```
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: scikit-learn[alldeps]==0.22.1 in /usr/local/lib/pytho
Requirement already satisfied: mxnet==1.4.0 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: typing==3.6.6 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: pandas==0.25.3 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: requests>=2.20.0 in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: graphviz<0.9.0,>=0.8.1 in /usr/local/lib/python3.7/di
Requirement already satisfied: numpy<1.15.0,>=1.8.2 in /usr/local/lib/python3.7/dist
Requirement already satisfied: python-dateutil>=2.6.1 in /usr/local/lib/python3.7/di
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/dist-package
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: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-pa
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
```

```
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 7:25 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','DiagnosisByCriteria'],axis=1,inplace=True)

# Ultrasound
df.drop(['AppendixOnSono','AppendixDiameter','AppendixWallLayers','Kokarde','TissuePerfusi
        'BowelWallThick','Ileus','Enteritis'],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','TreatmentGroupBinar',
                     '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()


#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 30 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
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
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
PathLymphNodes                430 non-null float64
MesentricLymphadenitis        430 non-null float64
FecalImpaction                430 non-null float64
Meteorism                     430 non-null float64
TreatmentGroupBinar           430 non-null int64
```

```
 PsoasSign                     430 non-null float64
 Stool                         430 non-null float64
 dtypes: float64(27), int64(3)
 memory usage: 100.9 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.TreatmentGroupBinar,df_final[col])
        corr_df.loc[col]=[round(r,3),round(p,3)]

corr_df
```

```
 Age
 BMI
 Height
 Weight
 AlvaradoScore
 PediatricAppendicitisScore
 BodyTemp
 WBCCount
 NeutrophilPerc
 CRPEntry
 Sex
 KetonesInUrine
 ErythrocytesInUrine
 WBCInUrine
 Peritonitis
 MigratoryPain
 LowerAbdominalPainRight
 ReboundTenderness
 CoughingPain
 Nausea
 AppetiteLoss
 Dysuria
 FreeFluids
 PathLymphNodes
 MesentricLymphadenitis
 FecalImpaction
 Meteorism
 TreatmentGroupBinar
 PsoasSign
 Stool
```

	r	p
Age	-0.069	0.151
BMI	-0.088	0.070

Height	-0.070	0.146
Weight	-0.085	0.078
AlvaradoScore	0.410	0.000
PediatricAppendicitisScore	0.332	0.000
BodyTemp	0.210	0.000
WBCCount	0.442	0.000
NeutrophilPerc	0.431	0.000
CRPEntry	0.374	0.000
Sex	0.061	0.207
KetonesInUrine	-0.137	0.005
ErythrocytesInUrine	-0.032	0.503
WBCInUrine	0.097	0.044
Peritonitis	-0.760	0.000
MigratoryPain	0.074	0.123
LowerAbdominalPainRight	0.056	0.251
ReboundTenderness	0.157	0.001
CoughingPain	0.102	0.034
Nausea	0.165	0.001
AppetiteLoss	0.085	0.080
Dysuria	-0.031	0.517
FreeFluids	0.184	0.000
PathLymphNodes	-0.030	0.535
MesentricLymphadenitis	0.106	0.028
FecalImpaction	-0.053	0.271
Meteorism	-0.017	0.731
TreatmentGroupBinar	1.000	0.000
PsoasSign	-0.075	0.120
Stool	-0.063	0.194

```
df_final.shape
```

```
(430, 30)
```

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

```
0    265
1    165
Name: TreatmentGroupBinar, dtype: int64
```

1 = yes, 0 = NO

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

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

```
(265, 30)
(165, 30)
```

```
#spliting the data for training and testing

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

```
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, 29)
(344, 29)
(86, 29)
```

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

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

N_estimator_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_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)
```

```
model_score2 = forest.score(X_test, Y_test)
model_score1 = forest.score(X_train, Y_train)
print(model_score1)
print(model_score2)
```

```
0.997093023255814
0.8837209302325582
```

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:  0.9186046511627907
Accuracy score for testing data:  0.8604651162790697
```

```
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
```

```
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/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:940: Conver
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```

```
    Increase the number of iterations (max_iter) or scale the data as shown in:
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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: 0.9035294117647059
```

```
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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    Please also refer to the documentation for alternative solver options:
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```

```
  extra_warning_msg=_LOGISTIC_SOLVER_CONVERGENCE_MSG)
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    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
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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.
```
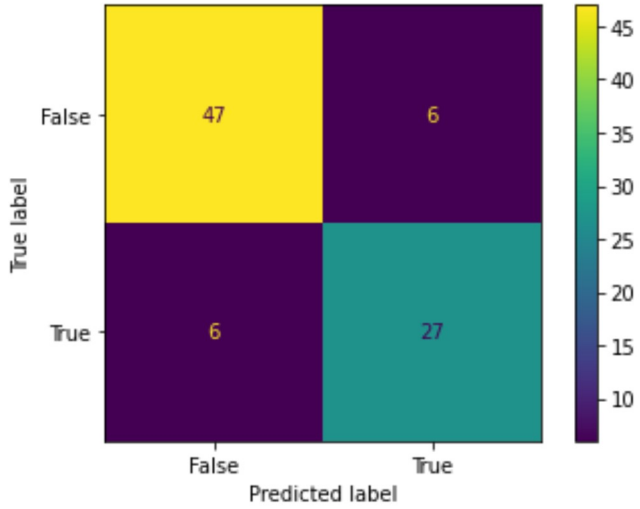

```
print("Avg accuracy: {}".format(result.mean()))
```

```
Avg accuracy: 0.7916666666666666
```

```
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]

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:  0.8181818181818182
specificity:  0.8867924528301887
PPV:  0.8181818181818182
NPV:  0.8867924528301887
```

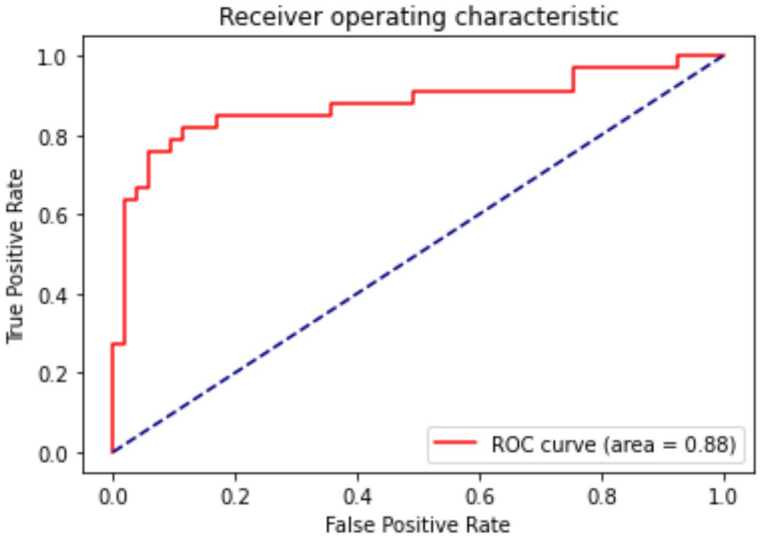
```
# AUROC and AUPR value
from sklearn.metrics import auc, roc_curve, precision_recall_curve

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])
```

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

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

```
AUROC: 0.8759291023441967
AUPR: 0.8664769150964641
```

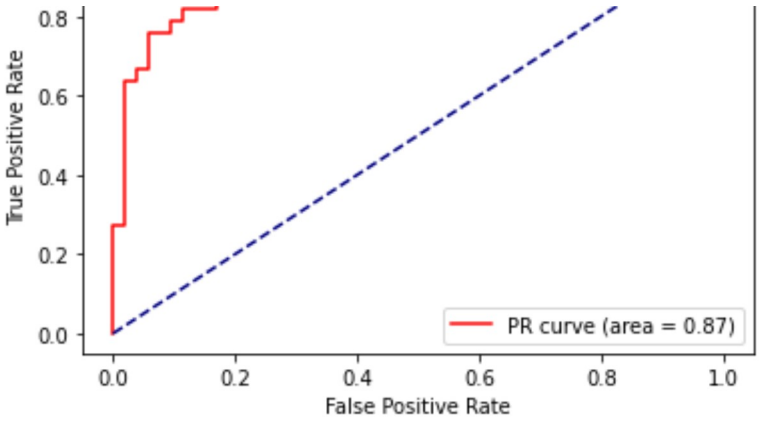
```
# AURoc graph

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_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:  0.997093023255814
Accuracy score for testing data:  0.8837209302325582
```

```
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([0.8       , 0.94285714, 0.91428571, 0.88571429, 0.79411765,
       0.79411765, 0.82352941, 0.67647059, 0.88235294, 0.79411765])
```

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

```
Avg accuracy: 0.8307563025210085
```

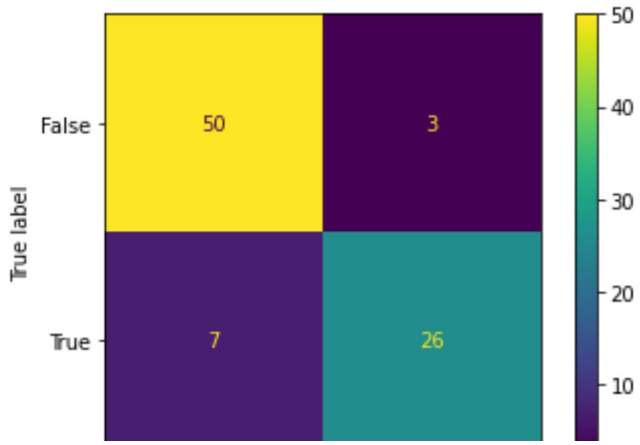
```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

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

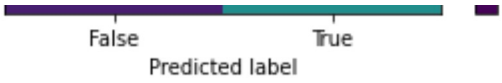
```
array([0.66666667, 0.66666667, 0.44444444, 0.66666667, 0.88888889,
       0.88888889, 0.625     , 0.875     , 0.875     , 0.75      ])
```

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

```
Avg accuracy: 0.7347222222222223
```

```
# 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)
```

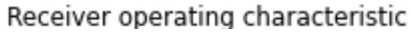
```
Sensitivity:  0.7878787878787878
specificity:  0.9433962264150944
PPV:  0.896551724137931
NPV:  0.8771929824561403
```

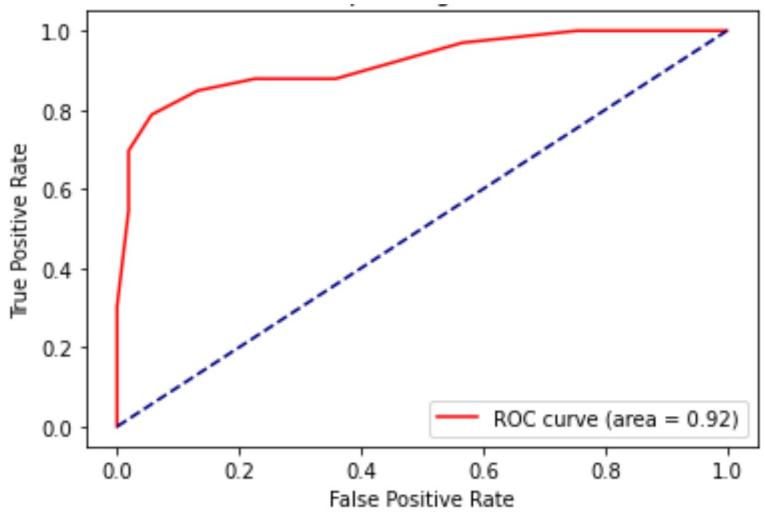
```
y_predictProb = forest.predict_proba(X_test)

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: 0.9182389937106918
AUPR: 0.9076000417843042
```

```
# 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
```

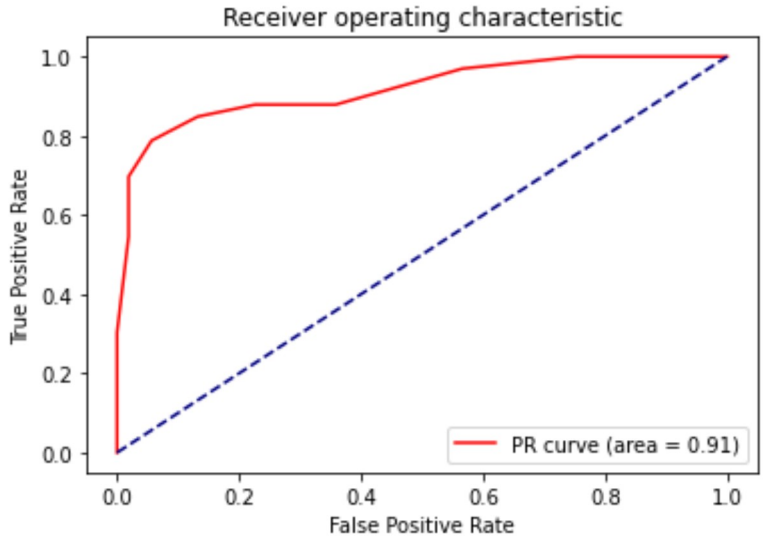
```
<function matplotlib.pyplot.show(*args, **kw)>
```






```
# 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)
```

```
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:  0.8604651162790697
```

```
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_train, Y_train, cv = kf)
result
```

```
array([0.8       , 0.91428571, 0.82857143, 0.82857143, 0.79411765,
       0.76470588, 0.97058824, 0.76470588, 0.91176471, 0.91176471])
```

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

```
Avg accuracy: 0.8489075630252101
```

```
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
```

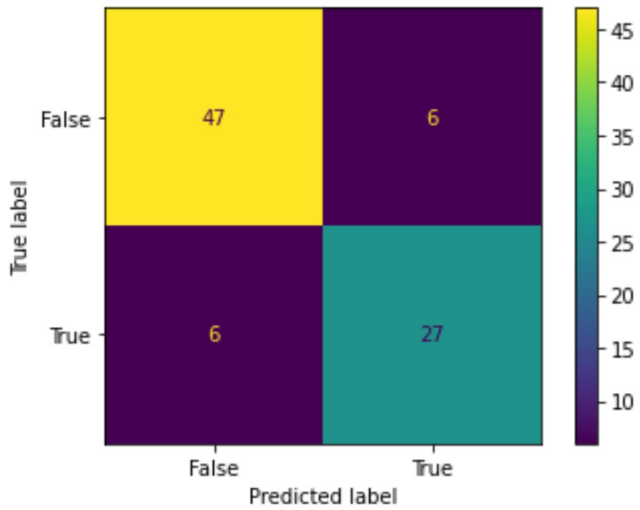
```
array([0.66666667, 0.55555556, 0.88888889, 0.88888889, 0.88888889,
```

```
            0.88888889, 0.875     , 0.875     , 0.75      , 0.625     ])
```

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

```
     Avg accuracy: 0.7902777777777777
```

```
# 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)
```

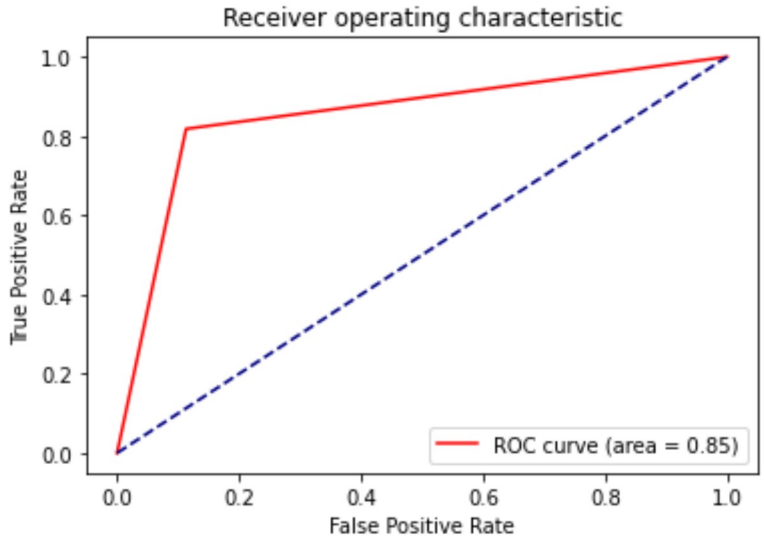
```
     Sensitivity:  0.8181818181818182
     specificity:  0.8867924528301887
     PPV:  0.8181818181818182
     NPV:  0.8867924528301887
```

```
# 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: 0.8524871355060035
AUPR: 0.8530655391120507
```

```
# 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
```

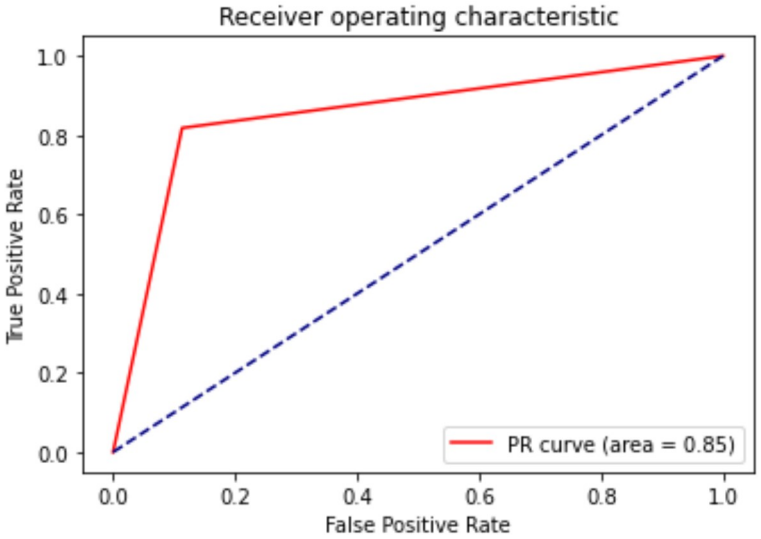
```
<function matplotlib.pyplot.show(*args, **kw)>
```




```
# 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.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

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



Gradient Boost

```
#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:  0.936046511627907
Accuracy score for testing data:  0.872093023255814
```

```
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([0.8       , 0.97142857, 0.91428571, 0.94285714, 0.82352941,
       0.82352941, 0.94117647, 0.79411765, 0.97058824, 0.91176471])
```

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

```
Avg accuracy: 0.889327731092437
```

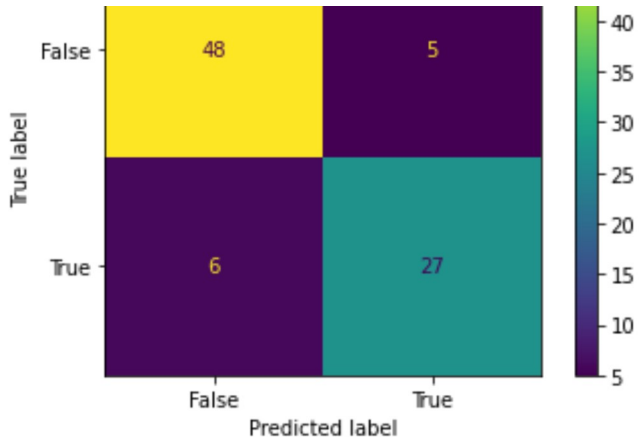
```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

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, 0.66666667, 0.88888889, 1.        , 0.88888889,
       0.88888889, 0.875     , 0.875     , 0.75      , 0.75      ])
```

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

```
Avg accuracy: 0.8472222222222221
```

```
# 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:  0.8181818181818182
specificity:  0.9056603773584906
PPV:  0.84375
NPV:  0.8888888888888888
```

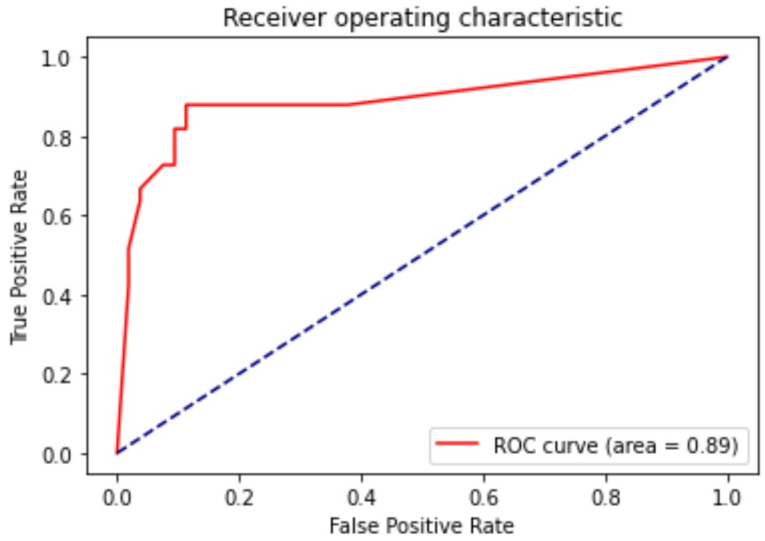
```
# AUROC and AUPR value
y_predictProb = gdb.predict_proba(X_test)

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: 0.8873642081189251
AUPR: 0.8745462580500099
```

```
# AURoc graph
```

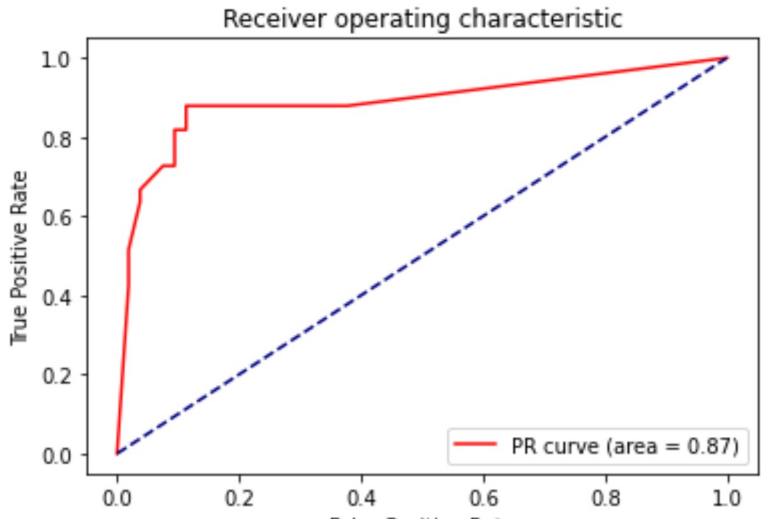
```
plt.plot(fpr, tpr, color='red', label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show
```

```
<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)>
```



False Positive Rate

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_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:  0.9127906976744186
Accuracy score for testing data:  0.8604651162790697
```

```
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([0.88571429, 0.94285714, 0.91428571, 0.94285714, 0.82352941,
       0.82352941, 0.94117647, 0.79411765, 0.94117647, 0.91176471])
```

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

```
Avg accuracy: 0.8921008403361345
```

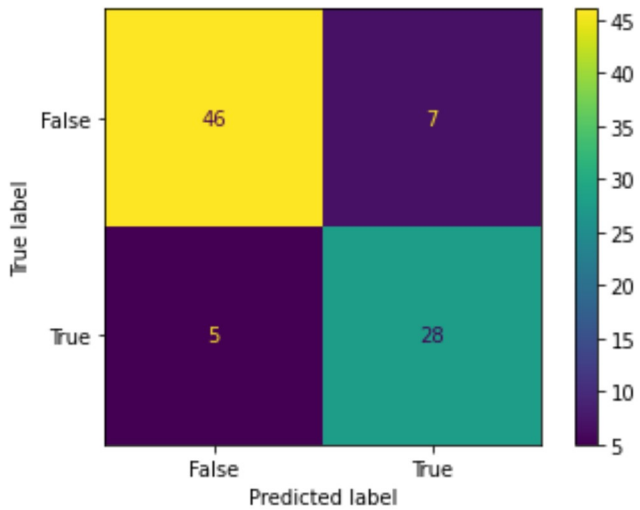
```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

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

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

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

```
Avg accuracy: 0.8375
```

```
# 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))
```

```
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)
```

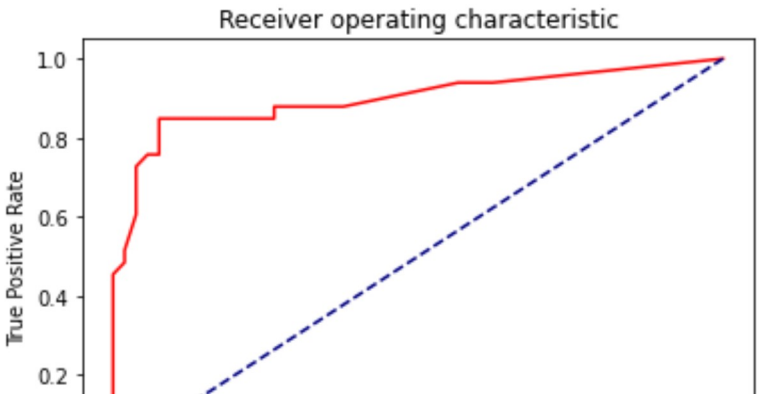
```
Sensitivity:  0.8484848484848485
specificity:  0.8679245283018868
PPV:  0.8
NPV:  0.9019607843137255
```

```
# 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: 0.8979416809605489
AUPR: 0.8943031706474345
```

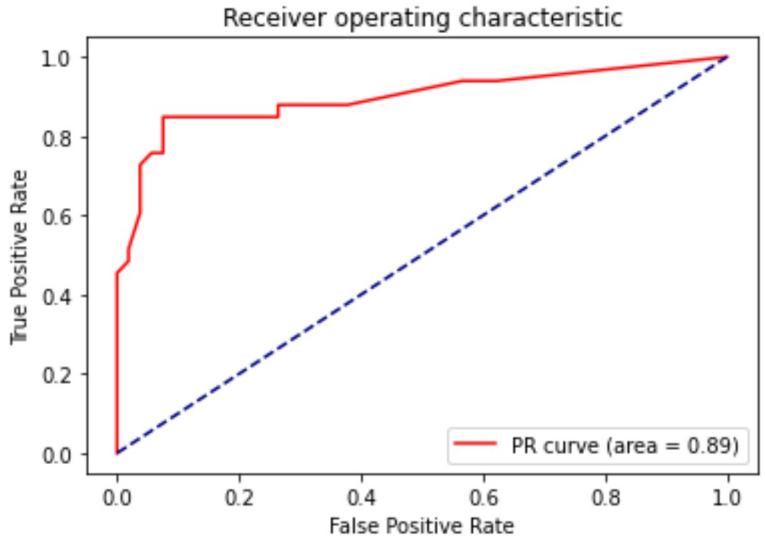
```
# AURoc graph

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:  0.7005813953488372
Accuracy score for testing data:  0.6976744186046512
```

```
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([0.74285714, 0.8       , 0.74285714, 0.57142857, 0.64705882,
       0.61764706, 0.70588235, 0.76470588, 0.61764706, 0.70588235])
```

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

```
Avg accuracy: 0.6915966386554622
```

```
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
```

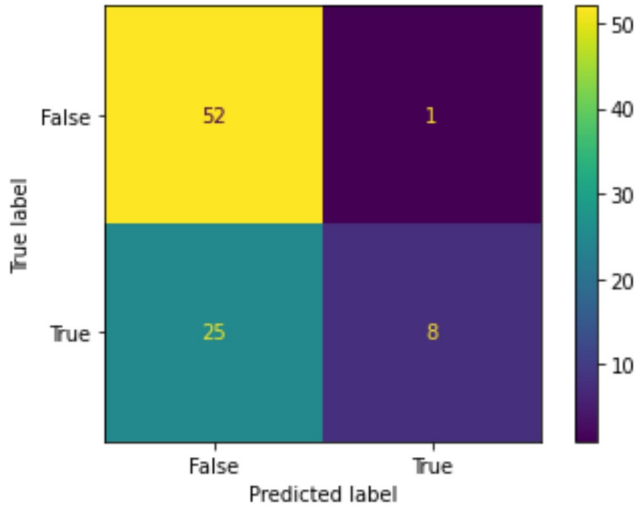
```
array([0.77777778, 0.77777778, 0.66666667, 0.44444444, 0.55555556,
       0.55555556, 0.875     , 0.875     , 0.5       , 0.75      ])
```

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

```
Avg accuracy: 0.6777777777777778
```

```
# 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()
```

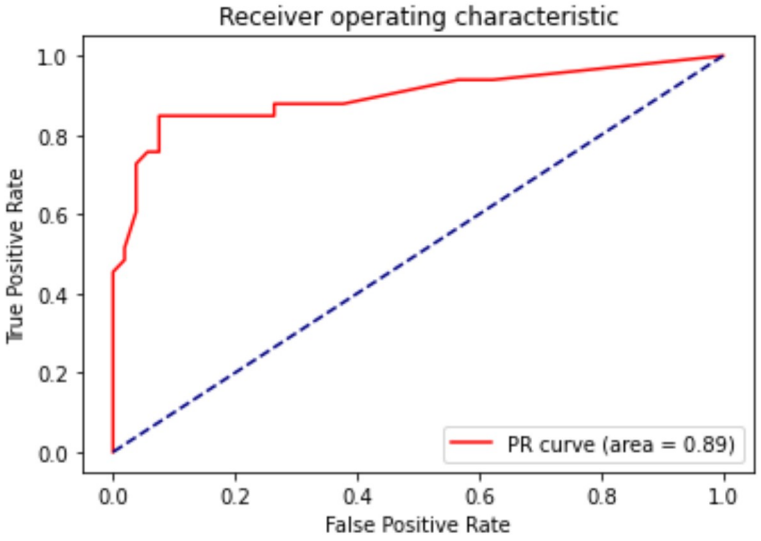



```
TN = confusion_matrix[0][0]
FN = confusion_matrix[1][0]
TP = confusion_matrix[1][1]
FP = confusion_matrix[0][1]

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:  0.24242424242424243
specificity:  0.9811320754716981
PPV:  0.8888888888888888
NPV:  0.6753246753246753
```

```
# 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)>
```




```
# 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-117-289267775586> 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:  0.8604651162790697
     Accuracy score for testing data:  0.8023255813953488


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_train, Y_train, cv = kf)
result
```

```
array([0.85714286, 0.88571429, 0.91428571, 0.85714286, 0.79411765,
       0.70588235, 0.97058824, 0.76470588, 0.82352941, 0.82352941])
```

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

```
Avg accuracy: 0.8396638655462185
```

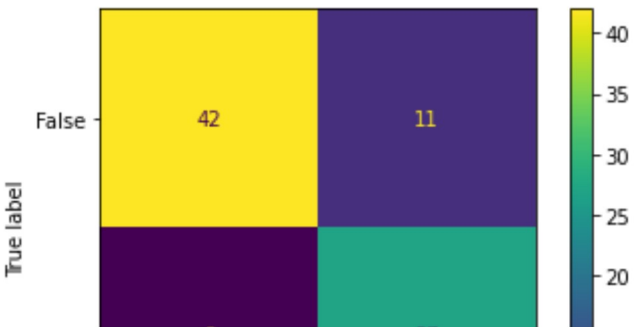
```
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import accuracy_score

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

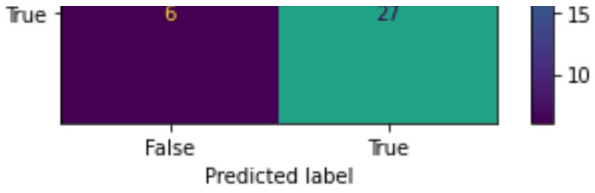
```
array([0.33333333, 0.33333333, 0.55555556, 0.55555556, 0.66666667,
       0.66666667, 0.875     , 0.375     , 0.625     , 0.75      ])
```

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

```
Avg accuracy: 0.5736111111111111
```

```
# 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:  0.8181818181818182
specificity:  0.7924528301886793
PPV:  0.7105263157894737
NPV:  0.875
```

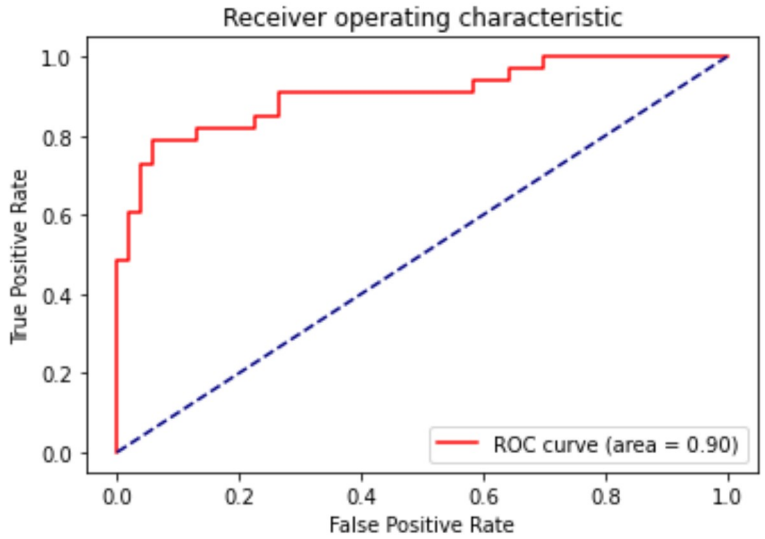
```
# AUROC and AUPR value
y_predictProb = gnb.predict_proba(X_test)

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: 0.9045168667810177
AUPR: 0.8945503619331895
```

```
# 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")
```

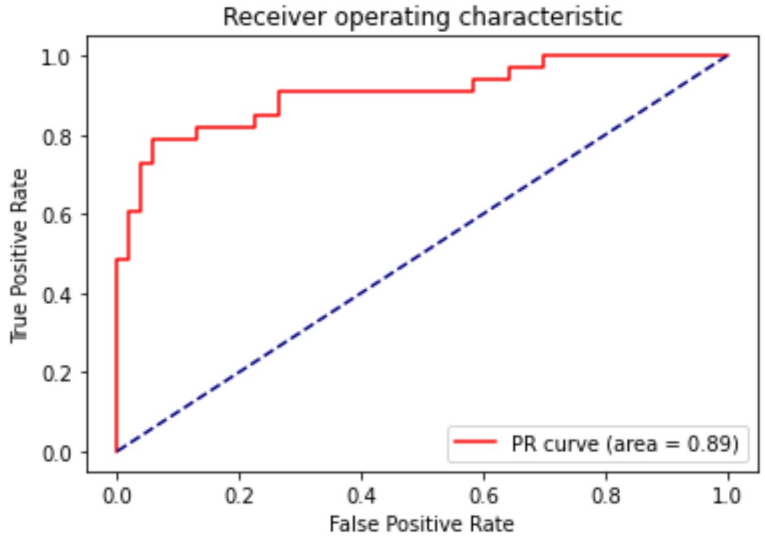
```
plt.show
```

```
<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)>
```



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