SMARTBRIDGE AIML ASSIGNMENT-4

September 22, 2023(morning slot)

Name :BOYA CHAITANYA **Registration No : 21BCE9968**

email : chaitanya.21bce9968@vitapstudent.ac.in **campus : vellore Institute of technology -AP**

1.0.1 Logistic regression, Decision tree and random forest classifiers on EmployeeAttritiondataset

1.1 DataPreprocessing.

```
#Importing necessary libraries.
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt import
seaborn as sns
```

[2]:
```
#Importing the dataset.
df=pd.read_csv("Employee-Attrition.csv")
```

[3]:
```
df.head()
```

[3]:

	Age	Attrition	BusinessTravel	DailyRate	Department	\
0	41	Yes	Travel_Rarely	1102	Sales	
1	49	No	Travel_Frequently	279	Research & Development	
2	37	Yes	Travel_Rarely	1373	Research & Development	
3	33	No	Trave l_Frequently	1392	Research & Development	
4	27	No	Travel_Rarely	591	Research & Development	

	DistanceFromHome	EducationEducationField		EmployeeCount	EmployeeNumber	\
0	1	2	LifeSciences	1	1	
1	8	1	LifeSciences	1	2	
2	2	2	Other	1	4	
3	3	4	LifeSciences	1	5	
4	2	1	Medical	1	7	

	…	RelationshipSatisfactionStandardHours		StockOptionLevel	\
0	…	1	80	0	
1	…	4	80	1	
2	…	2	80	0	
3	…	3	80	0	
4	…	4	80	1	

	TotalWorkingYears	TrainingTimesLastYear	WorkLifeBalance	YearsAtCompany	\
0	8	0	1	6	
1	10	3	3	10	
2	7	3	3	0	
3	8	3	3	8	
4	6	3	3	2	

	YearsInCurrentRole	YearsSinceLastPromotion	YearsWithCurrManager 0	4
		0		5
1	7		1	7
2	0		0	0
3	7		3	0
4	2		2	2

[5 rows x 35 columns]

[4]:
```
df.info()
```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1470 entries, 0 to 1469 Data columns
(total 35 columns):

#	Column	Non-NullCount		Dtype
0	Age	1470	non-null	int64
1	Attrition	1470	non-null	object
2	BusinessTravel	1470	non-null	object
3	DailyRate	1470	non-null	int64
4	Department	1470	non-null	object
5	DistanceFromHome	1470	non-null	int64
6	Education	1470	non-null	int64
7	EducationField	1470	non-null	object
8	EmployeeCount	1470	non-null	int64
9	EmployeeNumber	1470	non-null	int64
10	EnvironmentSatisfaction	1470	non-null	int64
11	Gender	1470	non-null	object
12	HourlyRate	1470	non-null	int64
13	JobInvolvement	1470	non-null	int64
14	JobLevel	1470	non-null	int64
15	JobRole	1470	non-null	object
16	JobSatisfaction	1470	non-null	int64
17	MaritalStatus	1470	non-null	object
18	MonthlyIncome	1470	non-null	int64
19	MonthlyRate	1470	non-null	int64
20	NumCompaniesWorked	1470	non-null	int64
21	Over18	1470	non-null	object
22	OverTime	1470	non-null	object

23	PercentSalaryHike	1470non-null	int64
24	PerformanceRating	1470non-null	int64
25	RelationshipSatisfaction	1470non-null	int64
26	StandardHours	1470non-null	int64
27	StockOptionLevel	1470non-null	int64
28	TotalWorkingYears	1470non-null	int64
29	TrainingTimesLastYear	1470non-null	int64
30	WorkLifeBalance	1470non-null	int64
31	YearsAtCompany	1470non-null	int64
32	YearsInCurrentRole	1470non-null	int64
33	YearsSinceLastPromotion	1470non-null	int64
34	YearsWithCurrManager	1470non-null	int64

dtypes: int64(26),object(9)

[5]: memory usage: 402.1+ KB

```
#Checking for Null Values.
df.isnull().any()
```

[5] :

Attrition	False
BusinessTravel	False
DailyRate	False
Department	False
DistanceFromHome	False
Education	False
EducationField	False
EmployeeCount	False
EmployeeNumber	False
EnvironmentSatisfaction	False
Gender	False
HourlyRate	False
JobInvolvement	False
JobLevel	False
JobRole	False
JobSatisfaction	False
MaritalStatus	False
MonthlyIncome	False
MonthlyRate	False
NumCompaniesWorked	False
Over18	False
OverTime	False
PercentSalaryHike	False
PerformanceRating	False
RelationshipSatisfaction	False
StandardHours	False
StockOptionLevel	False
TotalWorkingYears	False

```
TrainingTimesLastYear     False
WorkLifeBalance           False
YearsAtCompany            False
YearsInCurrentRole        False
YearsSinceLastPromotion   False
YearsWithCurrManager  False dtype: bool
```

[6]:
```
df.isnull().sum()
```

[6] :
```
Age                         0
Attrition                   0
BusinessTravel              0
DailyRate                   0
Department                  0
DistanceFromHome            0
Education                   0
EducationField              0
EmployeeCount               0
EmployeeNumber              0
EnvironmentSatisfaction     0
Gender                      0
HourlyRate                  0
JobInvolvement              0
JobLevel                    0
JobRole                     0
JobSatisfaction             0
MaritalStatus               0
MonthlyIncome               0
MonthlyRate                 0
NumCompaniesWorked          0
Over18                      0
OverTime                    0
PercentSalaryHike           0
PerformanceRating           0
RelationshipSatisfaction    0
StandardHours               0
StockOptionLevel            0
TotalWorkingYears           0
TrainingTimesLastYear       0
WorkLifeBalance             0
YearsAtCompany              0
YearsInCurrentRole          0
YearsSinceLastPromotion     0
YearsWithCurrManager        0
dtype: int64
```

[7]:
```
#Data Visualization.
sns.distplot(df["Age"])
```

C:\Users\Admin\AppData\Local\Temp\ipykernel_39480\2400079689.py:2: UserWarning:

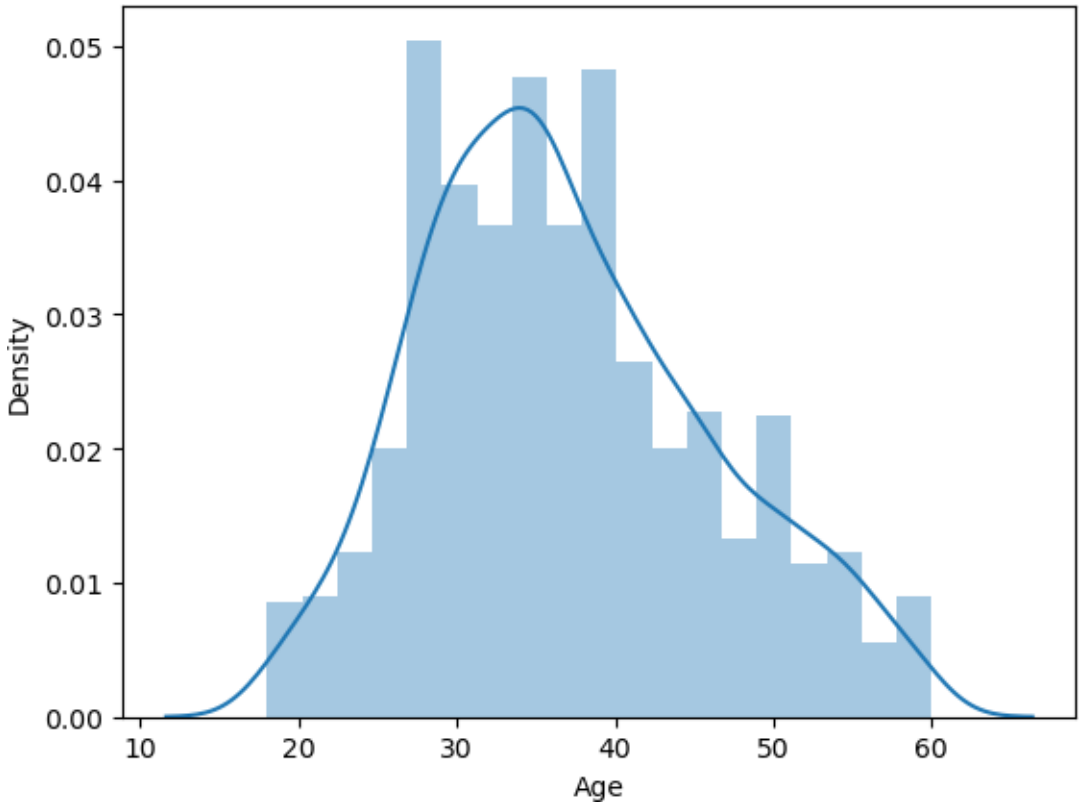
`distplot` is a deprecated function and will be removed in seabornv0.14.0.

Please adapt your code to use either `displot` (a figure-level functionwith similar flexibility) or `histplot` (an axes-level function forhistograms).

For a guide to updating your code to use the new functions, pleasesee https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

```
sns.distplot(df["Age"])
```

[7] : <Axes: xlabel='Age',ylabel='Density'>



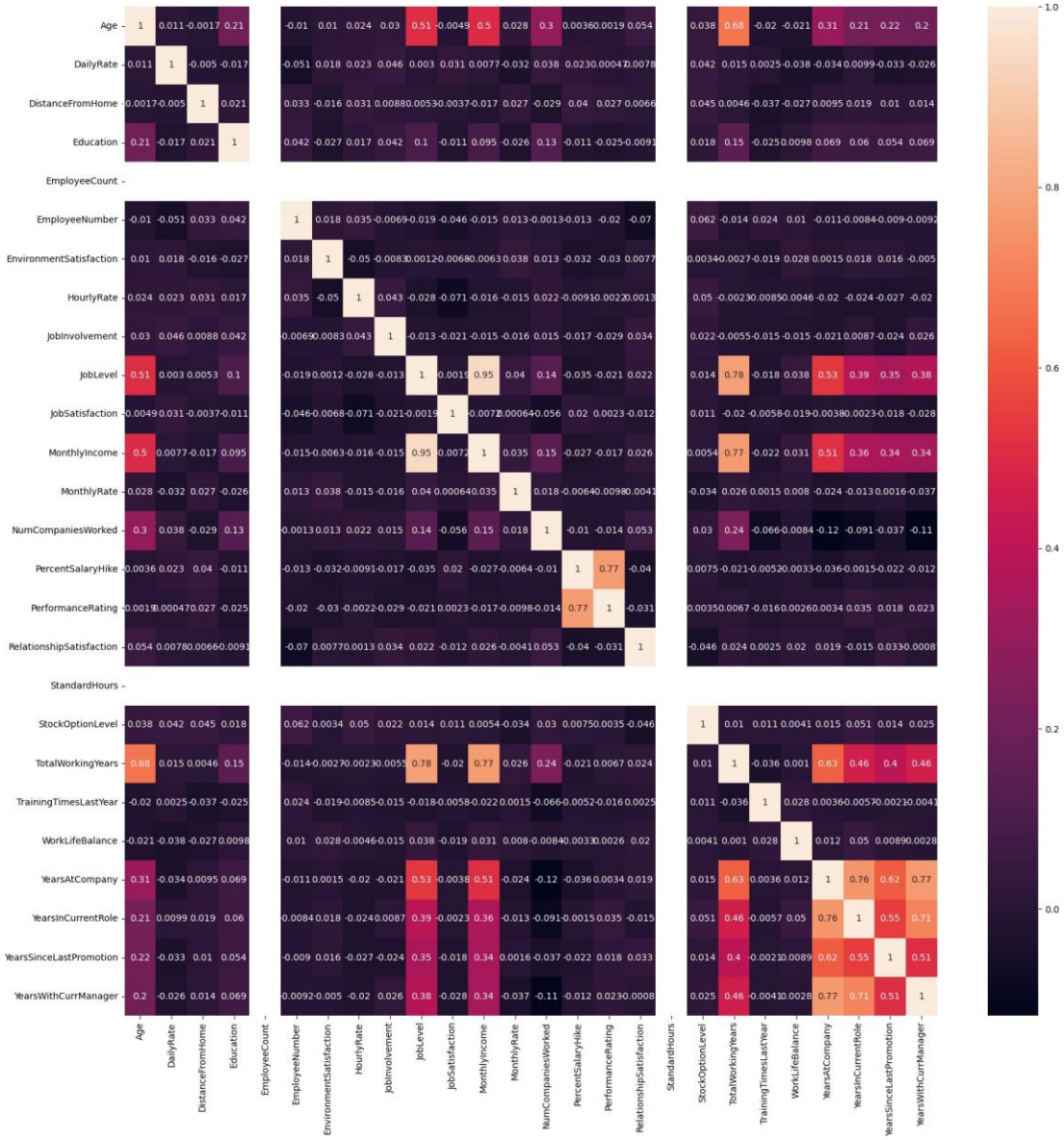
[8]:
```
attrition_count = pd.DataFrame(df['Attrition'].value_counts()) plt.pie(attrition_count['Attrition'], labels = ['No', 'Yes'], explode = (0.2,0))
```

[8] : ([<matplotlib.patches.Wedge at0x2634cd0cb80>,
<matplotlib.patches.Wedge at 0x2634ce105e0>], [Text(-1.136781068348268, 0.6306574368426737, 'No'),
Text(0.961891673217765, -0.5336332157899547, 'Yes')])

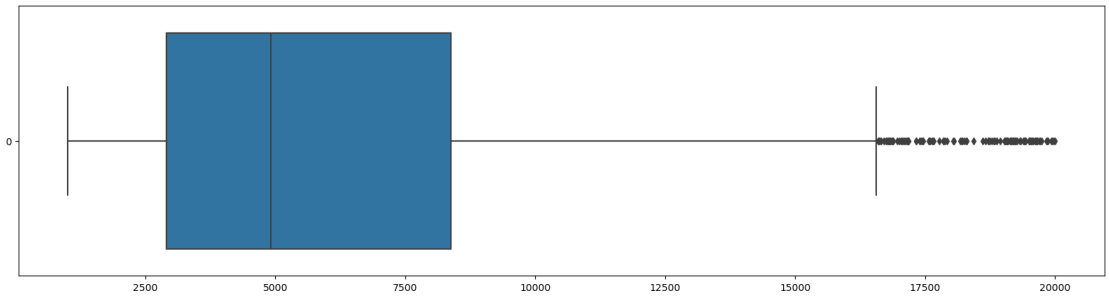
[9]:
```
plt.figure(figsize=[20,20])
sns.heatmap(df.corr(),annot=True)
```

C:\Users\Admin\AppData\Local\Temp\ipykernel_39480\3113117044.py:2: FutureWarning: The default value of numeric_only in DataFrame.corr is deprecated. In a future version, it will default to False. Select onlyvalid columns or specify the value of numeric_only to silence this warning.
sns.heatmap(df.corr(),annot=True) [9]:

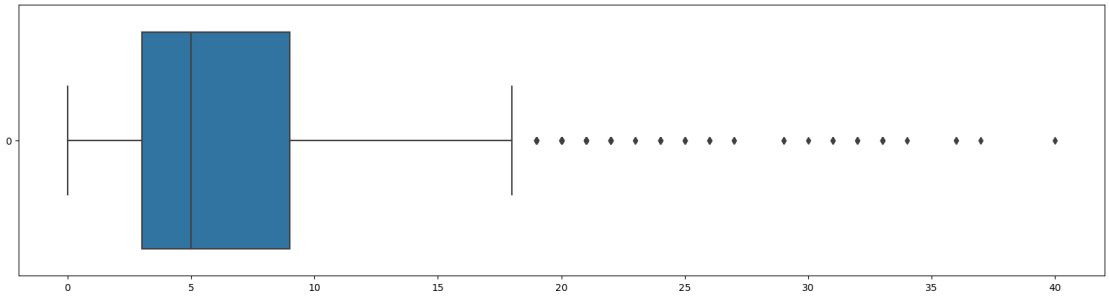
<Axes: >



[10]:
```
#Outlier detection plt.figure(figsize=[20,5])
sns.boxplot(df['MonthlyIncome'],orient='h') plt.show()
```



[11]:
```
plt.figure(figsize=[20,5])
sns.boxplot(df['YearsAtCompany'],orient='h') plt.show()
```



[12]:
```
# Label Encoding
categories =
    ['BusinessTravel','Department','Education','EducationField','Gender','MaritalStatus','OverT
    'EnvironmentSatisfaction','JobInvolvement','JobLevel','JobRole','JobSatisfaction','NumCompa
    'PerformanceRating','RelationshipSatisfaction','StockOptionLevel','TrainingTimesLastYear','
categorical = df[categories].astype('object')
categorical = pd.get_dummies(df[categories], drop_first = True)
```

[13]:
```
# Splitting Dependent and Independent variables
independent =
    ['Attrition','Over18','EmployeeCount','StandardHours','EmployeeNumber']
continuous = df.drop(columns= categories)
continuous = continuous.drop(columns= independent)
```

[14]:
```
# X - Features, Y- Target variables
X = pd.concat([categorical,continuous],axis=1)
Y = df['Attrition'].replace({'Yes': 1, 'No': 0}).values.reshape(-1,1)
```

[15]:
```
# Feature scaling
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

continuous_variables =list(continuous.columns) X =

X.reset_index()
del X['index']
X[continuous_variables] = pd.DataFrame(scaler.
```

[16]:
```
#Splitting Data into Train and Test.
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(X,Y,test_size=0.2,random_state=0)
```

[17]:
```
x_train.shape,x_test.shape,y_train.shape,y_test.shape
```

[17]: ((1176, 44), (294, 44), (1176, 1), (294, 1))

1.2 Logistic Regressionmodel

[18]:
```
#Importing necessary libraries
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score,precision_score, recall_score, ␣
↪f1_score,confusion_matrix,classification_report,roc_auc_score,roc_curve
```

[19]:
```
#Initializing the model
lr = LogisticRegression()
```

[20]:
```
#Training the model
lr.fit(x_train,y_train)
```

C:\Users\Admin\anaconda3\lib\site-packages\sklearn\utils\validation.py:1143: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
y = column_or_1d(y, warn=True)
C:\Users\Admin\anaconda3\lib\site-packages\sklearn\linear_model_logistic.py:458: ConvergenceWarning: lbfgsfailed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shownin: 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
n_iter_i = _check_optimize_result([20]:

LogisticRegression()

[21]:
```
#Testing the model
y_pred = lr.predict(x_test)
```

[22]:
```
# Evaluation of model #
Accuracy score
print("Accuracy of Logistic regression model:",accuracy_score(y_test,y_pred))
```

Accuracy of Logistic regression model: 0.8843537414965986

[23]:
```
# Precision score
precision_yes = precision_score(y_test, y_pred, pos_label=1) print("Precision
(Yes): " + str(round(precision_yes, 2))) precision_no = precision_score(y_test,
y_pred, pos_label=0) print("Precision (No): " + str(round(precision_no, 2)))
```

Precision (Yes): 0.76
Precision (No): 0.9

[24]:
```
# Recall score
recall_yes = recall_score(y_test, y_pred, pos_label=1) print("Recall
(Yes): " + str(round(recall_yes, 2))) recall_no = recall_score(y_test,
y_pred, pos_label=0) print("Recall (No): " + str(round(recall_no, 2)))
```

Recall (Yes): 0.45
Recall (No): 0.97

[25]:
```
# F1 score
f1_score_yes = f1_score(y_test, y_pred, pos_label=1) print("F1 Score
(Yes): " + str(round(f1_score_yes,2))) f1_score_no = f1_score(y_test,
y_pred, pos_label=0) print("F1 Score (No): " + str(round(f1_score_no,
2)))
```

F1 Score (Yes): 0.56 F1
Score (No): 0.93

[26]:
```
# Confusion matrix
print("Confusion matrix:\n\n",confusion_matrix(y_test,y_pred))
```

Confusion matrix:

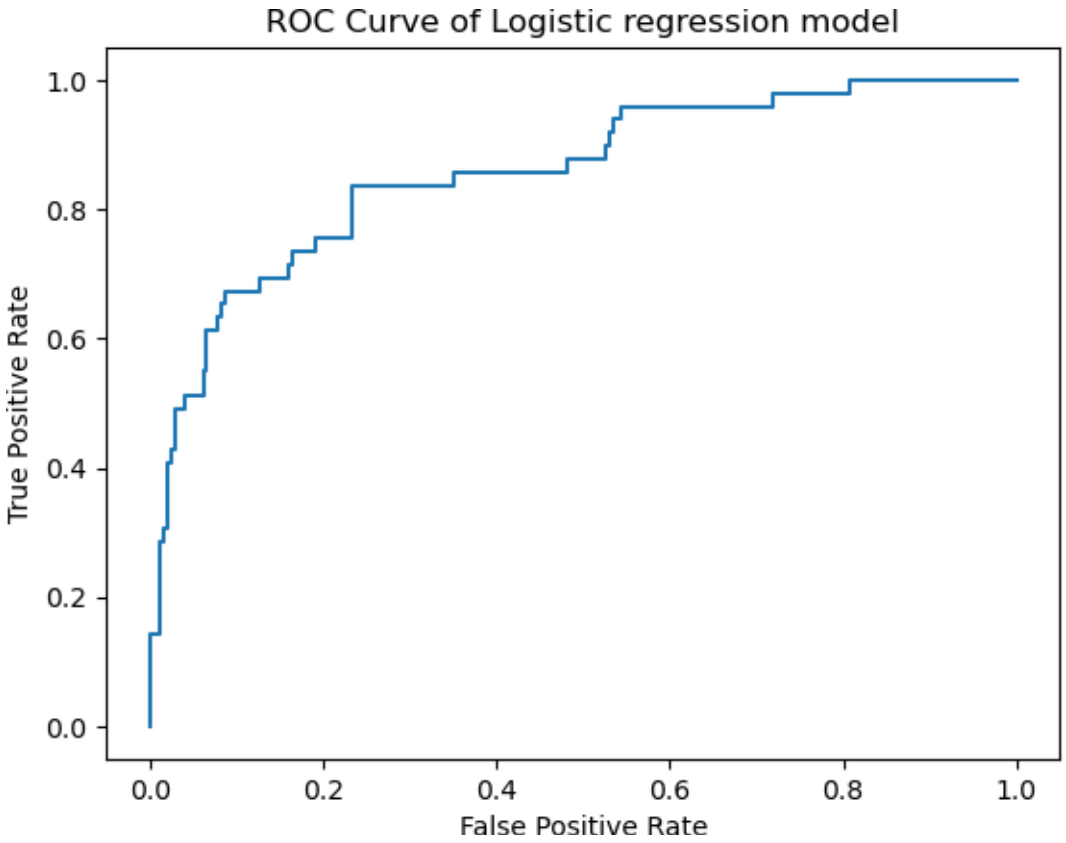
[[238 7]
[27 22]]

[27]:
```
# Classification Report
print("Classification report of Logistic Regression model:
↪\n\n",classification_report(y_test,y_pred))
```

Classification report of Logistic Regression model:

	precision	recall	f1-score	support
0	0.90	0.97	0.93	245
1	0.76	0.45	0.56	49
accuracy			0.88	294
macro avg	0.83	0.71	0.75	294
weightedavg	0.87	0.88	0.87	294

[28]:
```
# ROC curve
probability =  lr.predict_proba(x_test)[:,1]
fpr,tpr,thresh sholds = roc_curve(y_test,probability) pr)
plt.plot(fpr,t lse Positive Rate') ue
plt.xlabel('Fa Positive Rate')
plt.ylabel('Tr
plt.title('ROC  Curve of Logistic regression model')
plt.show()
```



1.3 Decision TreeClassifier

[29]:
```
# Importing necesary packages
from sklearn.tree import DecisionTreeClassifier
```

[30]:
```
# Initializing the model
dtc = DecisionTreeClassifier(random_state=30)
```

[31]:
```
# Training the model
dtc.fit(x_train, y_train)
```

[31]: DecisionTreeClassifier(random_state=30)

[32]:
```
# Testing the model
y_pred1 = dtc.predict(x_test)
```

[33]:
```
# Evaluation metrics #
Accuracy score
accuracy = accuracy_score(y_test, y_pred1) print("Accuracy of
Decision tree model:",accuracy)
```

Accuracy of Decisiontreemodel: 0.7517006802721088

[34]:
```
# Precision score
precision_yes = precision_score(y_test, y_pred1, pos_label=1) print("Precision
(Yes): " , str(round(precision_yes,2))) precision_no = precision_score(y_test,
y_pred1, pos_label=0) print("Precision (No): " + str(round(precision_no, 2)))
```

Precision(Yes): 0.27
Precision (No): 0.86

[35]:
```
# Recall score
recall_yes = recall_score(y_test, y_pred1, pos_label=1) print("Recall
(Yes): " + str(round(recall_yes, 2))) recall_no = recall_score(y_test,
y_pred1, pos_label=0) print("Recall (No): " + str(round(recall_no, 2)))
```

Recall (Yes): 0.29
Recall (No): 0.84

[36]:
```
# F1 score
f1_score_yes = f1_score(y_test, y_pred1, pos_label=1) print("F1 Score
(Yes): " + str(round(f1_score_yes,2))) f1_score_no = f1_score(y_test,
y_pred1, pos_label=0) print("F1 Score (No): " +
str(round(f1_score_no, 2)))
```

F1 Score (Yes): 0.28 F1
Score (No): 0.85

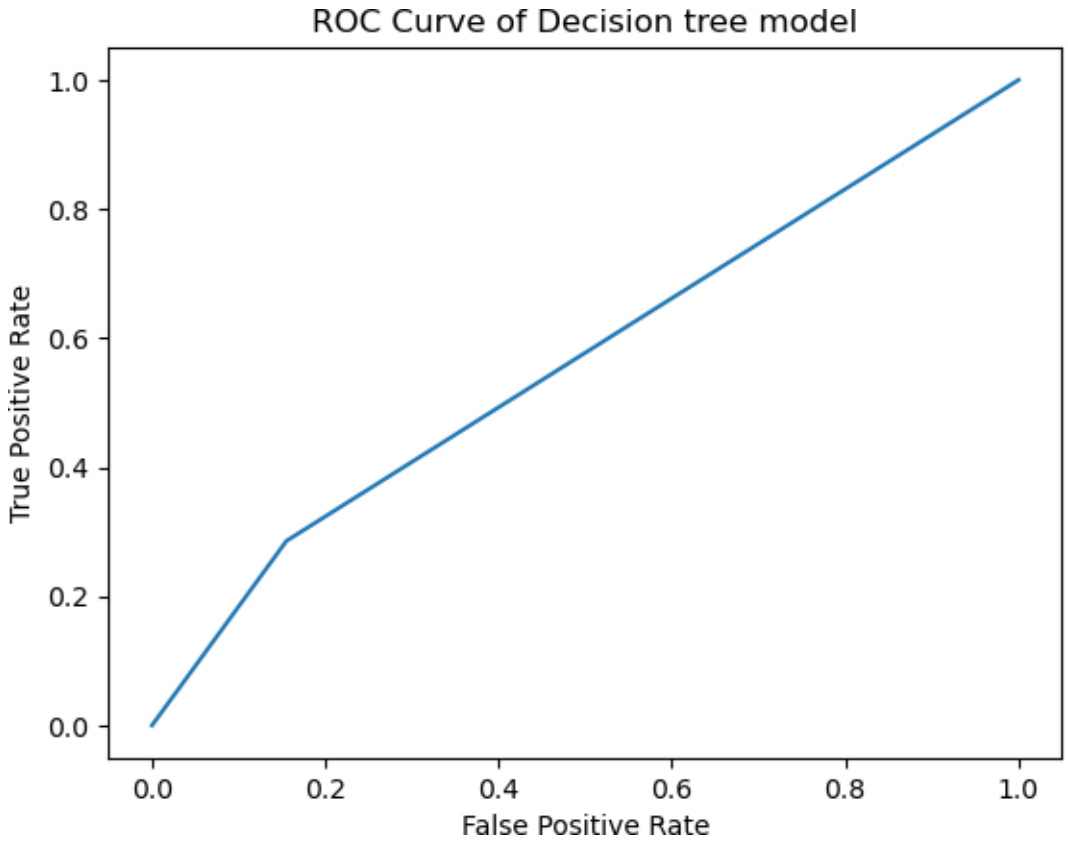
[37]:
```
# Classification report
print("Classification report of Decision tree model:

↪\n\n",classification_report(y_test,y_pred1))
```

Classification report of Decision tree model:

	precision	recall	f1-score	support
0	0.86	0.84	0.85	245
1	0.27	0.29	0.28	49
accuracy			0.75	294
macro avg	0.56	0.57	0.56	294
weightedavg	0.76	0.75	0.75	294

[38]:
```
# ROC curve
probability = dtc.predict_proba(x_test)[:,1]
fpr,tpr,thresh sholds = roc_curve(y_test,probability)
```

```
plt.plot(fpr,tpr) plt.xlabel('False Positive
Rate') plt.ylabel('True Positive Rate')
plt.title('ROC Curve of Decision tree model') plt.show()
```



1.4 Random ForestClassifier

[39]:
```
# Importing necessary packages
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
```

[40]:
```
# Initializing the model
rf = RandomForestClassifier(n_estimators=10, criterion='entropy', ␣
↪random_state=30)
```

[41]:
```
# Training the model
rf.fit(x_train, y_train)
```

C:\Users\Admin\AppData\Local\Temp\ipykernel_39480\391630832.py:2:

DataConversionWarning: A column-vector y was passed when a 1d array was expected.
Please change the shape of y to (n_samples,), for exampleusing ravel().
rf.fit(x_train, y_train)

[41]: RandomForestClassifier(criterion='entropy', n_estimators=10,random_state=30)[42]:

[42]: 0.983843537414966

```
rf.score(x_train,y_train)
```

[43]:
```
# Testing the model
y_pred2 = rf.predict(x_test)
```

[44]:
```
# Evaluation metrics #
Accuracy score
accuracy = accuracy_score(y_test, y_pred2) print("Accuracy of
Random forest model:",accuracy)
```

Accuracy of Randomforestmodel: 0.8435374149659864

[45]:
```
# Precision score
precision_yes = precision_score(y_test, y_pred2, pos_label=1) print("Precision
(Yes): " , str(round(precision_yes,2))) precision_no = precision_score(y_test,
y_pred2, pos_label=0) print("Precision (No): " + str(round(precision_no, 2)))
```

Precision(Yes): 0.71
Precision (No): 0.85

[46]:
```
# Recall score
recall_yes = recall_score(y_test, y_pred2, pos_label=1) print("Recall
(Yes): " + str(round(recall_yes, 2))) recall_no = recall_score(y_test,
y_pred2, pos_label=0) print("Recall (No): " + str(round(recall_no, 2)))
```

Recall (Yes):0.1
Recall (No):0.99

[47]:
```
# F1 score
f1_score_yes = f1_score(y_test, y_pred2, pos_label=1) print("F1 Score
(Yes): " + str(round(f1_score_yes,2))) f1_score_no = f1_score(y_test,
y_pred2, pos_label=0) print("F1 Score (No): " +
str(round(f1_score_no, 2)))
```

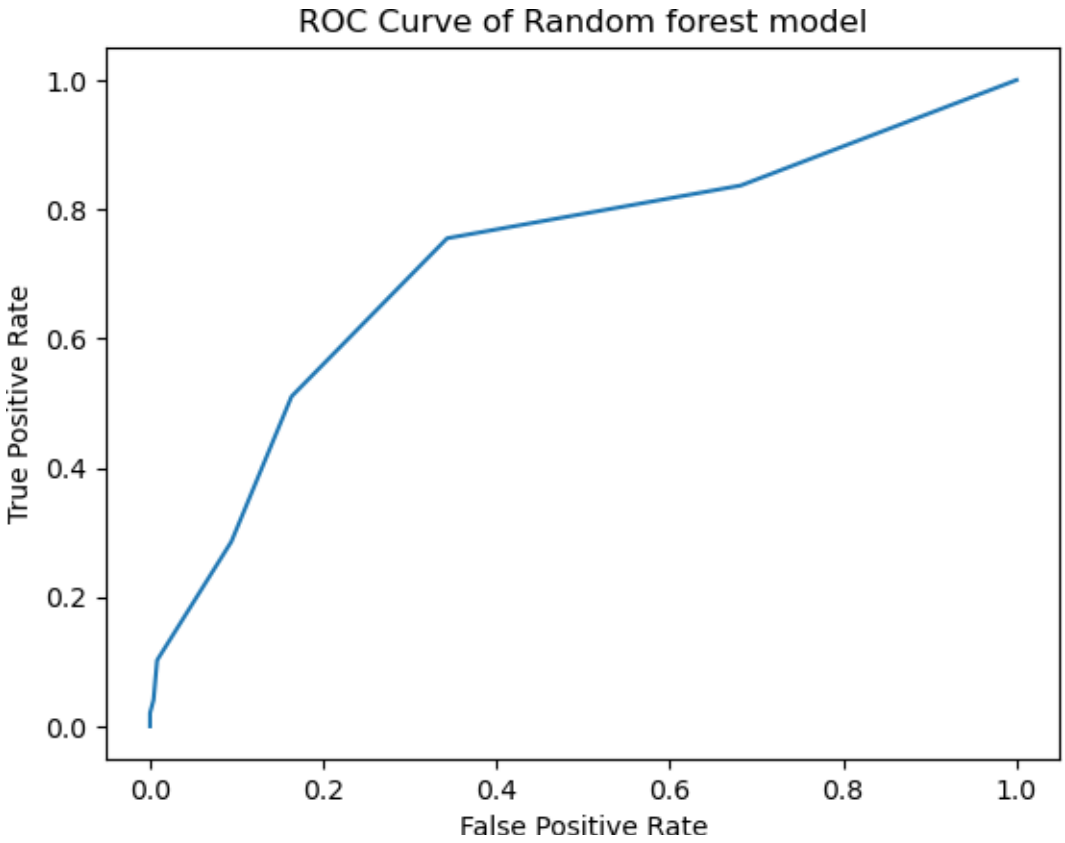
F1 Score (Yes): 0.18 F1
Score (No): 0.91

[48]:
```
# Classification Report
print("Classification report of Random Forest model:
↪\n\n",classification_report(y_test,y_pred2))
```

Classification report of Random Forest model:

	precision	recall	f1-score	support
0	0.85	0.99	0.91	245
1	0.71	0.10	0.18	49
accuracy			0.84	294
macro avg	0.78	0.55	0.55	294
weightedavg	0.82	0.84	0.79	294

[49]:
```
# ROC curve
probability = rf.predict_proba(x_test)[:,1]
fpr,tpr,thresholds = roc_curve(y_test,probability) pr)
plt.plot(fpr,t lse Positive Rate') ue
plt.xlabel('Fa Positive Rate')
plt.ylabel('Tr
plt.title('ROC Curve of Random forest model')
plt.show()
```


ROC Curve of Random forest model
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0