ASSIGNMENT 4

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Question: 1.Download the Employee Attrition Dataset https://www.kaggle.com/datasets/patelprashant/employee-attrition 2.Perfrom Data Preprocessing 3.Model Building using Logistic Regression and Decision Tree and Random forest 4.Calculate Performance metrics

2.DATA PREPROCESSING

Steps 1.import necessary libraries

2.import dataset

3.Handling null values

4.Data Visualization

5.Outlier detection

6.Seperate dependent and independent variables

7.Encoding

8.Splitting into training set and testing set

9.Feature Scaling

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

1.Import necessary libraries

In [1]:
```python
import numpy as np
```

In [2]:
```python
import pandas as pd
```

In [3]:
```python
import matplotlib.pyplot as plt
```

In [4]:
```python
import seaborn as sns
```

2.Load the Dataset

In [5]:
```python
dataset=pd.read_csv("HR-Employee-Attrition.csv")
```

In [6]:
```python
dataset
```

Out[6]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	...	RelationshipSat
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life Sciences	1	1	...	
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life Sciences	1	2	...	
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	Other	1	4	...	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life Sciences	1	5	...	
4	27	No	Travel_Rarely	591	Research & Development	2	1	Medical	1	7	...	
...	...	...	...	...	...	...	...	...	...	...	...	
1465	36	No	Travel_Frequently	884	Research & Development	23	2	Medical	1	2061	...	
1466	39	No	Travel_Rarely	613	Research & Development	6	1	Medical	1	2062	...	
1467	27	No	Travel_Rarely	155	Research & Development	4	3	Life Sciences	1	2064	...	
1468	49	No	Travel_Frequently	1023	Sales	2	3	Medical	1	2065	...	
1469	34	No	Travel_Rarely	628	Research & Development	8	3	Medical	1	2068	...	

1470 rows × 35 columns

In [7]:
```
dataset.head()
```

Out[7]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	...	RelationshipSatisfa
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life Sciences	1	1	...	
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life Sciences	1	2	...	
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	Other	1	4	...	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life Sciences	1	5	...	
4	27	No	Travel_Rarely	591	Research & Development	2	1	Medical	1	7	...	

5 rows × 35 columns

In [8]:
```
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 [9]:
```
dataset.shape
```

Out[9]:
```
(1470, 35)
```

In [10]:
```
dataset.describe()
```

Out[10]:

	Age	DailyRate	DistanceFromHome	Education	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	HourlyRate	JobInvolvement	JobL
count	1470.000000	1470.000000	1470.000000	1470.000000	1470.0	1470.000000	1470.000000	1470.000000	1470.000000	1470.00
mean	36.923810	802.485714	9.192517	2.912925	1.0	1024.865306	2.721769	65.891156	2.729932	2.06
std	9.135373	403.509100	8.106864	1.024165	0.0	602.024335	1.093082	20.329428	0.711561	1.10
min	18.000000	102.000000	1.000000	1.000000	1.0	1.000000	1.000000	30.000000	1.000000	1.00
25%	30.000000	465.000000	2.000000	2.000000	1.0	491.250000	2.000000	48.000000	2.000000	1.00
50%	36.000000	802.000000	7.000000	3.000000	1.0	1020.500000	3.000000	66.000000	3.000000	2.00
75%	43.000000	1157.000000	14.000000	4.000000	1.0	1555.750000	4.000000	83.750000	3.000000	3.00
max	60.000000	1499.000000	29.000000	5.000000	1.0	2068.000000	4.000000	100.000000	4.000000	5.00

8 rows × 26 columns

In [11]:
```
dataset.Age.value_counts()
```

```
Out[11]: 35    78
34    77
36    69
31    69
29    68
32    61
30    60
33    58
38    58
40    57
37    50
27    48
28    48
42    46
39    42
45    41
41    40
26    39
44    33
46    33
43    32
50    30
25    26
24    26
49    24
47    24
55    22
51    19
53    19
48    19
54    18
52    18
22    16
56    14
23    14
58    14
21    13
20    11
59    10
19     9
18     8
60     5
57     4
Name: Age, dtype: int64
```

```
In [12]: dataset.DailyRate.value_counts()
```

```
Out[12]: 691     6
408     5
530     5
1329    5
1082    5
       ..
650     1
279     1
316     1
314     1
628     1
Name: DailyRate, Length: 886, dtype: int64
```

3.Handling Null values

```
In [13]: dataset.isnull().any()
```

Out[13]:
```
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
```

No null values present

In [14]:
```
dataset.isnull().sum()
```

Out[14]:
```
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
```

4.Data Visualization

In [115…
```
dataset
```

```
Out[115]:
```

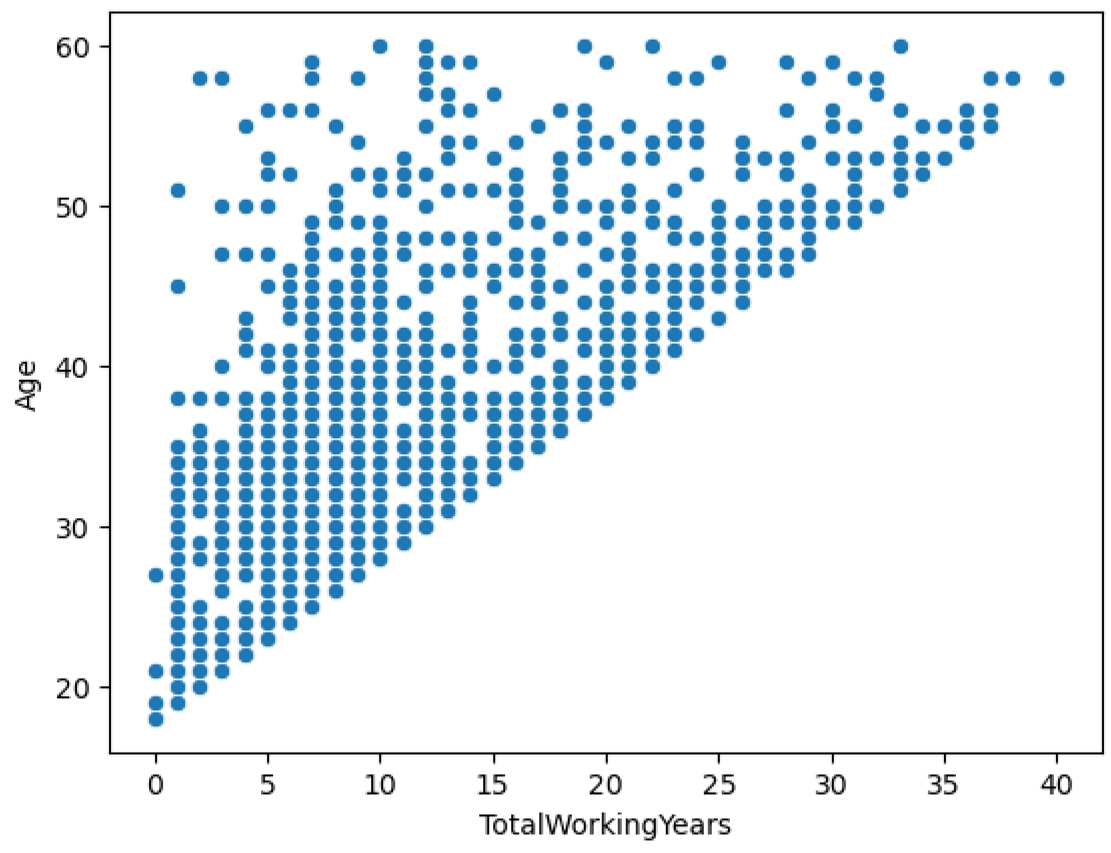
	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	...	RelationshipSa
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life Sciences	1	1	...	
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life Sciences	1	2	...	
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	Other	1	4	...	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life Sciences	1	5	...	
4	27	No	Travel_Rarely	591	Research & Development	2	1	Medical	1	7	...	
...	...	...	...	...	...	...	...	...	...	...	...	
1465	36	No	Travel_Frequently	884	Research & Development	23	2	Medical	1	2061	...	
1466	39	No	Travel_Rarely	613	Research & Development	6	1	Medical	1	2062	...	
1467	27	No	Travel_Rarely	155	Research & Development	4	3	Life Sciences	1	2064	...	
1468	49	No	Travel_Frequently	1023	Sales	2	3	Medical	1	2065	...	
1469	34	No	Travel_Rarely	628	Research & Development	8	3	Medical	1	2068	...	

1470 rows × 35 columns

i) Scatter plot

```
In [117…
sns.scatterplot(x="TotalWorkingYears",y="Age",data=dataset)
```

```
Out[117]: <Axes: xlabel='TotalWorkingYears', ylabel='Age'>
```

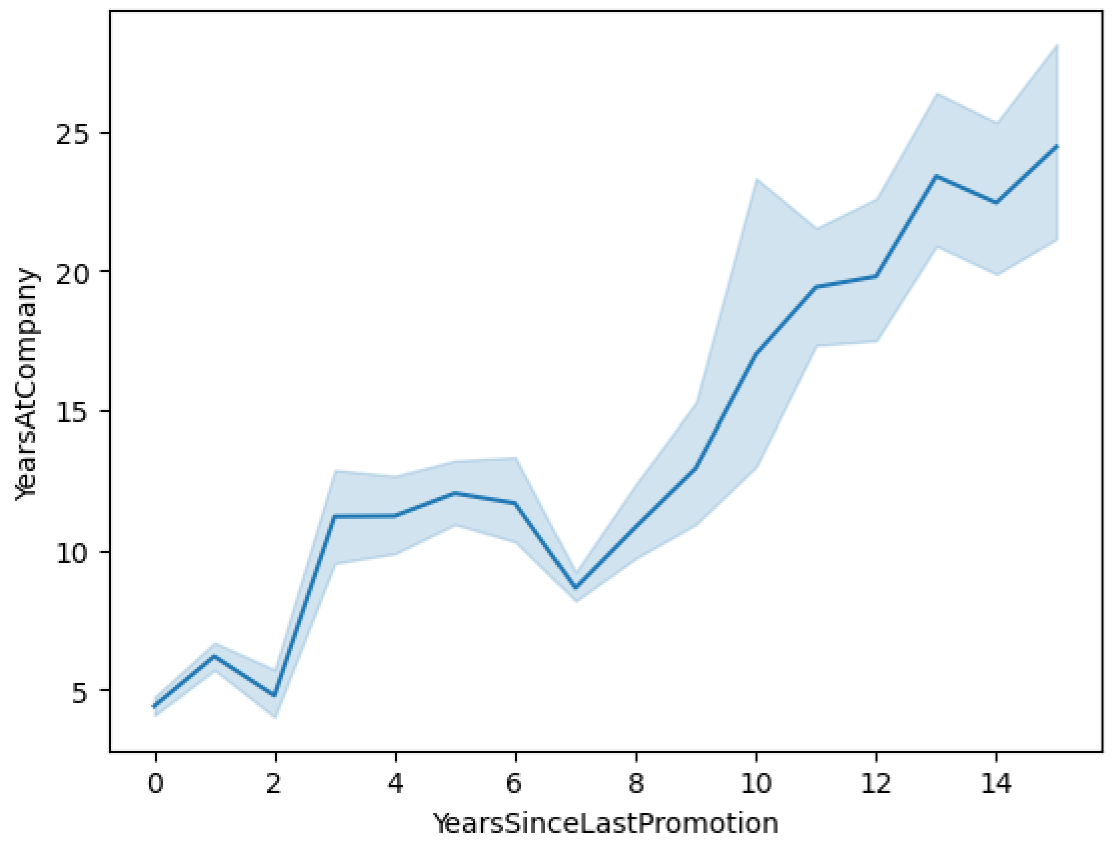


Inference: The scatterplot comparing "TotalWorkingYears" on the x-axis and "Age" on the y-axis using the data from the dataset.this scatterplot confirms the expected positive correlation between total working years and age, but it also highlights the presence of outliers and individual variations within the dataset.

ii)Line Plot

```
In [120…
sns.lineplot(x="YearsSinceLastPromotion",y="YearsAtCompany",data=dataset)
```

```
Out[120]: <Axes: xlabel='YearsSinceLastPromotion', ylabel='YearsAtCompany'>
```

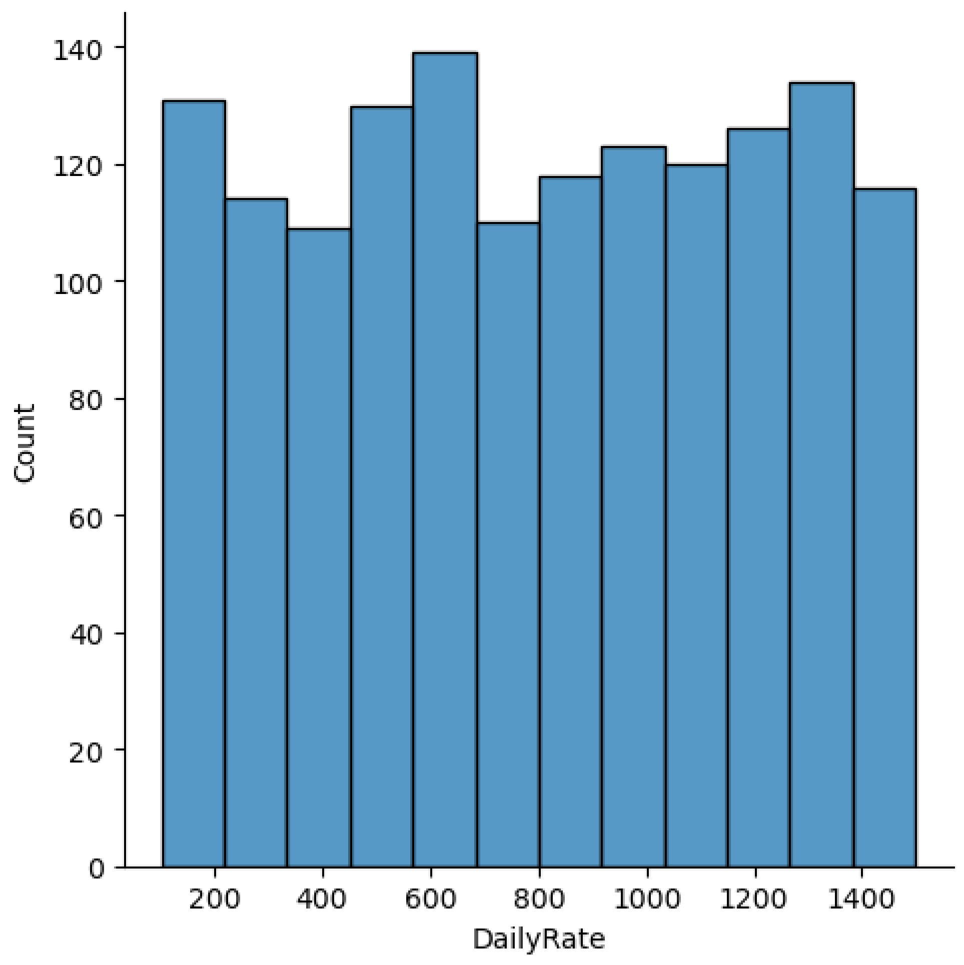


Inference :The line plot displays the relationship between "YearsSinceLastPromotion" on the x-axis and "YearsAtCompany" on the y-axis using the data from the dataset.this line plot shows a negative trend between "YearsSinceLastPromotion" and "YearsAtCompany," indicating that promotions tend to occur more frequently for employees who have been with the company for a shorter period.

iii)Distribution plot

In [121…
```
sns.displot(dataset["DailyRate"])
```

Out[121]:
```
<seaborn.axisgrid.FacetGrid at 0x1fb8ac054d0>
```

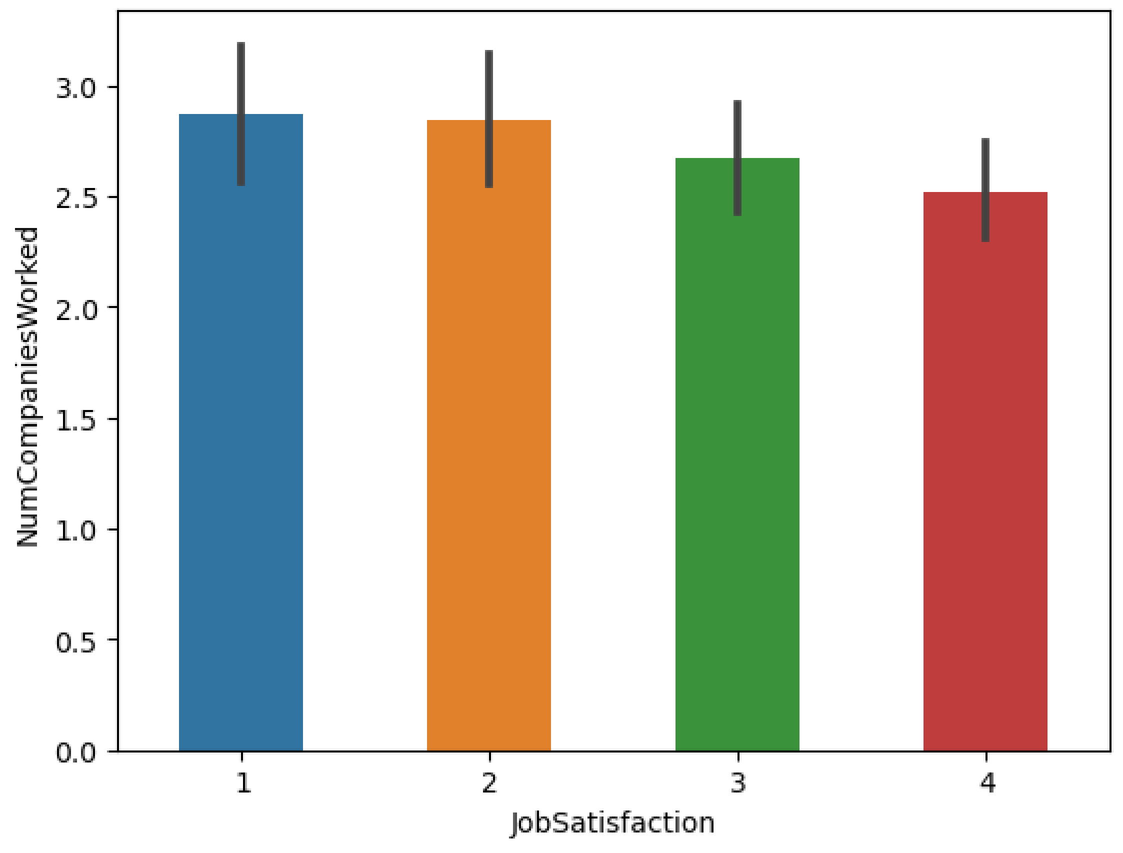


Inference : This is a distribution plot (histogram) of the "DailyRate" variable from your dataset using Seaborn.seful for understanding the distribution of daily rates and identifying any patterns or irregularities in the data

iv)Relational Plot

In [133…
```
sns.barplot(data=dataset, x="JobSatisfaction", y="NumCompaniesWorked", width=0.5)
```

Out[133]:
```
<Axes: xlabel='JobSatisfaction', ylabel='NumCompaniesWorked'>
```

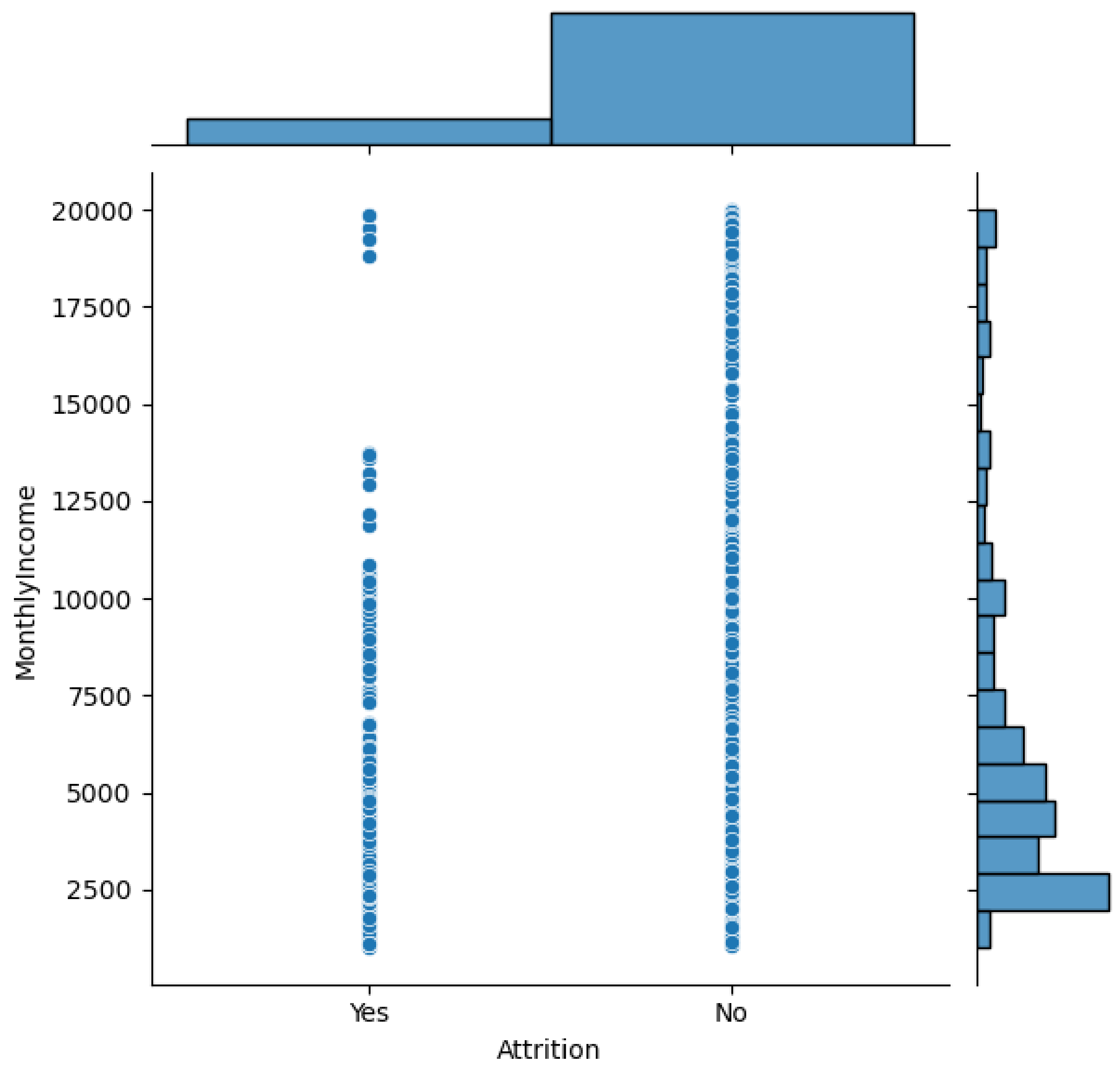


Inference : This Bar plot shows the relationship between job satisfaction and the number of companies worked for in your dataset.: The x-axis represents different levels of job satisfaction, and the y-axis represents the average or aggregated number of companies employees have worked for ("NumCompaniesWorked") for each level of job satisfaction.

v)Joint Plot

```
In [135…  sns.jointplot(x="Attrition",y="MonthlyIncome",data=dataset)
```

```
Out[135]: <seaborn.axisgrid.JointGrid at 0x1fb92580150>
```

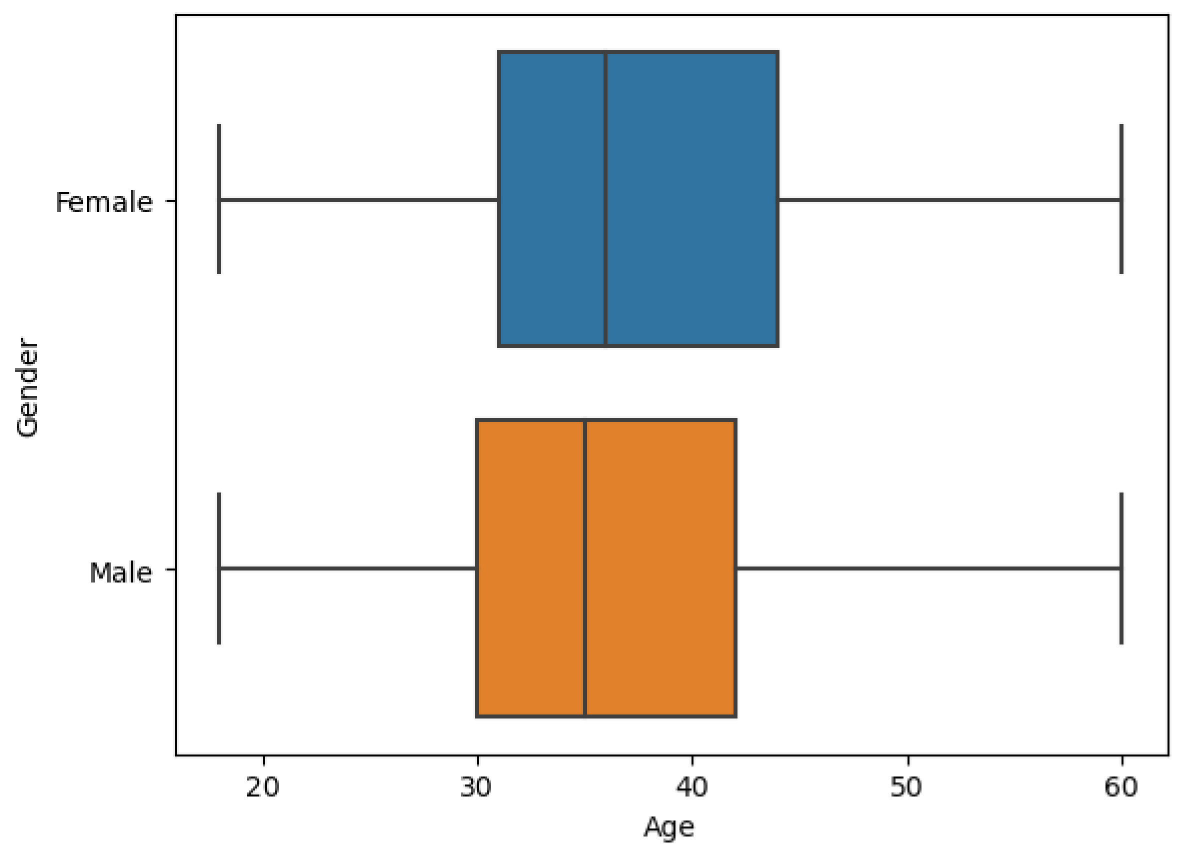


Inference : This joint plot provides a visual representation of the relationship between attrition and monthly income in your dataset.The central part of the joint plot is a scatter plot. In this case, "Attrition" is on the x-axis (usually a categorical variable), and "MonthlyIncome" is on the y-axis (a continuous variable). Each point on the scatter plot represents an employee's monthly income, and its position on the x-axis is determined by their attrition status. he marginal histograms on the top and right sides provide insights into the individual distributions of each variable.It helps assess whether there's a correlation between the two variables

vi)Box Plot

```
In [136…  sns.boxplot(x="Age",y="Gender",data=dataset)
```

```
Out[136]: <Axes: xlabel='Age', ylabel='Gender'>
```



Inference : This box plot visualizes and compare the distribution of ages within different gender categories in your dataset. It provides insights into the central tendency, spread, and potential outliers in the age data for each gender group, facilitating a better understanding of how age varies by gender in your dataset.

Heatmap

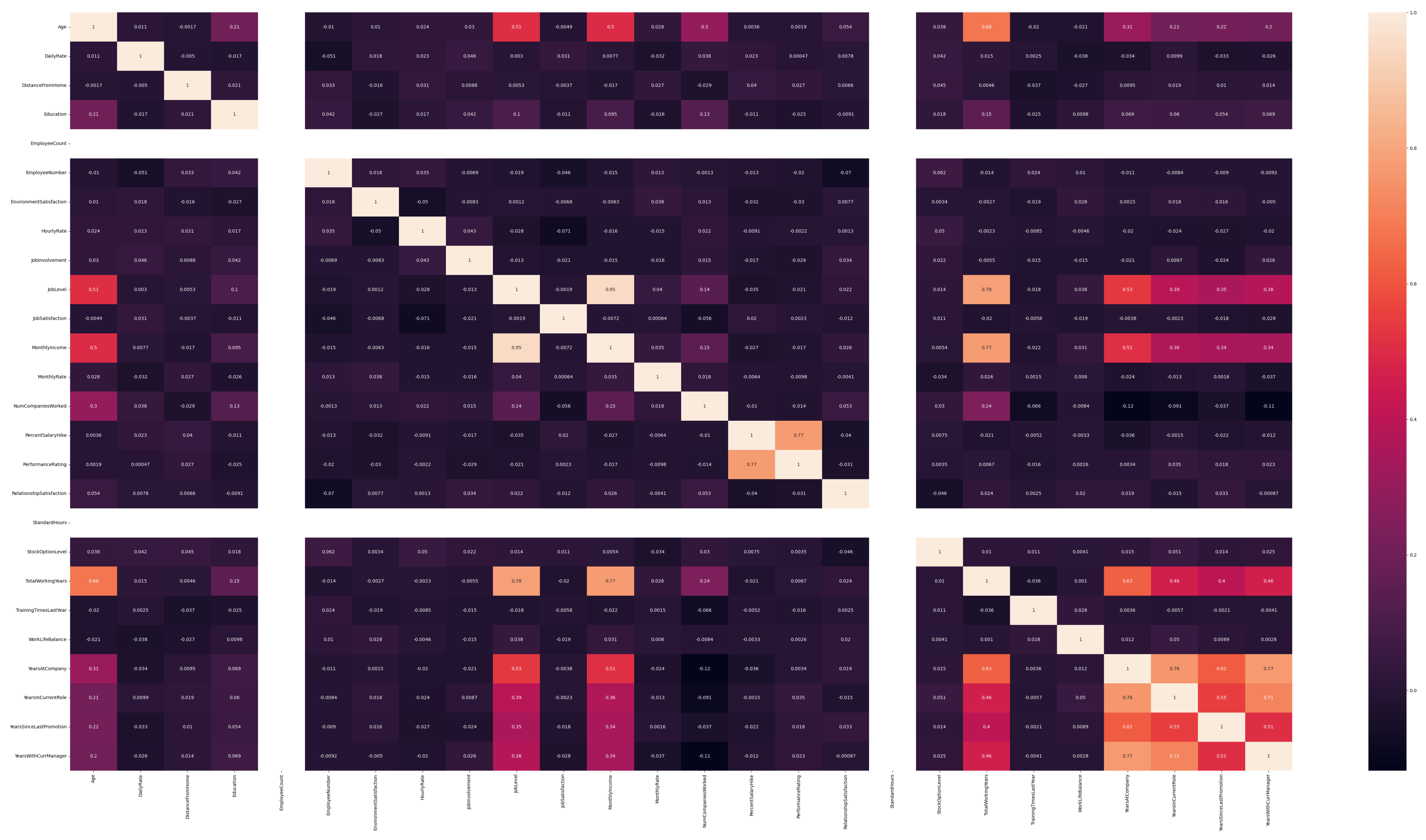
Correlation before Encoding

In [137…
```
corr=dataset.corr() #As Data visualization step in the question is given before encoding we are getting warning message.
```

```
C:\Users\hansi\AppData\Local\Temp\ipykernel_17304\2244050776.py:1: FutureWarning: The default value of numeric_only in DataFrame.corr is de
precated. In a future version, it will default to False. Select only valid columns or specify the value of numeric_only to silence this war
ning.
  corr=dataset.corr() #As Data visualization step in the question is given before encoding we are getting warning message.
```

In [139…
```
plt.subplots(figsize=(60,30))
sns.heatmap(corr,annot=True)
```

Out[139]:
```
<Axes: >
```



Inference : This heatmap is a graphical representation of the correlation between variables in a dataset. The color intensity and annotations provide a quick way to identify the strength and direction of relationships between variables. It's used in exploratory data analysis to identify potential correlations among features.

5.Outlier detection

Outliers are those data points that are significantly different from the rest of the dataset. They are often abnormal observations that skew the data distribution, and arise due to inconsistent data entry, or erroneous observations.

Outlier Removal 3 methods:

1.IQR - Inter quartile range => Q3-Q1

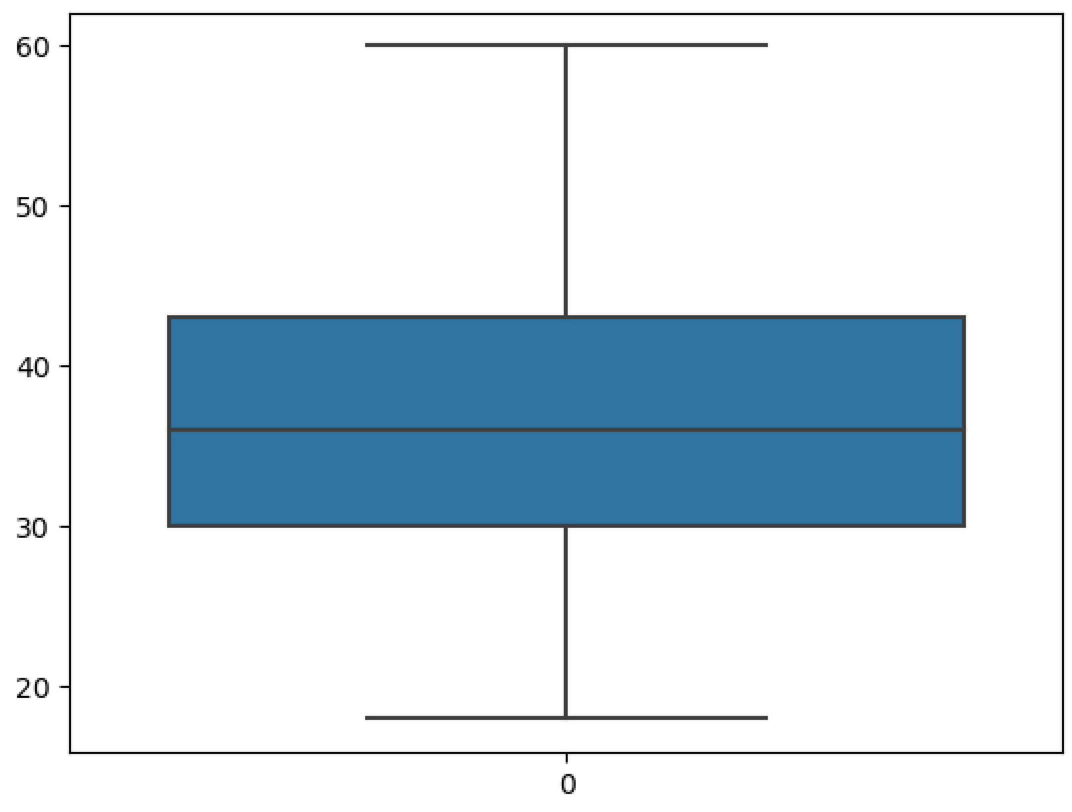
2.z Score

3.Percentile

Outlier Detection for Age

In [15]:
```
sns.boxplot(dataset.Age)
```

Out[15]:
```
<Axes: >
```

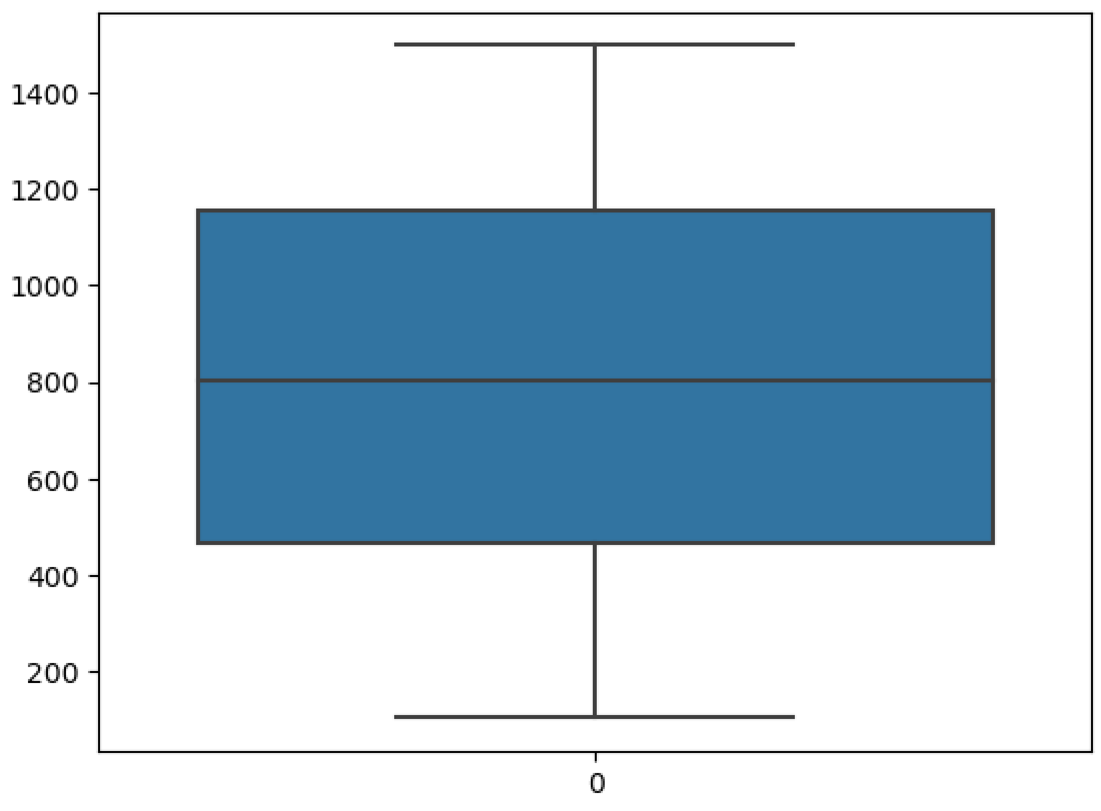


No outliers for Age

Outlier Detection for DailyRate

In [16]:
```
sns.boxplot(dataset.DailyRate)
```

Out[16]:
```
<Axes: >
```

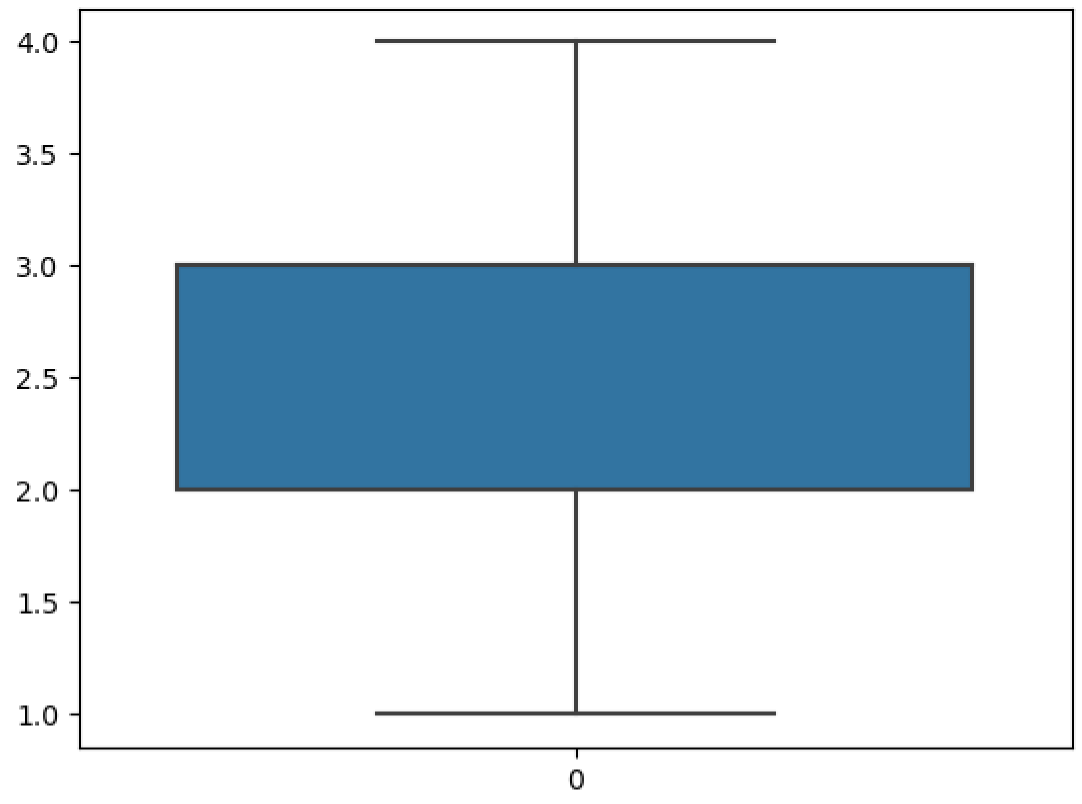


No outliers for Daily Rate

Outlier Detection for WorkLifeBalance

In [17]:
```
sns.boxplot(dataset.WorkLifeBalance)
```

Out[17]:
```
<Axes: >
```



No outliers for WorkLifeBalance

6.Seperation of dependent and independent variables

In [18]:
```
#Independent Variables
x=dataset.drop(columns=['Attrition'], inplace=False)
x
```

Out[18]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	...
0	41	Travel_Rarely	1102	Sales	1	2	Life Sciences	1	1	2	...
1	49	Travel_Frequently	279	Research & Development	8	1	Life Sciences	1	2	3	...
2	37	Travel_Rarely	1373	Research & Development	2	2	Other	1	4	4	...
3	33	Travel_Frequently	1392	Research & Development	3	4	Life Sciences	1	5	4	...
4	27	Travel_Rarely	591	Research & Development	2	1	Medical	1	7	1	...
...	...	...	...	...	...	...	...	...	...	...	...
1465	36	Travel_Frequently	884	Research & Development	23	2	Medical	1	2061	3	...
1466	39	Travel_Rarely	613	Research & Development	6	1	Medical	1	2062	4	...
1467	27	Travel_Rarely	155	Research & Development	4	3	Life Sciences	1	2064	2	...
1468	49	Travel_Frequently	1023	Sales	2	3	Medical	1	2065	4	...
1469	34	Travel_Rarely	628	Research & Development	8	3	Medical	1	2068	2	...

1470 rows × 34 columns

In [19]:
```
x.head()
```

Out[19]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	...	Rel
0	41	Travel_Rarely	1102	Sales	1	2	Life Sciences	1	1	2	...	
1	49	Travel_Frequently	279	Research & Development	8	1	Life Sciences	1	2	3	...	
2	37	Travel_Rarely	1373	Research & Development	2	2	Other	1	4	4	...	
3	33	Travel_Frequently	1392	Research & Development	3	4	Life Sciences	1	5	4	...	
4	27	Travel_Rarely	591	Research & Development	2	1	Medical	1	7	1	...	

5 rows × 34 columns

In [20]:
```
#Dependent variable
y=dataset.iloc[:,1:2]
```

```
In [21]: y
```

Out[21]:

	Attrition
0	Yes
1	No
2	Yes
3	No
4	No
...	...
1465	No
1466	No
1467	No
1468	No
1469	No

1470 rows × 1 columns

```
In [22]: dataset.shape
```

```
Out[22]: (1470, 35)
```

```
In [23]: x.shape
```

```
Out[23]: (1470, 34)
```

```
In [24]: y.shape
```

```
Out[24]: (1470, 1)
```

7.Encoding

Convert the strings into numerical or binary format

1.Nominal Encoding :If varaible is not worried the about arrangement of data i)one hot encoding ii)one hot encoding with many categorical variables iii)mean encoding

2.Ordinal Encoding : Take care about the rank of the data i)label encoding ii)Target guided ordinal encoding

```
In [25]: 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
```

Label Encoding on BusinessTravel

In [26]:
```
from sklearn.preprocessing import LabelEncoder
```

In [27]:
```
l=LabelEncoder()
```

In [28]:
```
x.BusinessTravel=l.fit_transform(x.BusinessTravel)
x["BusinessTravel"]
```

Out[28]:
```
0       2
1       1
2       2
3       1
4       2
       ..
1465    1
1466    2
1467    2
1468    1
1469    2
Name: BusinessTravel, Length: 1470, dtype: int32
```

In [29]:
```
x
```

Out[29]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	...	F
0	41	2	1102	Sales	1	2	Life Sciences	1	1	2	...	
1	49	1	279	Research & Development	8	1	Life Sciences	1	2	3	...	
2	37	2	1373	Research & Development	2	2	Other	1	4	4	...	
3	33	1	1392	Research & Development	3	4	Life Sciences	1	5	4	...	
4	27	2	591	Research & Development	2	1	Medical	1	7	1	...	
...	...	...	...	...	...	...	...	...	...	...	...	
1465	36	1	884	Research & Development	23	2	Medical	1	2061	3	...	
1466	39	2	613	Research & Development	6	1	Medical	1	2062	4	...	
1467	27	2	155	Research & Development	4	3	Life Sciences	1	2064	2	...	
1468	49	1	1023	Sales	2	3	Medical	1	2065	4	...	
1469	34	2	628	Research & Development	8	3	Medical	1	2068	2	...	

1470 rows × 34 columns

In [30]:
```
x["BusinessTravel"].value_counts()
```
Out[30]:
```
2    1043
1     277
0     150
Name: BusinessTravel, dtype: int64
```

Label Encoding on Department

In [31]:
```
x.Department=l.fit_transform(x.Department)
x["Department"]
```
Out[31]:
```
0       2
1       1
2       1
3       1
4       1
       ..
1465    1
1466    1
1467    1
1468    2
1469    1
Name: Department, Length: 1470, dtype: int32
```
In [32]:
```
x["Department"].value_counts()
```
Out[32]:
```
1    961
2    446
0     63
Name: Department, dtype: int64
```

Label Encoding on EducationField

In [33]:
```
x.EducationField=l.fit_transform(x.EducationField)
x["EducationField"]
```
Out[33]:
```
0       1
1       1
2       4
3       1
4       3
       ..
1465    3
1466    3
1467    1
1468    3
1469    3
Name: EducationField, Length: 1470, dtype: int32
```
In [34]:
```
x["EducationField"].value_counts()
```
Out[34]:
```
1    606
3    464
2    159
5    132
4     82
0     27
Name: EducationField, dtype: int64
```
In [35]:
```
x
```

Out[35]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	...	R
0	41	2	1102	2	1	2	1	1	1	2	...	
1	49	1	279	1	8	1	1	1	2	3	...	
2	37	2	1373	1	2	2	4	1	4	4	...	
3	33	1	1392	1	3	4	1	1	5	4	...	
4	27	2	591	1	2	1	3	1	7	1	...	
...	...	...	...	...	...	...	...	...	...	...	...	
1465	36	1	884	1	23	2	3	1	2061	3	...	
1466	39	2	613	1	6	1	3	1	2062	4	...	
1467	27	2	155	1	4	3	1	1	2064	2	...	
1468	49	1	1023	2	2	3	3	1	2065	4	...	
1469	34	2	628	1	8	3	3	1	2068	2	...	

1470 rows × 34 columns

Label Encoding on Gender,JobRole,MaritalStatus,Over18 & OverTime

In [36]:
```
# Label Encoding on Gender
x.Gender=l.fit_transform(x.Gender)
x["Gender"]
```

Out[36]:
```
0       0
1       1
2       1
3       0
4       1
       ..
1465    1
1466    1
1467    1
1468    1
1469    1
Name: Gender, Length: 1470, dtype: int32
```

In [37]:
```
#Label Encoding on JobRole
x.JobRole=l.fit_transform(x.JobRole)
x["JobRole"]
```

Out[37]:
```
0       7
1       6
2       2
3       6
4       2
       ..
1465    2
1466    0
1467    4
1468    7
1469    2
Name: JobRole, Length: 1470, dtype: int32
```

In [38]:
```
#Label Encoding on MaritalStatus
x.MaritalStatus=l.fit_transform(x.MaritalStatus)
x["MaritalStatus"]
```

Out[38]:
```
0       2
1       1
2       2
3       1
4       1
       ..
1465    1
1466    1
1467    1
1468    1
1469    1
Name: MaritalStatus, Length: 1470, dtype: int32
```

In [39]:
```
#Label Encoding on Over18
x.Over18=l.fit_transform(x.Over18)
x["Over18"]
```

Out[39]:
```
0       0
1       0
2       0
3       0
4       0
       ..
1465    0
1466    0
1467    0
1468    0
1469    0
Name: Over18, Length: 1470, dtype: int32
```

In [40]:
```python
#Label Encoding on OverTime
x.OverTime=l.fit_transform(x.OverTime)
x["OverTime"]
```
Out[40]:
```
0       1
1       0
2       1
3       1
4       0
       ..
1465    0
1466    0
1467    1
1468    0
1469    0
Name: OverTime, Length: 1470, dtype: int32
```
In [41]:
```python
x
```
Out[41]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	...	R
0	41	2	1102	2	1	2	1	1	1	2	...	
1	49	1	279	1	8	1	1	1	2	3	...	
2	37	2	1373	1	2	2	4	1	4	4	...	
3	33	1	1392	1	3	4	1	1	5	4	...	
4	27	2	591	1	2	1	3	1	7	1	...	
...	...	...	...	...	...	...	...	...	...	...	...	
1465	36	1	884	1	23	2	3	1	2061	3	...	
1466	39	2	613	1	6	1	3	1	2062	4	...	
1467	27	2	155	1	4	3	1	1	2064	2	...	
1468	49	1	1023	2	2	3	3	1	2065	4	...	
1469	34	2	628	1	8	3	3	1	2068	2	...	

1470 rows × 34 columns

Label encoding on Dependent Variable Attrition

In [42]:
```python
#Label Encoding on Attrition
y["Attrition"]=l.fit_transform(y.Attrition)
y["Attrition"]
```
Out[42]:
```
0       1
1       0
2       1
3       0
4       0
       ..
1465    0
1466    0
1467    0
1468    0
1469    0
Name: Attrition, Length: 1470, dtype: int32
```
We have training and testting data

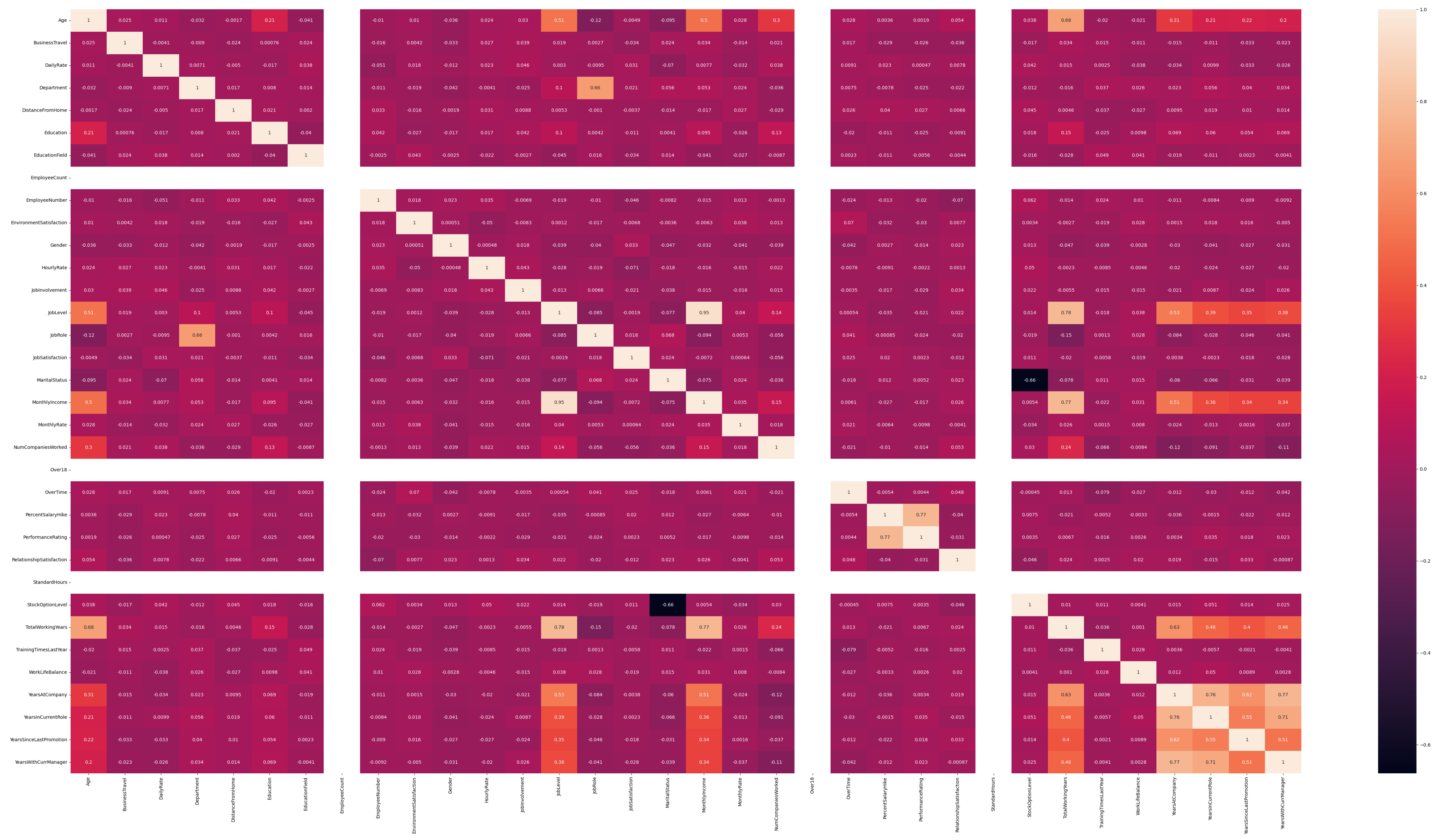
example: 1000 rows

Training data : 70%-80%

Testing data : 20%-30% (checking performance)

Correlation after encoding

In [43]:
```python
corr = x.corr()
plt.subplots(figsize=(60,30))
sns.heatmap(corr,annot=True)
```
Out[43]:
```
<Axes: >
```



9.Feature Scaling

```
In [44]: from sklearn.preprocessing import MinMaxScaler
         ms=MinMaxScaler()
         x_scaled=pd.DataFrame(ms.fit_transform(x),columns=x.columns)
```

```
In [45]: x_scaled
```

Out[45]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	.
0	0.547619	1.0	0.715820	1.0	0.000000	0.25	0.2	0.0	0.000000	0.333333	.
1	0.738095	0.5	0.126700	0.5	0.250000	0.00	0.2	0.0	0.000484	0.666667	.
2	0.452381	1.0	0.909807	0.5	0.035714	0.25	0.8	0.0	0.001451	1.000000	.
3	0.357143	0.5	0.923407	0.5	0.071429	0.75	0.2	0.0	0.001935	1.000000	.
4	0.214286	1.0	0.350036	0.5	0.035714	0.00	0.6	0.0	0.002903	0.000000	.
...	...	...	...	...	...	...	...	...	...	...	
1465	0.428571	0.5	0.559771	0.5	0.785714	0.25	0.6	0.0	0.996613	0.666667	.
1466	0.500000	1.0	0.365784	0.5	0.178571	0.00	0.6	0.0	0.997097	1.000000	.
1467	0.214286	1.0	0.037938	0.5	0.107143	0.50	0.2	0.0	0.998065	0.333333	.
1468	0.738095	0.5	0.659270	1.0	0.035714	0.50	0.6	0.0	0.998549	1.000000	.
1469	0.380952	1.0	0.376521	0.5	0.250000	0.50	0.6	0.0	1.000000	0.333333	.

1470 rows × 34 columns

8.Splitting into training set and testing set

```
In [59]: 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_state=0)
```

```
In [60]: x_train.shape,x_test.shape,y_train.shape,y_test.shape
```

```
Out[60]: ((1176, 34), (294, 34), (1176, 1), (294, 1))
```

```
In [61]: x_train.head()
```

Out[61]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	.
1374	0.952381	1.0	0.360057	1.0	0.714286	0.50	0.2	0.0	0.937107	1.000000	.
1092	0.642857	1.0	0.607015	0.5	0.964286	0.50	1.0	0.0	0.747460	1.000000	.
768	0.523810	1.0	0.141732	1.0	0.892857	0.50	0.4	0.0	0.515239	0.666667	.
569	0.428571	0.0	0.953472	1.0	0.250000	0.75	0.2	0.0	0.381229	0.000000	.
911	0.166667	0.5	0.355762	1.0	0.821429	0.00	0.2	0.0	0.615385	0.666667	.

5 rows × 34 columns

```
In [49]: x_test
```

Out[49]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	...	R
442	36	0	635	2	10	4	3	1	592	2	...	
1091	33	2	575	1	25	3	1	1	1545	4	...	
981	35	1	662	2	18	4	2	1	1380	4	...	
785	40	2	1492	1	20	4	5	1	1092	1	...	
1332	29	1	459	1	24	2	1	1	1868	4	...	
...	...	...	...	...	...	...	...	...	...	...	...	
1439	36	2	557	2	3	3	3	1	2024	1	...	
481	34	2	254	1	1	2	1	1	649	2	...	
124	31	2	249	2	6	4	1	1	163	2	...	
198	38	2	1261	1	2	4	1	1	271	4	...	
1229	40	2	369	1	8	2	1	1	1724	2	...	

294 rows × 34 columns

```
In [50]: y_train
```

Out[50]:

	Attrition
1374	0
1092	0
768	0
569	0
911	1
...	...
763	0
835	0
1216	0
559	0
684	0

1176 rows × 1 columns

```
In [51]: y_test
```

Out[51]:

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

294 rows × 1 columns

In [ ]:

```
```

MODEL BUILDING

1.Train the model using the training set

2.Test the model on testing set

3.Evaluation of the model

In [62]:

```
from sklearn.linear_model import LogisticRegression
model=LogisticRegression()
```

Initializing the model

In [63]:

```
model.fit(x_train,y_train)
```

```
C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\utils\validation.py:1184: 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)
```

Out[63]:

```
▾ LogisticRegression
LogisticRegression()
```

In [64]:

```
pred=model.predict(x_test)
```

In [65]:

```
pred
```

Out[65]:

```
array([0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 1, 0, 0, 1, 1, 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, 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, 1, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 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, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 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, 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, 1, 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, 1, 0, 0])
```

In [66]:

```
y_test
```

Out[66]:

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

294 rows × 1 columns

Evaluation of classification model

In [67]:
```
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report,roc_auc_score,roc_curve
```

In [68]:
```
accuracy_score(y_test,pred)
```

Out[68]:
```
0.8843537414965986
```

In [69]:
```
confusion_matrix(y_test,pred)
```

Out[69]:
```
array([[242,   3],
       [ 31,  18]], dtype=int64)
```

In [71]:
```
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.89      0.99      0.93       245
           1       0.86      0.37      0.51        49

    accuracy                           0.88       294
   macro avg       0.87      0.68      0.72       294
weighted avg       0.88      0.88      0.86       294
```

ROC CURVE

In [73]:
```
prob=model.predict_proba(x_test)[:,1]
```

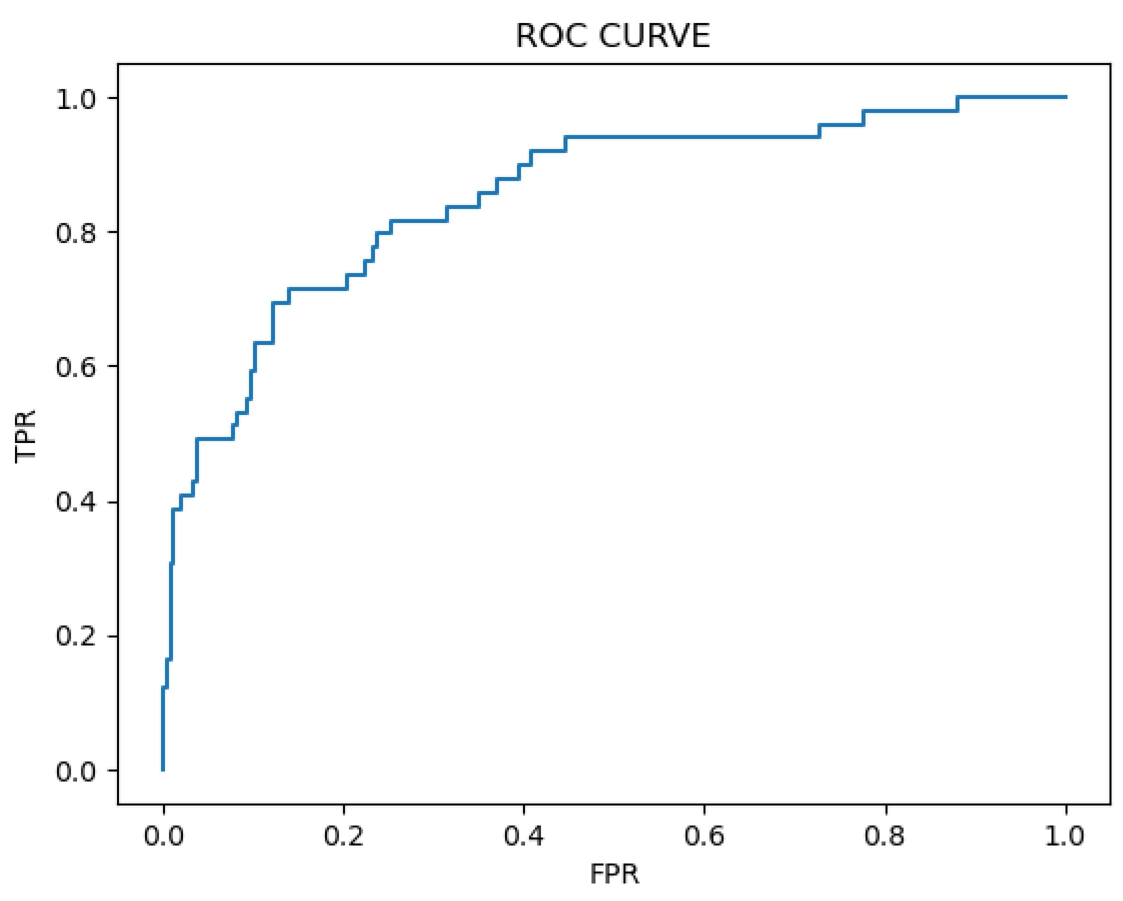
In [74]:
```
prob
```

```
Out[74]: array([0.16000127, 0.20600667, 0.31532384, 0.09242886, 0.63667551,
                0.06153061, 0.61819432, 0.0757087 , 0.00841372, 0.3912069 ,
                0.05398439, 0.33293123, 0.02020698, 0.67215483, 0.19786547,
                0.03454902, 0.11043981, 0.17101703, 0.04477777, 0.22783614,
                0.2335018 , 0.01553905, 0.06464492, 0.05029956, 0.58792413,
                0.44849464, 0.07412714, 0.04460935, 0.67666632, 0.0584383 ,
                0.01599026, 0.03521098, 0.06963085, 0.17397462, 0.07830857,
                0.04288032, 0.08150424, 0.07106342, 0.03622137, 0.05223965,
                0.04862098, 0.02091497, 0.01819361, 0.01362467, 0.02873997,
                0.50236969, 0.41553218, 0.00306874, 0.73976412, 0.51382382,
                0.09637213, 0.48845516, 0.08036228, 0.25757243, 0.66516772,
                0.26308027, 0.01964858, 0.30198497, 0.02919946, 0.16038964,
                0.02102747, 0.21670232, 0.13981568, 0.0358316 , 0.37208403,
                0.03002317, 0.29091186, 0.16041142, 0.10437497, 0.08695177,
                0.08217589, 0.30984518, 0.08531362, 0.07420689, 0.12268651,
                0.06192552, 0.04640904, 0.07624712, 0.19738483, 0.03236316,
                0.00884439, 0.0244108 , 0.13635803, 0.0260104 , 0.03341008,
                0.08186888, 0.00499397, 0.03474852, 0.03858027, 0.14602694,
                0.26167665, 0.16667357, 0.27400109, 0.24159565, 0.02160421,
                0.17748606, 0.34076078, 0.28022482, 0.06914126, 0.05003806,
                0.24437761, 0.74698271, 0.35438567, 0.01920627, 0.08778845,
                0.03255847, 0.05461351, 0.15123251, 0.06843702, 0.13752637,
                0.09584388, 0.04669882, 0.02493091, 0.15383171, 0.07081259,
                0.03089296, 0.0537667 , 0.11554316, 0.00881616, 0.01263271,
                0.17552253, 0.05045234, 0.08823238, 0.82995757, 0.03017756,
                0.0236819 , 0.0087012 , 0.1349589 , 0.16474801, 0.05202613,
                0.01524549, 0.29278083, 0.54767448, 0.34275448, 0.04629541,
                0.38966344, 0.61333366, 0.14552367, 0.07402366, 0.24143471,
                0.09418418, 0.0689069 , 0.10061956, 0.19346327, 0.20026293,
                0.03004939, 0.14900424, 0.00348846, 0.11225149, 0.15843155,
                0.06047573, 0.18601882, 0.06085869, 0.12221317, 0.03280184,
                0.02738799, 0.06356425, 0.08302382, 0.01541716, 0.014665  ,
                0.38517822, 0.01264231, 0.14961974, 0.80508787, 0.11598661,
                0.2842811 , 0.17020143, 0.1530583 , 0.02764153, 0.00613226,
                0.04191632, 0.09782393, 0.11551417, 0.10377982, 0.01779313,
                0.14371315, 0.10615435, 0.10298963, 0.05132621, 0.09061081,
                0.02897383, 0.09924087, 0.00512032, 0.75108423, 0.04296968,
                0.04062134, 0.37518972, 0.04563128, 0.7251816 , 0.10671665,
                0.36949086, 0.38146941, 0.32095493, 0.05266802, 0.08172004,
                0.13947833, 0.04334317, 0.01469593, 0.26413988, 0.06330966,
                0.1614747 , 0.15380517, 0.67152357, 0.05840793, 0.27891823,
                0.04512564, 0.46033865, 0.00348431, 0.14068967, 0.02747401,
                0.12714133, 0.17284246, 0.07341066, 0.10099827, 0.16870885,
                0.02560842, 0.01824031, 0.08670796, 0.02834237, 0.13710215,
                0.08778935, 0.2200061 , 0.73401148, 0.15938978, 0.4095449 ,
                0.01513845, 0.11306309, 0.21497506, 0.32337575, 0.03409266,
                0.04256318, 0.32157531, 0.05454465, 0.02348479, 0.16423352,
                0.32696147, 0.22892063, 0.00877159, 0.08198819, 0.01156361,
                0.1408691 , 0.29235147, 0.01270305, 0.17329916, 0.04081391,
                0.04094165, 0.42771425, 0.34958286, 0.03766772, 0.12025286,
                0.37698923, 0.3192629 , 0.79559338, 0.05385659, 0.21597037,
                0.06383728, 0.00570991, 0.66018187, 0.35855286, 0.37783606,
                0.36781398, 0.03554512, 0.21718203, 0.05943622, 0.06554485,
                0.10081475, 0.00818713, 0.26591316, 0.42809675, 0.06542835,
                0.09296803, 0.01259826, 0.14226651, 0.05072662, 0.02372258,
                0.02586923, 0.06760427, 0.24315648, 0.26961432, 0.19831733,
                0.2652296 , 0.0165923 , 0.15784236, 0.08398982, 0.02711775,
                0.18750547, 0.00783535, 0.2844239 , 0.00270742, 0.02484969,
                0.22585745, 0.72775605, 0.07691547, 0.26304359])
```

ROC_curve

```
In [75]: fpr,tpr,threshsholds = roc_curve(y_test,probability)
```

```
In [76]: plt.plot(fpr,tpr)
         plt.xlabel('FPR')
         plt.ylabel('TPR')
         plt.title('ROC CURVE')
         plt.show()
```



DECISION TREE

In [77]:
```
from sklearn.tree import DecisionTreeClassifier
dc=DecisionTreeClassifier()
```

In [78]:
```
dc.fit(x_train,y_train)
```

Out[78]:
```
▾ DecisionTreeClassifier
DecisionTreeClassifier()
```

In [79]:
```
pred=dc.predict(x_test)
```

In [80]:
```
pred
```

Out[80]:
```
array([0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0,
       0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0,
       0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
       0, 0, 1, 0, 0, 1, 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, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1,
       1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 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, 1,
       0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
       0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0,
       0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1,
       0, 1, 1, 0, 0, 0, 0, 0])
```

In [81]:
```
y_test
```

Out[81]:

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

294 rows × 1 columns

In [82]:
```
dataset
```

Out[82]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	...	RelationshipSat
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life Sciences	1	1	...	
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life Sciences	1	2	...	
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	Other	1	4	...	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life Sciences	1	5	...	
4	27	No	Travel_Rarely	591	Research & Development	2	1	Medical	1	7	...	
...	...	...	...	...	...	...	...	...	...	...	...	
1465	36	No	Travel_Frequently	884	Research & Development	23	2	Medical	1	2061	...	
1466	39	No	Travel_Rarely	613	Research & Development	6	1	Medical	1	2062	...	
1467	27	No	Travel_Rarely	155	Research & Development	4	3	Life Sciences	1	2064	...	
1468	49	No	Travel_Frequently	1023	Sales	2	3	Medical	1	2065	...	
1469	34	No	Travel_Rarely	628	Research & Development	8	3	Medical	1	2068	...	

1470 rows × 35 columns

In [85]:
```python
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report,roc_auc_score,roc_curve
```

In [86]:
```python
accuracy_score(y_test,pred)
```

Out[86]:
```
0.7517006802721088
```

In [87]:
```python
confusion_matrix(y_test,pred)
```

Out[87]:
```
array([[204,  41],
       [ 32,  17]], dtype=int64)
```

In [89]:
```python
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.86      0.83      0.85       245
           1       0.29      0.35      0.32        49

    accuracy                           0.75       294
   macro avg       0.58      0.59      0.58       294
weighted avg       0.77      0.75      0.76       294
```

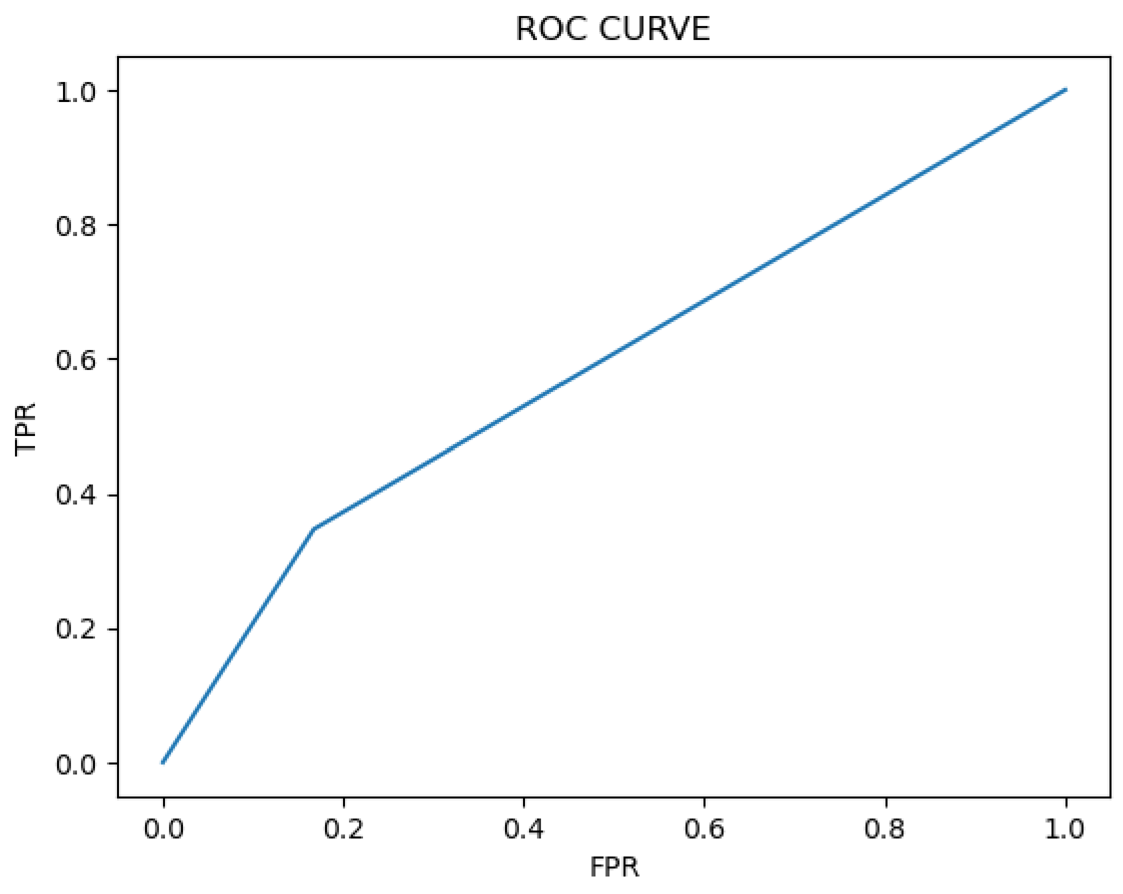
In [91]:
```python
probability=dc.predict_proba(x_test)[:,1]
```

In [92]:
```python
probability
```

Out[92]:
```
array([0., 0., 0., 0., 0., 0., 1., 0., 0., 0., 0., 0., 0., 1., 0., 0., 0.,
       0., 0., 0., 1., 0., 0., 0., 1., 0., 0., 0., 1., 0., 0., 0., 0., 0.,
       0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0., 1.,
       1., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0., 1., 0., 0., 0.,
       0., 0., 0., 1., 0., 1., 0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 0.,
       0., 1., 1., 0., 0., 1., 0., 0., 1., 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.,
       0., 0., 0., 0., 1., 1., 0., 0., 0., 0., 0., 0., 1., 1., 1., 1., 0.,
       0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 0., 1., 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., 1., 0., 1., 1., 0., 0., 0., 0., 1., 0., 0., 1.,
       0., 0., 1., 0., 1., 1., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0.,
       1., 0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0., 1., 1., 0.,
       0., 1., 0., 0., 1., 0., 1., 1., 0., 0., 1., 0., 0., 0., 0., 0., 0.,
       0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0., 0.,
       0., 0., 1., 0., 0., 0., 0., 1., 0., 0., 1., 0., 1., 0., 0., 0., 0.,
       0., 0., 0., 0., 0., 0., 0., 1., 0., 0., 1., 0., 0., 1., 0., 1., 1.,
       0., 0., 0., 0., 0.])
```

In [93]:
```python
fpr,tpr,threshsholds = roc_curve(y_test,probability)
```

In [94]:
```python
plt.plot(fpr,tpr)
plt.xlabel('FPR')
plt.ylabel('TPR')
plt.title('ROC CURVE')
plt.show()
```



Hyper Parameter Tuning

```
In [96]: from sklearn import tree
         plt.figure(figsize=(25,15))
         tree.plot_tree(dc,filled=True)
```

```
Out[96]: [Text(0.3255570652173913, 0.9722222222222222, 'x[27] <= 0.038\ngini = 0.269\nsamples = 1176\nvalue = [988, 188]'),
          Text(0.08347826086956522, 0.9166666666666666, 'x[16] <= 0.75\ngini = 0.5\nsamples = 78\nvalue = [39, 39]'),
          Text(0.05217391304347826, 0.8611111111111112, 'x[4] <= 0.554\ngini = 0.426\nsamples = 39\nvalue = [27, 12]'),
          Text(0.034782608695652174, 0.8055555555555556, 'x[15] <= 0.167\ngini = 0.312\nsamples = 31\nvalue = [25, 6]'),
          Text(0.020869565217391306, 0.75, 'x[21] <= 0.5\ngini = 0.49\nsamples = 7\nvalue = [3, 4]'),
          Text(0.01391304347826087, 0.6944444444444444, 'x[22] <= 0.321\ngini = 0.375\nsamples = 4\nvalue = [3, 1]'),
          Text(0.006956521739130435, 0.6388888888888888, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]'),
          Text(0.020869565217391306, 0.6388888888888888, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.02782608695652174, 0.6944444444444444, 'gini = 0.0\nsamples = 3\nvalue = [0, 3]'),
          Text(0.04869565217391304, 0.75, 'x[19] <= 0.056\ngini = 0.153\nsamples = 24\nvalue = [22, 2]'),
          Text(0.04173913043478261, 0.6944444444444444, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.05565217391304348, 0.6944444444444444, 'x[9] <= 0.167\ngini = 0.083\nsamples = 23\nvalue = [22, 1]'),
          Text(0.04869565217391304, 0.6388888888888888, 'x[28] <= 0.583\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
          Text(0.04173913043478261, 0.5833333333333334, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.05565217391304348, 0.5833333333333334, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
          Text(0.06260869565217392, 0.6388888888888888, 'gini = 0.0\nsamples = 21\nvalue = [21, 0]'),
          Text(0.06956521739130435, 0.8055555555555556, 'x[22] <= 0.679\ngini = 0.375\nsamples = 8\nvalue = [2, 6]'),
          Text(0.06260869565217392, 0.75, 'gini = 0.0\nsamples = 6\nvalue = [0, 6]'),
          Text(0.07652173913043478, 0.75, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),
          Text(0.11478260869565217, 0.8611111111111112, 'x[11] <= 0.364\ngini = 0.426\nsamples = 39\nvalue = [12, 27]'),
          Text(0.09739130434782609, 0.8055555555555556, 'x[0] <= 0.369\ngini = 0.133\nsamples = 14\nvalue = [1, 13]'),
          Text(0.09043478260869565, 0.75, 'gini = 0.0\nsamples = 13\nvalue = [0, 13]'),
          Text(0.10434782608695652, 0.75, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
          Text(0.13217391304347825, 0.8055555555555556, 'x[8] <= 0.105\ngini = 0.493\nsamples = 25\nvalue = [11, 14]'),
          Text(0.11826086956521739, 0.75, 'x[22] <= 0.464\ngini = 0.278\nsamples = 6\nvalue = [5, 1]'),
          Text(0.11130434782608696, 0.6944444444444444, 'gini = 0.0\nsamples = 5\nvalue = [5, 0]'),
          Text(0.12521739130434784, 0.6944444444444444, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.14608695652173914, 0.75, 'x[15] <= 0.5\ngini = 0.432\nsamples = 19\nvalue = [6, 13]'),
          Text(0.1391304347826087, 0.6944444444444444, 'gini = 0.0\nsamples = 7\nvalue = [0, 7]'),
          Text(0.15304347826086956, 0.6944444444444444, 'x[6] <= 0.4\ngini = 0.5\nsamples = 12\nvalue = [6, 6]'),
          Text(0.1391304347826087, 0.6388888888888888, 'x[5] <= 0.125\ngini = 0.278\nsamples = 6\nvalue = [5, 1]'),
          Text(0.13217391304347825, 0.5833333333333334, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.14608695652173914, 0.5833333333333334, 'gini = 0.0\nsamples = 5\nvalue = [5, 0]'),
          Text(0.16695652173913045, 0.6388888888888888, 'x[8] <= 0.249\ngini = 0.278\nsamples = 6\nvalue = [1, 5]'),
          Text(0.16, 0.5833333333333334, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
          Text(0.17391304347826086, 0.5833333333333334, 'gini = 0.0\nsamples = 5\nvalue = [0, 5]'),
          Text(0.5676358695652174, 0.9166666666666666, 'x[21] <= 0.5\ngini = 0.235\nsamples = 1098\nvalue = [949, 149]'),
          Text(0.3196195652173913, 0.8611111111111112, 'x[29] <= 0.167\ngini = 0.162\nsamples = 798\nvalue = [727, 71]'),
          Text(0.18782608695652173, 0.8055555555555556, 'x[8] <= 0.445\ngini = 0.38\nsamples = 47\nvalue = [35, 12]'),
          Text(0.17391304347826086, 0.75, 'x[16] <= 0.75\ngini = 0.1\nsamples = 19\nvalue = [18, 1]'),
          Text(0.16695652173913045, 0.6944444444444444, 'gini = 0.0\nsamples = 18\nvalue = [18, 0]'),
          Text(0.1808695652173913, 0.6944444444444444, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.20173913043478262, 0.75, 'x[17] <= 0.094\ngini = 0.477\nsamples = 28\nvalue = [17, 11]'),
          Text(0.19478260869565217, 0.6944444444444444, 'gini = 0.0\nsamples = 4\nvalue = [0, 4]'),
          Text(0.20869565217391303, 0.6944444444444444, 'x[32] <= 0.6\ngini = 0.413\nsamples = 24\nvalue = [17, 7]'),
          Text(0.20173913043478262, 0.6388888888888888, 'x[11] <= 0.486\ngini = 0.351\nsamples = 22\nvalue = [17, 5]'),
          Text(0.19478260869565217, 0.5833333333333334, 'x[24] <= 0.5\ngini = 0.496\nsamples = 11\nvalue = [6, 5]'),
          Text(0.18782608695652173, 0.5277777777777778, 'x[0] <= 0.56\ngini = 0.408\nsamples = 7\nvalue = [2, 5]'),
          Text(0.1808695652173913, 0.4722222222222222, 'gini = 0.0\nsamples = 5\nvalue = [0, 5]'),
          Text(0.19478260869565217, 0.4722222222222222, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),
          Text(0.20173913043478262, 0.5277777777777778, 'gini = 0.0\nsamples = 4\nvalue = [4, 0]'),
          Text(0.20869565217391303, 0.5833333333333334, 'gini = 0.0\nsamples = 11\nvalue = [11, 0]'),
          Text(0.21565217391304348, 0.6388888888888888, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
          Text(0.4514130434782609, 0.8055555555555556, 'x[27] <= 0.975\ngini = 0.145\nsamples = 751\nvalue = [692, 59]'),
          Text(0.4444565217391304, 0.75, 'x[30] <= 0.113\ngini = 0.143\nsamples = 750\nvalue = [692, 58]'),
          Text(0.3143478260869565, 0.6944444444444444, 'x[9] <= 0.167\ngini = 0.218\nsamples = 257\nvalue = [225, 32]'),
          Text(0.26956521739130435, 0.6388888888888888, 'x[33] <= 0.147\ngini = 0.355\nsamples = 65\nvalue = [50, 15]'),
          Text(0.24695652173913044, 0.5833333333333334, 'x[33] <= 0.029\ngini = 0.303\nsamples = 59\nvalue = [48, 11]'),
          Text(0.22260869565217392, 0.5277777777777778, 'x[12] <= 0.5\ngini = 0.463\nsamples = 22\nvalue = [14, 8]'),
          Text(0.20869565217391303, 0.4722222222222222, 'x[11] <= 0.179\ngini = 0.198\nsamples = 9\nvalue = [8, 1]'),
          Text(0.20173913043478262, 0.4166666666666667, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.21565217391304348, 0.4166666666666667, 'gini = 0.0\nsamples = 8\nvalue = [8, 0]'),
          Text(0.23652173913043478, 0.4722222222222222, 'x[11] <= 0.4\ngini = 0.497\nsamples = 13\nvalue = [6, 7]'),
          Text(0.22956521739130434, 0.4166666666666667, 'gini = 0.0\nsamples = 4\nvalue = [4, 0]'),
          Text(0.24347826086956523, 0.4166666666666667, 'x[4] <= 0.286\ngini = 0.346\nsamples = 9\nvalue = [2, 7]'),
          Text(0.23652173913043478, 0.3611111111111111, 'x[5] <= 0.5\ngini = 0.444\nsamples = 3\nvalue = [2, 1]'),
          Text(0.22956521739130434, 0.3055555555555556, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.24347826086956523, 0.3055555555555556, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),
          Text(0.25043478260869567, 0.3611111111111111, 'gini = 0.0\nsamples = 6\nvalue = [0, 6]'),
          Text(0.271304347826087, 0.5277777777777778, 'x[15] <= 0.167\ngini = 0.149\nsamples = 37\nvalue = [34, 3]'),
          Text(0.2643478260869565, 0.4722222222222222, 'x[29] <= 0.5\ngini = 0.5\nsamples = 6\nvalue = [3, 3]'),
          Text(0.2573913043478261, 0.4166666666666667, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]'),
          Text(0.271304347826087, 0.4166666666666667, 'gini = 0.0\nsamples = 3\nvalue = [0, 3]'),
          Text(0.2782608695652174, 0.4722222222222222, 'gini = 0.0\nsamples = 31\nvalue = [31, 0]'),
          Text(0.2921739130434783, 0.5833333333333334, 'x[8] <= 0.065\ngini = 0.444\nsamples = 6\nvalue = [2, 4]'),
          Text(0.2852173913043478, 0.5277777777777778, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),
          Text(0.2991304347826087, 0.5277777777777778, 'gini = 0.0\nsamples = 4\nvalue = [0, 4]'),
          Text(0.3591304347826087, 0.6388888888888888, 'x[0] <= 0.321\ngini = 0.161\nsamples = 192\nvalue = [175, 17]'),
          Text(0.32, 0.5833333333333334, 'x[6] <= 0.1\ngini = 0.294\nsamples = 67\nvalue = [55, 12]'),
          Text(0.3130434782608696, 0.5277777777777778, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
          Text(0.3269565217391304, 0.5277777777777778, 'x[29] <= 0.5\ngini = 0.26\nsamples = 65\nvalue = [55, 10]'),
          Text(0.3026086956521739, 0.4722222222222222, 'x[6] <= 0.5\ngini = 0.469\nsamples = 16\nvalue = [10, 6]'),
          Text(0.2956521739130435, 0.4166666666666667, 'gini = 0.0\nsamples = 7\nvalue = [7, 0]'),
          Text(0.3095652173913043, 0.4166666666666667, 'x[9] <= 0.833\ngini = 0.444\nsamples = 9\nvalue = [3, 6]'),
          Text(0.3026086956521739, 0.3611111111111111, 'gini = 0.0\nsamples = 5\nvalue = [0, 5]'),
          Text(0.3165217391304348, 0.3611111111111111, 'x[2] <= 0.566\ngini = 0.375\nsamples = 4\nvalue = [3, 1]'),
          Text(0.3095652173913043, 0.3055555555555556, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]'),
          Text(0.3234782608695652, 0.3055555555555556, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.35130434782608694, 0.4722222222222222, 'x[2] <= 0.037\ngini = 0.15\nsamples = 49\nvalue = [45, 4]'),
          Text(0.3443478260869565, 0.4166666666666667, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
          Text(0.3582608695652174, 0.4166666666666667, 'x[2] <= 0.938\ngini = 0.117\nsamples = 48\nvalue = [45, 3]'),
          Text(0.35130434782608694, 0.3611111111111111, 'x[5] <= 0.875\ngini = 0.081\nsamples = 47\nvalue = [45, 2]'),
          Text(0.3373913043478261, 0.3055555555555556, 'x[12] <= 0.167\ngini = 0.043\nsamples = 45\nvalue = [44, 1]'),
          Text(0.33043478260869563, 0.25, 'x[14] <= 0.625\ngini = 0.444\nsamples = 3\nvalue = [2, 1]'),
          Text(0.3234782608695652, 0.19444444444444445, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),
Text(0.3373913043478261, 0.19444444444444445, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.3443478260869565, 0.25, 'gini = 0.0\nsamples = 42\nvalue = [42, 0]'),
Text(0.3652173913043478, 0.3055555555555556, 'x[10] <= 0.5\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.3582608695652174, 0.25, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.37217391304347824, 0.25, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.3652173913043478, 0.3611111111111111, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.3982608695652174, 0.5833333333333334, 'x[8] <= 0.022\ngini = 0.077\nsamples = 125\nvalue = [120, 5]'),
Text(0.3791304347826087, 0.5277777777777778, 'x[14] <= 0.5\ngini = 0.5\nsamples = 4\nvalue = [2, 2]'),
Text(0.37217391304347824, 0.4722222222222222, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),
Text(0.38608695652173913, 0.4722222222222222, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.41739130434782606, 0.5277777777777778, 'x[18] <= 0.968\ngini = 0.048\nsamples = 121\nvalue = [118, 3]'),
Text(0.4, 0.4722222222222222, 'x[2] <= 0.98\ngini = 0.033\nsamples = 118\nvalue = [116, 2]'),
Text(0.38608695652173913, 0.4166666666666667, 'x[14] <= 0.938\ngini = 0.017\nsamples = 114\nvalue = [113, 1]'),
Text(0.3791304347826087, 0.3611111111111111, 'gini = 0.0\nsamples = 107\nvalue = [107, 0]'),
Text(0.39304347826086955, 0.3611111111111111, 'x[16] <= 0.25\ngini = 0.245\nsamples = 7\nvalue = [6, 1]'),
Text(0.38608695652173913, 0.3055555555555556, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.4, 0.3055555555555556, 'gini = 0.0\nsamples = 6\nvalue = [6, 0]'),
Text(0.41391304347826086, 0.4166666666666667, 'x[3] <= 0.75\ngini = 0.375\nsamples = 4\nvalue = [3, 1]'),
Text(0.40695652173913044, 0.3611111111111111, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]'),
Text(0.42086956521739133, 0.3611111111111111, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.43478260869565216, 0.4722222222222222, 'x[1] <= 0.75\ngini = 0.444\nsamples = 3\nvalue = [2, 1]'),
Text(0.42782608695652175, 0.4166666666666667, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),
Text(0.44173913043478263, 0.4166666666666667, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.5745652173913044, 0.6944444444444444, 'x[30] <= 0.787\ngini = 0.1\nsamples = 493\nvalue = [467, 26]'),
Text(0.538695652173913, 0.6388888888888888, 'x[15] <= 0.5\ngini = 0.094\nsamples = 486\nvalue = [462, 24]'),
Text(0.48782608695652174, 0.5833333333333334, 'x[14] <= 0.938\ngini = 0.154\nsamples = 191\nvalue = [175, 16]'),
Text(0.4808695652173913, 0.5277777777777778, 'x[18] <= 0.481\ngini = 0.145\nsamples = 190\nvalue = [175, 15]'),
Text(0.46260869565217394, 0.4722222222222222, 'x[33] <= 0.794\ngini = 0.221\nsamples = 95\nvalue = [83, 12]'),
Text(0.45565217391304347, 0.4166666666666667, 'x[18] <= 0.47\ngini = 0.207\nsamples = 94\nvalue = [83, 11]'),
Text(0.44869565217391305, 0.3611111111111111, 'x[5] <= 0.375\ngini = 0.192\nsamples = 93\nvalue = [83, 10]'),
Text(0.4260869565217391, 0.3055555555555556, 'x[6] <= 0.9\ngini = 0.363\nsamples = 21\nvalue = [16, 5]'),
Text(0.4191304347826087, 0.25, 'x[17] <= 0.413\ngini = 0.266\nsamples = 19\nvalue = [16, 3]'),
Text(0.4052173913043478, 0.19444444444444445, 'x[19] <= 0.056\ngini = 0.117\nsamples = 16\nvalue = [15, 1]'),
Text(0.3982608695652174, 0.1388888888888889, 'x[15] <= 0.167\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.391304347826087, 0.08333333333333333, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.4052173913043478, 0.08333333333333333, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.4121739130434783, 0.1388888888888889, 'gini = 0.0\nsamples = 14\nvalue = [14, 0]'),
Text(0.4330434782608696, 0.19444444444444445, 'x[24] <= 0.833\ngini = 0.444\nsamples = 3\nvalue = [1, 2]'),
Text(0.4260869565217391, 0.1388888888888889, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.44, 0.1388888888888889, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.4330434782608696, 0.25, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.47130434782608693, 0.3055555555555556, 'x[31] <= 0.139\ngini = 0.129\nsamples = 72\nvalue = [67, 5]'),
Text(0.4539130434782609, 0.25, 'x[8] <= 0.68\ngini = 0.444\nsamples = 6\nvalue = [4, 2]'),
Text(0.4469565217391304, 0.19444444444444445, 'gini = 0.0\nsamples = 4\nvalue = [4, 0]'),
Text(0.4608695652173913, 0.19444444444444445, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.48869565217391303, 0.25, 'x[2] <= 0.958\ngini = 0.087\nsamples = 66\nvalue = [63, 3]'),
Text(0.4747826086956522, 0.19444444444444445, 'x[28] <= 0.583\ngini = 0.061\nsamples = 64\nvalue = [62, 2]'),
Text(0.4678260869565217, 0.1388888888888889, 'gini = 0.0\nsamples = 52\nvalue = [52, 0]'),
Text(0.4817391304347826, 0.1388888888888889, 'x[3] <= 0.75\ngini = 0.278\nsamples = 12\nvalue = [10, 2]'),
Text(0.4747826086956522, 0.08333333333333333, 'gini = 0.0\nsamples = 9\nvalue = [9, 0]'),
Text(0.48869565217391303, 0.08333333333333333, 'x[18] <= 0.353\ngini = 0.444\nsamples = 3\nvalue = [1, 2]'),
Text(0.4817391304347826, 0.027777777777777776, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.4956521739130435, 0.027777777777777776, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.5026086956521739, 0.19444444444444445, 'x[22] <= 0.286\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.4956521739130435, 0.1388888888888889, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.5095652173913043, 0.1388888888888889, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.46260869565217394, 0.3611111111111111, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.46956521739130436, 0.4166666666666667, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.4991304347826087, 0.4722222222222222, 'x[19] <= 0.5\ngini = 0.061\nsamples = 95\nvalue = [92, 3]'),
Text(0.49217391304347824, 0.4166666666666667, 'gini = 0.0\nsamples = 76\nvalue = [76, 0]'),
Text(0.5060869565217392, 0.4166666666666667, 'x[8] <= 0.161\ngini = 0.266\nsamples = 19\nvalue = [16, 3]'),
Text(0.49217391304347824, 0.3611111111111111, 'x[2] <= 0.096\ngini = 0.444\nsamples = 3\nvalue = [1, 2]'),
Text(0.4852173913043478, 0.3055555555555556, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.4991304347826087, 0.3055555555555556, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.52, 0.3611111111111111, 'x[31] <= 0.639\ngini = 0.117\nsamples = 16\nvalue = [15, 1]'),
Text(0.5130434782608696, 0.3055555555555556, 'gini = 0.0\nsamples = 14\nvalue = [14, 0]'),
Text(0.5269565217391304, 0.3055555555555556, 'x[27] <= 0.537\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.52, 0.25, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.5339130434782609, 0.25, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.49478260869565216, 0.5277777777777778, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.5895652173913043, 0.5833333333333334, 'x[22] <= 0.036\ngini = 0.053\nsamples = 295\nvalue = [287, 8]'),
Text(0.5652173913043478, 0.5277777777777778, 'x[32] <= 0.7\ngini = 0.159\nsamples = 46\nvalue = [42, 4]'),
Text(0.5582608695652174, 0.4722222222222222, 'x[12] <= 0.167\ngini = 0.124\nsamples = 45\nvalue = [42, 3]'),
Text(0.5408695652173913, 0.4166666666666667, 'x[13] <= 0.375\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.5339130434782609, 0.3611111111111111, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.5478260869565217, 0.3611111111111111, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.5756521739130435, 0.4166666666666667, 'x[27] <= 0.688\ngini = 0.089\nsamples = 43\nvalue = [41, 2]'),
Text(0.5617391304347826, 0.3611111111111111, 'x[14] <= 0.062\ngini = 0.048\nsamples = 41\nvalue = [40, 1]'),
Text(0.5547826086956522, 0.3055555555555556, 'x[18] <= 0.346\ngini = 0.375\nsamples = 4\nvalue = [3, 1]'),
Text(0.5478260869565217, 0.25, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]'),
Text(0.5617391304347826, 0.25, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.568695652173913, 0.3055555555555556, 'gini = 0.0\nsamples = 37\nvalue = [37, 0]'),
Text(0.5895652173913043, 0.3611111111111111, 'x[30] <= 0.212\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.5826086956521739, 0.3055555555555556, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.5965217391304348, 0.3055555555555556, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.5721739130434783, 0.4722222222222222, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.6139130434782609, 0.5277777777777778, 'x[17] <= 0.056\ngini = 0.032\nsamples = 249\nvalue = [245, 4]'),
Text(0.5965217391304348, 0.4722222222222222, 'x[8] <= 0.33\ngini = 0.32\nsamples = 5\nvalue = [4, 1]'),
Text(0.5895652173913043, 0.4166666666666667, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.6034782608695652, 0.4166666666666667, 'gini = 0.0\nsamples = 4\nvalue = [4, 0]'),
Text(0.6313043478260869, 0.4722222222222222, 'x[2] <= 0.015\ngini = 0.024\nsamples = 244\nvalue = [241, 3]'),
Text(0.6173913043478261, 0.4166666666666667, 'x[22] <= 0.714\ngini = 0.278\nsamples = 6\nvalue = [5, 1]'),
Text(0.6104347826086957, 0.3611111111111111, 'gini = 0.0\nsamples = 5\nvalue = [5, 0]'),
Text(0.6243478260869565, 0.3611111111111111, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.6452173913043479, 0.4166666666666667, 'x[24] <= 0.167\ngini = 0.017\nsamples = 238\nvalue = [236, 2]'),
Text(0.6382608695652174, 0.3611111111111111, 'x[29] <= 0.833\ngini = 0.073\nsamples = 53\nvalue = [51, 2]'),
Text(0.6243478260869565, 0.3055555555555556, 'x[33] <= 0.088\ngini = 0.041\nsamples = 48\nvalue = [47, 1]'),
Text(0.6173913043478261, 0.25, 'x[0] <= 0.345\ngini = 0.245\nsamples = 7\nvalue = [6, 1]'),
Text(0.6104347826086957, 0.19444444444444445, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.6243478260869565, 0.19444444444444445, 'gini = 0.0\nsamples = 6\nvalue = [6, 0]'),
Text(0.6313043478260869, 0.25, 'gini = 0.0\nsamples = 41\nvalue = [41, 0]'),
Text(0.6521739130434783, 0.3055555555555556, 'x[17] <= 0.38\ngini = 0.32\nsamples = 5\nvalue = [4, 1]'),
Text(0.6452173913043479, 0.25, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.6591304347826087, 0.25, 'gini = 0.0\nsamples = 4\nvalue = [4, 0]'),
Text(0.6521739130434783, 0.3611111111111111, 'gini = 0.0\nsamples = 185\nvalue = [185, 0]'),
Text(0.6104347826086957, 0.6388888888888888, 'x[2] <= 0.366\ngini = 0.408\nsamples = 7\nvalue = [5, 2]'),
Text(0.6034782608695652, 0.5833333333333334, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.6173913043478261, 0.5833333333333334, 'gini = 0.0\nsamples = 5\nvalue = [5, 0]'),
Text(0.4583695652173913, 0.75, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.8156521739130435, 0.8611111111111112, 'x[17] <= 0.157\ngini = 0.385\nsamples = 300\nvalue = [222, 78]'),
Text(0.7243478260869565, 0.8055555555555556, 'x[26] <= 0.167\ngini = 0.5\nsamples = 96\nvalue = [49, 47]'),
Text(0.6869565217391305, 0.75, 'x[4] <= 0.161\ngini = 0.459\nsamples = 42\nvalue = [15, 27]'),
Text(0.6591304347826087, 0.6944444444444444, 'x[8] <= 0.415\ngini = 0.499\nsamples = 23\nvalue = [12, 11]'),
Text(0.6382608695652174, 0.6388888888888888, 'x[18] <= 0.561\ngini = 0.355\nsamples = 13\nvalue = [3, 10]'),
Text(0.6313043478260869, 0.5833333333333334, 'gini = 0.0\nsamples = 8\nvalue = [0, 8]'),
Text(0.6452173913043479, 0.5833333333333334, 'x[28] <= 0.583\ngini = 0.48\nsamples = 5\nvalue = [3, 2]'),
Text(0.6382608695652174, 0.5277777777777778, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]'),
Text(0.6521739130434783, 0.5277777777777778, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.68, 0.6388888888888888, 'x[27] <= 0.1\ngini = 0.18\nsamples = 10\nvalue = [9, 1]'),
Text(0.6730434782608695, 0.5833333333333334, 'x[11] <= 0.457\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.6660869565217391, 0.5277777777777778, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.68, 0.5277777777777778, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.6869565217391305, 0.5833333333333334, 'gini = 0.0\nsamples = 8\nvalue = [8, 0]'),
Text(0.7147826086956521, 0.6944444444444444, 'x[13] <= 0.125\ngini = 0.266\nsamples = 19\nvalue = [3, 16]'),
Text(0.7078260869565217, 0.6388888888888888, 'x[11] <= 0.2\ngini = 0.198\nsamples = 18\nvalue = [2, 16]'),
Text(0.7008695652173913, 0.5833333333333334, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.7147826086956521, 0.5833333333333334, 'x[31] <= 0.306\ngini = 0.111\nsamples = 17\nvalue = [1, 16]'),
Text(0.7078260869565217, 0.5277777777777778, 'gini = 0.0\nsamples = 15\nvalue = [0, 15]'),
Text(0.7217391304347827, 0.5277777777777778, 'x[12] <= 0.333\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.7147826086956521, 0.4722222222222222, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.7286956521739131, 0.4722222222222222, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.7217391304347827, 0.6388888888888888, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.7617391304347826, 0.75, 'x[0] <= 0.202\ngini = 0.466\nsamples = 54\nvalue = [34, 20]'),
Text(0.7426086956521739, 0.6944444444444444, 'x[8] <= 0.164\ngini = 0.245\nsamples = 7\nvalue = [1, 6]'),
Text(0.7356521739130435, 0.6388888888888888, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.7495652173913043, 0.6388888888888888, 'gini = 0.0\nsamples = 6\nvalue = [0, 6]'),
Text(0.7808695652173913, 0.6944444444444444, 'x[2] <= 0.622\ngini = 0.418\nsamples = 47\nvalue = [33, 14]'),
Text(0.7634782608695653, 0.6388888888888888, 'x[2] <= 0.145\ngini = 0.482\nsamples = 32\nvalue = [19, 13]'),
Text(0.7495652173913043, 0.5833333333333334, 'x[17] <= 0.068\ngini = 0.18\nsamples = 10\nvalue = [9, 1]'),
Text(0.7426086956521739, 0.5277777777777778, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.7565217391304347, 0.5277777777777778, 'gini = 0.0\nsamples = 9\nvalue = [9, 0]'),
Text(0.7773913043478261, 0.5833333333333334, 'x[18] <= 0.87\ngini = 0.496\nsamples = 22\nvalue = [10, 12]'),
Text(0.7704347826086957, 0.5277777777777778, 'x[8] <= 0.41\ngini = 0.465\nsamples = 19\nvalue = [7, 12]'),
Text(0.7565217391304347, 0.4722222222222222, 'x[18] <= 0.715\ngini = 0.469\nsamples = 8\nvalue = [5, 3]'),
Text(0.7495652173913043, 0.4166666666666667, 'gini = 0.0\nsamples = 5\nvalue = [5, 0]'),
Text(0.7634782608695653, 0.4166666666666667, 'gini = 0.0\nsamples = 3\nvalue = [0, 3]'),
Text(0.7843478260869565, 0.4722222222222222, 'x[0] <= 0.25\ngini = 0.298\nsamples = 11\nvalue = [2, 9]'),
Text(0.7773913043478261, 0.4166666666666667, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.7913043478260869, 0.4166666666666667, 'x[18] <= 0.202\ngini = 0.18\nsamples = 10\nvalue = [1, 9]'),
Text(0.7843478260869565, 0.3611111111111111, 'x[28] <= 0.417\ngini = 0.5\nsamples = 2\nvalue = [1, 1]'),
Text(0.7773913043478261, 0.3055555555555556, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
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Text(0.7982608695652174, 0.3611111111111111, 'gini = 0.0\nsamples = 8\nvalue = [0, 8]'),
Text(0.7843478260869565, 0.5277777777777778, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]'),
Text(0.7982608695652174, 0.6388888888888888, 'x[19] <= 0.944\ngini = 0.124\nsamples = 15\nvalue = [14, 1]'),
Text(0.7913043478260869, 0.5833333333333334, 'gini = 0.0\nsamples = 14\nvalue = [14, 0]'),
Text(0.8052173913043478, 0.5833333333333334, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.9069565217391304, 0.8055555555555556, 'x[16] <= 0.75\ngini = 0.258\nsamples = 204\nvalue = [173, 31]'),
Text(0.8521739130434782, 0.75, 'x[17] <= 0.992\ngini = 0.138\nsamples = 147\nvalue = [136, 11]'),
Text(0.8452173913043478, 0.6944444444444444, 'x[4] <= 0.482\ngini = 0.128\nsamples = 146\nvalue = [136, 10]'),
Text(0.8260869565217391, 0.6388888888888888, 'x[30] <= 0.063\ngini = 0.038\nsamples = 104\nvalue = [102, 2]'),
Text(0.8191304347826087, 0.5833333333333334, 'x[11] <= 0.193\ngini = 0.32\nsamples = 10\nvalue = [8, 2]'),
Text(0.8121739130434783, 0.5277777777777778, 'x[6] <= 0.7\ngini = 0.444\nsamples = 3\nvalue = [1, 2]'),
Text(0.8052173913043478, 0.4722222222222222, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.8191304347826087, 0.4722222222222222, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.8260869565217391, 0.5277777777777778, 'gini = 0.0\nsamples = 7\nvalue = [7, 0]'),
Text(0.8330434782608696, 0.5833333333333334, 'gini = 0.0\nsamples = 94\nvalue = [94, 0]'),
Text(0.8643478260869565, 0.6388888888888888, 'x[9] <= 0.167\ngini = 0.308\nsamples = 42\nvalue = [34, 8]'),
Text(0.8469565217391304, 0.5833333333333334, 'x[18] <= 0.194\ngini = 0.375\nsamples = 4\nvalue = [1, 3]'),
Text(0.84, 0.5277777777777778, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.8539130434782609, 0.5277777777777778, 'gini = 0.0\nsamples = 3\nvalue = [0, 3]'),
Text(0.8817391304347826, 0.5833333333333334, 'x[0] <= 0.393\ngini = 0.229\nsamples = 38\nvalue = [33, 5]'),
Text(0.8678260869565217, 0.5277777777777778, 'x[4] <= 0.821\ngini = 0.5\nsamples = 6\nvalue = [3, 3]'),
Text(0.8608695652173913, 0.4722222222222222, 'x[22] <= 0.643\ngini = 0.375\nsamples = 4\nvalue = [1, 3]'),
Text(0.8539130434782609, 0.4166666666666667, 'gini = 0.0\nsamples = 3\nvalue = [0, 3]'),
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Text(0.8747826086956522, 0.4722222222222222, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),
Text(0.8956521739130435, 0.5277777777777778, 'x[28] <= 0.917\ngini = 0.117\nsamples = 32\nvalue = [30, 2]'),
Text(0.888695652173913, 0.4722222222222222, 'x[8] <= 0.992\ngini = 0.062\nsamples = 31\nvalue = [30, 1]'),
Text(0.8817391304347826, 0.4166666666666667, 'gini = 0.0\nsamples = 30\nvalue = [30, 0]'),
Text(0.8956521739130435, 0.4166666666666667, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.9026086956521739, 0.4722222222222222, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.8591304347826086, 0.6944444444444444, 'gini = 0.0\nsamples = 1\nvalue = [0, 1]'),
Text(0.9617391304347827, 0.75, 'x[14] <= 0.812\ngini = 0.456\nsamples = 57\nvalue = [37, 20]'),
Text(0.9373913043478261, 0.6944444444444444, 'x[32] <= 0.4\ngini = 0.238\nsamples = 29\nvalue = [25, 4]'),
Text(0.9234782608695652, 0.6388888888888888, 'x[8] <= 0.071\ngini = 0.142\nsamples = 26\nvalue = [24, 2]'),
Text(0.9165217391304348, 0.5833333333333334, 'x[33] <= 0.412\ngini = 0.444\nsamples = 3\nvalue = [1, 2]'),
Text(0.9095652173913044, 0.5277777777777778, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.9234782608695652, 0.5277777777777778, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.9304347826086956, 0.5833333333333334, 'gini = 0.0\nsamples = 23\nvalue = [23, 0]'),
Text(0.951304347826087, 0.6388888888888888, 'x[29] <= 0.833\ngini = 0.444\nsamples = 3\nvalue = [1, 2]'),
Text(0.9443478260869566, 0.5833333333333334, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.9582608695652174, 0.5833333333333334, 'gini = 0.0\nsamples = 1\nvalue = [1, 0]'),
Text(0.9860869565217392, 0.6944444444444444, 'x[32] <= 0.1\ngini = 0.49\nsamples = 28\nvalue = [12, 16]'),
Text(0.9791304347826087, 0.6388888888888888, 'x[12] <= 0.833\ngini = 0.48\nsamples = 20\nvalue = [12, 8]'),
Text(0.9721739130434782, 0.5833333333333334, 'x[30] <= 0.013\ngini = 0.415\nsamples = 17\nvalue = [12, 5]'),
Text(0.9652173913043478, 0.5277777777777778, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
Text(0.9791304347826087, 0.5277777777777778, 'x[18] <= 0.505\ngini = 0.32\nsamples = 15\nvalue = [12, 3]'),
Text(0.9721739130434782, 0.4722222222222222, 'gini = 0.0\nsamples = 9\nvalue = [9, 0]'),
Text(0.9860869565217392, 0.4722222222222222, 'x[18] <= 0.706\ngini = 0.5\nsamples = 6\nvalue = [3, 3]'),
Text(0.9791304347826087, 0.4166666666666667, 'gini = 0.0\nsamples = 3\nvalue = [0, 3]'),
Text(0.9930434782608696, 0.4166666666666667, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]'),
Text(0.9860869565217392, 0.5833333333333334, 'gini = 0.0\nsamples = 3\nvalue = [0, 3]'),
Text(0.9930434782608696, 0.6388888888888888, 'gini = 0.0\nsamples = 8\nvalue = [0, 8]')]
```

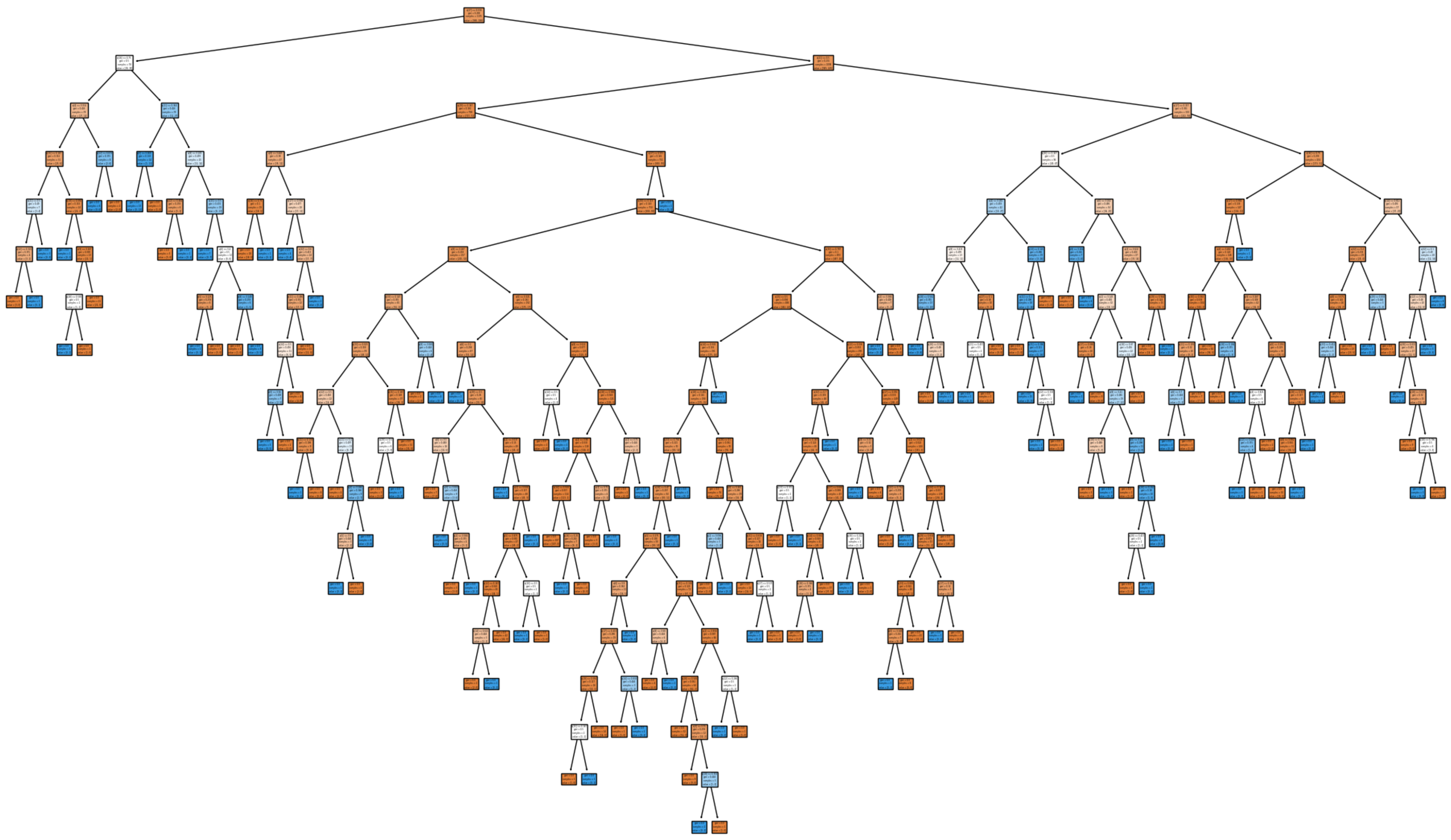

In [97]:
```python
from sklearn.model_selection import GridSearchCV
parameter={
 'criterion':['gini','entropy'],
  'splitter':['best','random'],
  'max_depth':[1,2,3,4,5],
  'max_features':['auto', 'sqrt', 'log2']

}
```

In [99]:
```python
grid_search=GridSearchCV(estimator=dc,param_grid=parameter,cv=5,scoring="accuracy")
```

In [100…
```python
grid_search.fit(x_train,y_train)
```

```
C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\model_selection\_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 nan.
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\hansi\anaconda_3\Lib\site-packages\sklearn\model_selection\_validation.py", line 732, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\base.py", line 1144, in wrapper
    estimator._validate_params()
  File "C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\base.py", line 637, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\utils\_param_validation.py", line 95, in validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'max_features' parameter of DecisionTreeClassifier must be an int in the range
[1, inf), a float in the range (0.0, 1.0], a str among {'sqrt', 'log2'} or None. Got 'auto' instead.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\model_selection\_search.py:976: UserWarning: One or more of the test scores are non-fin
ite: [       nan        nan 0.84013704 0.84013704 0.84013704 0.84013704
        nan        nan 0.83759106 0.84013704 0.84183195 0.84013704
        nan        nan 0.8349982  0.84182834 0.83927876 0.83247746
        nan        nan 0.83588893 0.84609448 0.84097367 0.83929679
        nan        nan 0.83335377 0.85288136 0.83843851 0.83503065
        nan        nan 0.84013704 0.84013704 0.84013704 0.84013704
        nan        nan 0.8316264  0.84013704 0.84269023 0.84013704
        nan        nan 0.8469203  0.84013704 0.84351965 0.83758384
        nan        nan 0.84268662 0.83844573 0.8435485  0.83673278
        nan        nan 0.82228994 0.847793   0.82569059 0.84183556]
  warnings.warn(
```

Out[100]:

```
GridSearchCV
estimator: DecisionTreeClassifier
  DecisionTreeClassifier
```

In [101…

```
grid_search.best_params_
```

Out[101]:

```
{'criterion': 'gini',
 'max_depth': 5,
 'max_features': 'sqrt',
 'splitter': 'random'}
```

In [102…

```
dc_cv=DecisionTreeClassifier(criterion= 'gini',
 max_depth= 5,
 max_features= 'log2',
 splitter= 'random')
```

In [104…

```
dc_cv.fit(x_train,y_train)
```

Out[104]:

```
DecisionTreeClassifier
DecisionTreeClassifier(max_depth=5, max_features='log2', splitter='random')
```

In [105…

```
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.86      0.83      0.85       245
           1       0.29      0.35      0.32        49

    accuracy                           0.75       294
   macro avg       0.58      0.59      0.58       294
weighted avg       0.77      0.75      0.76       294
```

RANDOM FOREST

In [107…

```
from sklearn.ensemble import RandomForestClassifier
rc=RandomForestClassifier()
```

In [108…

```
forest_params = [{'max_depth': list(range(10, 15)), 'max_features': list(range(0,14))}]
```

In [109…

```
rc_cv= GridSearchCV(rfc,param_grid=forest_params,cv=10,scoring="accuracy")
```

In [111…

```
rc_cv.fit(x_train,y_train)
```

```
C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\base.py:1151: DataConversionWarning: A column-vector y was passed when a 1d array was e
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C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\model_selection\_validation.py:425: FitFailedWarning:
50 fits failed out of a total of 700.
The score on these train-test partitions for these parameters will be set to nan.
If these failures are not expected, you can try to debug them by setting error_score='raise'.

Below are more details about the failures:
--------------------------------------------------------------------------------
50 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\model_selection\_validation.py", line 732, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\base.py", line 1144, in wrapper
    estimator._validate_params()
  File "C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\base.py", line 637, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\utils\_param_validation.py", line 95, in validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'max_features' parameter of RandomForestClassifier must be an int in the range
[1, inf), a float in the range (0.0, 1.0], a str among {'sqrt', 'log2'} or None. Got 0 instead.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\model_selection\_search.py:976: UserWarning: One or more of the test scores are non-fin
ite: [       nan 0.84779806 0.85373751 0.85290453 0.85627264 0.8596842
 0.85967695 0.86222657 0.86050992 0.85796755 0.86138635 0.85882225
 0.85966247 0.85883674        nan 0.85119513 0.85628712 0.85545415
 0.85969144 0.85627264 0.86734029 0.85714182 0.86222657 0.85713458
 0.86221932 0.8596842  0.86307403 0.86307403        nan 0.84949297
 0.85798928 0.85714907 0.85969144 0.85798928 0.85969144 0.85967695
 0.8605389  0.86050992 0.85882225 0.85966247 0.85627988 0.86052441
        nan 0.85120238 0.85629436 0.85714182 0.85798928 0.86053165
 0.86306678 0.85965522 0.85543242 0.85797479 0.85627264 0.85627988
 0.85966971 0.85796031        nan 0.85034767 0.85290453 0.85544691
 0.85798204 0.85799652 0.86051717 0.85543242 0.85966247 0.85797479
 0.85204259 0.85966971 0.85710561 0.86054614]
  warnings.warn(
C:\Users\hansi\anaconda_3\Lib\site-packages\sklearn\base.py:1151: DataConversionWarning: A column-vector y was passed when a 1d array was e
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  return fit_method(estimator, *args, **kwargs)
```

Out[111]:

```
▸          GridSearchCV
▸ estimator: RandomForestClassifier
      ▸ RandomForestClassifier
```

In [112…
```
pred=rc_cv.predict(x_test)
```

In [113…
```
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.86      1.00      0.92       245
           1       0.89      0.16      0.28        49

    accuracy                           0.86       294
   macro avg       0.87      0.58      0.60       294
weighted avg       0.86      0.86      0.81       294
```

In [114…
```
rc_cv.best_params_
```

Out[114]:
```
{'max_depth': 11, 'max_features': 6}
```

In [ ]: