Assignment-4

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1 ASSIGNMENT-4

1.0.1 Logisticregression,Decisiontreeandrandomforestclassifierson EmployeeAttritiondataset

1.1 DataPreprocessing.

[1]:
```
#Importingnecessarylibraries.
importnumpyasnpimport
pandasaspd
importmatplotlib.pyplotaspltimpo
rtseabornassns
```

[2]:
```
#Importingthe 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	Travel_Frequently	1392	Research&Development	
4	27	No	Travel_Rarely	591	Research&Development	

	DistanceFromHome	Education	EducationField	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	

	...	RelationshipSatisfaction	StandardHours	StockOptionLevel	\
0	...	1	80	0	
1	...	4	80	1	
2	...	2	80	0	
3	...	3	80	0	
4	...	4	80	1	

```
   TotalWorkingYears  TrainingTimesLastYearWorkLifeBalance  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  YearsWithCurrManager0                       4                       0
                   5
1                   7                       1                       7
2                   0                       0                       0
3                   7                       3                       0
4                   2                       2                       2

[5rowsx35columns]
```

[4]:

```
df.info()
```

```
<class'pandas.core.frame.DataFrame'>
RangeIndex:1470entries,0to1469Datac
olumns(total35columns):
 #   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
     int64dtypes:int64(26),object(9)
memoryusage:402.1+KB
```

[5]:
```
#CheckingforNullValues.
df.isnull().any()
```

[5]:
```
Age                        False
Attrition                  False
BusinessTravel             False
DailyRate                  False
Department                 False
DistanceFromHome           False
Education                  False
EducationField             False
EmployeeCount              False
EmployeeNumber
                           False
EnvironmentSatisfactionFalseGend
er                         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
RelationshipSatisfactionFalseStan
dardHours                  False
StockOptionLevel           False
TotalWorkingYears          False
```

```
TrainingTimesLastYear          False
WorkLifeBalance                False
YearsAtCompany                 False
YearsInCurrentRole
                               False
YearsSinceLastPromotionFalseYears
WithCurrManager
                               False
```

[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:

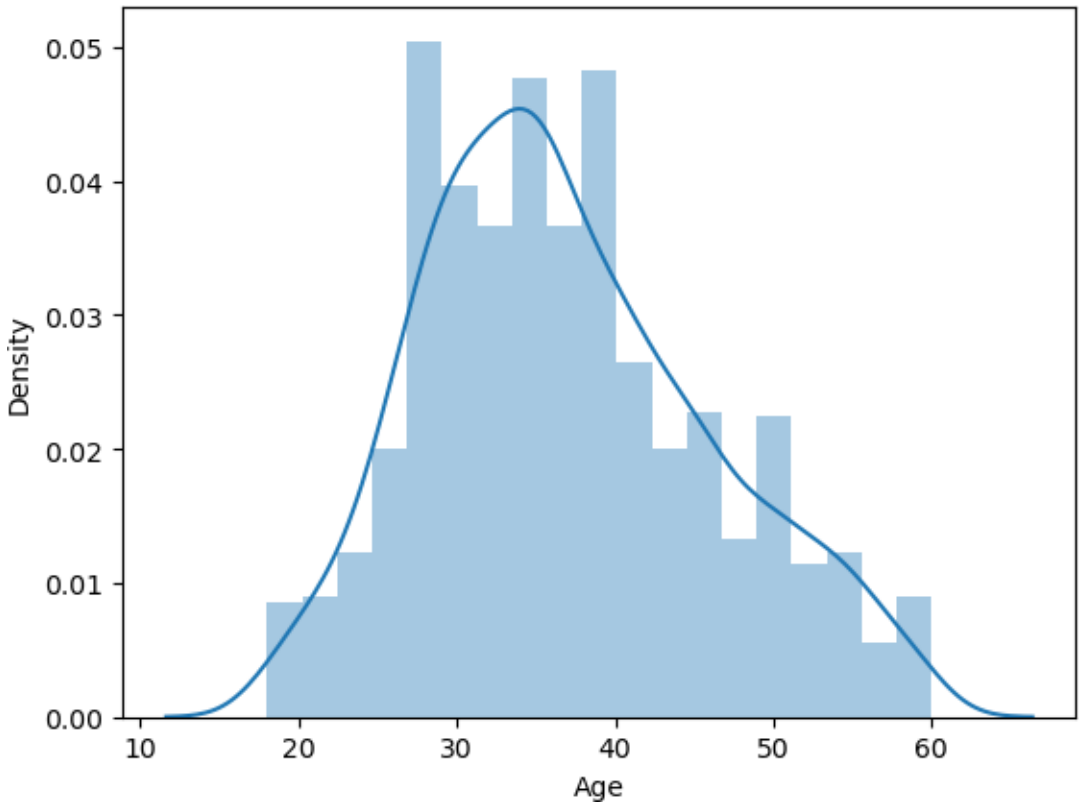
`distplot`isadeprecatedfunctionandwillberemovedinseabornv0.14.0.

Please adapt your code to use either `displot` (a figure-level function withsimilarflexibility)or`histplot`(anaxes-levelfunctionforhistograms).

Foraguidetoupdatingyourcodetousethenewfunctions,pleaseseehttps://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

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

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



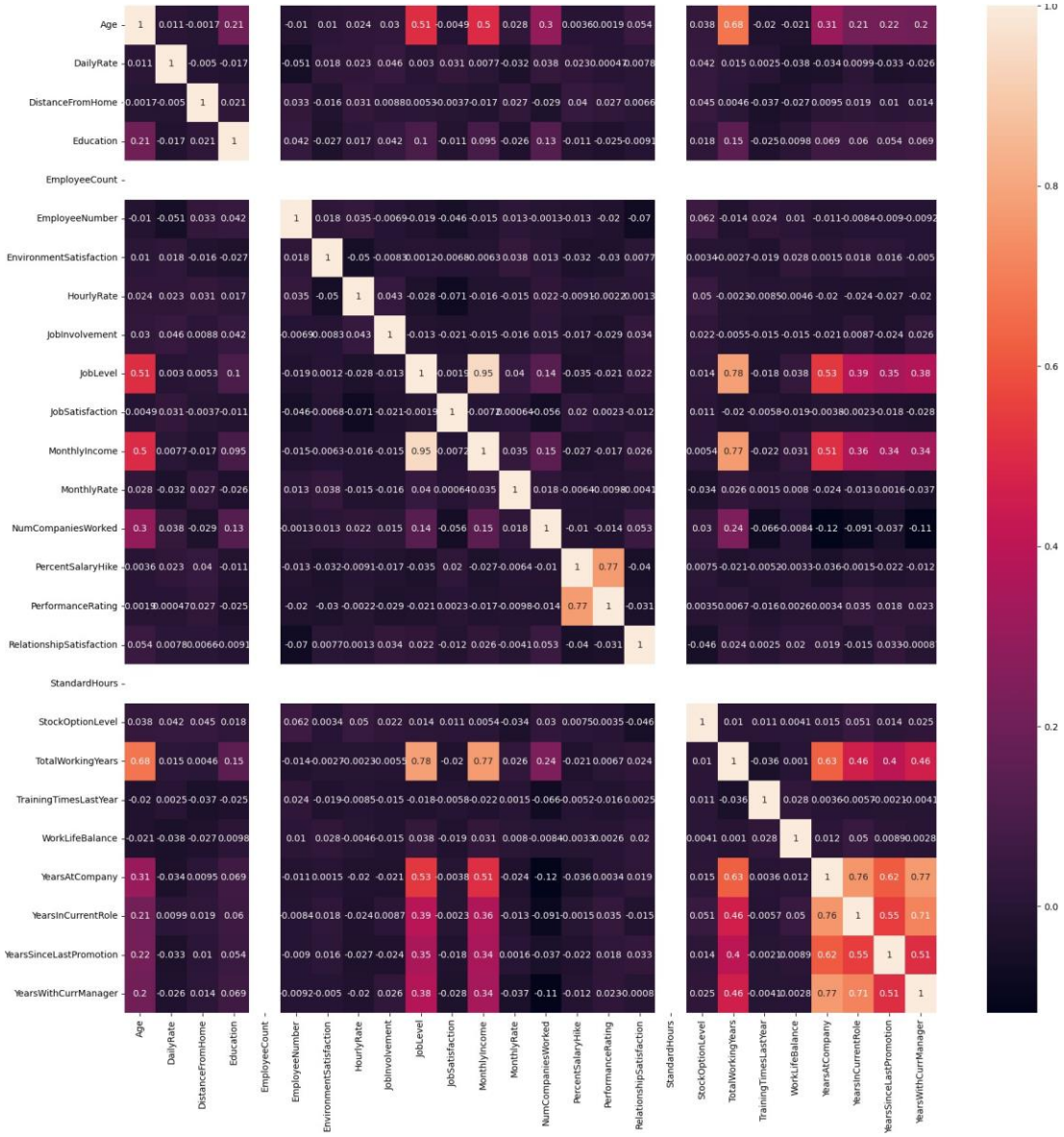
[8]:
```
attrition_count=pd.DataFrame(df['Attrition'].value_counts())
plt.pie(attrition_count['Attrition'],labels=['No','Yes'],explode=(0.2,0))
```

[8]:([<matplotlib.patches.Wedge at 0x2634cd0cb80>,
<matplotlib.patches.Wedgeat0x2634ce105e0>],[Text(
-1.136781068348268,0.6306574368426737,'No'),
Text(0.961891673217765,-0.5336332157899547,'Yes')])

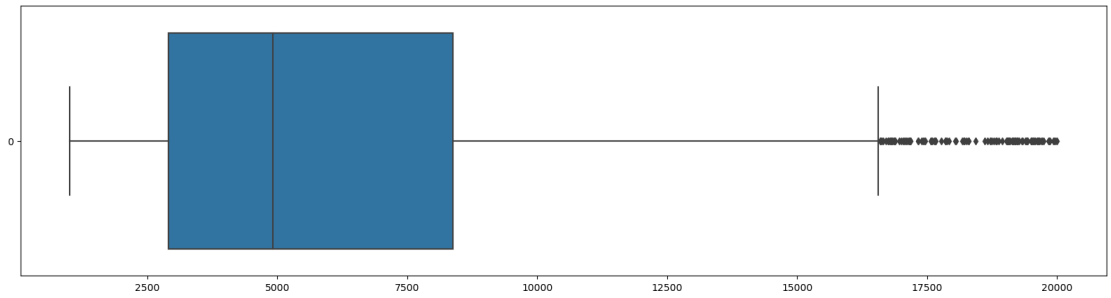
[9]:
```
plt.figure(figsize=[20,20])
sns.heatmap(df.corr(),annot=True)
```

C:\Users\Admin\AppData\Local\Temp\ipykernel_39480\3113117044.py:2:Futu
reWarning:Thedefaultvalueofnumeric_onlyinDataFrame.corrisdeprecated.Inafu
tureversion,itwilldefaulttoFalse.Selectonlyvalidcolumnsorspecifythevalueofnu
meric_onlytosilencethiswarning.
sns.heatmap(df.corr(),annot=True)

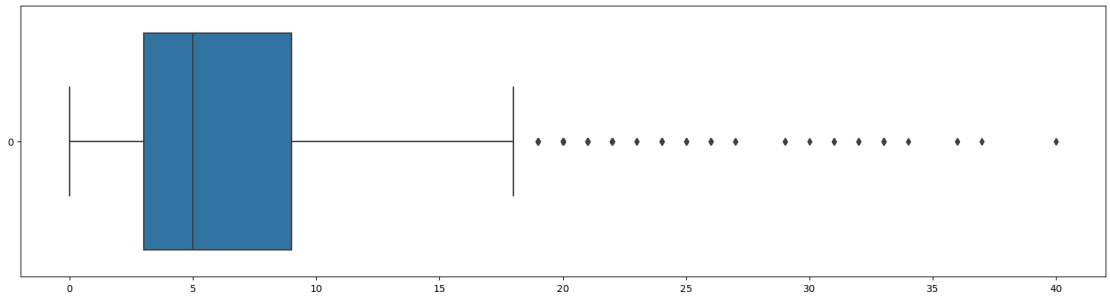
[9]:<Axes:>



[10]:
```
#Outlierdetection
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
fromsklearn.preprocessingimportStandardScalerscaler

=StandardScaler()

continuous_variables=list(continuous.columns)

X=X.reset_index()
delX["index"]
X[continuous_variables]=pd.DataFrame(scaler.
  ↪fit_transform(X[continuous_variables]),columns=continuous_variables)
```

[16]:
```
#SplittingData into Train and Test.
fromsklearn.model_selectionimporttrain_test_splitx_train,x_test,y_train,y_test=tra
in_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 LogisticRegressionmodel

[18]:
```
#Importingnecessarylibraries
fromsklearn.linear_model import LogisticRegression
    fromsklearn.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]:
```
#Trainingthemodel
lr.fit(x_train,y_train)
```

```
C:\Users\Admin\anaconda3\lib\site-
packages\sklearn\utils\validation.py:1143:DataConversionWarning:Acolumn-
vectorywaspassedwhena1darraywasexpected.Pleasechangetheshapeofyto(n_sa
mples,),forexampleusingravel().
  y=column_or_1d(y,warn=True)C:\U
sers\Admin\anaconda3\lib\site-
packages\sklearn\linear_model\_logistic.py:458:ConvergenceWarning:lbfgsfailedtoco
nverge(status=1):
STOP:TOTALNO.ofITERATIONSREACHEDLIMIT.

Increasethenumberofiterations(max_iter)orscalethedataasshownin:https://sci
    kit-learn.org/stable/modules/preprocessing.html
Pleasealsorefertothedocumentationforalternativesolveroptions:https://sci
    kit-learn.org/stable/modules/linear_model.html#logistic-
```

```
regression
  n_iter_i=_check_optimize_result(
```

[20]:
```
LogisticRegression()
```

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

[22]:
```
#Evaluationof
model#Accuracyscore
print("AccuracyofLogisticregressionmodel:",accuracy_score(y_test,y_pred))
```

```
AccuracyofLogisticregressionmodel:0.8843537414965986
```

[23]:
```
# Precision score
precision_yes=precision_score(y_test,y_pred,pos_label=1)print("Preci
sion(Yes):"+str(round(precision_yes,2)))precision_no=precision_sc
ore(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=rec
all_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]:
```
#F1score
f1_score_yes=f1_score(y_test,y_pred,pos_label=1)
print("F1Score(Yes):"+str(round(f1_score_yes,2)))f1_sc
ore_no=f1_score(y_test,y_pred,pos_label=0)
print("F1Score(No):"+str(round(f1_score_no,2)))
```

```
F1Score(Yes):0.56F1Sc
ore(No):0.93
```

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

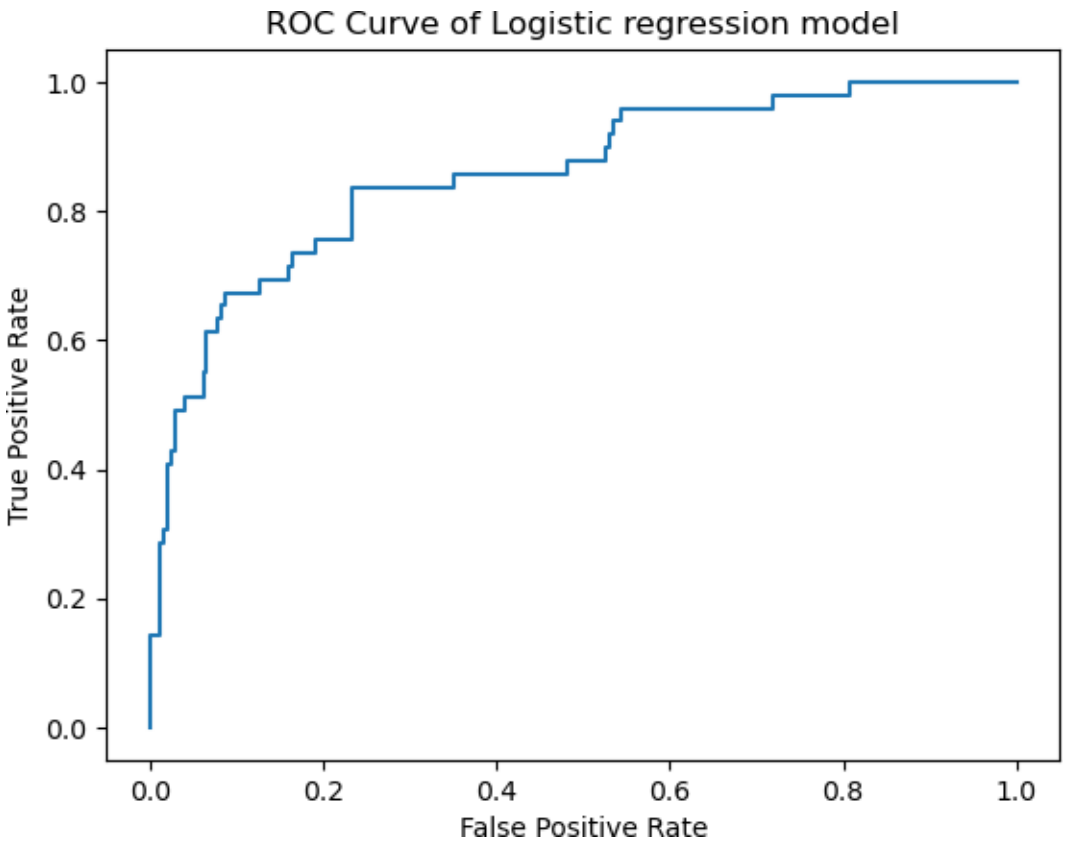
```
Confusionmatrix:

 [[238   7]
 [27   22]]
```

[27]:
```
# Classification Report
print("ClassificationreportofLogisticRegressionmodel:
↪\n\n",classification_report(y_test,y_pred))
```

ClassificationreportofLogisticRegressionmodel:

	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
macroavg	0.83	0.71	0.75	294
weightedavg	0.87	0.88	0.87	294

[28]:
```
#ROCcurve
probability=lr.predict_proba(x_test)[:,1]
pr,tpr,thresholds=roc_curve(y_test,probability)pr)
plt.plot(fpr,tpr)lsePositiveRate")ueP
plt.xlabel("FositiveRate")
plt.ylabel("T CurveofLogisticregressionmodel")
plt.title("RO
plt.show()
```



1.3 DecisionTreeClassifier

[29]:
```
#Importing necesary packages
fromsklearn.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#Accuracyscore
accuracy=accuracy_score(y_test,y_pred1)print("Accura
cyofDecisiontreemodel:",accuracy)
```

AccuracyofDecisiontreemodel: 0.7517006802721088

[34]:
```
# Precision score
precision_yes=precision_score(y_test,y_pred1,pos_label=1)print("Pre
cision(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)prin
t("Recall(Yes):"+str(round(recall_yes,2)))recall_no=re
call_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]:
```
#F1score
f1_score_yes=f1_score(y_test,y_pred1,pos_label=1)
print("F1Score(Yes):"+str(round(f1_score_yes,2)))f1_sc
ore_no=f1_score(y_test,y_pred1,pos_label=0)
print("F1Score(No):"+str(round(f1_score_no,2)))
```

F1Score(Yes):0.28F1Sc
ore(No):0.85

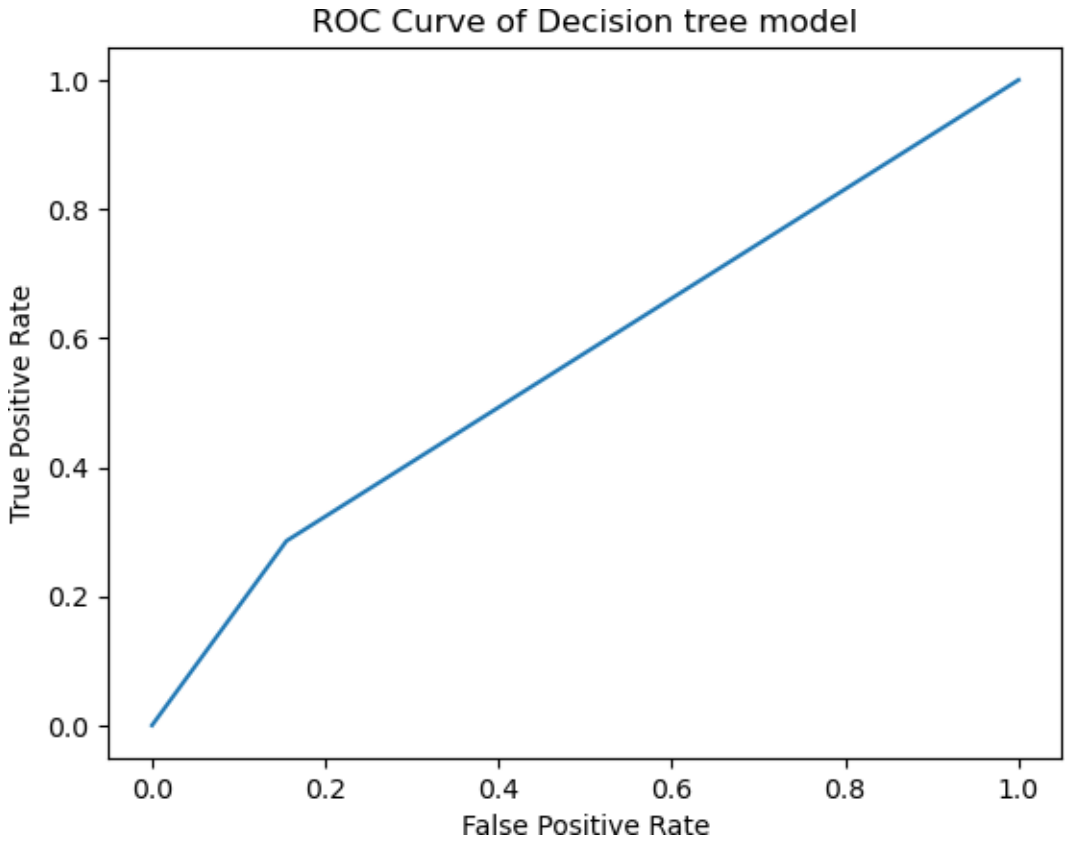
[37]:
```
# Classification report
print("ClassificationreportofDecisiontreemodel:
↪\n\n",classification_report(y_test,y_pred1))
```

ClassificationreportofDecisiontreemodel:

	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
macroavg	0.56	0.57	0.56	294
weightedavg	0.76	0.75	0.75	294

[38]:
```
#ROCcurve
probability=fpr,tpr,thresholds=roc_curve(y_test,dtc.predict_proba(x_test)[:,1])
```

```
plt.plot(fpr,tpr)plt.xlabel("Fals
ePositiveRate")plt.ylabel("TrueP
ositiveRate")
plt.title("ROCCurveofDecisiontreemodel")plt.show()
```



1.4 RandomForestClassifier

[39]:
```
# Importing necessary packages
fromsklearn.ensemble import RandomForestClassifier
fromsklearn.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:Acolumn-
vectorywaspassedwhena1darraywasexpected.Pleasechangetheshapeofyto(n_sa
mples,),forexampleusingravel().
  rf.fit(x_train,y_train)
```

[41]:
```
RandomForestClassifier(criterion='entropy',n_estimators=10,random_state=30)
```
[4
2]:
```
rf.score(x_train,y_train)
```

[42]:
```
0.983843537414966
```

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

[44]:
```
# Evaluation
metrics#Accuracyscore
accuracy=accuracy_score(y_test,y_pred2)print("Accuracyo
fRandomforestmodel:",accuracy)
```

```
AccuracyofRandomforestmodel:      0.8435374149659864
```

[45]:
```
# Precision score
precision_yes=precision_score(y_test,y_pred2,pos_label=1)print("Pre
cision(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)prin
t("Recall(Yes):"+str(round(recall_yes,2)))recall_no=re
call_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]:
```
#F1score
f1_score_yes=f1_score(y_test,y_pred2,pos_label=1)
print("F1Score(Yes):"+str(round(f1_score_yes,2)))f1_sc
ore_no=f1_score(y_test,y_pred2,pos_label=0)
print("F1Score(No):"+str(round(f1_score_no,2)))
```

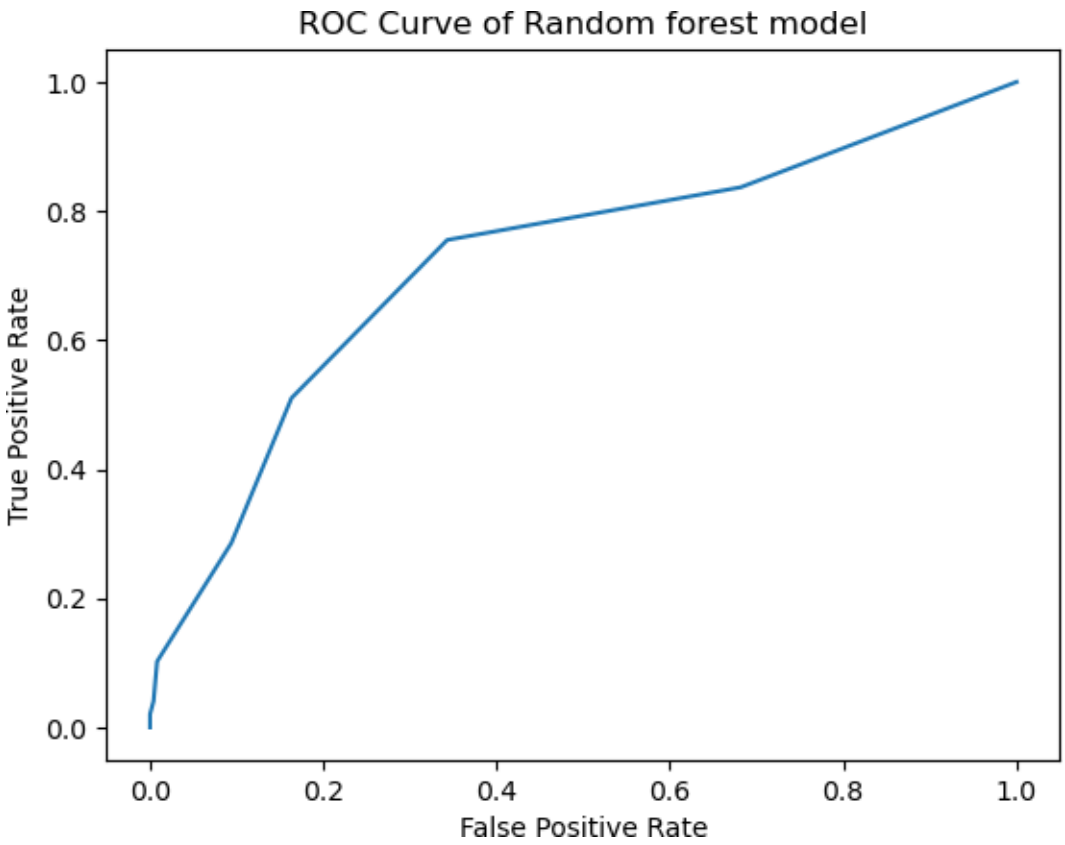
```
F1Score(Yes):0.18F1Sc
ore(No):0.91
```

[48]:
```
# Classification Report
print("ClassificationreportofRandomForestmodel:
↪\n\n",classification_report(y_test,y_pred2))
```

ClassificationreportofRandomForestmodel:

	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
macroavg	0.78	0.55	0.55	294
weightedavg	0.82	0.84	0.79	294

[49]:
```
#ROCcurve
probability=rf.predict_proba(x_test)[:,1]
pr,tpr,thresholds=roc_curve(y_test,probability)pr)
plt.plot(fpr, tpr)lsePositiveRate")ueP
plt.xlabel("FositiveRate")
plt.ylabel("T CurveofRandomforestmodel")
plt.title("RO
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