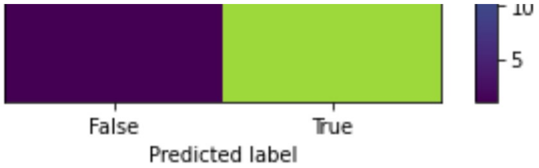
```
array([0.88888889, 0.88888889, 0.77777778, 0.77777778, 1.        ,
       1.        , 0.875     , 0.75      , 0.75      , 0.75      ])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
Avg accuracy: 0.8458333333333332
```

```
# make predictions
predicted = dclf.predict(X_test)
from sklearn.metrics import accuracy_score, confusion_matrix
confusion_matrix = metrics.confusion_matrix(Y_test,predicted)

cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_matrix, display_l
cm_display.plot()
plt.show()
```





```
TN = confusion_matrix[0][0]
FN = confusion_matrix[1][0]
TP = confusion_matrix[1][1]
FP = confusion_matrix[0][1]

sensitivity = (TP / float(TP + FN))
specificity = (TN / float(TN + FP))
ppv = (TP / float(TP + FP))
npv = (TN / float(TN + FN))

print("Sensitivity: ",sensitivity)
print("specificity: ",specificity)
print("PPV: ",ppv)
print("NPV: ",npv)
```

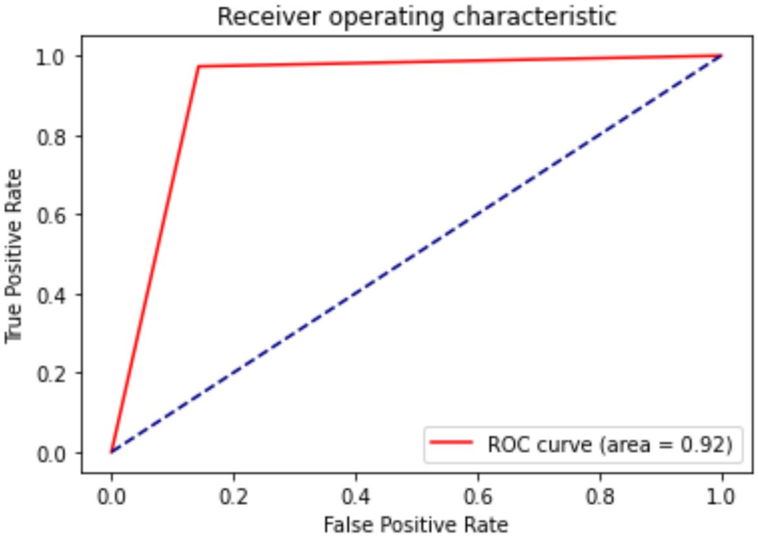
```
Sensitivity:  0.972972972972973
specificity:  0.8571428571428571
PPV:  0.8372093023255814
NPV:  0.9767441860465116
```

```
# AUROC and AUPR value
y_predictProb = dclf.predict_proba(X_test)

fpr, tpr, thresholds = roc_curve(Y_test, y_predictProb[::,1])
roc_auc = auc(fpr, tpr)

precision, recall, thresholds = precision_recall_curve(Y_test, y_predictProb[::,1])
area = auc(recall, precision)

print("AUROC:",roc_auc)
print("AUPR:",area)
```

```
AUROC: 0.9150579150579151
AUPR: 0.9109050911376494
```

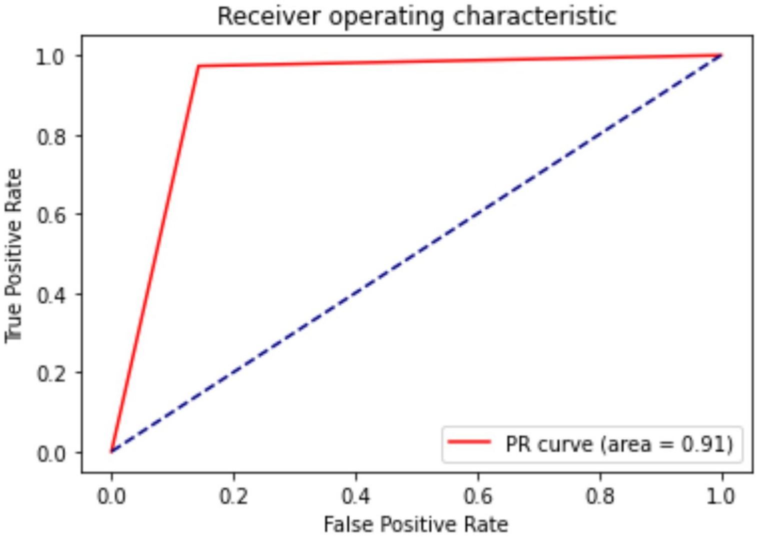
```
# AURoc graph

plt.plot(fpr, tpr, color='red', label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
plt.show
```

```
<function matplotlib.pyplot.show(*args, **kw)>
```



```
# AUPR graph

plt.plot(fpr, tpr, color='red', label='PR curve (area = %0.2f)' % area)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
<function matplotlib.pyplot.show(*args, **kw)>
```



Gradient Bosst

```
#using GradientBoost
from sklearn.ensemble import GradientBoostingClassifier
gdb = GradientBoostingClassifier(random_state = 1, n_estimators = 10, min_samples_split =
gdb.fit(X_train,Y_train)
```

```
     GradientBoostingClassifier(ccp_alpha=0.0, criterion='friedman_mse', init=None,
                                learning_rate=0.1, loss='deviance', max_depth=3,
                                max_features=None, max_leaf_nodes=None,
                                min_impurity_decrease=0.0, min_impurity_split=None,
                                min_samples_leaf=1, min_samples_split=2,
                                min_weight_fraction_leaf=0.0, n_estimators=10,
                                n_iter_no_change=None, presort='deprecated',
                                random_state=1, subsample=1.0, tol=0.0001,
                                validation_fraction=0.1, verbose=0,
                                warm_start=False)
```

```
# accuracy score for training data and testing data
X_train_prediction=gdb.predict(X_train)
X_training_accuracy=accuracy_score(X_train_prediction,Y_train)

X_test_prediction=gdb.predict(X_test)
X_testing_accuracy=accuracy_score(X_test_prediction,Y_test)


print('Accuracy score for training data: ',X_training_accuracy)
print('Accuracy score for testing data: ',X_testing_accuracy)
```

```
     Accuracy score for training data:  0.9273255813953488
     Accuracy score for testing data:  0.9651162790697675
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(gdb, X_train, Y_train, cv = kf)
result
```

```
     array([0.91428571, 0.8       , 0.91428571, 0.88571429, 0.91176471,
            0.91176471, 1.        , 0.82352941, 0.85294118, 0.91176471])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
     Avg accuracy: 0.8926050420168068
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score
```

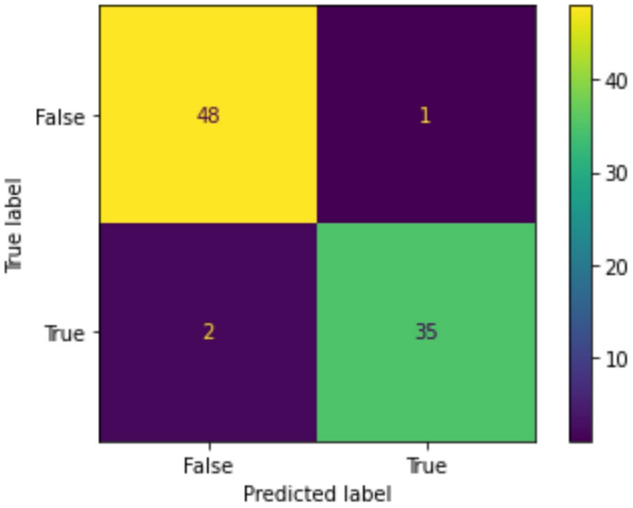
```
k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(gdb, X_test, Y_test, cv = kf)
result
```

```
     array([0.88888889, 0.77777778, 0.88888889, 0.77777778, 1.        ,
            1.        , 1.        , 0.625     , 0.875     , 0.75      ])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
     Avg accuracy: 0.8583333333333332
```

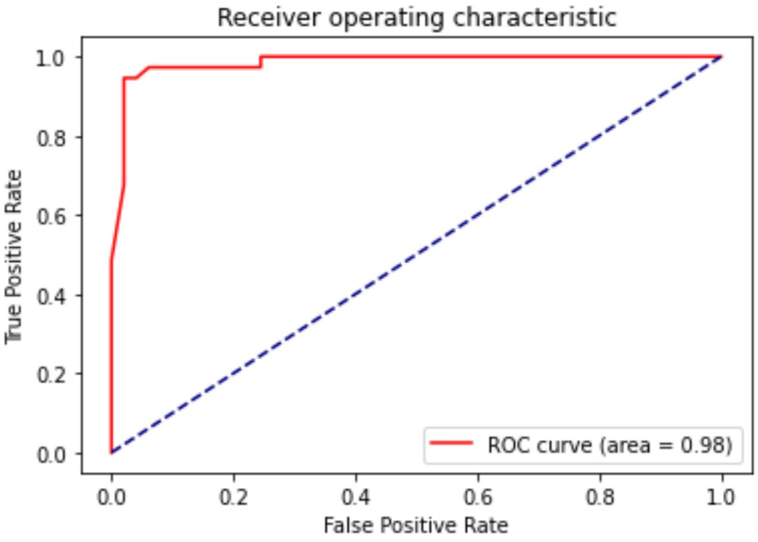
```
# make predictions
predicted = gdb.predict(X_test)
from sklearn.metrics import accuracy_score, confusion_matrix
confusion_matrix = metrics.confusion_matrix(Y_test,predicted)

cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_matrix, display_l
cm_display.plot()
plt.show()
```



```
TN = confusion_matrix[0][0]
FN = confusion_matrix[1][0]
TP = confusion_matrix[1][1]
FP = confusion_matrix[0][1]

sensitivity = (TP / float(TP + FN))
specificity = (TN / float(TN + FP))
ppv = (TP / float(TP + FP))
npv = (TN / float(TN + FN))

print("Sensitivity: ",sensitivity)
print("specificity: ",specificity)
print("PPV: ",ppv)
print("NPV: ",npv)

     Sensitivity:  0.9459459459459459
     specificity:  0.9795918367346939
     PPV:  0.9722222222222222
     NPV:  0.96
```

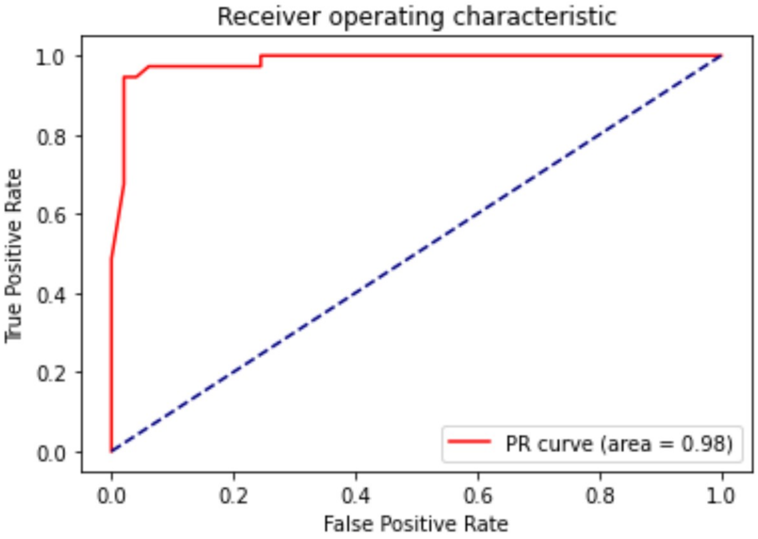
```
# AUROC and AUPR value
y_predictProb = gdb.predict_proba(X_test)

fpr, tpr, thresholds = roc_curve(Y_test, y_predictProb[::,1])
roc_auc = auc(fpr, tpr)

precision, recall, thresholds = precision_recall_curve(Y_test, y_predictProb[::,1])
area = auc(recall, precision)

print("AUROC:",roc_auc)
print("AUPR:",area)

     AUROC: 0.9845559845559846
     AUPR: 0.9790529939632824
```

```
# AURoc graph

plt.plot(fpr, tpr, color='red', label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show

     <function matplotlib.pyplot.show(*args, **kw)>
```



```
# AUPR graph

plt.plot(fpr, tpr, color='red', label='PR curve (area = %0.2f)' % area)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
<function matplotlib.pyplot.show(*args, **kw)>
```



XGBoost

```
#using XGBClassifier
from xgboost import XGBClassifier
xgb_clf = XGBClassifier(random_state = 1, n_estimators = 10, min_samples_split = 2)
xgb_clf.fit(X_train, Y_train)
```

```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=1, gamma=0,
              learning_rate=0.1, max_delta_step=0, max_depth=3,
              min_child_weight=1, min_samples_split=2, missing=None,
              n_estimators=10, n_jobs=1, nthread=None,
              objective='binary:logistic', random_state=1, reg_alpha=0,
              reg_lambda=1, scale_pos_weight=1, seed=None, silent=None,
              subsample=1, verbosity=1)
```

```
# accuracy score for training data and testing data
X_train_prediction=xgb_clf.predict(X_train)
X_training_accuracy=accuracy_score(X_train_prediction,Y_train)

X_test_prediction=xgb_clf.predict(X_test)
```

```
X_test_prediction=xgb_clf.predict(X_test)
X_testing_accuracy=accuracy_score(X_test_prediction,Y_test)


print('Accuracy score for training data: ',X_training_accuracy)
print('Accuracy score for testing data: ',X_testing_accuracy)
```

```
     Accuracy score for training data:  0.9215116279069767
     Accuracy score for testing data:  0.9651162790697675
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(xgb_clf, X_train, Y_train, cv = kf)
result
```

```
     array([0.91428571, 0.8       , 0.88571429, 0.88571429, 0.91176471,
            0.91176471, 1.        , 0.82352941, 0.85294118, 0.91176471])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
     Avg accuracy: 0.8897478991596637
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(xgb_clf, X_test, Y_test, cv = kf)
result
```

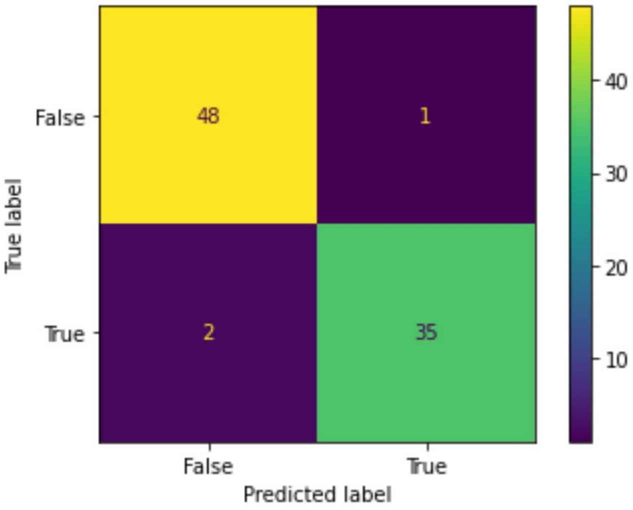
```
     array([0.88888889, 0.88888889, 0.88888889, 0.88888889, 1.        ,
            1.        , 1.        , 0.625     , 0.75      , 0.75      ])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
     Avg accuracy: 0.8680555555555556
```

```
# make predictions
predicted = xgb_clf.predict(X_test)
from sklearn.metrics import accuracy_score, confusion_matrix
confusion_matrix = metrics.confusion_matrix(Y_test,predicted)

cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_matrix, display_l
cm_display.plot()
```

```
plt.show()
```



```
TN = confusion_matrix[0][0]
FN = confusion_matrix[1][0]
TP = confusion_matrix[1][1]
FP = confusion_matrix[0][1]

sensitivity = (TP / float(TP + FN))
specificity = (TN / float(TN + FP))
ppv = (TP / float(TP + FP))
npv = (TN / float(TN + FN))

print("Sensitivity: ",sensitivity)
print("specificity: ",specificity)
print("PPV: ",ppv)
print("NPV: ",npv)
```

```
Sensitivity:  0.9459459459459459
specificity:  0.9795918367346939
PPV:  0.9722222222222222
NPV:  0.96
```

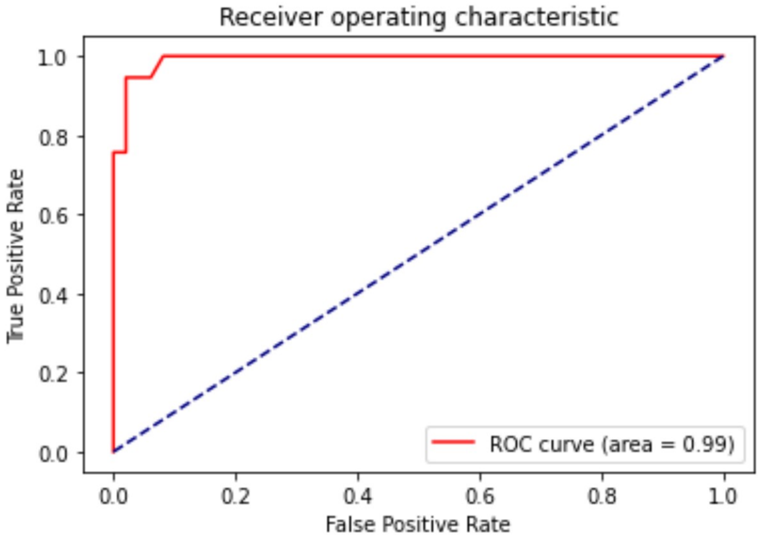
```
# AUROC and AUPR value
y_predictProb = xgb_clf.predict_proba(X_test)

fpr, tpr, thresholds = roc_curve(Y_test, y_predictProb[::,1])
roc_auc = auc(fpr, tpr)

precision, recall, thresholds = precision_recall_curve(Y_test, y_predictProb[::,1])
area = auc(recall, precision)

print("AUROC:",roc_auc)
print("AUPR:",area)
```

```
AUROC: 0.9922779922779923
```

```
    AUPR: 0.9893802449432034
```

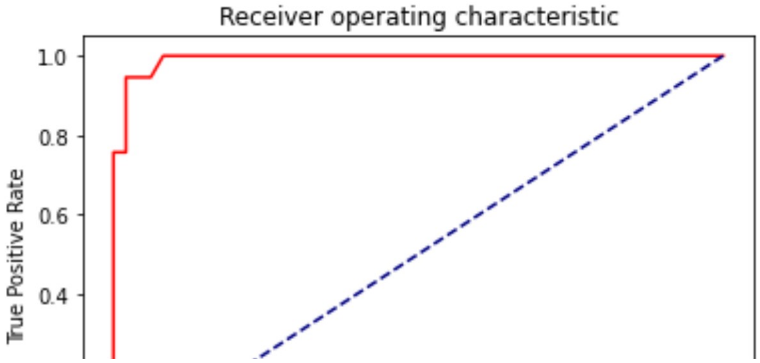
```
# AURoc graph

plt.plot(fpr, tpr, color='red', label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

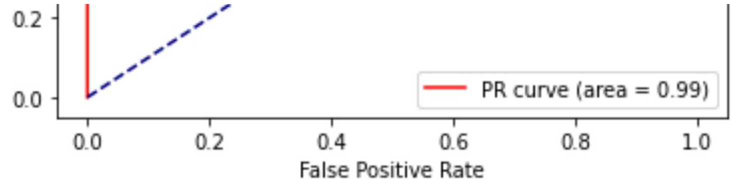
```
    <function matplotlib.pyplot.show(*args, **kw)>
```



```
# AUPR graph

plt.plot(fpr, tpr, color='red', label='PR curve (area = %0.2f)' % area)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
    <function matplotlib.pyplot.show(*args, **kw)>
```





Support Vector

```
#using support vector
from sklearn import svm
sv_clf = svm.SVC()
sv_clf.fit(X_train, Y_train)
```

```
     SVC(C=1.0, break_ties=False, cache_size=200, class_weight=None, coef0=0.0,
         decision_function_shape='ovr', degree=3, gamma='scale', kernel='rbf',
         max_iter=-1, probability=False, random_state=None, shrinking=True,
         tol=0.001, verbose=False)
```

```
# accuracy score for training data and testing data
X_train_prediction=sv_clf.predict(X_train)
X_training_accuracy=accuracy_score(X_train_prediction,Y_train)

X_test_prediction=sv_clf.predict(X_test)
X_testing_accuracy=accuracy_score(X_test_prediction,Y_test)


print('Accuracy score for training data: ',X_training_accuracy)
print('Accuracy score for testing data: ',X_testing_accuracy)
```

```
     Accuracy score for training data:  0.7209302325581395
     Accuracy score for testing data:  0.7906976744186046
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(sv_clf , X_train, Y_train, cv = kf)
result
```

```
     array([0.71428571, 0.71428571, 0.68571429, 0.68571429, 0.73529412,
            0.76470588, 0.64705882, 0.79411765, 0.73529412, 0.61764706])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
    Avg accuracy: 0.7094117647058823
```

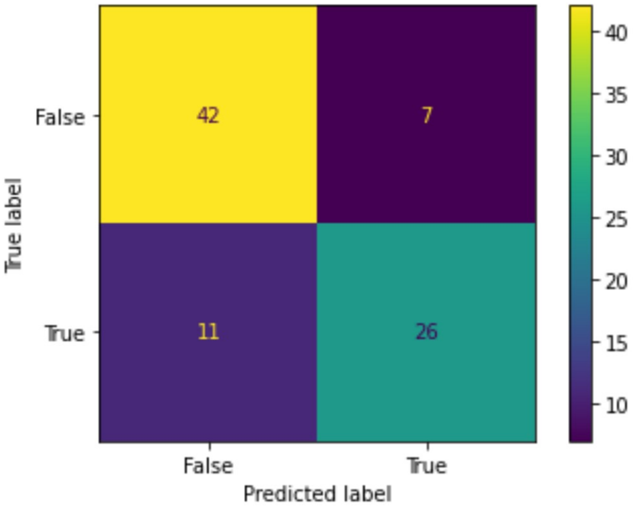
```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(sv_clf , X_test, Y_test, cv = kf)
result
```

```
    array([0.77777778, 0.88888889, 0.77777778, 0.77777778, 0.77777778,
           0.66666667, 0.875     , 0.875     , 0.625     , 0.625     ])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
    Avg accuracy: 0.7666666666666667
```

```
# make predictions
predicted = sv_clf.predict(X_test)
from sklearn.metrics import accuracy_score, confusion_matrix
confusion_matrix = metrics.confusion_matrix(Y_test,predicted)

cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_matrix, display_l
cm_display.plot()
plt.show()
```



```
TN = confusion_matrix[0][0]
FN = confusion_matrix[1][0]
TP = confusion_matrix[1][1]
FP = confusion_matrix[0][1]

sensitivity = (TP / float(TP + FN))
```

```
specificity = (TN / float(TN + FP))
ppv = (TP / float(TP + FP))
npv = (TN / float(TN + FN))

print("Sensitivity: ",sensitivity)
print("specificity: ",specificity)
print("PPV: ",ppv)
print("NPV: ",npv)
```

```
Sensitivity:  0.7027027027027027
specificity:  0.8571428571428571
PPV:  0.7878787878787878
NPV:  0.7924528301886793
```

```
# AUROC and AUPR value
y_predictProb = sv_clf.predict_proba(X_test)

fpr, tpr, thresholds = roc_curve(Y_test, y_predictProb[::,1])
roc_auc = auc(fpr, tpr)

precision, recall, thresholds = precision_recall_curve(Y_test, y_predictProb[::,1])
area = auc(recall, precision)

print("AUROC:",roc_auc)
print("AUPR:",area)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-114-289267775586> in <module>
      1 # AUROC and AUPR value
----> 2 y_predictProb = sv_clf.predict_proba(X_test)
      3 
      4 fpr, tpr, thresholds = roc_curve(Y_test, y_predictProb[::,1])
      5 roc_auc = auc(fpr, tpr)

                                   1 frames

/usr/local/lib/python3.7/dist-packages/sklearn/svm/_base.py in _check_proba(self)
    601     def _check_proba(self):
    602         if not self.probability:
--> 603             raise AttributeError("predict_proba is not available when "
    604                                  " probability=False")
    605         if self._impl not in ('c_svc', 'nu_svc'):

AttributeError: predict_proba is not available when  probability=False
```

SEARCH STACK OVERFLOW

```
# AURoc graph

plt.plot(fpr, tpr, color='red', label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show


# AUPR graph

plt.plot(fpr, tpr, color='red', label='PR curve (area = %0.2f)' % area)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

Gausian Naive Bayes

```
#using Naive Bayesian

from sklearn.naive_bayes import GaussianNB
gnb = GaussianNB()
gnb.fit(X_train, Y_train)

     GaussianNB(priors=None, var_smoothing=1e-09)
```

```
# accuracy score for training data and testing data
X_train_prediction=gnb.predict(X_train)
X_training_accuracy=accuracy_score(X_train_prediction,Y_train)

X_test_prediction=gnb.predict(X_test)
X_testing_accuracy=accuracy_score(X_test_prediction,Y_test)


print('Accuracy score for training data: ',X_training_accuracy)
print('Accuracy score for testing data: ',X_testing_accuracy)

     Accuracy score for training data:  0.7994186046511628
     Accuracy score for testing data:  0.8255813953488372
```

```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
```

```
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(gnb , X, Y, cv = kf)
result
```

```
array([0.44186047, 0.46511628, 0.74418605, 0.76744186, 0.86046512,
       0.90697674, 0.90697674, 1.        , 0.86046512, 0.86046512])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
Avg accuracy: 0.7813953488372093
```

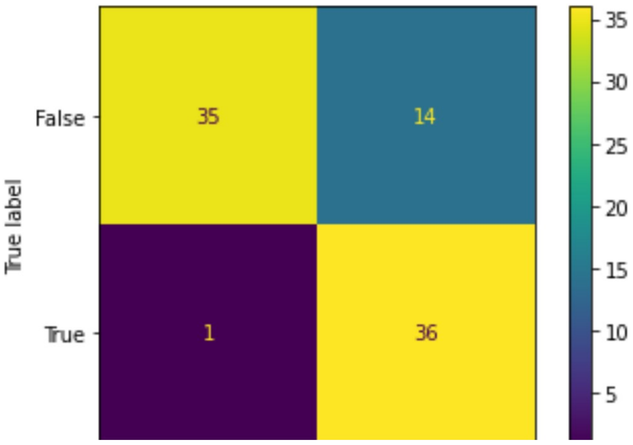
```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

k = 10
kf = KFold(n_splits=k, random_state=None)
result = cross_val_score(gnb , X_test, Y_test, cv = kf)
result
```

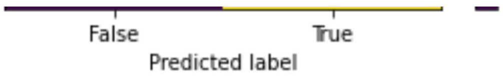
```
array([0.66666667, 0.88888889, 0.88888889, 0.77777778, 0.88888889,
       0.88888889, 0.75      , 0.75      , 1.        , 0.875     ])
```

```
print("Avg accuracy: {}".format(result.mean()))
```

```
Avg accuracy: 0.8375
```

```
# make predictions
predicted = gnb.predict(X_test)
from sklearn.metrics import accuracy_score, confusion_matrix
confusion_matrix = metrics.confusion_matrix(Y_test,predicted)

cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_matrix, display_l
cm_display.plot()
plt.show()
```





```
TN = confusion_matrix[0][0]
FN = confusion_matrix[1][0]
TP = confusion_matrix[1][1]
FP = confusion_matrix[0][1]

sensitivity = (TP / float(TP + FN))
specificity = (TN / float(TN + FP))
ppv = (TP / float(TP + FP))
npv = (TN / float(TN + FN))

print("Sensitivity: ",sensitivity)
print("specificity: ",specificity)
print("PPV: ",ppv)
print("NPV: ",npv)
```

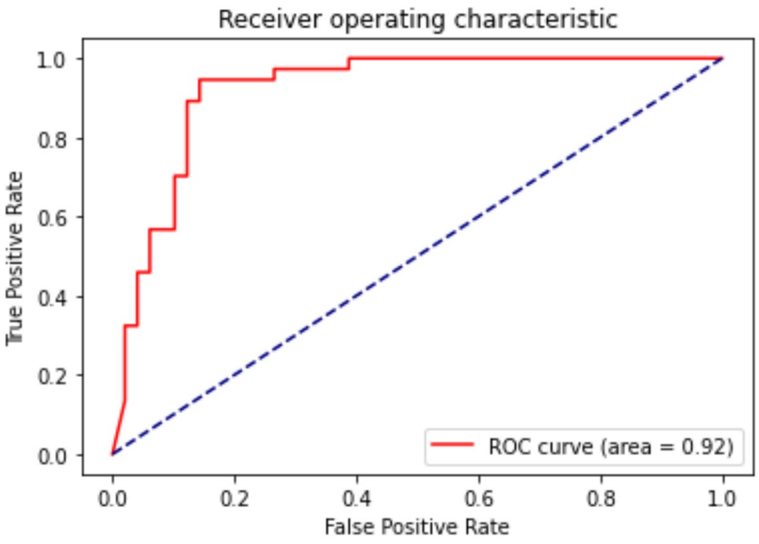
```
Sensitivity:  0.972972972972973
specificity:  0.7142857142857143
PPV:  0.72
NPV:  0.9722222222222222
```

```
# AUROC and AUPR value
y_predictProb = gnb.predict_proba(X_test)

fpr, tpr, thresholds = roc_curve(Y_test, y_predictProb[::,1])
roc_auc = auc(fpr, tpr)

precision, recall, thresholds = precision_recall_curve(Y_test, y_predictProb[::,1])
area = auc(recall, precision)

print("AUROC:",roc_auc)
print("AUPR:",area)
```

```
AUROC: 0.9202978488692775
AUPR: 0.8548990703890742
```

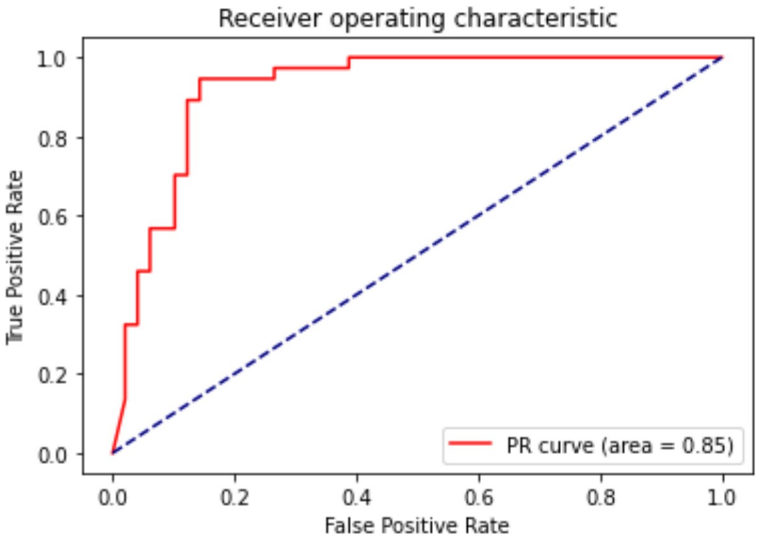
```
# AURoc graph

plt.plot(fpr, tpr, color='red', label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
<function matplotlib.pyplot.show(*args, **kw)>
```



```
# AUPR graph

plt.plot(fpr, tpr, color='red', label='PR curve (area = %0.2f)' % area)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
<function matplotlib.pyplot.show(*args, **kw)>
```


Receiver operating characteristic
True Positive Rate
False Positive Rate
PR curve (area = 0.85)