

▼ Naïve Bayes

```
# Import required libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import sklearn
from sklearn.naive_bayes import GaussianNB

# Import necessary modules
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
from math import sqrt
from sklearn.metrics import r2_score
from sklearn.metrics import accuracy_score
from sklearn.metrics import mean_squared_error
from sklearn.metrics import classification_report, confusion_matrix
from sklearn import metrics
from sklearn.metrics import confusion_matrix
from sklearn.metrics import roc_curve
from sklearn.metrics import auc
```

```
df = pd.read_csv('breast_cancer_data.csv')
df.head()
```

	id	diagnosis	radius_1ean	texture_1ean	perileter_1ean	area_1ean	s1o
0	842302	1	17.99	10.38	122.80	1001.0	
1	842517	1	20.57	17.77	132.90	1326.0	
2	84300903	1	19.69	21.25	130.00	1203.0	
3	84348301	1	11.42	20.38	77.58	386.1	
4	84358402	1	20.29	14.34	135.10	1297.0	

```
print(df.shape)
df.describe().transpose()
```

id	569.0	3.037183e+07	1.250206e+08	8670.000000	869218.000000	906024
diagnosis	569.0	3.725835e-01	4.839180e-01	0.000000	0.000000	0.000000
radius_1ean	569.0	1.412729e+01	3.524049e+00	6.981000	11.700000	15.080000
texture_1ean	569.0	1.928965e+01	4.301036e+00	9.710000	16.170000	18.840000
perimeter_1ean	569.0	9.196903e+01	2.429898e+01	43.790000	75.170000	80.130000
area_1ean	569.0	6.548891e+02	3.519141e+02	143.500000	420.300000	558.340000
smoothness_1ean	569.0	9.636028e-02	1.406413e-02	0.052630	0.086370	0.109800
compactness_1ean	569.0	1.043410e-01	5.281276e-02	0.019380	0.064920	0.125490
concavity_1ean	569.0	8.879932e-02	7.971981e-02	0.000000	0.029560	0.059610
concave points_1ean	569.0	4.891915e-02	3.880284e-02	0.000000	0.020310	0.040620
symmetry_1ean	569.0	1.811619e-01	2.741428e-02	0.106000	0.161900	0.216800
fractal_dimension_1ean	569.0	6.279761e-02	7.060363e-03	0.049960	0.057700	0.065540
radius_se	569.0	4.051721e-01	2.773127e-01	0.111500	0.232400	0.353600
texture_se	569.0	1.216853e+00	5.516484e-01	0.360200	0.833900	1.297400
perimeter_se	569.0	2.866059e+00	2.021855e+00	0.757000	1.606000	2.165600
area_se	569.0	4.033708e+01	4.549101e+01	6.802000	17.850000	22.858400
smoothness_se	569.0	7.040979e-03	3.002518e-03	0.001713	0.005169	0.008326
compactness_se	569.0	2.547814e-02	1.790818e-02	0.002252	0.013080	0.021916
concavity_se	569.0	3.189372e-02	3.018606e-02	0.000000	0.015090	0.029180
concave points_se	569.0	1.179614e-02	6.170285e-03	0.000000	0.007638	0.015276
symmetry_se	569.0	2.054230e-02	8.266372e-03	0.007882	0.015160	0.029312
fractal_dimension_se	569.0	3.794904e-03	2.646071e-03	0.000895	0.002248	0.004496
radius_worst	569.0	1.626919e+01	4.833242e+00	7.930000	13.010000	14.180000
texture_worst	569.0	2.567722e+01	6.146258e+00	12.020000	21.080000	21.860000
perimeter_worst	569.0	1.072612e+02	3.360254e+01	50.410000	84.110000	90.520000
area_worst	569.0	8.805831e+02	5.693570e+02	185.200000	515.300000	686.220000
smoothness_worst	569.0	1.323686e-01	2.283243e-02	0.071170	0.116600	0.154800
compactness_worst	569.0	2.542650e-01	1.573365e-01	0.027290	0.147200	0.239900

```
target_column = ['diagnosis']
predictors = list(set(list(df.columns))-set(target_column))
df[predictors] = df[predictors]/df[predictors].max()
df.describe().transpose()
```

id	569.0	0.033327	0.137186	0.000010	0.000954	0.000994	0.009671	1.0
diagnosis	569.0	0.372583	0.483918	0.000000	0.000000	0.000000	1.000000	1.0
radius_1ean	569.0	0.502572	0.125366	0.248346	0.416222	0.475631	0.561366	1.0
texture_1ean	569.0	0.491081	0.109497	0.247200	0.411660	0.479633	0.554990	1.0
perimeter_1ean	569.0	0.487899	0.128907	0.232308	0.398780	0.457507	0.552255	1.0
area_1ean	569.0	0.261851	0.140709	0.057377	0.168053	0.220352	0.312955	1.0
smoothness_1ean	569.0	0.589720	0.086072	0.322093	0.528580	0.586720	0.644431	1.0
compactness_1ean	569.0	0.302087	0.152903	0.056109	0.187956	0.268182	0.377533	1.0
concavity_1ean	569.0	0.208058	0.186785	0.000000	0.069260	0.144189	0.306232	1.0
concave points_1ean	569.0	0.243137	0.192857	0.000000	0.100944	0.166501	0.367793	1.0
symmetry_1ean	569.0	0.595927	0.090179	0.348684	0.532566	0.589474	0.643750	1.0
fractal_dimension_1ean	569.0	0.644475	0.072459	0.512726	0.592159	0.631568	0.678571	1.0
radius_se	569.0	0.141028	0.096524	0.038810	0.080891	0.112844	0.166690	1.0
texture_se	569.0	0.249100	0.112927	0.073736	0.170706	0.226817	0.301740	1.0
perimeter_se	569.0	0.130394	0.091986	0.034440	0.073066	0.104049	0.152730	1.0
area_se	569.0	0.074395	0.083901	0.012545	0.032921	0.045242	0.083346	1.0
smoothness_se	569.0	0.226180	0.096451	0.055027	0.166046	0.204947	0.261677	1.0
compactness_se	569.0	0.188169	0.132261	0.016632	0.096603	0.151034	0.239660	1.0
concavity_se	569.0	0.080540	0.076227	0.000000	0.038106	0.065379	0.106187	1.0
concave points_se	569.0	0.223454	0.116884	0.000000	0.144686	0.207047	0.278651	1.0
symmetry_se	569.0	0.260194	0.104704	0.099835	0.192020	0.237239	0.297403	1.0
fractal_dimension_se	569.0	0.127175	0.088675	0.029987	0.075335	0.106803	0.152748	1.0
radius_worst	569.0	0.451420	0.134108	0.220033	0.360988	0.415372	0.521365	1.0
texture_worst	569.0	0.518313	0.124067	0.242632	0.425515	0.512919	0.599919	1.0
perimeter_worst	569.0	0.426995	0.133768	0.200677	0.334833	0.388774	0.499204	1.0
area_worst	569.0	0.207001	0.133840	0.043535	0.121133	0.161378	0.254819	1.0
smoothness_worst	569.0	0.594648	0.102572	0.319721	0.523810	0.589847	0.655885	1.0
compactness_worst	569.0	0.240326	0.148711	0.025794	0.139130	0.200284	0.320510	1.0
concavity_worst	569.0	0.217403	0.166633	0.000000	0.091454	0.181070	0.305831	1.0
concave points_worst	569.0	0.393836	0.225884	0.000000	0.223127	0.343402	0.554639	1.0

```

X = df[predictors].values
y = df[target_column].values

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.30, random_state=40)
print(X_train.shape);
print(X_test.shape)

```

```

model = GaussianNB()
model.fit(X_train,y_train.ravel())

predict_train = model.predict(X_train)
predict_test = model.predict(X_test)

print("Confustion Matrix For Training Data")
print("-----")
print(confusion_matrix(y_train,predict_train))
print("-----")
print("Accuracy:", accuracy_score(y_train,predict_train))
print("Sensitivity/Recall:",metrics.recall_score(y_train,predict_train))
tn, fp, fn, tp = confusion_matrix(y_train,predict_train).ravel()
specificity = tn / (tn+fp)
print("Specificity:", specificity)
print("Precision:", metrics.precision_score(y_train,predict_train))
print("F-Score:", metrics.f1_score(y_train,predict_train))
print("Mens Squire Error:", mean_squared_error(y_test,predict_test))
print("Root Mens Squire Error:", np.sqrt(mean_squared_error(y_test,predict_test)))
print("ROC_AUC scores:",metrics.roc_auc_score(y_train,predict_train, average="macro"))

# Compute fpr, tpr, thresholds and roc auc
fpr, tpr, thresholds = roc_curve(y_train,predict_train)
roc_auc = auc(fpr,tpr)

# Plot ROC curve
plt.plot(fpr, tpr, label='ROC curve (area = %0.3f)' % roc_auc)
plt.plot([0, 1], [0, 1], 'k--') # random predictions curve
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.0])
plt.xlabel('False Positive Rate or (1 - Specifity)')
plt.ylabel('True Positive Rate or (Sensitivity)')
plt.title('Receiver Operating Characteristic')
plt.legend(loc="lower right")

```

Confusion Matrix For Training Data

```
-----  
[[236   6]  
 [ 17 139]]  
-----
```

Accuracy: 0.9422110552763819
Sensitivity/Recall: 0.8910256410256411
Specificity: 0.9752066115702479
Precision: 0.9586206896551724
F-Score: 0.9235880398671097

```
print("Confusion Matrix For Testing Data")  
print("-----")  
print(confusion_matrix(y_test,predict_test))  
print("-----")  
print("Accuracy:", accuracy_score(y_test,predict_test))  
print("Sensitivity/Recall:",metrics.recall_score(y_test,predict_test))  
tn, fp, fn, tp = confusion_matrix(y_test,predict_test).ravel()  
specificity = tn / (tn+fp)  
print("Specificity:", specificity)  
print("Precision:", metrics.precision_score(y_test,predict_test))  
print("F-Score:", metrics.f1_score(y_test,predict_test))  
print("Mens Squire Error:", mean_squared_error(y_test,predict_test))  
print("Root Mens Squire Error:", np.sqrt(mean_squared_error(y_test,predict_test)))  
print("ROC_AUC scores:",metrics.roc_auc_score(y_test,predict_test, average="macro"))
```

```
# Compute fpr, tpr, thresholds and roc auc  
fpr, tpr, thresholds = roc_curve(y_test,predict_test)  
roc_auc = auc(fpr,tpr)
```

```
# Plot ROC curve  
plt.plot(fpr, tpr, label='ROC curve (area = %0.3f)' % roc_auc)  
plt.plot([0, 1], [0, 1], 'k--') # random predictions curve  
plt.xlim([0.0, 1.0])  
plt.ylim([0.0, 1.0])  
plt.xlabel('False Positive Rate or (1 - Specifity)')  
plt.ylabel('True Positive Rate or (Sensitivity)')  
plt.title('Receiver Operating Characteristic')  
plt.legend(loc="lower right")
```

Confusion Matrix For Testing Data

```
[[112   3]
 [  3  53]]
```

Accuracy: 0.9649122807017544

Sensitivity/Recall: 0.9464285714285714

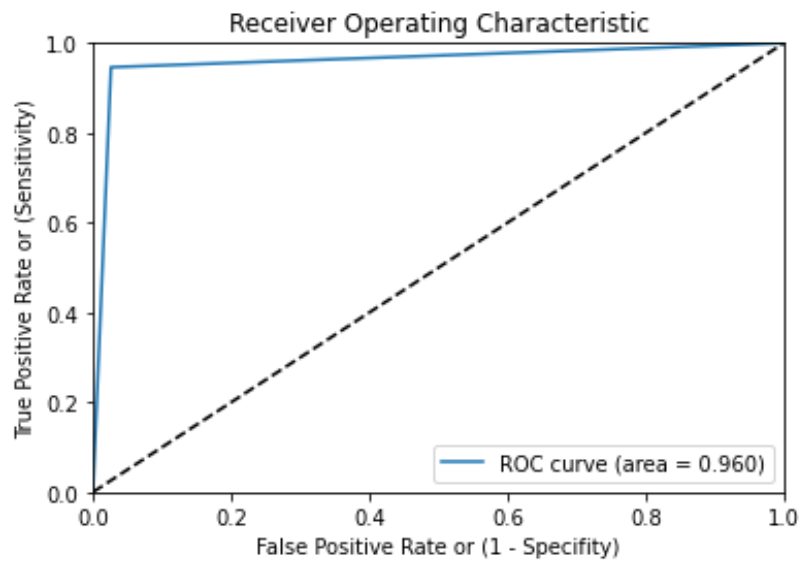
Specificity: 0.9739130434782609

Precision: 0.9464285714285714

F-Score: 0.9464285714285714

Mean Score Fmax: 0.92508771020824561

<matplotlib.legend.Legend at 0x7f20f3b6ccd0>



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