In [ ]:

```
Name: J.Ganesh
Reg.no: 21BCE7325
```

In [1]:

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:

```python
data=pd.read_csv("Employee-Attrition.csv")
```

In [3]:

```python
data.head()
```

Out[3]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber
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 [4]:

```python
data.tail()
```

Out[4]:

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

5 rows × 35 columns

In [5]:

```python
data.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 [6]:
```
data.describe()
```

Out[6]:

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

8 rows × 26 columns

Handling the null values

In [7]:
```
data.isnull().any()
```

Out[7]:
```
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 [8]:
```
data.isnull().sum()
```

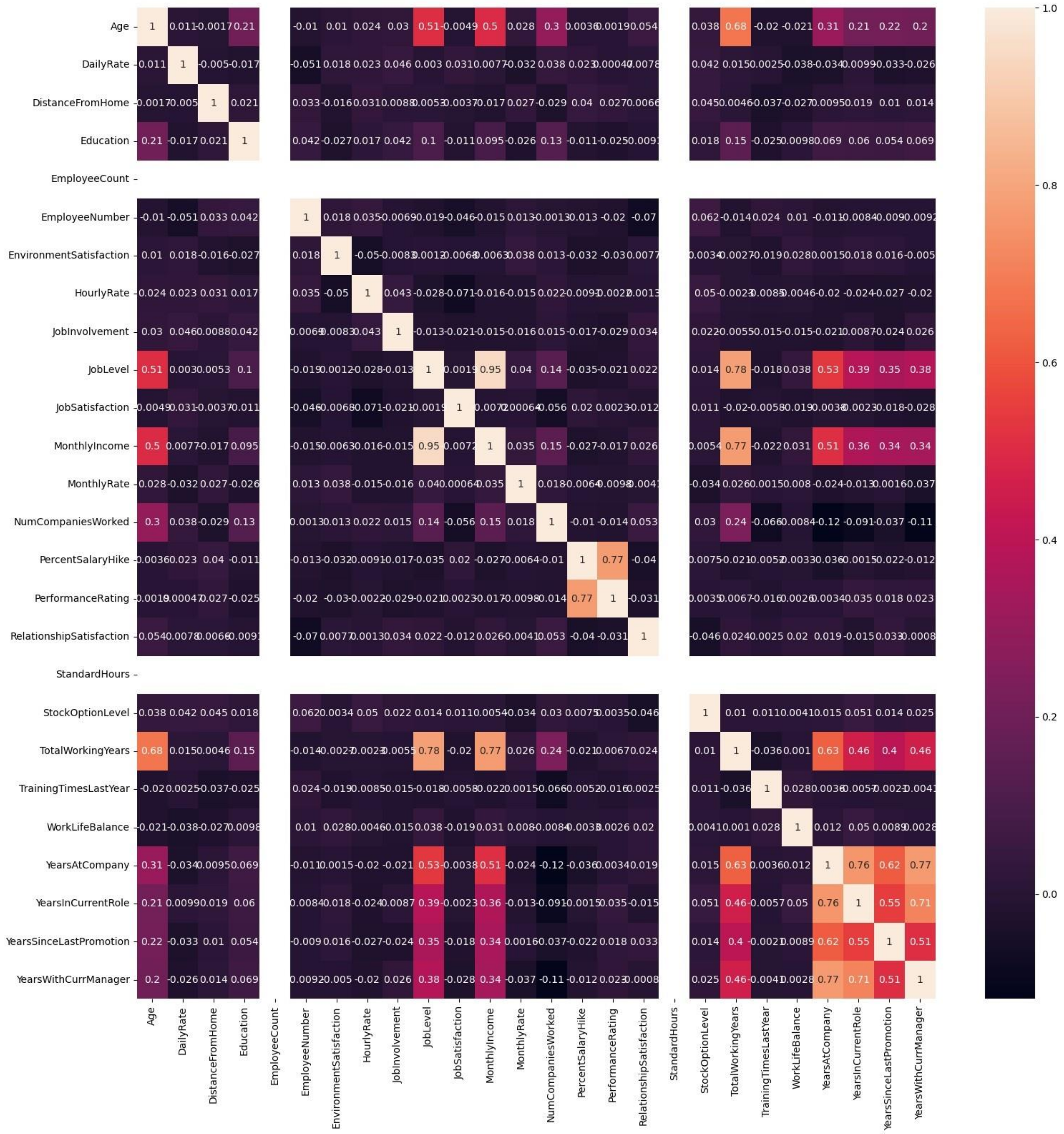
Out[8]:
```
Age                         0
Attrition                   0
BusinessTravel              0
DailyRate                   0
Department                  0
DistanceFromHome            0
Education                   0
EducationField              0
EmployeeCount               0
EmployeeNumber              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 [9]:
```
cor=data.corr()
```

```
C:\Users\Prasanth Nimmala\AppData\Local\Temp\ipykernel_8884\1426905697.py:1: FutureWarning: The default value o
f numeric_only in DataFrame.corr is deprecated. In a future version, it will default to False. Select only vali
d columns or specify the value of numeric_only to silence this warning.
  cor=data.corr()
```

In [10]:
```
fig=plt.figure(figsize=(18,18))
sns.heatmap(cor,annot=True)
```

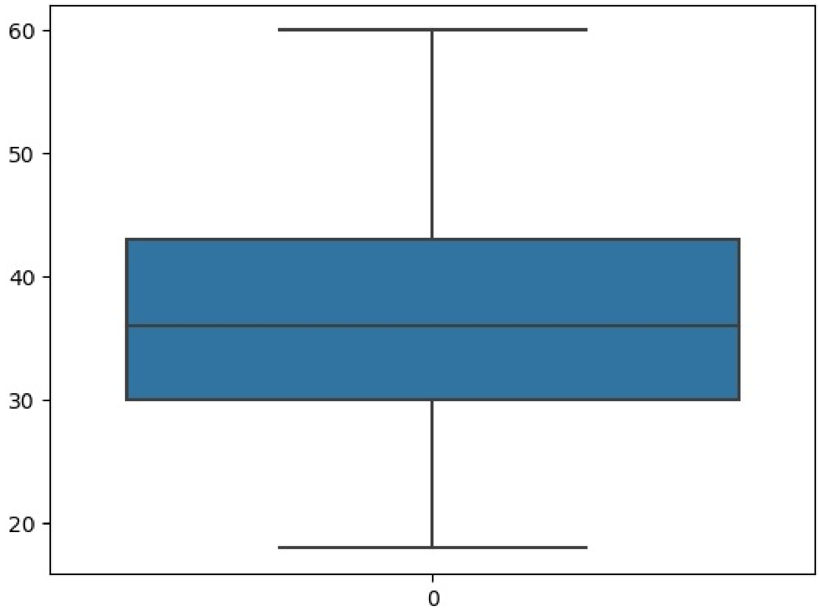
Out[10]:
```
<Axes: >
```



Outliers

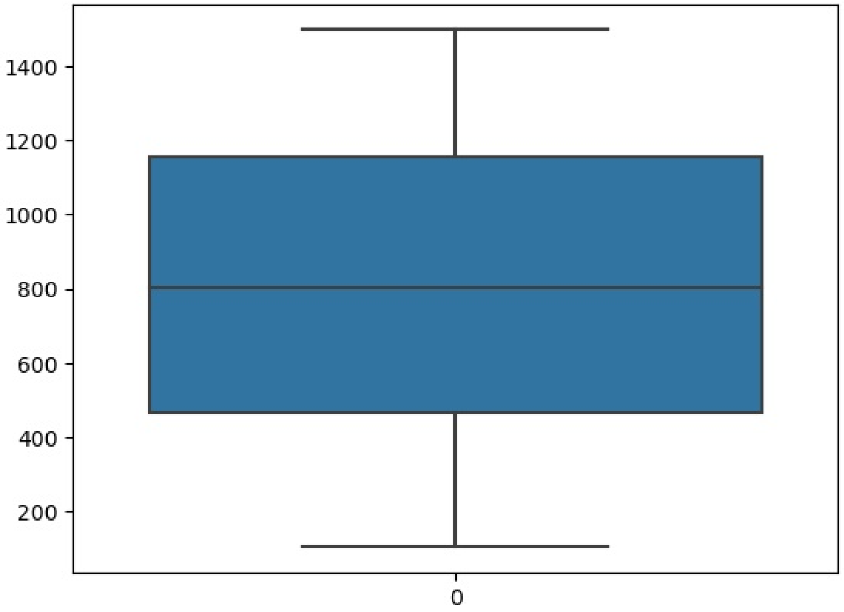
In [11]:
```
sns.boxplot(data["Age"])
```

Out[11]: <Axes: >



In [12]:
```
sns.boxplot(data["DailyRate"])
```

Out[12]: <Axes: >



In [29]:
```
data.describe()
```

Out[29]:

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

8 rows × 26 columns

In [30]:

```
data.head()
```

Out[30]:

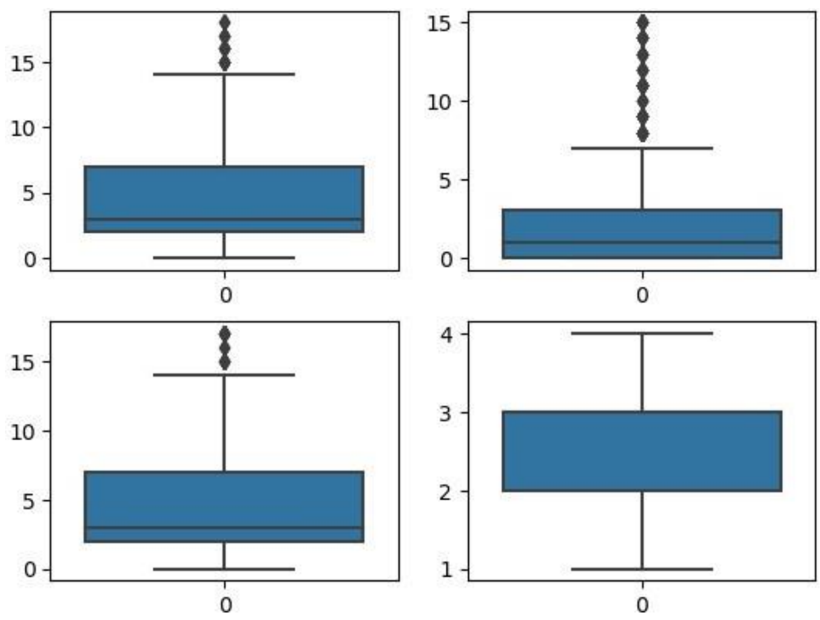
	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction
0	41	Travel_Rarely	1102	Sales	1	2	1	1	2
1	49	Travel_Frequently	279	Research & Development	8	1	1	2	3
2	37	Travel_Rarely	1373	Research & Development	2	2	1	4	4
3	33	Travel_Frequently	1392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

5 rows × 33 columns

In [14]:

```
fig, axes = plt.subplots(2,2)
sns.boxplot(data=data["YearsInCurrentRole"],ax=axes[0,0])
sns.boxplot(data=data["YearsSinceLastPromotion"],ax=axes[0,1])
sns.boxplot(data=data["YearsWithCurrManager"],ax=axes[1,0])
sns.boxplot(data=data["WorkLifeBalance"],ax=axes[1,1])
```

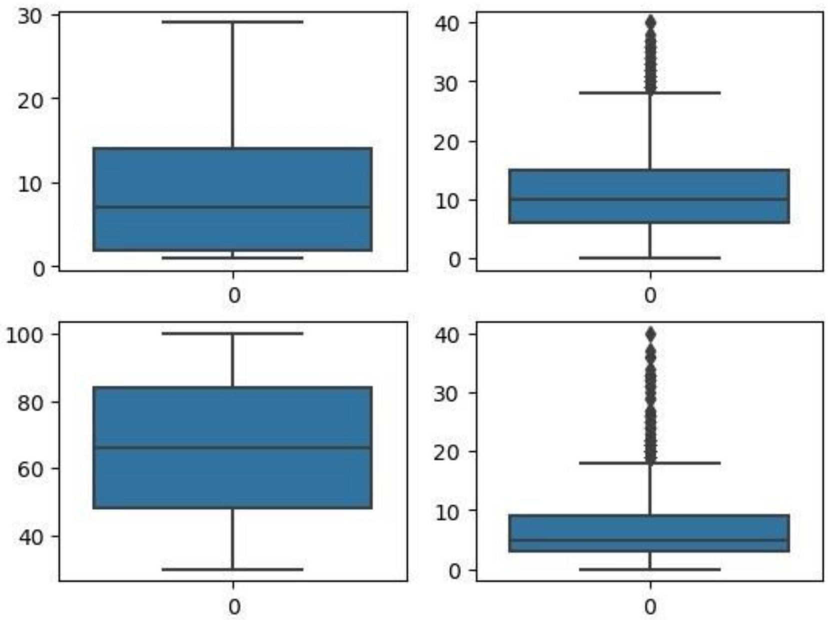
Out[14]: <Axes: >



In [15]:

```
fig, axes = plt.subplots(2,2)
sns.boxplot(data=data["DistanceFromHome"],ax=axes[0,0])
sns.boxplot(data=data["TotalWorkingYears"],ax=axes[0,1])
sns.boxplot(data=data["HourlyRate"],ax=axes[1,0])
sns.boxplot(data=data["YearsAtCompany"],ax=axes[1,1])
```

Out[15]: <Axes: >



Handling the outliers

```
YearsInCurrentRole_q1 = data.YearsInCurrentRole.quantile(0.25)
YearsInCurrentRole_q3 = data.YearsInCurrentRole.quantile(0.75)
IQR_YearsInCurrentRole=YearsInCurrentRole_q3-YearsInCurrentRole_q1
upperlimit_YearsInCurrentRole=YearsInCurrentRole_q3+1.5*IQR_YearsInCurrentRole
lower_limit_YearsInCurrentRole =YearsInCurrentRole_q1-1.5*IQR_YearsInCurrentRole
median_YearsInCurrentRole=data["YearsInCurrentRole"].median()
data['YearsInCurrentRole'] = np.where(
    (data['YearsInCurrentRole'] > upperlimit_YearsInCurrentRole),
    median_YearsInCurrentRole,
    data['YearsInCurrentRole']
)
```

```
YearsSinceLastPromotion_q1 = data.YearsSinceLastPromotion.quantile(0.25)
YearsSinceLastPromotion_q3 = data.YearsSinceLastPromotion.quantile(0.75)
IQR_YearsSinceLastPromotion=YearsSinceLastPromotion_q3-YearsSinceLastPromotion_q1
upperlimit_YearsSinceLastPromotion=YearsSinceLastPromotion_q3+1.5*IQR_YearsSinceLastPromotion
lower_limit_YearsSinceLastPromotion =YearsSinceLastPromotion_q1-1.5*IQR_YearsSinceLastPromotion
median_YearsSinceLastPromotion=data["YearsSinceLastPromotion"].median()
data['YearsSinceLastPromotion'] = np.where(
    (data['YearsSinceLastPromotion'] > upperlimit_YearsSinceLastPromotion),
    median_YearsSinceLastPromotion,
    data['YearsSinceLastPromotion']
)
```

```
YearsWithCurrManager_q1 = data.YearsWithCurrManager.quantile(0.25)
YearsWithCurrManager_q3 = data.YearsWithCurrManager.quantile(0.75)
IQR_YearsWithCurrManager=YearsWithCurrManager_q3-YearsWithCurrManager_q1
upperlimit_YearsWithCurrManager=YearsWithCurrManager_q3+1.5*IQR_YearsWithCurrManager
lower_limit_YearsWithCurrManager =YearsWithCurrManager_q1-1.5*IQR_YearsWithCurrManager
median_YearsWithCurrManager=data["YearsWithCurrManager"].median()
data['YearsWithCurrManager'] = np.where(
    (data['YearsWithCurrManager'] > upperlimit_YearsWithCurrManager),
    median_YearsWithCurrManager,
    data['YearsWithCurrManager']
)
```

```
TotalWorkingYears_q1 = data.TotalWorkingYears.quantile(0.25)
TotalWorkingYears_q3 = data.TotalWorkingYears.quantile(0.75)
IQR_TotalWorkingYears=TotalWorkingYears_q3-TotalWorkingYears_q1
upperlimit_TotalWorkingYears=TotalWorkingYears_q3+1.5*IQR_TotalWorkingYears
lower_limit_TotalWorkingYears=TotalWorkingYears_q1-1.5*IQR_TotalWorkingYears
median_TotalWorkingYears=data["TotalWorkingYears"].median()
data['TotalWorkingYears'] = np.where(
    (data['TotalWorkingYears'] > upperlimit_TotalWorkingYears),
    median_TotalWorkingYears,
    data['TotalWorkingYears']
)
```

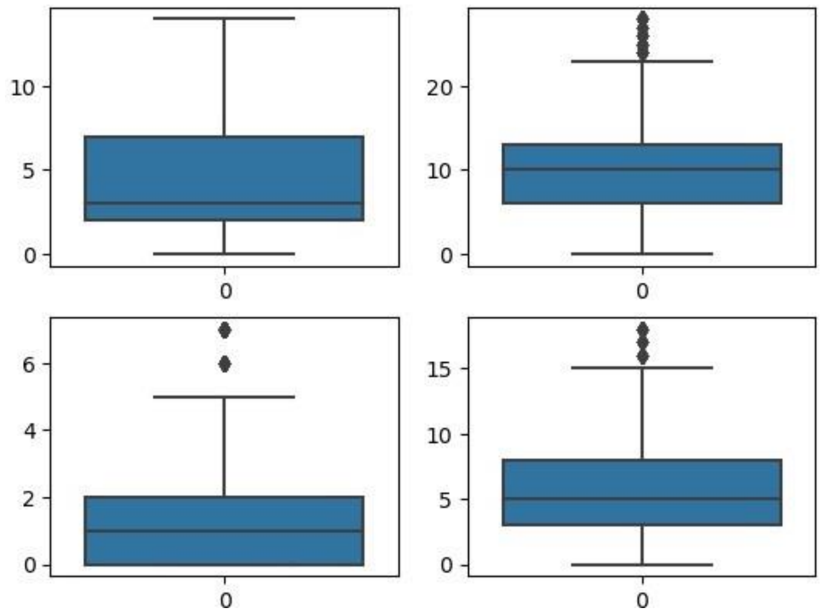
```
YearsAtCompany_q1 = data.YearsAtCompany.quantile(0.25)
```

```python
YearsAtCompany_q3 = data.YearsAtCompany.quantile(0.75)
IQR_YearsAtCompany=YearsAtCompany_q3-YearsAtCompany_q1
upperlimit_YearsAtCompany=YearsAtCompany_q3+1.5*IQR_YearsAtCompany
lower_limit_YearsAtCompany=YearsAtCompany_q1-1.5*IQR_YearsAtCompany
median_YearsAtCompany=data["YearsAtCompany"].median()
data['YearsAtCompany'] = np.where(
    (data['YearsAtCompany'] > upperlimit_YearsAtCompany),
    median_YearsAtCompany,
    data['YearsAtCompany']
)
```

In [21]:

```python
fig, axes = plt.subplots(2,2)
sns.boxplot(data=data["YearsWithCurrManager"],ax=axes[0,0])
sns.boxplot(data=data["TotalWorkingYears"],ax=axes[0,1])
sns.boxplot(data=data["YearsSinceLastPromotion"],ax=axes[1,0])
sns.boxplot(data=data["YearsAtCompany"],ax=axes[1,1])
```

Out[21]: <Axes: >



In [31]:

```python
data.head()
```

Out[31]:

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

5 rows × 33 columns

In [22]:

```python
data.drop("EducationField",axis=1,inplace=True)
```

In [23]:

```python
data.head(2)
```

Out[23]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EmployeeCount	EmployeeNumber	EnvironmentSa
0	41	Yes	Travel_Rarely	1102	Sales	1	2	1	1	
1	49	No	Travel_Frequently	279	Research & Development	8	1	1	2	

2 rows × 34 columns

In [24]:

```python
data["BusinessTravel"].unique()
```

Out[24]:

```
array(['Travel_Rarely', 'Travel_Frequently', 'Non-Travel'], dtype=object)
```

Splitting the data

```python
y=data["Attrition"]
```

```
y.head()
```

```
0    Yes
1     No
2    Yes
3     No
4     No
Name: Attrition, dtype: object
```

```
data.drop("Attrition",axis=1,inplace=True)
```

```
data.head()
```

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

5 rows × 33 columns

Encoding

```
from sklearn.preprocessing import LabelEncoder
```

```
le=LabelEncoder()
```

```
data["BusinessTravel"]=le.fit_transform(data["BusinessTravel"])
```

```
data["Department"]=le.fit_transform(data["Department"])
```

```
data["Gender"]=le.fit_transform(data["Gender"])
```

```
y=le.fit_transform(y)
```

```
y
```

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

```
data["JobRole"]=le.fit_transform(data["JobRole"])
```

```
data["Over18"]=le.fit_transform(data["Over18"])
```

```
data["MaritalStatus"]=le.fit_transform(data["MaritalStatus"])
```

```
data["OverTime"]=le.fit_transform(data["OverTime"])
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1470 entries, 0 to 1469
Data columns (total 33 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   Age                       1470 non-null   int64
 1   BusinessTravel            1470 non-null   int32
 2   DailyRate                 1470 non-null   int64
 3   Department                1470 non-null   int32
 4   DistanceFromHome          1470 non-null   int64
 5   Education                 1470 non-null   int64
 6   EmployeeCount             1470 non-null   int64
 7   EmployeeNumber            1470 non-null   int64
 8   EnvironmentSatisfaction   1470 non-null   int64
 9   Gender                    1470 non-null   int32
 10  HourlyRate                1470 non-null   int64
 11  JobInvolvement            1470 non-null   int64
 12  JobLevel                  1470 non-null   int64
 13  JobRole                   1470 non-null   int32
 14  JobSatisfaction           1470 non-null   int64
 15  MaritalStatus             1470 non-null   int32
 16  MonthlyIncome             1470 non-null   int64
 17  MonthlyRate               1470 non-null   int64
 18  NumCompaniesWorked        1470 non-null   int64
 19  Over18                    1470 non-null   int32
 20  OverTime                  1470 non-null   int32
 21  PercentSalaryHike         1470 non-null   int64
 22  PerformanceRating         1470 non-null   int64
 23  RelationshipSatisfaction  1470 non-null   int64
 24  StandardHours             1470 non-null   int64
 25  StockOptionLevel          1470 non-null   int64
 26  TotalWorkingYears         1470 non-null   float64
 27  TrainingTimesLastYear     1470 non-null   int64
 28  WorkLifeBalance           1470 non-null   int64
 29  YearsAtCompany            1470 non-null   float64
 30  YearsInCurrentRole        1470 non-null   float64
 31  YearsSinceLastPromotion   1470 non-null   float64
 32  YearsWithCurrManager      1470 non-null   float64
dtypes: float64(5), int32(7), int64(21)
memory usage: 338.9 KB
```

train test split

```python
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(data,y,test_size=0.3,random_state=0)
```

```python
x_train.shape,x_test.shape,y_train.shape,y_test.shape
```

Out[45]:

```
((1029, 33), (441, 33), (1029,), (441,))
```

Feature Scaling

```python
from sklearn.preprocessing import StandardScaler
```

```python
sc=StandardScaler()
```

```python
x_train=sc.fit_transform(x_train)
```

```python
x_test=sc.fit_transform(x_test)
```

Building the model

Multi-Linear Regression

```python
from sklearn.linear_model import LinearRegression
```

```python
lr = LinearRegression()
```

```python
lr.fit(x_train,y_train)
```

Out[52]:

```
▾ LinearRegression
LinearRegression()
```

```python
lr.coef_   #slope(m)
```

Out[53]:

```
array([-3.54940447e-02, 7.88352347e-05, -1.70825038e-02, 3.46389690e-02,
        2.44612841e-02,  3.65668214e-03,  4.16333634e-17, -9.46820520e-03,
       -4.11203734e-02,  1.06338881e-02, -2.97662154e-03, -3.84864283e-02,
       -1.52927977e-02, -1.57839139e-02, -3.67252862e-02,  3.35765928e-02,
       -5.90043558e-03, 5.81099165e-03, 3.78471890e-02, -6.93889390e-18,
        9.55263279e-02, -2.55800078e-02,  2.01844797e-02, -2.64773510e-02,
       -1.21430643e-17, -1.79286106e-02, -3.30529386e-02, -1.09247807e-02,
       -3.10631611e-02, -2.47887717e-02, -1.10177742e-02,  2.11897289e-02,
       -6.60823991e-03])
```

In [54]:

```python
lr.intercept_  #(c)
```

Out[54]:

```
0.16229348882410102
```

In [55]:

```python
y_pred = lr.predict(x_test)
```

In [56]:

```python
y_pred
```

Out[56]:

```
array([ 1.30302477e-01, 2.17626230e-01, 3.46282415e-01, 5.41382549e-03,
        4.99292896e-01,  1.01628868e-01,  3.44742777e-01,  1.23994945e-01,
       -1.60694945e-01,  4.02435622e-01,  1.44159172e-01,  2.67416840e-01,
       -4.62559536e-02, 5.58671849e-01, 2.81858700e-01, 1.53537792e-02,
        1.78573363e-01,  2.77532834e-01,  9.37121052e-02,  2.17571624e-01,
        2.65936178e-01,  1.41499184e-02,  8.36251186e-02,  9.58849826e-02,
        5.09869963e-01,  2.94764240e-01,  7.85819529e-02,  1.26647773e-01,
        5.05518902e-01,  8.48456917e-02, -7.97229275e-02,  2.15516993e-02,
        1.08079105e-01,  3.65998400e-01,  1.24517362e-01,  5.13682786e-02,
        1.06749689e-01,  6.07640778e-02,  6.66425313e-02,  4.81312859e-02,
       -1.16761425e-02, -2.97852924e-02,  5.25135582e-02, -1.59076817e-02,
       -1.71522795e-02, 4.17777714e-01, 3.67341564e-01, -2.14569245e-01,
        5.47964121e-01,  4.40723777e-01,  1.96701754e-01,  4.42415223e-01,
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       -8.21467550e-02])
```

In [57]:

```python
y_test
```

Out[57]:

```
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       0])
```

Logistic Regression

In [58]:

```python
from sklearn.linear_model import LogisticRegression
```

In [59]:

```python
lg=LogisticRegression()
```

In [60]:

```python
lg.fit(x_train,y_train)
```

Out[60]:

```
▾ LogisticRegression
LogisticRegression()
```

In [61]:

```python
y_pred_lg=lg.predict(x_test)
```

In [62]:

```python
y_pred
```

Out[62]:

```
array([ 1.30302477e-01,  2.17626230e-01,  3.46282415e-01,  5.41382549e-03,
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3.11830741e-01, 2.55878748e-01, 5.64831824e-01, -8.48534911e-02,
2.27251205e-01, 1.35034035e-01, 1.83392922e-01, 2.67565441e-02,
1.04636218e-01, 1.31700032e-01, 2.07655641e-01, 3.32733438e-01,
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2.09656376e-01, 2.75173006e-01, 2.27685889e-01, 2.80495892e-01,
2.36503496e-01, 7.47322815e-02, 1.20343079e-01, -1.10102575e-02,
2.66505865e-01, 1.34380235e-01, 3.83985037e-01, 3.27038149e-01,
1.92718914e-01, 1.38040637e-01, 3.13471437e-01, 3.03369774e-01,
-1.79198125e-01, 1.06960652e-01, -3.23223785e-03, 3.45401694e-01,
1.36157048e-01, 3.82744300e-01, 2.46142802e-01, -1.70015194e-01,
2.55048994e-01, -2.28290648e-01, 3.36992530e-01, 1.49968922e-01,
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1.16743641e-01, 9.56873703e-03, 2.34800404e-01, 1.36313424e-01,
7.74987760e-03, 2.34345722e-01, 6.10723706e-02, 3.41757613e-01,
1.59047657e-01, 9.67999468e-02, 2.32540380e-01, -8.19460772e-02,
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       -2.02255818e-01,  2.52065992e-01, -1.51719947e-01,  3.50282752e-01,
       -9.84668529e-02,  2.14753151e-01,  2.46151971e-02,  2.09633480e-01,
        9.48374386e-02,  3.12075361e-01,  4.06959059e-01, -2.26761393e-02,
        7.65002089e-02,  3.06988986e-01,  4.37484499e-02,  1.09186169e-01,
        4.21237022e-01,  1.49225126e-01,  4.45704191e-02,  3.37793947e-02,
        9.97831984e-02, -5.30137196e-02,  3.47224412e-01,  1.03944090e-01,
       -4.09963236e-02, -5.78838569e-02,  3.09525724e-01,  1.02060488e-01,
        2.09447907e-01,  4.10525192e-01,  3.33473319e-01,  1.80971041e-01,
        2.76792072e-01,  2.86132531e-01,  2.62476320e-01, -1.83021903e-02,
        2.36094900e-01,  1.54018489e-01,  6.36220924e-02,  6.18224799e-03,
        1.85057193e-02,  7.69476922e-02,  1.34623859e-01,  1.87169316e-01,
        2.36666289e-01, -1.82114662e-01,  2.98547908e-01,  1.73398527e-01,
       -8.87118635e-02,  3.51838607e-02,  1.35598577e-01,  1.70085191e-01,
        1.69932034e-01,  2.29056852e-01,  2.15573570e-01,  1.04403736e-01,
       -8.21467550e-02])
```

In [63]:
```python
y_test
```

Out[63]:
```
array([0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 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, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 1, 0, 1, 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, 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, 1,
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       0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0,
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       1, 0, 0, 0, 1, 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, 1, 0, 0, 0, 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, 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, 1, 0, 0, 0, 1, 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, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 1, 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, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0,
       0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1,
       0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0])
```

In [64]:
```python
score = lg.score(x_test, y_test)
print(score)
```

```
0.8820861678004536
```

Confusion matrix

In [65]:
```python
from sklearn import metrics
cm = metrics.confusion_matrix(y_test,y_pred_lg)
print(cm)
```

```
[[366   5]
 [ 47  23]]
```

Ridge and Lasso

In [66]:
```python
from sklearn.linear_model import Ridge
from sklearn.model_selection import GridSearchCV
```

In [67]:
```python
rg=Ridge()
```

In [68]:
```python
parametres={"alpha":[1,2,3,5,10,20,30,40,60,70,80,90]}
ridgecv=GridSearchCV(rg,parametres,scoring="neg_mean_squared_error",cv=5)
ridgecv.fit(x_train,y_train)
```

Out[68]:
```
▸ GridSearchCV
▸ estimator: Ridge
    ▸ Ridge
```

In [69]:
```python
print(ridgecv.best_params_)
```

```
{'alpha': 90}
```

In [70]:
```python
print(ridgecv.best_score_)
```

```
-0.11390621139234183
```

In [71]:
```python
y_pred_rg=ridgecv.predict(x_test)
```

In [72]:
```python
y_pred_rg
```

Out[72]:
```
array([ 1.34413485e-01, 2.22561818e-01, 3.41692977e-01, 3.88209867e-03,
        4.84617338e-01, 1.16361483e-01, 3.30449743e-01, 1.27358807e-01,
       -1.34442619e-01, 3.77692888e-01, 1.33001445e-01, 2.69898751e-01,
       -2.54707392e-02, 5.25771894e-01, 2.67543514e-01, 2.78725024e-02,
        1.82233111e-01, 2.78896415e-01, 9.12689699e-02, 2.11494641e-01,
        2.70103341e-01, 8.44922044e-03, 8.74746722e-02, 1.05348798e-01,
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        1.06690533e-01, 7.08689637e-02, 7.51570276e-02, 6.05829413e-02,
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       -4.02267475e-03, 4.08010612e-01, 3.43668700e-01, -1.83519405e-01,
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        1.40754410e-01, 3.52173952e-01, 4.70372694e-01, 2.89240343e-01,
       -3.11642726e-02, 3.04206456e-01, 9.89337674e-03, 2.44569884e-01,
       -1.40249115e-02, 2.75133912e-01, 8.64669565e-02, 1.24214885e-01,
        3.48994545e-01, 3.41026778e-02, 3.40548051e-01, 1.95847356e-01,
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        1.12452197e-01, 1.30525275e-01, 2.19329505e-01, 9.44722098e-02,
        9.98185782e-02, 2.60042486e-01, 2.51475715e-01, 4.59039018e-02,
       -7.94007856e-02, -7.05812314e-03, 2.04344419e-01, -3.97180151e-03,
       -5.91286905e-03, 1.26797761e-01, 8.02495203e-02, 2.55422079e-02,
        4.65384158e-02, 2.32985240e-01, 3.16063931e-01, 2.02833301e-01,
        3.14235904e-01, 2.33427101e-01, -1.42446708e-02, 2.24789285e-01,
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        2.86026178e-01, 4.75925979e-01, 2.87802013e-01, 6.72561468e-03,
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        9.61150570e-02, 1.27870464e-01, 2.13995902e-01, -9.95070059e-03,
        2.59908614e-02, 1.24499158e-01, 3.31256404e-02, 2.39369272e-01,
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        2.24222741e-01, 1.35207932e-01, 1.91240682e-01, 3.87158365e-02,
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       -1.61842349e-01, 1.22990350e-01, 1.33351902e-02, 3.42072173e-01,
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```

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        1.86467739e-01,  2.03098589e-01, -1.10349710e-02,  2.63095846e-01,
       -2.48406147e-01, -3.25418955e-02, 1.74487006e-01, 2.62780720e-02,
        1.91428194e-01,  2.03493779e-01, -8.84696022e-02,  3.35631012e-01,
        6.29476544e-02,  2.28818932e-01, -7.72255471e-02,  3.05353195e-01,
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        1.26693452e-02,  9.53511494e-02,  4.52766233e-01, -4.37470263e-02,
        3.05687630e-01,  3.57706117e-02,  1.82867743e-01,  2.10106289e-01,
       -1.71378996e-01,  2.60157245e-01, -1.38655420e-01,  3.36603939e-01,
       -7.65297319e-02,  2.15165094e-01,  3.72947326e-02,  1.96608549e-01,
        1.07172893e-01,  3.07687901e-01,  3.97760529e-01,  1.06797074e-03,
        8.12866229e-02,  2.95445495e-01,  5.47994817e-02,  1.13818287e-01,
        4.07117263e-01,  1.48860323e-01,  3.88471838e-02,  3.79029267e-02,
        1.09895981e-01, -4.30946471e-02,  3.30298512e-01,  1.07254284e-01,
       -1.13032643e-02, -3.69192632e-02, 2.87732288e-01, 9.91961213e-02,
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        2.69970366e-01,  2.81850174e-01,  2.49972461e-01, -2.33065542e-03,
        2.34240860e-01,  1.51536128e-01,  6.56810225e-02,  1.35221573e-02,
        3.03956323e-02,  9.22075626e-02,  1.28297232e-01,  2.04669352e-01,
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       -6.34810776e-02,  4.36092057e-02,  1.39814157e-01,  1.72029014e-01,
        1.65538329e-01,  2.24411690e-01,  2.15315070e-01,  1.16342630e-01,
       -6.24745967e-02])
```

In [73]:
```python
y_test
```

Out[73]:
```
array([0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 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, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 1, 0, 1, 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, 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, 1,
       1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1,
       0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 1, 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, 1, 0, 0, 0, 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, 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, 1, 0, 0, 0, 1, 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, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 1, 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, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0,
       0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1,
       0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0])
```

In [74]:
```python
from sklearn import metrics
print(metrics.r2_score(y_test,y_pred_rg))
print(metrics.r2_score(y_train,ridgecv.predict(x_train)))
```

```
0.21073458438815906
0.2061567210285109
```

Lasso

In [75]:
```python
from sklearn.linear_model import Lasso
from sklearn.model_selection import GridSearchCV
```

In [76]:
```python
la=Ridge()
```

In [77]:
```python
parametres={"alpha":[1,2,3,5,10,20,30,40,60,70,80,90]}
ridgecv=GridSearchCV(la,parametres,scoring="neg_mean_squared_error",cv=5)
ridgecv.fit(x_train,y_train)
```

Out[77]:
```
▸ GridSearchCV
▸ estimator: Ridge
    ▸ Ridge
```

In [78]:
```python
print(ridgecv.best_params_)
```

```
{'alpha': 90}
```

In [79]:
```python
print(ridgecv.best_score_)
```

```
-0.11390621139234183
```

In [80]:
```python
y_pred_la=ridgecv.predict(x_test)
```

In [81]:
```python
y_pred_la
```

Out[81]:
```
array([ 1.34413485e-01, 2.22561818e-01, 3.41692977e-01, 3.88209867e-03,
        4.84617338e-01, 1.16361483e-01, 3.30449743e-01, 1.27358807e-01,
```

-1.34442619e-01, 3.77692888e-01, 1.33001445e-01, 2.69898751e-01,
-2.54707392e-02, 5.25771894e-01, 2.67543514e-01, 2.78725024e-02,
1.82233111e-01, 2.78896415e-01, 9.12689699e-02, 2.11494641e-01,
2.70103341e-01, 8.44922044e-03, 8.74746722e-02, 1.05348798e-01,
4.87749940e-01, 2.83080512e-01, 8.80556209e-02, 1.23817268e-01,
4.82185624e-01, 9.34824523e-02, -7.16448509e-02, 4.07003104e-02,
1.08437994e-01, 3.42151399e-01, 1.22270929e-01, 6.85889862e-02,
1.06690533e-01, 7.08689637e-02, 7.51570276e-02, 6.05829413e-02,
1.08782897e-02, -6.91368661e-03, 5.83191600e-02, -1.54680056e-02,
-4.02267475e-03, 4.08010612e-01, 3.43668700e-01, -1.83519405e-01,
5.29536511e-01, 4.27646098e-01, 1.95234877e-01, 4.25012930e-01,
1.40754410e-01, 3.52173952e-01, 4.70372694e-01, 2.89240343e-01,
-3.11642726e-02, 3.04206456e-01, 9.89337674e-03, 2.44569884e-01,
-1.40249115e-02, 2.75133912e-01, 8.64669565e-02, 1.24214885e-01,
3.48994545e-01, 3.41026778e-02, 3.40548051e-01, 1.95847356e-01,
1.30040885e-01, 1.32259137e-01, -2.34680143e-02, 3.04595468e-01,
1.12452197e-01, 1.30525275e-01, 2.19329505e-01, 9.44722098e-02,
9.98185782e-02, 2.60042486e-01, 2.51475715e-01, 4.59039018e-02,
-7.94007856e-02, -7.05812314e-03, 2.04344419e-01, -3.97180151e-03,
-5.91286905e-03, 1.26797761e-01, 8.02495203e-02, 2.55422079e-02,
4.65384158e-02, 2.32985240e-01, 3.16063931e-01, 2.02833301e-01,
3.14235904e-01, 2.33427101e-01, -1.42446708e-02, 2.24789285e-01,
2.94719863e-01, 2.94698323e-01, 1.19907108e-01, 9.47152062e-02,
2.86026178e-01, 4.75925979e-01, 2.87802013e-01, 6.72561468e-03,
1.65013565e-01, 1.72887026e-02, 3.34684186e-02, 2.15466121e-01,
7.50317322e-02, 1.67646673e-01, 1.16585544e-01, 1.07157808e-01,
-1.84689359e-02, 1.86217544e-01, 1.16586463e-01, 4.67201201e-02,
1.11060472e-01, 2.27053971e-01, -7.00247692e-02, -5.81070776e-02,
2.03141688e-01, 4.69029664e-02, 1.31525768e-01, 5.66738022e-01,
2.41883060e-02, -3.41250985e-02, -1.13904557e-01, 2.18572744e-01,
2.60568042e-01, 1.65533667e-01, -5.94078459e-05, 2.60009384e-01,
4.20709666e-01, 3.71031267e-01, 1.70250288e-01, 4.03052216e-01,
4.67312765e-01, 1.98845366e-01, 1.55005619e-01, 3.41505080e-01,
2.20024496e-01, 1.40989758e-01, 1.97796963e-01, 2.57841889e-01,
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1.97670909e-01, 2.70864780e-01, 1.22454317e-01, 2.58893294e-01,
6.78818374e-02, 3.08485027e-01, 1.49347982e-01, 2.01436659e-02,
-3.30262214e-02, 1.44305312e-01, -8.99199978e-02, -3.74712872e-02,
3.10198738e-01, -7.96862570e-02, 2.18579680e-01, 5.85363859e-01,
1.98166099e-01, 3.02558934e-01, 1.82182301e-01, 1.84955080e-01,
1.83694574e-02, -7.41419216e-02, 4.48013268e-02, 1.38405390e-01,
1.84013774e-01, 1.60373463e-01, -6.83819091e-02, 2.00146771e-01,
1.97563797e-01, 1.73505024e-01, 1.01481984e-01, 1.83169586e-01,
1.99747065e-02, 1.81881922e-01, -5.23948254e-02, 5.46171171e-01,
6.66114639e-02, 5.88865384e-02, 3.17247692e-01, 9.77721299e-02,
5.25297461e-01, 1.62566350e-01, 3.51341492e-01, 3.58324715e-01,
2.37059552e-01, 8.05788438e-02, 1.36041888e-01, 2.66653277e-01,
7.95513973e-02, -6.96788172e-02, 3.29442074e-01, 8.93231393e-02,
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2.72059331e-01, 6.13056795e-02, 4.38912502e-01, -7.79381284e-02,
2.09974643e-01, 2.20746796e-02, 1.56186553e-01, 2.26485767e-01,
9.61150570e-02, 1.27870464e-01, 2.13995902e-01, -9.95070059e-03,
2.59908614e-02, 1.24499158e-01, 3.31256404e-02, 2.39369272e-01,
1.48870840e-01, 2.49438253e-01, 5.25239856e-01, 1.25104891e-01,
3.65711314e-01, -5.96554519e-02, 1.45443911e-01, 2.80327834e-01,
3.15149040e-01, 2.25038913e-02, -2.55968584e-02, 3.39893959e-01,
1.13068264e-01, -1.40778596e-02, 2.41548652e-01, 3.30468114e-01,
2.79352111e-01, -1.11653133e-01, 1.30812123e-01, 5.94136334e-03,
2.15791900e-01, 2.89769560e-01, 6.35971718e-02, 2.98116673e-01,
5.90198982e-02, 4.13352130e-02, 3.77978672e-01, 3.28916149e-01,
3.93836061e-03, 2.47850806e-01, 3.23692453e-01, 3.69738410e-01,
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1.33675781e-02, 5.03508194e-01, 3.13852304e-01, 3.23698856e-01,
3.56168397e-01, 6.40677131e-02, 2.39875950e-01, 1.30293453e-01,
1.49885837e-01, 1.46778013e-01, -1.27871947e-01, 3.00062088e-01,
3.83140060e-01, 1.33561747e-01, 1.76445188e-01, -2.02405714e-02,
2.05300799e-01, 8.08917915e-02, -2.89389327e-02, 3.88975789e-02,
1.66754600e-01, 3.46231726e-01, 3.01325806e-01, 2.82141156e-01,
2.72386022e-01, -4.84039332e-02, 1.90411095e-01, 1.89810174e-01,
1.67705712e-01, 2.58007480e-01, -1.08871386e-01, 2.70056893e-01,
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1.25404974e-01, 2.97241061e-01, 2.29580043e-01, 2.16006118e-03,
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1.17416027e-01, 1.20780070e-01, 2.19845528e-01, 3.11363894e-01,
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2.28214280e-01, 8.56533063e-02, 1.28782763e-01, 6.89964545e-03,
2.66888647e-01, 1.25060071e-01, 3.71449815e-01, 3.23080605e-01,
1.80691831e-01, 1.35736688e-01, 3.05937337e-01, 3.02505887e-01,
-1.61842349e-01, 1.22990350e-01, 1.33351902e-02, 3.42072173e-01,
1.35302335e-01, 3.71921241e-01, 2.43987619e-01, -1.42777272e-01,
2.54178774e-01, -1.97769860e-01, 3.22194537e-01, 1.46753524e-01,
1.28207748e-01, 4.59813547e-01, 1.49345212e-01, 3.97978765e-01,
1.11492990e-01, 2.94090069e-02, 2.30676290e-01, 1.19192017e-01,
1.49461455e-02, 2.42284371e-01, 7.22361156e-02, 3.33852369e-01,
1.61213354e-01, 9.69685794e-02, 2.32264965e-01, -6.93181380e-02,
1.86467739e-01, 2.03098589e-01, -1.10349710e-02, 2.63095846e-01,
-2.48406147e-01, -3.25418955e-02, 1.74487006e-01, 2.62780720e-02,

```
        1.91428194e-01,  2.03493779e-01, -8.84696022e-02,  3.35631012e-01,
        6.29476544e-02,  2.28818932e-01, -7.72255471e-02,  3.05353195e-01,
        3.63634109e-02,  2.30128273e-01,  3.03522210e-01,  1.05913376e-01,
        1.26693452e-02,  9.53511494e-02,  4.52766233e-01, -4.37470263e-02,
        3.05687630e-01,  3.57706117e-02,  1.82867743e-01,  2.10106289e-01,
       -1.71378996e-01,  2.60157245e-01, -1.38655420e-01,  3.36603939e-01,
       -7.65297319e-02,  2.15165094e-01,  3.72947326e-02,  1.96608549e-01,
        1.07172893e-01,  3.07687901e-01,  3.97760529e-01,  1.06797074e-03,
        8.12866229e-02,  2.95445495e-01,  5.47994817e-02,  1.13818287e-01,
        4.07117263e-01,  1.48860323e-01,  3.88471838e-02,  3.79029267e-02,
        1.09895981e-01, -4.30946471e-02,  3.30298512e-01,  1.07254284e-01,
       -1.13032643e-02, -3.69192632e-02,  2.87732288e-01,  9.91961213e-02,
        2.12225886e-01,  3.88660531e-01,  3.15623317e-01,  1.80996998e-01,
        2.69970366e-01,  2.81850174e-01,  2.49972461e-01, -2.33065542e-03,
        2.34240860e-01,  1.51536128e-01,  6.56810225e-02,  1.35221573e-02,
        3.03956323e-02,  9.22075626e-02,  1.28297232e-01,  2.04669352e-01,
        2.26917512e-01, -1.62627965e-01,  2.95984225e-01,  1.80934145e-01,
       -6.34810776e-02,  4.36092057e-02,  1.39814157e-01,  1.72029014e-01,
        1.65538329e-01,  2.24411690e-01,  2.15315070e-01,  1.16342630e-01,
       -6.24745967e-02])
```

In [82]:

```
from sklearn import metrics
print(metrics.r2_score(y_test,y_pred_la))
print(metrics.r2_score(y_train,ridgecv.predict(x_train)))
```

```
0.21073458438815906
0.2061567210285109
```

Decision Tree

In [83]:

```
from sklearn.tree import DecisionTreeClassifier
dtc=DecisionTreeClassifier()
```

In [84]:

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

Out[84]:

```
▾ DecisionTreeClassifier
DecisionTreeClassifier()
```

In [85]:

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

In [86]:

```
pred
```

Out[86]:

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

In [87]:

```
y_test
```

Out[87]:
```
array([0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 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, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 1, 0, 1, 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, 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, 1,
       1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1,
       0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 1, 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, 1, 0, 0, 0, 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, 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, 1, 0, 0, 0, 1, 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, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 1, 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, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0,
       0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1,
       0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0])
```

In [88]:
```python
#Accuracy score
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report,roc_auc_score,roc_curve
```

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

Out[89]:
```
0.7664399092970522
```

In [90]:
```python
confusion_matrix(y_test,pred)
```

Out[90]:
```
array([[316,  55],
       [ 48,  22]], dtype=int64)
```

In [91]:
```python
pd.crosstab(y_test,pred)
```

Out[91]:

col_0	0	1
row_0		
0	316	55
1	48	22

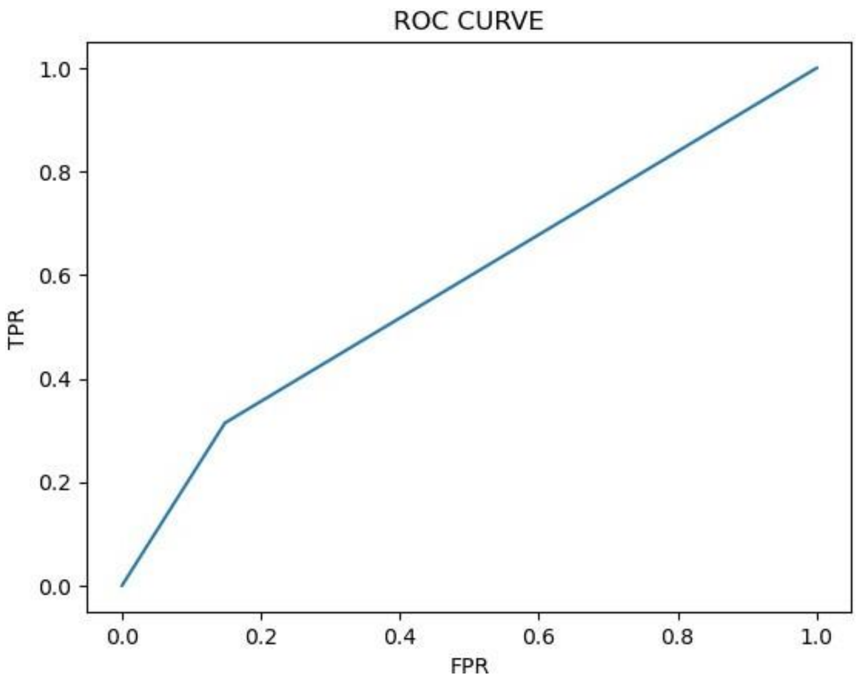
In [92]:
```python
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.87      0.85      0.86       371
           1       0.29      0.31      0.30        70

    accuracy                           0.77       441
   macro avg       0.58      0.58      0.58       441
weighted avg       0.78      0.77      0.77       441
```

In [93]:
```python
probability=dtc.predict_proba(x_test)[:,1]
```

In [94]:
```python
# roc_curve
fpr,tpr,threshsholds = roc_curve(y_test,probability)
```

In [95]:
```python
plt.plot(fpr,tpr)
plt.xlabel("FPR")
plt.ylabel("TPR")
plt.title("ROC CURVE")
plt.show()
```



Random Forest

In [96]:
```
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier()
```

In [97]:
```
forest_params = [{'max_depth': list(range(10, 15)), 'max_features': list(range(0,14))}]
```

In [98]:
```
from sklearn.model_selection import GridSearchCV
```

In [99]:
```
rfc_cv= GridSearchCV(rfc,param_grid=forest_params,cv=10,scoring="accuracy")
```

In [100]:
```
rfc_cv.fit(x_train,y_train)
```

```
C:\Users\Prasanth Nimmala\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:378: FitFailedWarn
ing:
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\Prasanth Nimmala\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 686
, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Prasanth Nimmala\anaconda3\lib\site-packages\sklearn\ensemble\_forest.py", line 340, in fit
    self._validate_params()
  File "C:\Users\Prasanth Nimmala\anaconda3\lib\site-packages\sklearn\base.py", line 581, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Prasanth Nimmala\anaconda3\lib\site-packages\sklearn\utils\_param_validation.py", line 97, in
validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'max_features' parameter of RandomForestClassifier m
ust be an int in the range [1, inf), a float in the range (0.0, 1.0], a str among {'log2', 'sqrt', 'auto' (depr
ecated)} or None. Got 0 instead.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
C:\Users\Prasanth Nimmala\anaconda3\lib\site-packages\sklearn\model_selection\_search.py:952: UserWarning: One
or more of the test scores are non-finite: [       nan 0.84353703 0.84840091 0.8483914  0.85325528 0.85033314
 0.85421664 0.85033314 0.85422616 0.84644013 0.85517799 0.85519703
 0.85033314 0.84449838        nan 0.8445079  0.84935275 0.85031411
 0.85421664 0.84936227 0.85516848 0.85032362 0.84934323 0.8512945
 0.84935275 0.84934323 0.85322673 0.85032362        nan 0.8445079
 0.84936227 0.85324576 0.85033314 0.85033314 0.85324576 0.85810013
 0.85711974 0.84935275 0.85225585 0.8483914  0.85131354 0.85324576
        nan 0.84546926 0.84937179 0.84936227 0.85325528 0.85324576
 0.85615839 0.85324576 0.85520655 0.85615839 0.85517799 0.85324576
 0.8512945  0.85030459        nan 0.84547877 0.84644965 0.84546926
 0.85518751 0.84353703 0.84937179 0.85615839 0.85031411 0.8561679
 0.85713878 0.84838188 0.85227489 0.84643061]
  warnings.warn(
```

Out[100]:

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

In [101]:

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

In [102]:

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

```
              precision    recall  f1-score   support

           0       0.87      0.99      0.93       371
           1       0.84      0.23      0.36        70

    accuracy                           0.87       441
   macro avg       0.86      0.61      0.64       441
weighted avg       0.87      0.87      0.84       441
```

In [103]:

```
rfc_cv.best_params_
```

Out[103]: {'max_depth': 12, 'max_features': 7}

In [104]:

```
rfc_cv.best_score_
```

Out[104]: 0.8581001332571864