In [ ]:
```
Assignment 8 th september
1.Take car crashes dataset from seaborn library
2.load the dataset
3.data visualiation
4.Inference is must for each and every graph
5.Submit it by wednesday in html format

Feedback - https://forms.gle/7vFfvANDVfvDxxW28
```

Steps:

1.import the necessary libraries

2.import the dataset

3.Handling null values

4.outlier detection---surya

5.Seperate Dependent and independent variables

6.Encoding

7.splitting into training and testing set

8.Feature scaling

1.import the necessary libraries

In [16]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

2.import the dataset

In [37]:
```
dataset=pd.read_csv("C:\\Users\\ Rakesh kumar255 \\OneDrive\\Documents\\employee.c
```

In [18]:
```
dataset
```

Out[18]:

In [18]:
```
dataset
```

Out[18]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educ
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life
4	27	No	Travel_Rarely	591	Research & Development	2	1	
...	...	...	...	...	...	...	...	
1465	36	No	Travel_Frequently	884	Research & Development	23	2	
1466	39	No	Travel_Rarely	613	Research & Development	6	1	
1467	27	No	Travel_Rarely	155	Research & Development	4	3	Life
1468	49	No	Travel_Frequently	1023	Sales	2	3	
1469	34	No	Travel_Rarely	628	Research & Development	8	3	

1470 rows × 35 columns

In [19]:
```
dataset.head(3)
```

Out[19]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educatic
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life Sc
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life Sc
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	

3 rows × 35 columns

In [20]:
```
dataset.tail()
```

Out[20]:

In [20]:
```
dataset.tail()
```

Out[20]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educ
1465	36	No	Travel_Frequently	884	Research & Development	23	2	
1466	39	No	Travel_Rarely	613	Research & Development	6	1	
1467	27	No	Travel_Rarely	155	Research & Development	4	3	Lif
1468	49	No	Travel_Frequently	1023	Sales	2	3	
1469	34	No	Travel_Rarely	628	Research & Development	8	3	

5 rows × 35 columns

In [21]:
```
dataset.shape
```

Out[21]:
```
(1470, 35)
```

In [22]:
```
dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

In [22]:
```
dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1470 entries, 0 to 1469
Data columns (total 35 columns):
 #   Column                    Non-Null Count  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         1470 non-null   int64 
 24  PerformanceRating         1470 non-null   int64 
 25  RelationshipSatisfaction  1470 non-null   int64 
 26  StandardHours             1470 non-null   int64 
 27  StockOptionLevel          1470 non-null   int64 
 28  TotalWorkingYears         1470 non-null   int64 
 29  TrainingTimesLastYear     1470 non-null   int64 
 30  WorkLifeBalance           1470 non-null   int64 
 31  YearsAtCompany            1470 non-null   int64 
 32  YearsInCurrentRole        1470 non-null   int64 
 33  YearsSinceLastPromotion   1470 non-null   int64 
 34  YearsWithCurrManager      1470 non-null   int64 
dtypes: int64(26), object(9)
memory usage: 402.1+ KB
```

In [23]:
```
dataset.describe()
```

Out[23]:

In [23]:
```
dataset.describe()
```

Out[23]:

	Age	DailyRate	DistanceFromHome	Education	EmployeeCount	EmployeeNumbe
count	1470.000000	1470.000000	1470.000000	1470.000000	1470.0	1470.00000
mean	36.923810	802.485714	9.192517	2.912925	1.0	1024.86530
std	9.135373	403.509100	8.106864	1.024165	0.0	602.02433
min	18.000000	102.000000	1.000000	1.000000	1.0	1.00000
25%	30.000000	465.000000	2.000000	2.000000	1.0	491.25000
50%	36.000000	802.000000	7.000000	3.000000	1.0	1020.50000
75%	43.000000	1157.000000	14.000000	4.000000	1.0	1555.75000
max	60.000000	1499.000000	29.000000	5.000000	1.0	2068.00000

8 rows × 26 columns

In [ ]:
```

```

Formula

$$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}}$$

σ = population standard deviation

N = the size of the population

x_i = each value from the population

μ = the population mean

#

In [24]:
```
dataset.head()
```

In [24]:
```
dataset.head()
```

Out[24]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educatic
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life Sc
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life Sc
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life Sc
4	27	No	Travel_Rarely	591	Research & Development	2	1	M

5 rows × 35 columns

In [25]:
```
dataset = dataset.drop(columns=['EducationField'])
dataset = dataset.drop(columns=['Department'])
```

In [26]:
```
pip install scikit-learn
```

```
Requirement already satisfied: scikit-learn in c:\users\keerthi krishana\.conda
\envs\tf\lib\site-packages (1.3.1)
Requirement already satisfied: numpy<2.0,>=1.17.3 in c:\users\keerthi krishana
\.conda\envs\tf\lib\site-packages (from scikit-learn) (1.24.3)
Requirement already satisfied: scipy>=1.5.0 in c:\users\keerthi krishana\.conda
\envs\tf\lib\site-packages (from scikit-learn) (1.10.1)
Requirement already satisfied: joblib>=1.1.1 in c:\users\keerthi krishana\.cond
a\envs\tf\lib\site-packages (from scikit-learn) (1.3.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\keerthi krishan
a\.conda\envs\tf\lib\site-packages (from scikit-learn) (3.2.0)
Note: you may need to restart the kernel to use updated packages.


[notice] A new release of pip is available: 23.1.2 -> 23.2.1
[notice] To update, run: python.exe -m pip install --upgrade pip
```

In [42]:
```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
dataset["Gender"]=le.fit_transform(dataset["Gender"])
dataset["Attrition"]=le.fit_transform(dataset["Attrition"])
```

In [43]:
```
dataset["MaritalStatus"]=le.fit_transform(dataset["MaritalStatus"])
dataset["OverTime"]=le.fit_transform(dataset["OverTime"])
```

In [44]:
```
dataset["Over18"]=le.fit_transform(dataset["Over18"])
```

In [45]:
```
dataset["BusinessTravel"]=le.fit_transform(dataset["BusinessTravel"])
```

In [45]:
```
dataset["BusinessTravel"]=le.fit_transform(dataset["BusinessTravel"])
```

In [47]:
```
dataset["Department"]=le.fit_transform(dataset["Department"])
```

In [49]:
```
dataset["EducationField"]=le.fit_transform(dataset["EducationField"])
```

In [51]:
```
dataset["JobRole"]=le.fit_transform(dataset["JobRole"])
```

In [52]:
```
corr=dataset.corr()
corr
```

In [52]:
```
corr=dataset.corr()
corr
```

Out[52]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFrom
Age	1.000000	-0.159205	0.024751	0.010661	-0.031882	-0.(

Out[52]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFrom
Age	1.000000	-0.159205	0.024751	0.010661	-0.031882	-0.(
Attrition	-0.159205	1.000000	0.000074	-0.056652	0.063991	0.(
BusinessTravel	0.024751	0.000074	1.000000	-0.004086	-0.009044	-0.(
DailyRate	0.010661	-0.056652	-0.004086	1.000000	0.007109	-0.(
Department	-0.031882	0.063991	-0.009044	0.007109	1.000000	0.(
DistanceFromHome	-0.001686	0.077924	-0.024469	-0.004985	0.017225	1.(
Education	0.208034	-0.031373	0.000757	-0.016806	0.007996	0.(
EducationField	-0.040873	0.026846	0.023724	0.037709	0.013720	0.(
EmployeeCount	NaN	NaN	NaN	NaN	NaN	
EmployeeNumber	-0.010145	-0.010577	-0.015578	-0.050990	-0.010895	0.(
EnvironmentSatisfaction	0.010146	-0.103369	0.004174	0.018355	-0.019395	-0.(
Gender	-0.036311	0.029453	-0.032981	-0.011716	-0.041583	-0.(
HourlyRate	0.024287	-0.006846	0.026528	0.023381	-0.004144	0.(
JobInvolvement	0.029820	-0.130016	0.039062	0.046135	-0.024586	0.(
JobLevel	0.509604	-0.169105	0.019311	0.002966	0.101963	0.(
JobRole	-0.122427	0.067151	0.002724	-0.009472	0.662431	-0.(
JobSatisfaction	-0.004892	-0.103481	-0.033962	0.030571	0.021001	-0.(
MaritalStatus	-0.095029	0.162070	0.024001	-0.069586	0.056073	-0.(
MonthlyIncome	0.497855	-0.159840	0.034319	0.007707	0.053130	-0.(
MonthlyRate	0.028051	0.015170	-0.014107	-0.032182	0.023642	0.(
NumCompaniesWorked	0.299635	0.043494	0.020875	0.038153	-0.035882	-0.(
Over18	NaN	NaN	NaN	NaN	NaN	
OverTime	0.028062	0.246118	0.016543	0.009135	0.007481	0.(
PercentSalaryHike	0.003634	-0.013478	-0.029377	0.022704	-0.007840	0.(
PerformanceRating	0.001904	0.002889	-0.026341	0.000473	-0.024604	0.(
RelationshipSatisfaction	0.053535	-0.045872	-0.035986	0.007846	-0.022414	0.(
StandardHours	NaN	NaN	NaN	NaN	NaN	
StockOptionLevel	0.037510	-0.137145	-0.016727	0.042143	-0.012193	0.(
TotalWorkingYears	0.680381	-0.171063	0.034226	0.014515	-0.015762	0.(
TrainingTimesLastYear	-0.019621	-0.059478	0.015240	0.002453	0.036875	-0.(
WorkLifeBalance	-0.021490	-0.063939	-0.011256	-0.037848	0.026383	-0.(
YearsAtCompany	0.311309	-0.134392	-0.014575	-0.034055	0.022920	0.(
YearsInCurrentRole	0.212901	-0.160545	-0.011497	0.009932	0.056315	0.(
YearsSinceLastPromotion	0.216513	-0.033019	-0.032591	-0.033229	0.040061	0.(
YearsWithCurrManager	0.202089	-0.156199	-0.022636	-0.026363	0.034282	0.(

35 rows × 35 columns

In [ ]:
```
plt.subplots(figsize=(20,15))
sns.heatmap(corr,annot=True)
```

35 rows × 35 columns

In [ ]:
```
plt.subplots(figsize=(20,15))
sns.heatmap(corr,annot=True)
```

In [31]:
```
dataset.Attrition.value_counts()
```

Out[31]:
```
Attrition
0    1233
1     237
Name: count, dtype: int64
```

In [32]:
```
dataset.Gender.value_counts()
```

Out[32]:
```
Gender
1    882
0    588
Name: count, dtype: int64
```

In [33]:
```
dataset.head()
```

Out[33]:

	Age	Attrition	BusinessTravel	DailyRate	DistanceFromHome	Education	EmployeeCount	Empl
0	41	1	Travel_Rarely	1102	1	2	1	
1	49	0	Travel_Frequently	279	8	1	1	
2	37	1	Travel_Rarely	1373	2	2	1	
3	33	0	Travel_Frequently	1392	3	4	1	
4	27	0	Travel_Rarely	591	2	1	1	

5 rows × 33 columns

In [ ]:

In [ ]:

3.Handling null values

In [ ]:

In [53]:
```
dataset.isnull().any()
```

Out[53]:
```
Age                        False
```

In [53]:
```
dataset.isnull().any()
```

Out[53]:
```
Age                         False
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
```

In [54]:
```
dataset.isnull().sum()
```

Out[54]:
```
Age                         0
```

In [54]:
```
dataset.isnull().sum()
```

Out[54]:
```
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
```

In [ ]:
```

```

In [56]:
```
dataset.head()
```

Out[56]:

In [56]:
```
dataset.head()
```

Out[56]:

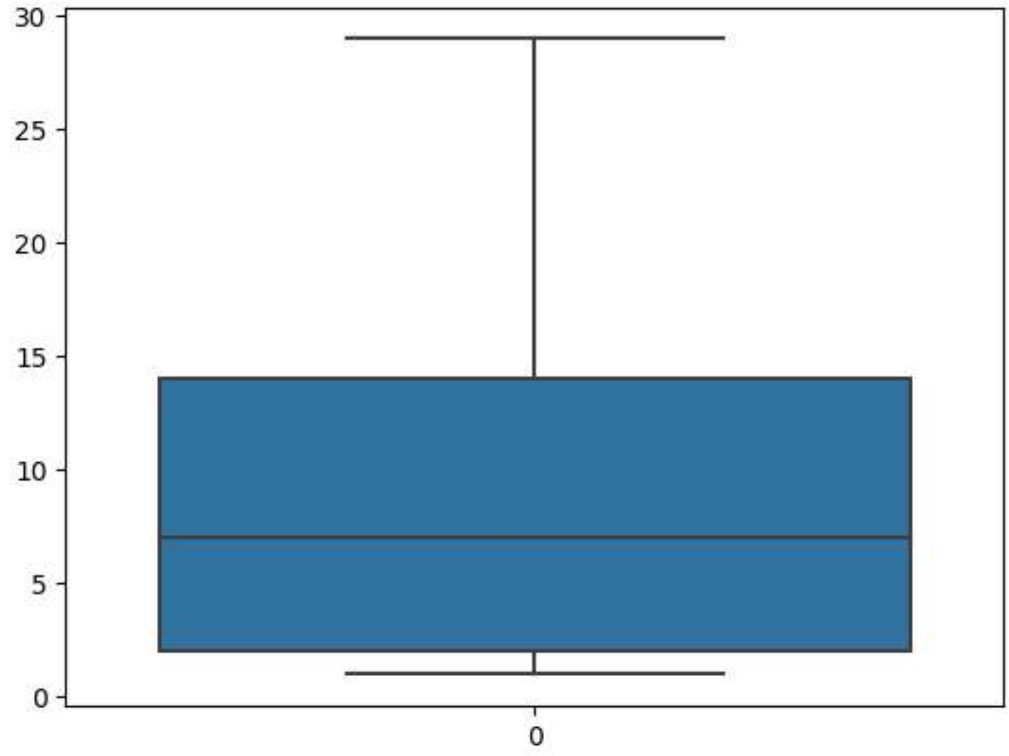
	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationI
0	41	1	2	1102	2	1	2	
1	49	0	1	279	1	8	1	
2	37	1	2	1373	1	2	2	
3	33	0	1	1392	1	3	4	
4	27	0	2	591	1	2	1	

5 rows × 35 columns

4.outliers

In [57]:
```
sns.boxplot(dataset.DistanceFromHome)
```

Out[57]: <Axes: >

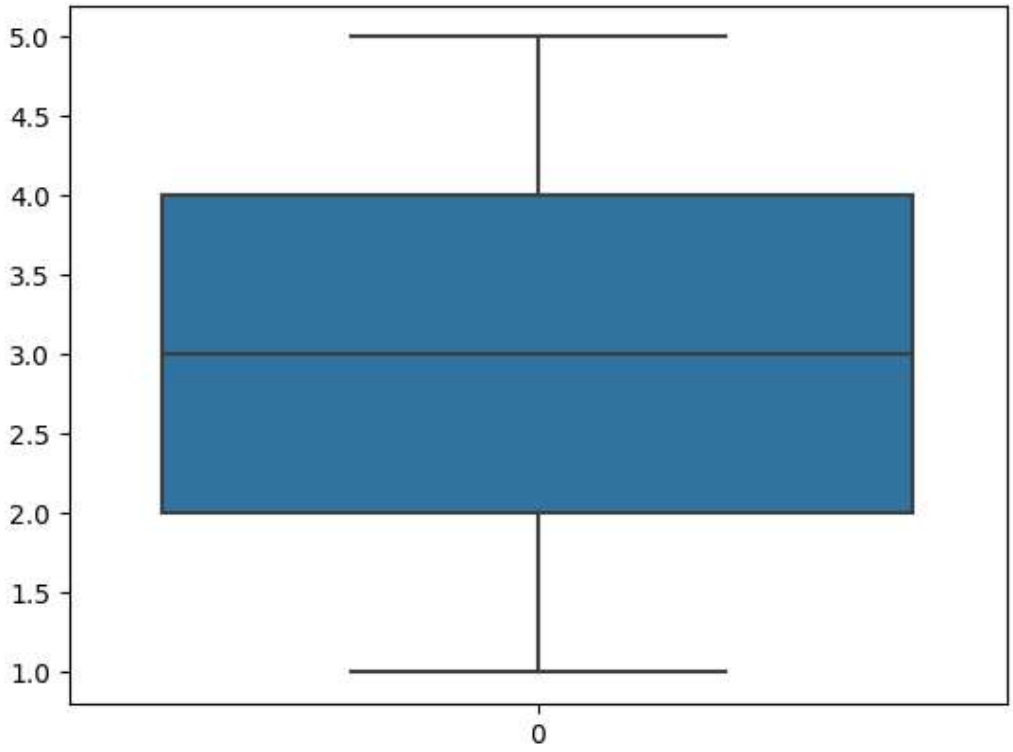


In [58]:
```
sns.boxplot(dataset.Education)
```

Out[58]: <Axes: >

In [58]:
```
sns.boxplot(dataset.Education)
```

Out[58]: <Axes: >



5.Seperate dependent and independent variables

In [208]:
```
#datset.iloc[rows,column]
x=dataset.iloc[:,1:4]
y=dataset.iloc[:,22:23]
```

In [209]:
```
x.head()
```

Out[209]:

	Attrition	BusinessTravel	DailyRate
0	1	2	1102
1	0	1	279
2	1	2	1373
3	0	1	1392
4	0	2	591

In [210]:
```
y.head()
```

Out[210]:

In [210]:
```
y.head()
```

Out[210]:

	OverTime
0	1
1	0
2	1
3	1
4	0

In [211]:
```
dataset.shape
```

Out[211]: (1470, 35)

In [212]:
```
x.shape
```

Out[212]: (1470, 3)

In [213]:
```
y.shape
```

Out[213]: (1470, 1)

Type *Markdown* and LaTeX: α^2

In [ ]:

In [ ]:

Label encoding on Gender column

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [214]:
```
x.head()
```

Out[214]:

In [214]:
```
x.head()
```

Out[214]:

	Attrition	BusinessTravel	DailyRate
0	1	2	1102
1	0	1	279
2	1	2	1373
3	0	1	1392
4	0	2	591

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

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In [ ]:

In [ ]:

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In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

```
![image.png](attachment:image.png)
```

In [ ]:

In [215]:
```
from sklearn.preprocessing import MinMaxScaler
ms=MinMaxScaler()
x_scaled=pd.DataFrame(ms.fit_transform(x),columns=x.columns)
```

In [216]:
```
x_scaled
```

Out[216]:

	Attrition	BusinessTravel	DailyRate
0	1.0	1.0	0.715820
1	0.0	0.5	0.126700
2	1.0	1.0	0.909807
3	0.0	0.5	0.923407
4	0.0	1.0	0.350036
...	...	...	...
1465	0.0	0.5	0.559771
1466	0.0	1.0	0.365784
1467	0.0	1.0	0.037938
1468	0.0	0.5	0.659270
1469	0.0	1.0	0.376521

1470 rows × 3 columns

In [217]:
```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x_scaled,y,test_size=0.2,random_st
```

In [218]:
```
x_train.shape,x_test.shape,y_train.shape,y_test.shape
```

Out[218]: ((1176, 3), (294, 3), (1176, 1), (294, 1))

In [219]:
```
x_train.head()
```

Out[219]:

In [219]:
```
x_train.head()
```

Out[219]:

	Attrition	BusinessTravel	DailyRate
1374	0.0	1.0	0.360057
1092	0.0	1.0	0.607015
768	0.0	1.0	0.141732
569	0.0	0.0	0.953472
911	1.0	0.5	0.355762

In [220]:
```
y_test.head()
```

Out[220]:

	OverTime
442	0
1091	0
981	1
785	0
1332	1

In [221]:
```
x_test.head()
```

Out[221]:

	Attrition	BusinessTravel	DailyRate
442	0.0	0.0	0.381532
1091	0.0	1.0	0.338583
981	1.0	0.5	0.400859
785	0.0	1.0	0.994989
1332	1.0	0.5	0.255548

In [222]:
```
from sklearn.linear_model import LogisticRegression
model=LogisticRegression()
```

In [223]:
```
model.fit(x_train,y_train)
```

```
C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\utils\valida
tion.py:1183: DataConversionWarning: A column-vector y was passed when a 1d arr
ay was expected. Please change the shape of y to (n_samples, ), for example usi
ng ravel().
  y = column_or_1d(y, warn=True)
```

Out[223]:

▾ LogisticRegression

LogisticRegression()

In [224]:
```
pred=model.predict(x_test)
```

In [224]:
```
pred=model.predict(x_test)
```

In [225]:
```
pred
```

Out[225]:
```
array([0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0,
       0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0])
```

In [ ]:
```

```

In [ ]:
```

```

In [97]:
```
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report
```

In [226]:
```
accuracy_score(y_test,pred)
```

Out[226]:
```
0.7040816326530612
```

In [227]:
```
confusion_matrix(y_test,pred)
```

Out[227]:
```
array([[194,   7],
       [ 80,  13]], dtype=int64)
```

In [229]:
```
probability=model.predict_proba(x_test)[:,1]
probability
```

In [229]:
```
probability=model.predict_proba(x_test)[:,1]
probability
```

Out[229]:
```
array([0.21381276, 0.22661105, 0.48854887, 0.25902132, 0.47879227,
       0.20579433, 0.50546722, 0.23552353, 0.19838807, 0.48867727,
       0.25508854, 0.48478273, 0.23330162, 0.49892382, 0.24260724,
```

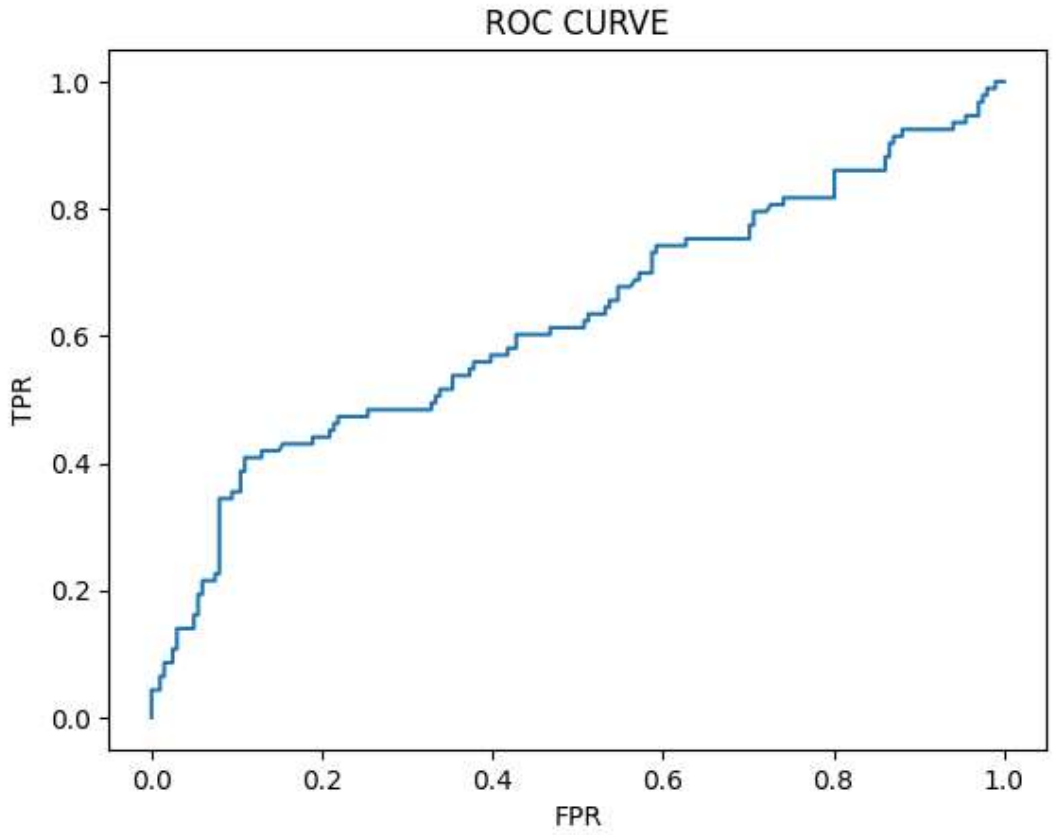
Out[229]:
```
array([0.21381276, 0.22661105, 0.48854887, 0.25902132, 0.47879227,
       0.20579433, 0.50546722, 0.23552353, 0.19838807, 0.48867727,
       0.25508854, 0.48478273, 0.23330162, 0.49892382, 0.24260724,
       0.25210134, 0.22057501, 0.49714359, 0.21828957, 0.24509131,
       0.22898086, 0.23508511, 0.22402436, 0.22581365, 0.25721545,
       0.22704984, 0.2316077 , 0.25115904, 0.22412474, 0.23487752,
       0.22089513, 0.24089021, 0.23464691, 0.49637379, 0.25780422,
       0.24077303, 0.2316077 , 0.22647616, 0.49964554, 0.21885924,
       0.21421226, 0.24978604, 0.21424465, 0.21159988, 0.23814427,
       0.46818917, 0.22715119, 0.22571273, 0.47021815, 0.50657371,
       0.24099581, 0.53265394, 0.19829627, 0.2588736 , 0.47443926,
       0.21957309, 0.22289988, 0.48374111, 0.24726997, 0.21289766,
       0.21564112, 0.25461341, 0.22102765, 0.25037545, 0.2153265 ,
       0.23922843, 0.51965121, 0.49648589, 0.23891333, 0.52070802,
       0.24766422, 0.23054762, 0.21783014, 0.2298655 , 0.23893643,
       0.23713312, 0.21275805, 0.23136803, 0.49052072, 0.22222288,
       0.21317741, 0.2346355 , 0.22059718, 0.21845382, 0.21912258,
       0.24137163, 0.23058176, 0.25036353, 0.24267797, 0.24420217,
       0.24069072, 0.25195622, 0.21842097, 0.21783014, 0.21582543,
       0.22199011, 0.22536547, 0.21118279, 0.24721015, 0.23364605,
       0.5330851 , 0.5242133 , 0.21128957, 0.2475925 , 0.23435911,
       0.25206506, 0.23838879, 0.25549103, 0.21219962, 0.2491133 ,
       0.25843074, 0.23769063, 0.22721877, 0.22173527, 0.23755117,
       0.20658185, 0.22015607, 0.2376209 , 0.23418649, 0.24587556,
       0.25257337, 0.23225912, 0.21276869, 0.47244046, 0.21134314,
       0.20473722, 0.23662275, 0.24519815, 0.24130116, 0.21645605,
       0.24063233, 0.49998234, 0.53346832, 0.24038625, 0.2556375 ,
       0.23880836, 0.47901657, 0.23237342, 0.23780678, 0.23164196,
       0.23366914, 0.24734162, 0.2221231 , 0.23609023, 0.25695814,
       0.49893969, 0.20984991, 0.22516394, 0.49295803, 0.25392004,
       0.22515252, 0.22860731, 0.21866189, 0.53710682, 0.24541193,
       0.20956285, 0.24477097, 0.210329  , 0.21639077, 0.24799895,
       0.47984899, 0.25275508, 0.21563005, 0.48545574, 0.20599352,
       0.23831891, 0.2402457 , 0.24576852, 0.22551098, 0.23845868,
       0.21849753, 0.48843682, 0.23129959, 0.25166614, 0.53284557,
       0.2398244 , 0.24406011, 0.21718583, 0.24430875, 0.21629289,
       0.25007467, 0.23350824, 0.2482862 , 0.52363725, 0.2529005 ,
       0.21250028, 0.24762836, 0.2269823 , 0.49420881, 0.21776457,
       0.22302225, 0.52968242, 0.22412474, 0.21362971, 0.25126764,
       0.21580393, 0.21760069, 0.25714191, 0.53882897, 0.22978578,
       0.24435601, 0.2202334 , 0.48588842, 0.23123115, 0.22938886,
       0.23224745, 0.2234895 , 0.23615965, 0.21479596, 0.2234895 ,
       0.23849363, 0.25571075, 0.23054762, 0.52864331, 0.50224373,
       0.25913216, 0.24477097, 0.22929803, 0.24335066, 0.25648073,
       0.23619437, 0.21427705, 0.20811059, 0.19936931, 0.2123071 ,
       0.2442377 , 0.22570163, 0.24045654, 0.48739478, 0.23679662,
       0.22236695, 0.21980403, 0.22844885, 0.21862901, 0.25268239,
       0.22462715, 0.22312232, 0.25876284, 0.25206506, 0.21105458,
       0.4773516 , 0.22688101, 0.24906542, 0.22901484, 0.22536547,
       0.223924  , 0.22913924, 0.24293734, 0.23612494, 0.24953366,
       0.22102765, 0.20976472, 0.45877717, 0.22708362, 0.25706839,
       0.24913742, 0.25000249, 0.51104697, 0.24601833, 0.51715263,
       0.22983143, 0.23836538, 0.22447065, 0.22748924, 0.24190065,
       0.23442819, 0.22759072, 0.51861009, 0.53744175, 0.24441537,
       0.21405032, 0.22932082, 0.22505181, 0.22382368, 0.22439259,
       0.22657732, 0.22844885, 0.25762013, 0.2199691 , 0.24094899,
       0.52250079, 0.24770008, 0.23723759, 0.23102594, 0.22248911,
       0.23205327, 0.23197302, 0.48334075, 0.25268239, 0.22600448,
       0.21596683, 0.47044866, 0.25058032, 0.21171803])
```

In [230]:
```
fpr,tpr,thresholds=roc_curve(y_test,probability)
```

```
0.23205327, 0.23197302, 0.48334075, 0.25268239, 0.22600448,
0.21595683, 0.47044866, 0.25058032, 0.21171803])
```

In [230]:
```
fpr,tpr,thresholds=roc_curve(y_test,probability)
```

In [231]:
```
plt.plot(fpr,tpr)
plt.xlabel('FPR')
plt.ylabel('TPR')
plt.title('ROC CURVE')
plt.show()
```



In [232]:
```
from sklearn.tree import DecisionTreeClassifier
dtc=DecisionTreeClassifier()
```

In [233]:
```
dtc.fit(x_train,y_train)
```

Out[233]:
```
DecisionTreeClassifier
DecisionTreeClassifier()
```

In [234]:
```
pred=dtc.predict(x_test)
pred
```

In [234]:
```
pred=dtc.predict(x_test)
pred
```

Out[234]:
```
array([1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 0, 1, 1,
       0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0,
       1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1,
       0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 1, 1, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0,
       0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1,
       0, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1,
       0, 1, 0, 1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
       0, 1, 0, 1, 0, 0, 0, 0])
```

In [235]:
```
y_test
```

Out[235]:

	OverTime
442	0
1091	0
981	1
785	0
1332	1
...	...
1439	0
481	1
124	1
198	0
1229	1

294 rows × 1 columns

In [236]:
```
accuracy_score(y_test,pred)
```

Out[236]:
```
0.6020408163265306
```

In [237]:
```
confusion_matrix(y_test,pred)
```

Out[237]:
```
array([[147,  54],
       [ 63,  30]], dtype=int64)
```

In [239]:
```
probability=dtc.predict_proba(x_test)[:,1]
probability
```

In [239]:
```
probability=dtc.predict_proba(x_test)[:,1]
probability
```

Out[239]:
```
array([1.        , 0.        , 1.        , 0.33333333, 1.        ,
       0.        , 1.        , 0.        , 1.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 1.        ,
```

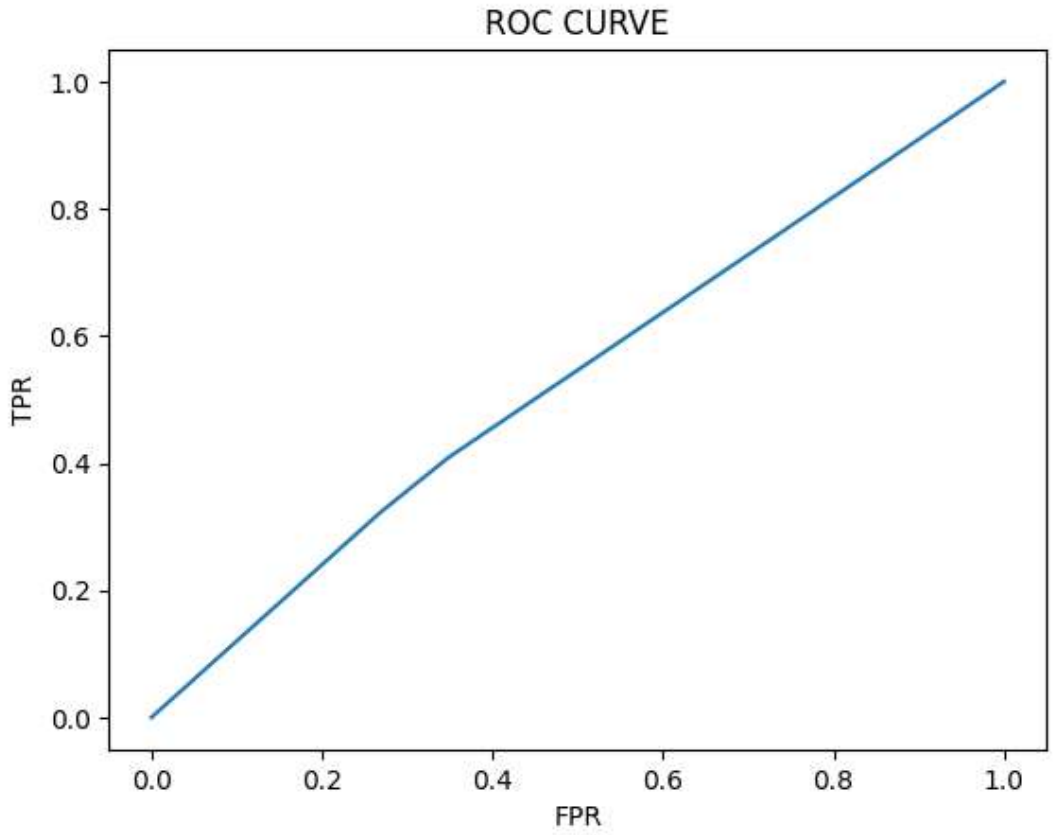
Out[239]:
```
array([1.        , 0.        , 1.        , 0.33333333, 1.        ,
       0.        , 1.        , 0.        , 1.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 1.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 1.        , 0.        , 0.        ,
       0.5       , 0.        , 0.        , 0.        , 0.        ,
       0.        , 1.        , 0.        , 1.        , 1.        ,
       1.        , 0.        , 1.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 1.        ,
       0.        , 0.        , 1.        , 0.        , 1.        ,
       1.        , 0.        , 1.        , 0.33333333, 1.        ,
       1.        , 0.        , 0.        , 0.        , 1.        ,
       0.        , 0.        , 1.        , 0.        , 1.        ,
       1.        , 0.        , 1.        , 0.        , 1.        ,
       0.5       , 0.33333333, 0.        , 0.        , 1.        ,
       0.        , 1.        , 0.        , 1.        , 0.        ,
       1.        , 0.        , 0.33333333, 0.        , 0.        ,
       1.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 1.        , 0.        , 1.        , 0.        ,
       0.        , 0.        , 1.        , 0.5       , 1.        ,
       0.        , 0.        , 0.        , 1.        , 0.        ,
       1.        , 0.        , 0.        , 0.        , 0.        ,
       1.        , 0.        , 0.        , 0.5       , 0.        ,
       1.        , 0.        , 0.        , 1.        , 0.        ,
       0.        , 1.        , 0.        , 1.        , 1.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.5       , 0.        , 0.        , 0.        , 0.        ,
       1.        , 0.        , 0.        , 0.5       , 0.        ,
       1.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 1.        , 1.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       1.        , 0.        , 0.33333333, 0.        , 0.        ,
       0.        , 0.        , 0.        , 1.        , 0.5       ,
       0.        , 0.        , 0.        , 0.        , 1.        ,
       0.        , 0.        , 0.        , 0.        , 0.5       ,
       0.        , 0.        , 0.        , 0.5       , 0.        ,
       0.5       , 0.5       , 0.        , 1.        , 1.        ,
       0.        , 1.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 1.        , 1.        ,
       1.        , 0.        , 1.        , 0.        , 0.        ,
       0.        , 1.        , 0.        , 0.        , 1.        ,
       0.5       , 0.        , 0.33333333, 1.        , 1.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 1.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 1.        , 0.        ,
       0.        , 0.        , 0.5       , 1.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       1.        , 1.        , 0.        , 0.        , 1.        ,
       1.        , 0.        , 1.        , 0.5       , 0.        ,
       1.        , 0.        , 0.        , 0.5       , 1.        ,
       1.        , 0.        , 0.        , 0.        , 1.        ,
       0.        , 1.        , 1.        , 1.        , 0.        ,
       1.        , 0.        , 1.        , 1.        , 1.        ,
       0.        , 0.        , 1.        , 0.        , 0.        ,
       0.        , 0.5       , 0.        , 0.        , 0.5       ,
       0.        , 0.        , 0.        , 0.        , 1.        ,
       1.        , 0.5       , 1.        , 0.        , 1.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ])
```

In [240]:
```
fpr,tpr,thresholds= roc_curve(y_test,probability)
```

```
       1.        , 0.5       , 1.        , 0.        , 1.        ,
```

In [240]:
```
fpr,tpr,threshshold = roc_curve(y_test,probability) ])
```

In [241]:
```
plt.plot(fpr,tpr)
plt.xlabel('FPR')
plt.ylabel('TPR')
plt.title('ROC CURVE')
plt.show()
```



In [242]:
```
from sklearn import tree
plt.figure(figsize=(25,15))
tree.plot_tree(dtc,filled=True)
```

In [242]:
```
from sklearn import tree
plt.figure(figsize=(25,15))
tree.plot_tree(dtc,filled=True)
```

```
 Text(0.5349487418452936, 0.4891304347826087, 'x[2] <= 0.685\ngini = 0.278\ns
amples = 6\nvalue = [5, 1]'),
 Text(0.5312208760484622, 0.4673913043478261, 'gini = 0.5\nsamples = 2\nvalue
= [1, 1]'),
 Text(0.5386766076421249, 0.4673913043478261, 'gini = 0.0\nsamples = 4\nvalue
= [4, 0]'),
 Text(0.5461323392357875, 0.5108695652173914, 'x[2] <= 0.699\ngini = 0.444\ns
amples = 9\nvalue = [6, 3]'),
 Text(0.5424044734389561, 0.4891304347826087, 'gini = 0.0\nsamples = 2\nvalue
= [0, 2]'),
 Text(0.5498602050326188, 0.4891304347826087, 'x[2] <= 0.705\ngini = 0.245\ns
amples = 7\nvalue = [6, 1]'),
 Text(0.5461323392357875, 0.4673913043478261, 'gini = 0.0\nsamples = 5\nvalue
= [5, 0]'),
 Text(0.5535880708294502, 0.4673913043478261, 'x[2] <= 0.707\ngini = 0.5\nsam
ples = 2\nvalue = [1, 1]'),
 Text(0.5498602050326188, 0.44565217391304346, 'gini = 0.0\nsamples = 1\nvalu
e = [0, 1]'),
 Text(0.5573159366262814, 0.44565217391304346, 'gini = 0.0\nsamples = 1\nvalu
```

In [244]:
```
from sklearn.model_selection import GridSearchCV
parameter={
 'criterion':['gini','entropy'],
  'splitter':['best','random'],
  'max_depth':[1,2,3,4,5],
  'max_features':['auto', 'sqrt', 'log2']

}
```

In [245]:
```
grid_search=GridSearchCV(estimator=dtc,param_grid=parameter,cv=5,scoring="accurac
```

In [246]:
```
grid_search.fit(x_train,y_train)
```

```
C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\model_select
```

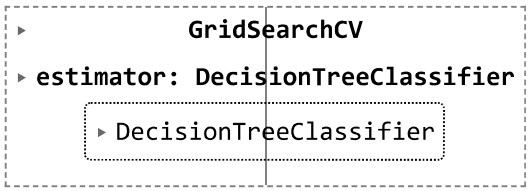
In [246]:
```
grid_search.fit(x_train,y_train)
```

```
C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\model_select
ion\_validation.py:425: FitFailedWarning:
100 fits failed out of a total of 300.
The score on these train-test partitions for these parameters will be set to na
n.
If these failures are not expected, you can try to debug them by setting error_
score='raise'.

Below are more details about the failures:
--------------------------------------------------------------------------------
-
100 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\mode
l_selection\_validation.py", line 729, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\bas
e.py", line 1145, in wrapper
    estimator._validate_params()
  File "C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\bas
e.py", line 638, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\util
s\_param_validation.py", line 95, in validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'max_features' param
eter of DecisionTreeClassifier must be an int in the range [1, inf), a float in
the range (0.0, 1.0], a str among {'log2', 'sqrt'} or None. Got 'auto' instead.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\model_select
ion\_search.py:979: UserWarning: One or more of the test scores are non-finite:
[       nan        nan 0.72534079 0.72025604 0.72534079 0.72534079
        nan        nan 0.71938334 0.71259647 0.72448972 0.73131266
        nan        nan 0.72449693 0.72364587 0.72706094 0.72109989
        nan        nan 0.73640822 0.71769924 0.71768842 0.72619906
        nan        nan 0.71004327 0.71684097 0.72024522 0.72024522
        nan        nan 0.72025604 0.72534079 0.72025604 0.72534079
        nan        nan 0.72278759 0.71429859 0.72363866 0.71429499
        nan        nan 0.72109989 0.72534439 0.72960332 0.72194374
        nan        nan 0.71768842 0.73046159 0.72280923 0.72706455
        nan        nan 0.71600433 0.71515687 0.70833393 0.7211071 ]
  warnings.warn(
```

Out[246]:



In [247]:
```
grid_search.best_params_
```

Out[247]:
```
{'criterion': 'gini',
 'max_depth': 4,
 'max_features': 'sqrt',
 'splitter': 'best'}
```

In [248]:
```
dtc_cv=DecisionTreeClassifier(criterion= 'entropy',
 max_depth=3,
 max_features='sqrt',
```

```
 max_depth': 4,
 'max_features': 'sqrt',
 'splitter': 'best'}
```

In [248]:
```python
dtc_cv=DecisionTreeClassifier(criterion= 'entropy',
 max_depth=3,
 max_features='sqrt',
 splitter='best')
dtc_cv.fit(x_train,y_train)
```

Out[248]:
```
DecisionTreeClassifier

DecisionTreeClassifier(criterion='entropy', max_depth=3, max_features='sqrt')
```

In [249]:
```python
pred=dtc_cv.predict(x_test)
```

In [250]:
```python
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.69      0.99      0.81       201
           1       0.60      0.03      0.06        93

    accuracy                           0.69       294
   macro avg       0.64      0.51      0.44       294
weighted avg       0.66      0.69      0.57       294
```

In [ ]:
```
RANDOM FOREST
```

In [251]:
```python
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier()
```

In [252]:
```python
forest_params = [{'max_depth': list(range(10, 15)), 'max_features': list(range(0
```

In [253]:
```python
rfc_cv= GridSearchCV(rfc,param_grid=forest_params,cv=10,scoring="accuracy")
```

In [254]:
```python
rfc_cv.fit(x_train,y_train)
```

```
  return fit_method(estimator, *args, **kwargs)
C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\base.py:11
52: DataConversionWarning: A column-vector y was passed when a 1d array was e
xpected. Please change the shape of y to (n_samples,), for example using rave
l().
  return fit_method(estimator, *args, **kwargs)
C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\base.py:11
52: DataConversionWarning: A column-vector y was passed when a 1d array was e
xpected. Please change the shape of y to (n_samples,), for example using rave
l().
  return fit_method(estimator, *args, **kwargs)
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xpected. Please change the shape of y to (n_samples,), for example using rave
l().
  return fit_method(estimator, *args, **kwargs)
C:\Users\KEERTHI KRISHANA\.conda\envs\tf\lib\site-packages\sklearn\base.py:11
52: DataConversionWarning: A column-vector y was passed when a 1d array was e
xpected. Please change the shape of y to (n_samples,), for example using rave
l().
```

In [255]:
```python
pred=rfc_cv.predict(x_test)
```

In [255]:
```
52: DataConversionWarning: A column-vector y was passed when a 1d array was e
xpected. Please change the shape of y to (n_samples,), for example using rave
l().
pred=rfc_cv.predict(g_test)
```

In [256]:
```
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.71      0.90      0.79       201
           1       0.47      0.20      0.29        93

    accuracy                           0.68       294
   macro avg       0.59      0.55      0.54       294
weighted avg       0.63      0.68      0.63       294
```

In [257]:
```
rfc_cv.best_params_
```

Out[257]:
```
{'max_depth': 10, 'max_features': 2}
```

In [ ]: