

```
In [1]: import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

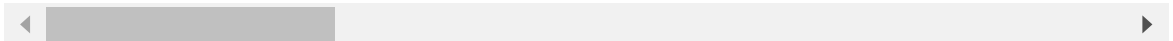
```
In [2]: data=pd.read_csv("Employee-Attrition.csv")
```

```
In [3]: data.head()
```

Out[3]:

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

5 rows × 35 columns

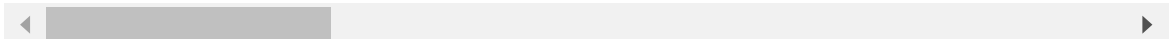


```
In [4]: data.tail()
```

Out[4]:

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

5 rows × 35 columns



In [5]: 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	Employee
count	1470.000000	1470.000000	1470.000000	1470.000000	1470.0	147
mean	36.923810	802.485714	9.192517	2.912925	1.0	102
std	9.135373	403.509100	8.106864	1.024165	0.0	60
min	18.000000	102.000000	1.000000	1.000000	1.0	
25%	30.000000	465.000000	2.000000	2.000000	1.0	49
50%	36.000000	802.000000	7.000000	3.000000	1.0	102
75%	43.000000	1157.000000	14.000000	4.000000	1.0	155
max	60.000000	1499.000000	29.000000	5.000000	1.0	206

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()
```

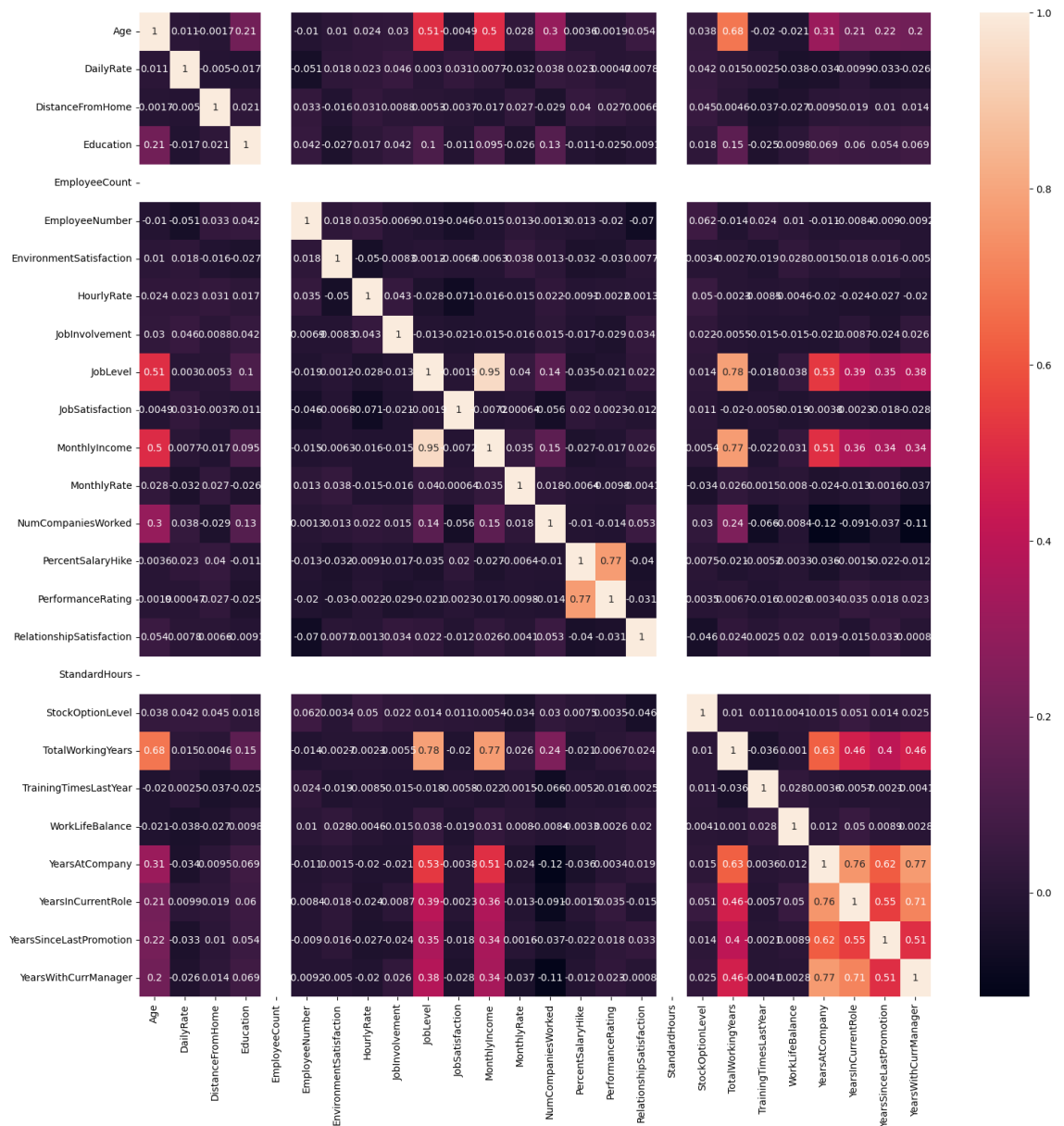
```
Out[8]: Age                                0
Attrition                                0
BusinessTravel                           0
DailyRate                                0
Department                               0
DistanceFromHome                         0
Education                                 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\pichi\AppData\Local\Temp\ipykernel_8760\1426905697.py:1: FutureWarning: The default value of numeric_only in DataFrame.corr is deprecated. In a future version, it will default to False. Select only valid 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)
```

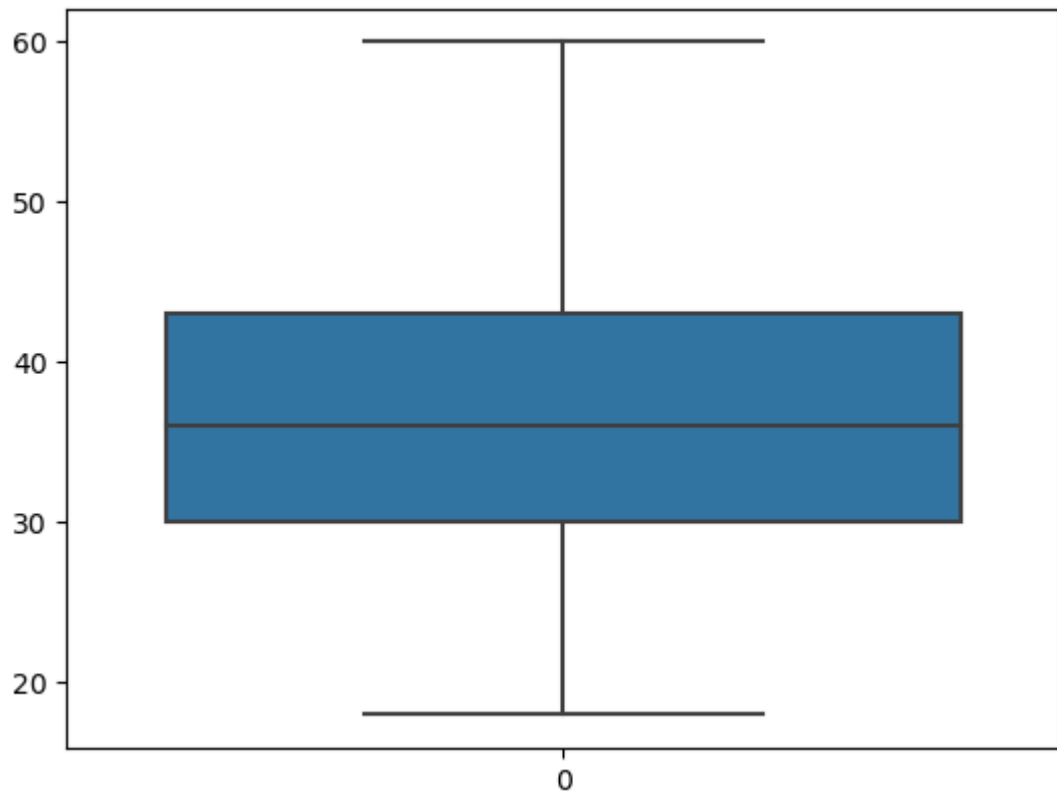
Out[10]: <Axes: >



outliers

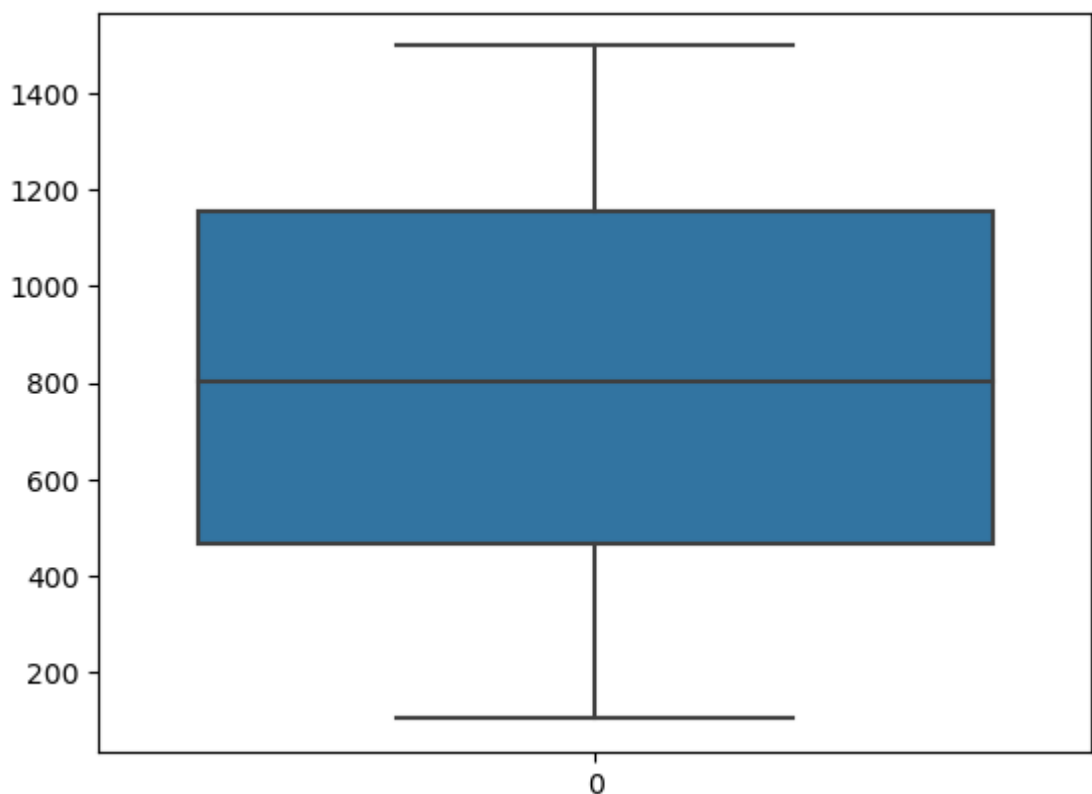
```
In [11]: sns.boxplot(data["Age"])
```

```
Out[11]: <Axes: >
```



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

```
Out[12]: <Axes: >
```

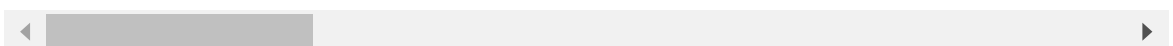


```
In [13]: data.describe()
```

```
Out[13]:
```

	Age	DailyRate	DistanceFromHome	Education	EmployeeCount	Employee
count	1470.000000	1470.000000	1470.000000	1470.000000	1470.0	147
mean	36.923810	802.485714	9.192517	2.912925	1.0	102
std	9.135373	403.509100	8.106864	1.024165	0.0	60
min	18.000000	102.000000	1.000000	1.000000	1.0	
25%	30.000000	465.000000	2.000000	2.000000	1.0	49
50%	36.000000	802.000000	7.000000	3.000000	1.0	102
75%	43.000000	1157.000000	14.000000	4.000000	1.0	155
max	60.000000	1499.000000	29.000000	5.000000	1.0	206

8 rows × 26 columns

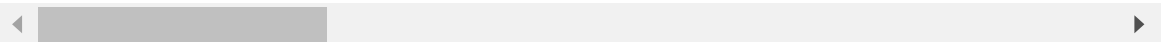


In [14]: `data.head()`

Out[14]:

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

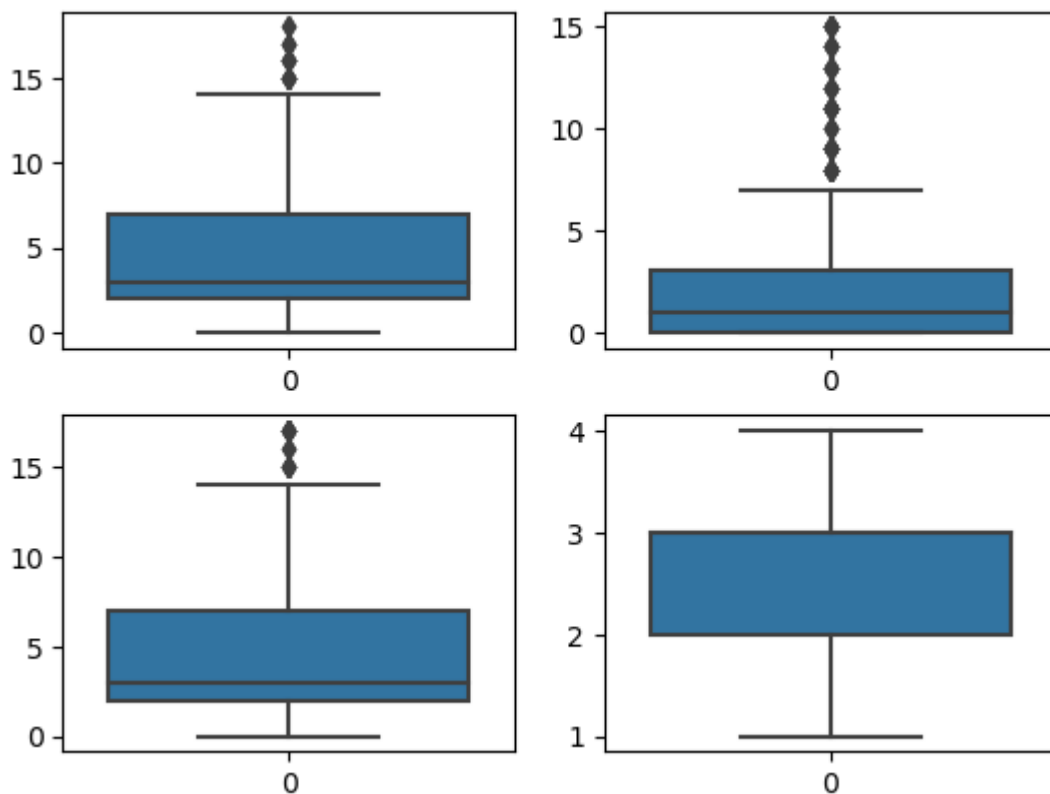
5 rows × 35 columns



In []:

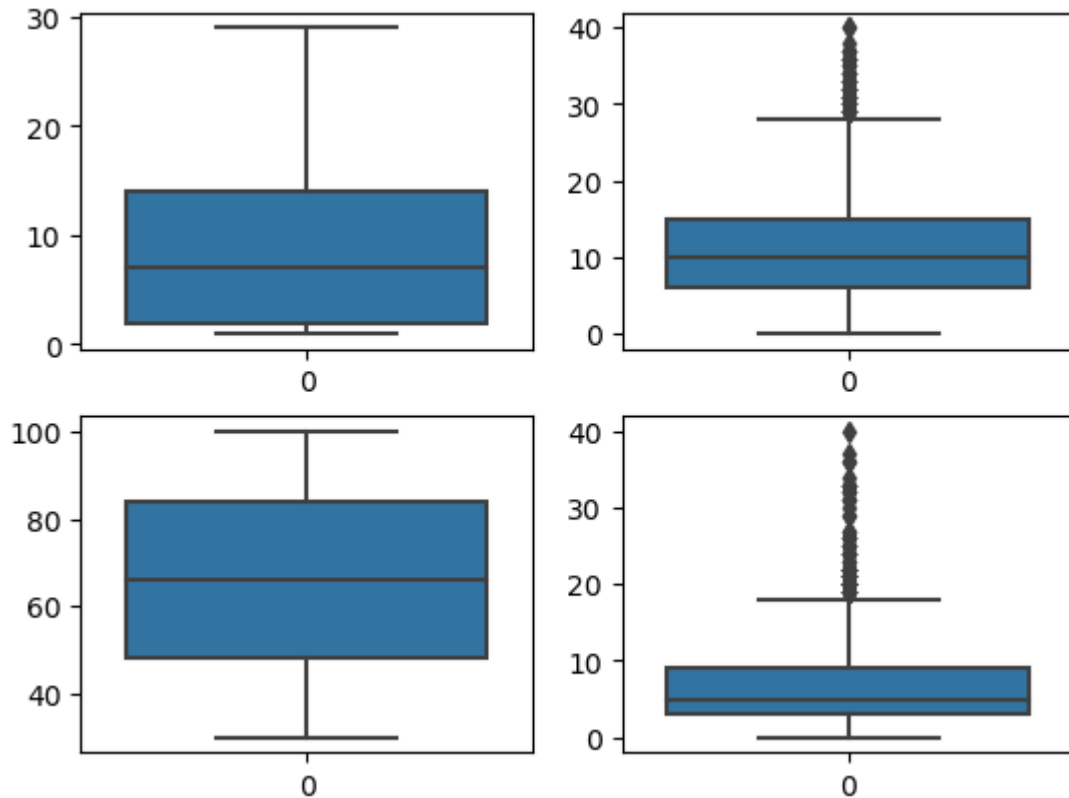
```
In [15]: fig, axes = plt.subplots(2,2)
sns.boxplot(data=data["YearsInCurrentRole"],ax=axes[0,0])
sns.boxplot(data=data["YearsSinceLastPromotion"],ax=axes[0,1])
sns.boxplot(data=data["YearsWithCurrManager"],ax=axes[1,0])
sns.boxplot(data=data["WorkLifeBalance"],ax=axes[1,1])
```

Out[15]: <Axes: >



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



Handling the outliers

```
In [17]: 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_YearsInCurrentR
lower_limit_YearsInCurrentRole =YearsInCurrentRole_q1-1.5*IQR_YearsInCurren
median_YearsInCurrentRole=data["YearsInCurrentRole"].median()
data['YearsInCurrentRole'] = np.where(
    (data['YearsInCurrentRole'] > upperlimit_YearsInCurrentRole),
    median_YearsInCurrentRole,
    data['YearsInCurrentRole']
)
```

```
In [18]: 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']
)
```

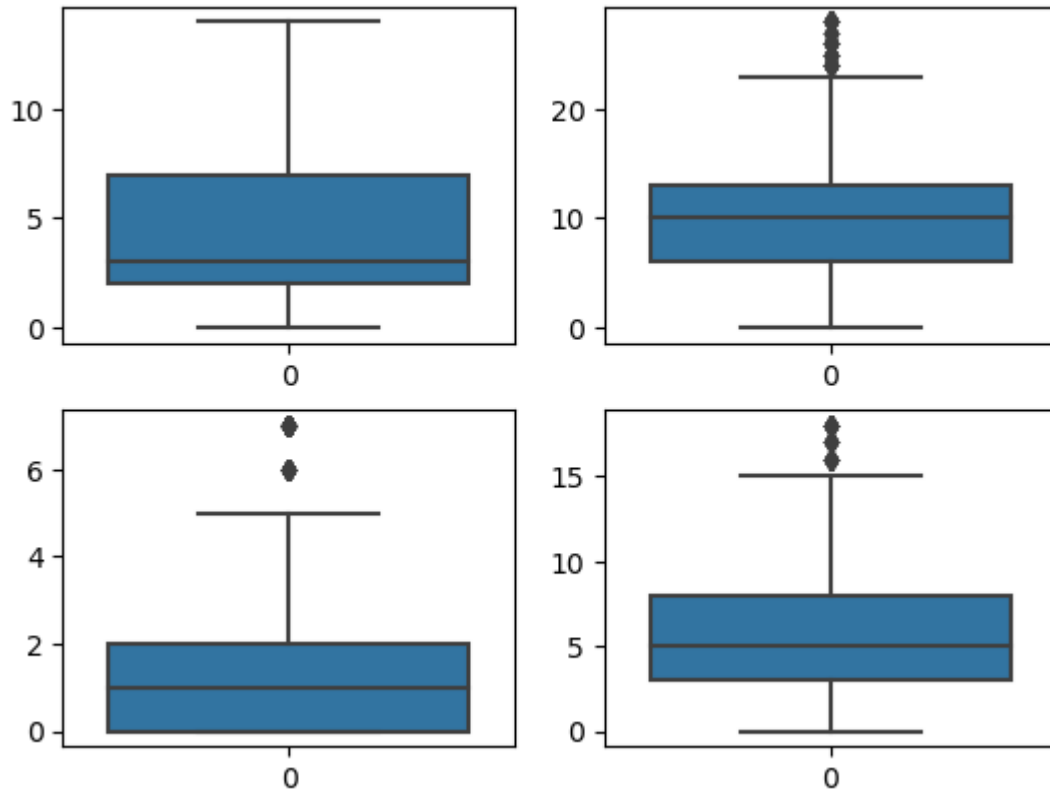
```
In [19]: YearsWithCurrManager_q1 = data.YearsWithCurrManager.quantile(0.25)
YearsWithCurrManager_q3 = data.YearsWithCurrManager.quantile(0.75)
IQR_YearsWithCurrManager=YearsWithCurrManager_q3-YearsWithCurrManager_q1
upperlimit_YearsWithCurrManager=YearsWithCurrManager_q3+1.5*IQR_YearsWithCurrManager
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']
)
```

```
In [20]: 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']
)
```

```
In [21]: YearsAtCompany_q1 = data.YearsAtCompany.quantile(0.25)
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 [22]: 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[22]: <Axes: >

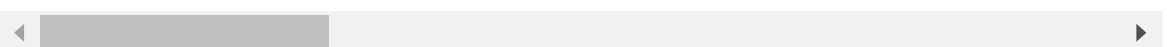


```
In [23]: data.head()
```

Out[23]:

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

5 rows × 35 columns



```
In [24]: data.drop("EducationField",axis=1,inplace=True)
```

In [25]: `data.head(2)`

Out[25]:

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

2 rows × 34 columns



In [26]: `data["BusinessTravel"].unique()`

Out[26]: `array(['Travel_Rarely', 'Travel_Frequently', 'Non-Travel'], dtype=object)`

splitting the data

In [27]: `y=data["Attrition"]`

In [28]: `y.head()`

Out[28]:

0	Yes
1	No
2	Yes
3	No
4	No

Name: Attrition, dtype: object

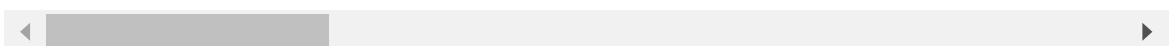
In [29]: `data.drop("Attrition",axis=1,inplace=True)`

In [30]: `data.head()`

Out[30]:

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

5 rows × 33 columns



Encoding

```
In [31]: from sklearn.preprocessing import LabelEncoder
```

```
In [32]: le=LabelEncoder()
```

```
In [33]: data["BusinessTravel"]=le.fit_transform(data["BusinessTravel"])
```

```
In [34]: data["Department"]=le.fit_transform(data["Department"])
```

```
In [35]: data["Gender"]=le.fit_transform(data["Gender"])
```

```
In [36]: y=le.fit_transform(y)
```

```
In [37]: y
```

```
Out[37]: array([1, 0, 1, ..., 0, 0, 0])
```

```
In [38]: data["JobRole"]=le.fit_transform(data["JobRole"])
```

```
In [39]: data["Over18"]=le.fit_transform(data["Over18"])
```

```
In [40]: data["MaritalStatus"]=le.fit_transform(data["MaritalStatus"])
```

```
In [41]: data["OverTime"]=le.fit_transform(data["OverTime"])
```

In [42]: 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

In [43]: `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_`

In [44]: `x_train.shape,x_test.shape,y_train.shape,y_test.shape`

Out[44]: ((1029, 33), (441, 33), (1029,), (441,))

Feature Scaling

```
In [45]: from sklearn.preprocessing import StandardScaler
```

```
In [46]: sc=StandardScaler()
```

```
In [47]: x_train=sc.fit_transform(x_train)
```

```
In [48]: x_test=sc.fit_transform(x_test)
```

Building the model

Multi-Linear Regression

```
In [49]: from sklearn.linear_model import LinearRegression
```

```
In [50]: lr = LinearRegression()
```

```
In [51]: lr.fit(x_train,y_train)
```

```
Out[51]: ▼ LinearRegression
          LinearRegression()
```

```
In [52]: lr.coef_ #slope(m)
```

```
Out[52]: 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 [53]: lr.intercept_ #(c)
```

```
Out[53]: 0.16229348882410102
```

```
In [54]: y_pred = lr.predict(x_test)
```


In [55]: `y_pred`

```
Out[55]: 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,
                ...])
```

In [56]: `y_test`

```
Out[56]: 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, 1, 0, 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, 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, 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,
                1, 0, 0, 0, 1, 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, 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, 0, 1, 0, 1, 0, 0, 0,
                0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
                0, 1, 0, 0, 0, 1, 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, 1, 0, 0, 1, 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,
                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, 0, 1, 0, 0, 1,
                0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0,
                0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

Logistic Regression

In [57]: `from sklearn.linear_model import LogisticRegression`

In [58]: `lg=LogisticRegression()`

In [59]: `lg.fit(x_train,y_train)`

Out[59]: `LogisticRegression`
`LogisticRegression()`

In [60]: `y_pred_lg=lg.predict(x_test)`

In [61]: `y_pred`

```
1.45760263e-01, 3.75821843e-01, 4.92762622e-01, 2.95885645e-
01,
-4.62363391e-02, 3.16337190e-01, -7.90813313e-03, 2.52644685e-
01,
-3.18239329e-02, 2.83907645e-01, 9.03615010e-02, 1.26934391e-
01,
3.58670014e-01, 2.40923530e-02, 3.55890111e-01, 1.95961225e-
01,
1.28554515e-01, 1.18806226e-01, -2.86217094e-02, 3.17635336e-
01,
1.08017895e-01, 1.25723940e-01, 2.30183307e-01, 9.84315444e-
02,
9.10911969e-02, 2.72901425e-01, 2.52029723e-01, 4.09210759e-
02,
-9.10277454e-02, -1.08769544e-02, 1.94114970e-01, -2.25933708e-
02,
-1.73984898e-02, 1.15587264e-01, 8.36037575e-02, 2.82744685e-
03,
4.96507732e-02, 2.41862504e-01, 3.14048594e-01, 2.26261102e-
01.
```

In [62]: `y_test`

Out[62]: `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, 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,`
`1, 1, 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, 0, 1, 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, 1,`
`1, 0, 0, 0, 1, 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, 1, 0, 0, 1, 0,`
`0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0,`
`1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0,`
`0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,`
`0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0,`
`0, 0, 0, 1, 1, 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, 1, 0, 0, 0, 0, 0, 0, 0, 1,`
`0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 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, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0,`
`1, 0, 0, 0, 1, 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, 1, 1, 0, 0, 0, 0, 1,`
`0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,`
`0])`

```
In [63]: score = lg.score(x_test, y_test)
print(score)
```

0.8820861678004536

confusion matrix

```
In [64]: from sklearn import metrics
cm = metrics.confusion_matrix(y_test,y_pred_lg)
print(cm)
```

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

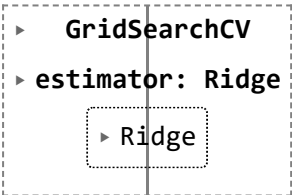
Ridge and Lasso

```
In [65]: from sklearn.linear_model import Ridge
from sklearn.model_selection import GridSearchCV
```

```
In [66]: rg=Ridge()
```

```
In [67]: parameters={"alpha":[1,2,3,5,10,20,30,40,60,70,80,90]}
ridgecv=GridSearchCV(rg,parameters,scoring="neg_mean_squared_error",cv=5)
ridgecv.fit(x_train,y_train)
```

```
Out[67]:
```



```
  ▸ GridSearchCV
  ▸ estimator: Ridge
      ▸ Ridge
```

```
In [68]: print(ridgecv.best_params_)
```

{'alpha': 90}

```
In [69]: print(ridgecv.best_score_)
```

-0.11390621139234183

```
In [70]: y_pred_rg=ridgecv.predict(x_test)
```

In [71]: `y_pred_rg`

```
Out[71]: 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-01,
                ..])
```

In [72]: `y_test`

```
Out[72]: 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, 1, 0, 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, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1,
                1, 0, 0, 0, 1, 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,
                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, 1, 0, 0, 1, 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,
                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, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
                0])
```

```
In [73]: 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
```

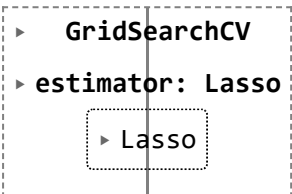
Lasso

```
In [74]: from sklearn.linear_model import Lasso  
from sklearn.model_selection import GridSearchCV
```

```
In [75]: la=Lasso()
```

```
In [76]: parameters={"alpha":[1,2,3,5,10,20,30,40,60,70,80,90]}  
ridgecv=GridSearchCV(la,parameters,scoring="neg_mean_squared_error",cv=5)  
ridgecv.fit(x_train,y_train)
```

```
Out[76]:
```



```
  ▸ GridSearchCV  
    ▸ estimator: Lasso  
      ▸ Lasso
```

```
In [77]: print(ridgecv.best_params_)  
  
{'alpha': 1}
```

```
In [78]: print(ridgecv.best_score_)  
  
-0.13606536538697322
```

```
In [79]: y_pred_la=ridgecv.predict(x_test)
```

In [80]: y_pred_la

localhost:8888/notebooks/Documents/Smart-Bridge/Assignment-4.ipynb

[illegible]

```
In [81]: from sklearn import metrics
print(metrics.r2_score(y_test,y_pred_la))
print(metrics.r2_score(y_train,ridgecv.predict(x_train)))
```

-9.508616692710525e-05
0.0

Decision Tree

```
In [82]: from sklearn.tree import DecisionTreeClassifier
         dtc=DecisionTreeClassifier()
```

```
In [83]: dtc.fit(x_train,y_train)
```

```
Out[83]: ▾ DecisionTreeClassifier
DecisionTreeClassifier()
```

```
In [84]: pred=dtc.predict(x_test)
```


In [85]: pred

```
Out[85]: array([0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0,
                0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
                0, 1, 0, 0, 1, 1, 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, 0, 0, 0, 0, 0, 0, 1, 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, 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, 1, 0, 1, 0, 0, 1, 0, 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, 1, 0, 0,
                0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 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, 1,
                0, 1, 1, 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, 1, 0, 1, 0, 0, 0, 0,
                0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 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, 1, 1, 0, 1, 0, 0, 0, 0, 1, 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, 0, 0, 0, 1,
                0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
                0])
```

In [86]: y_test

```
Out[86]: 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, 1, 0, 0, 0, 0, 0, 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, 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, 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, 0, 1, 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, 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, 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, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0,
                0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 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, 0, 1, 0, 0, 1,
                0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 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 [87]: #Accuracy score
from sklearn.metrics import accuracy_score, confusion_matrix, classification_
```

In [88]: accuracy_score(y_test, pred)

Out[88]: 0.7755102040816326

```
In [89]: confusion_matrix(y_test,pred)
```

```
Out[89]: array([[318,  53],
                [ 46,  24]], dtype=int64)
```

```
In [90]: pd.crosstab(y_test,pred)
```

```
Out[90]:
```

col_0	0	1
row_0		
0	318	53
1	46	24

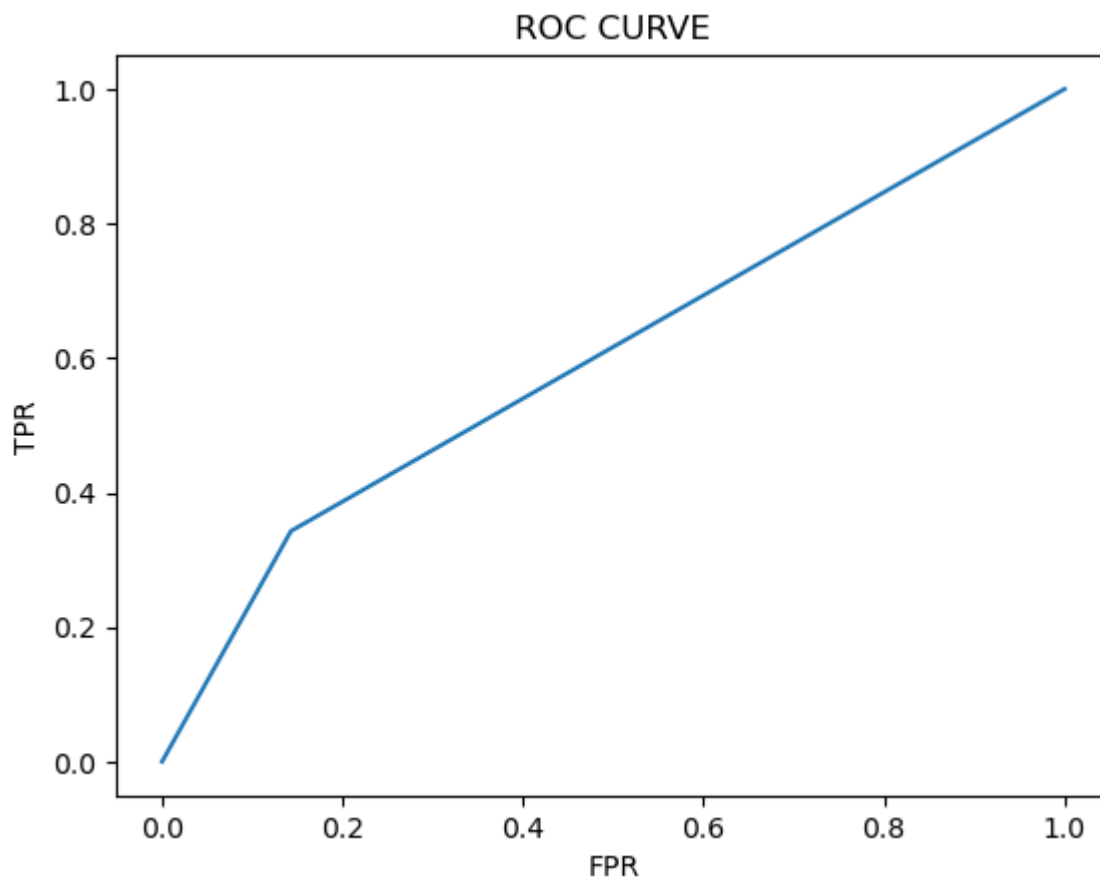
```
In [91]: print(classification_report(y_test,pred))
```

	precision	recall	f1-score	support
0	0.87	0.86	0.87	371
1	0.31	0.34	0.33	70
accuracy			0.78	441
macro avg	0.59	0.60	0.60	441
weighted avg	0.78	0.78	0.78	441

```
In [92]: probability=dtc.predict_proba(x_test)[: ,1]
```

```
In [93]: # roc_curve
fpr,tpr,threshholds = roc_curve(y_test,probability)
```

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



Random Forest

```
In [95]: from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier()
```

```
In [96]: forest_params = [{'max_depth': list(range(10, 15)), 'max_features': list(ra
```

```
In [97]: from sklearn.model_selection import GridSearchCV
```

```
In [98]: rfc_cv= GridSearchCV(rfc,param_grid=forest_params,cv=10,scoring="accuracy")
```

In [99]: `rfc_cv.fit(x_train,y_train)`

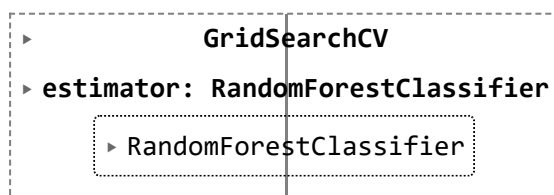
C:\Users\pichi\AppData\Roaming\Python\Python310\site-packages\sklearn\model_selection_validation.py:425: FitFailedWarning:
50 fits failed out of a total of 700.
The score on these train-test partitions for these parameters will be set to nan.
If these failures are not expected, you can try to debug them 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\pichi\AppData\Roaming\Python\Python310\site-packages\sklearn\model_selection\_validation.py", line 732, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\pichi\AppData\Roaming\Python\Python310\site-packages\sklearn\base.py", line 1144, in wrapper
    estimator._validate_params()
  File "C:\Users\pichi\AppData\Roaming\Python\Python310\site-packages\sklearn\base.py", line 637, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\pichi\AppData\Roaming\Python\Python310\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\pichi\AppData\Roaming\Python\Python310\site-packages\sklearn\model_selection\_search.py:976: UserWarning: One or more of the test scores are non-finite: [
nan 0.84353703 0.8483914 0.84936227 0.8483914 0.85
518751
0.85324576 0.84838188 0.85033314 0.84644013 0.85712926 0.85323625
0.85323625 0.85130402 nan 0.84644965 0.84936227 0.84936227
0.85032362 0.85033314 0.84838188 0.85033314 0.84936227 0.85420712
0.85227489 0.85613935 0.8512945 0.84546926 nan 0.8483914
0.84935275 0.85324576 0.85325528 0.85421664 0.85227489 0.85325528
0.85130402 0.85033314 0.85323625 0.85517799 0.85031411 0.84545974
nan 0.84644965 0.85033314 0.85325528 0.85518751 0.84838188
0.85032362 0.85421664 0.85131354 0.84448886 0.84643061 0.85517799
0.85031411 0.84935275 nan 0.84547877 0.84936227 0.85421664
0.84740148 0.85324576 0.85518751 0.85323625 0.85032362 0.8512945
0.85032362 0.85420712 0.8512945 0.85518751]
warnings.warn(
```

Out[99]:



```
In [100]: pred=rfc_cv.predict(x_test)
```

```
In [101]: print(classification_report(y_test,pred))
```

	precision	recall	f1-score	support
0	0.87	0.98	0.92	371
1	0.73	0.23	0.35	70
accuracy			0.86	441
macro avg	0.80	0.61	0.64	441
weighted avg	0.85	0.86	0.83	441

```
In [102]: rfc_cv.best_params_
```

```
Out[102]: {'max_depth': 10, 'max_features': 10}
```

```
In [103]: rfc_cv.best_score_
```

```
Out[103]: 0.8571292594707784
```

```
In [ ]:
```