Assignment-04 Sep 22

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

4.Calculate Performance metrics

```
import numpy as np
import pandas as pd
import matplotlib as plt
import seaborn as sns
```

```
df = pd.read_csv('/content/drive/MyDrive/SmartInternz-Notebooks/HR-Employee-Attrition.csv')
```

```
df
```

	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
...	...	...	...	...	...	...	...	...	...	...
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

```
df.shape
```

```
(1470, 35)
```

```
df.head()
```

	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

```
df.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
```

```
df.describe()
```

	Age	DailyRate	DistanceFromHome	Education	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	HourlyRate	JobIn
count	1470.000000	1470.000000	1470.000000	1470.000000	1470.0	1470.000000	1470.000000	1470.000000	14
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

```
#Dropping the unwanted columns
df.drop(['JobSatisfaction','JobInvolvement','Over18','RelationshipSatisfaction','EnvironmentSatisfaction','DistanceFromHome','StockOptionLeve
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1470 entries, 0 to 1469
Data columns (total 28 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   Education                1470 non-null   int64 
 6   EducationField           1470 non-null   object
 7   EmployeeCount            1470 non-null   int64 
 8   EmployeeNumber           1470 non-null   int64 
 9   Gender                   1470 non-null   object
 10  HourlyRate               1470 non-null   int64 
 11  JobLevel                 1470 non-null   int64 
 12  JobRole                  1470 non-null   object
 13  MaritalStatus            1470 non-null   object
 14  MonthlyIncome            1470 non-null   int64 
 15  MonthlyRate              1470 non-null   int64 
 16  NumCompaniesWorked       1470 non-null   int64 
 17  OverTime                 1470 non-null   object
 18  PercentSalaryHike        1470 non-null   int64 
 19  PerformanceRating        1470 non-null   int64 
 20  StandardHours            1470 non-null   int64 
 21  TotalWorkingYears        1470 non-null   int64 
 22  TrainingTimesLastYear    1470 non-null   int64 
 23  WorkLifeBalance          1470 non-null   int64 
 24  YearsAtCompany           1470 non-null   int64 
 25  YearsInCurrentRole       1470 non-null   int64 
 26  YearsSinceLastPromotion  1470 non-null   int64 
 27  YearsWithCurrManager     1470 non-null   int64 
dtypes: int64(20), object(8)
memory usage: 321.7+ KB
```

```
df.isnull().any()
```

```
Age                        False
Attrition                  False
BusinessTravel             False
DailyRate                  False
Department                 False
Education                  False
EducationField             False
EmployeeCount              False
EmployeeNumber             False
Gender                     False
HourlyRate                 False
JobLevel                   False
```

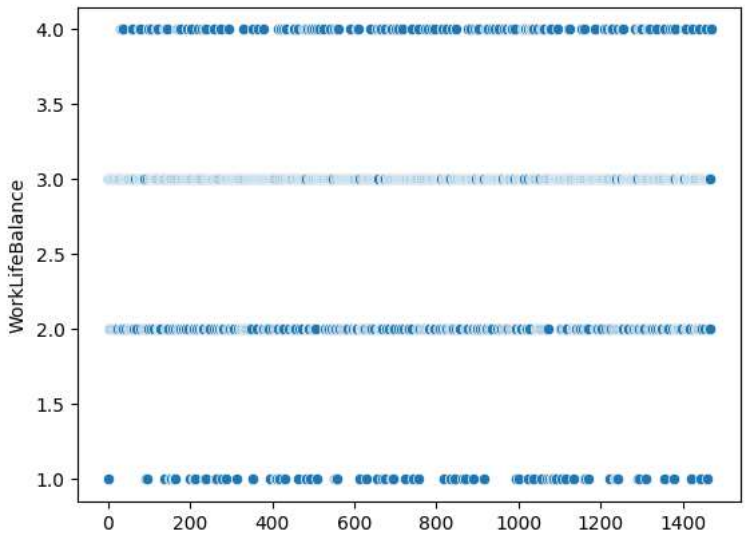
```
JobRole                   False
MaritalStatus             False
MonthlyIncome             False
MonthlyRate               False
NumCompaniesWorked        False
OverTime                  False
PercentSalaryHike         False
PerformanceRating         False
StandardHours             False
TotalWorkingYears         False
TrainingTimesLastYear     False
WorkLifeBalance           False
YearsAtCompany            False
YearsInCurrentRole        False
YearsSinceLastPromotion   False
YearsWithCurrManager      False
dtype: bool
```

```
df.isnull().sum()
```

```
Age                       0
Attrition                 0
BusinessTravel            0
DailyRate                 0
Department                0
Education                 0
EducationField            0
EmployeeCount             0
EmployeeNumber            0
Gender                    0
HourlyRate                0
JobLevel                  0
JobRole                   0
MaritalStatus             0
MonthlyIncome             0
MonthlyRate               0
NumCompaniesWorked        0
OverTime                  0
PercentSalaryHike         0
PerformanceRating         0
StandardHours             0
TotalWorkingYears         0
TrainingTimesLastYear     0
WorkLifeBalance           0
YearsAtCompany            0
YearsInCurrentRole        0
YearsSinceLastPromotion   0
YearsWithCurrManager      0
dtype: int64
```

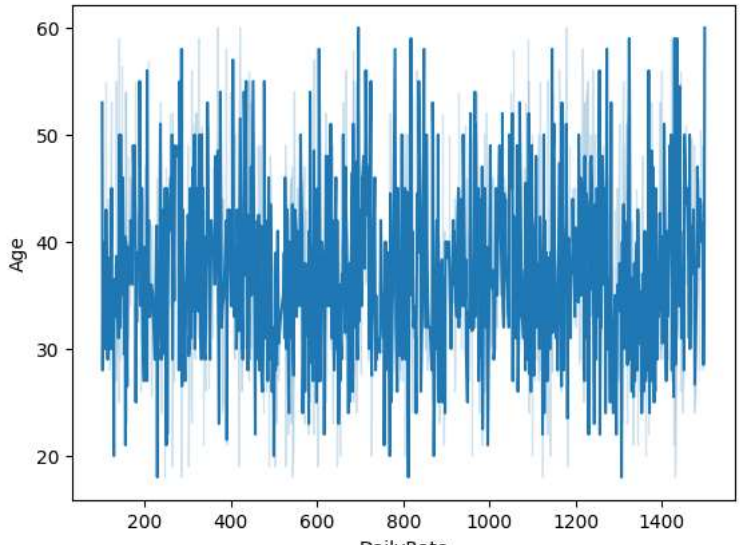
```
sns.scatterplot(df['WorkLifeBalance'])
```

```
<Axes: ylabel='WorkLifeBalance'>
```




```
sns.lineplot(x='DailyRate',y='Age',data=df)
```

```
<Axes: xlabel='DailyRate', ylabel='Age'>
```




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

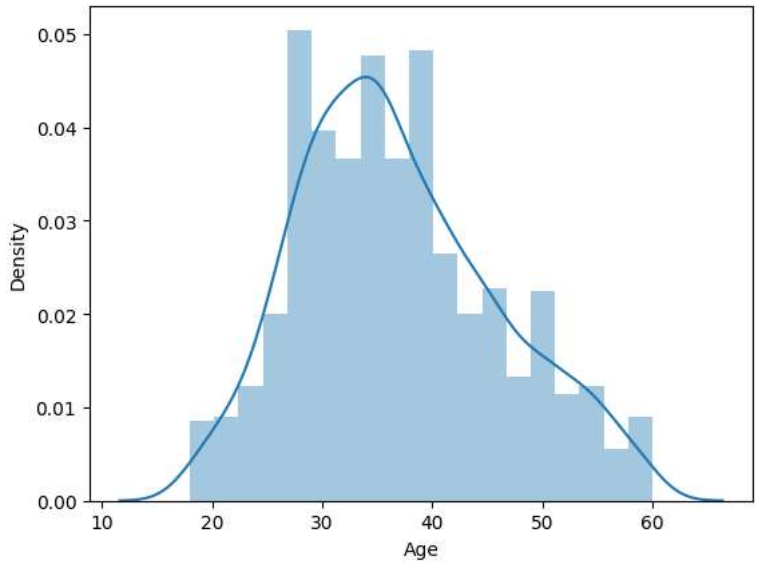
```
<ipython-input-16-0fafe04ea3f6>:1: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df['Age'])
<Axes: xlabel='Age', ylabel='Density'>
```



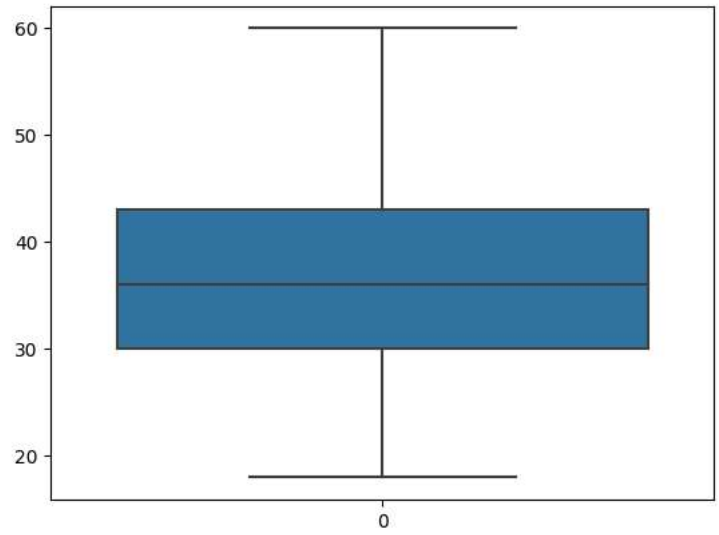

```
df.corr()
```

```
<ipython-input-17-2f6f6606aa2c>:1: FutureWarning: The default value of numeric_only in DataFrame.corr is deprecated. In a future version
  df.corr()
```

	Age	DailyRate	Education	EmployeeCount	EmployeeNumber	HourlyRate	JobLevel	MonthlyIncome	MonthlyRate
Age	1.000000	0.010661	0.208034	NaN	-0.010145	0.024287	0.509604	0.497855	0.028051
DailyRate	0.010661	1.000000	-0.016806	NaN	-0.050990	0.023381	0.002966	0.007707	-0.032182
Education	0.208034	-0.016806	1.000000	NaN	0.042070	0.016775	0.101589	0.094961	-0.026084
EmployeeCount	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
EmployeeNumber	-0.010145	-0.050990	0.042070	NaN	1.000000	0.035179	-0.018519	-0.014829	0.012648
HourlyRate	0.024287	0.023381	0.016775	NaN	0.035179	1.000000	-0.027853	-0.015794	-0.015297
JobLevel	0.509604	0.002966	0.101589	NaN	-0.018519	-0.027853	1.000000	0.950300	0.039563
MonthlyIncome	0.497855	0.007707	0.094961	NaN	-0.014829	-0.015794	0.950300	1.000000	0.034814
MonthlyRate	0.028051	-0.032182	-0.026084	NaN	0.012648	-0.015297	0.039563	0.034814	1.000000
NumCompaniesWorked	0.299635	0.038153	0.126317	NaN	-0.001251	0.022157	0.142501	0.149515	0.017521
PercentSalaryHike	0.003634	0.022704	-0.011111	NaN	-0.012944	-0.009062	-0.034730	-0.027269	-0.006429
PerformanceRating	0.001904	0.000473	-0.024539	NaN	-0.020359	-0.002172	-0.021222	-0.017120	-0.009811

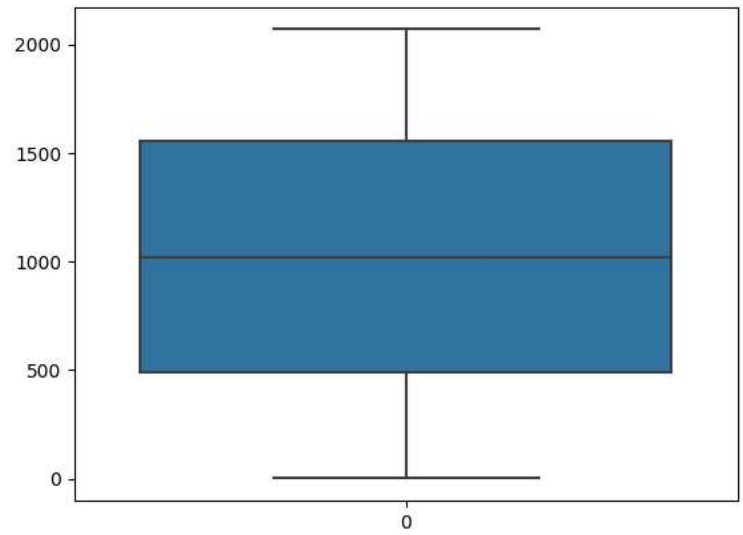
```
sns.boxplot(df['Age'])
```

```
<Axes: >
```



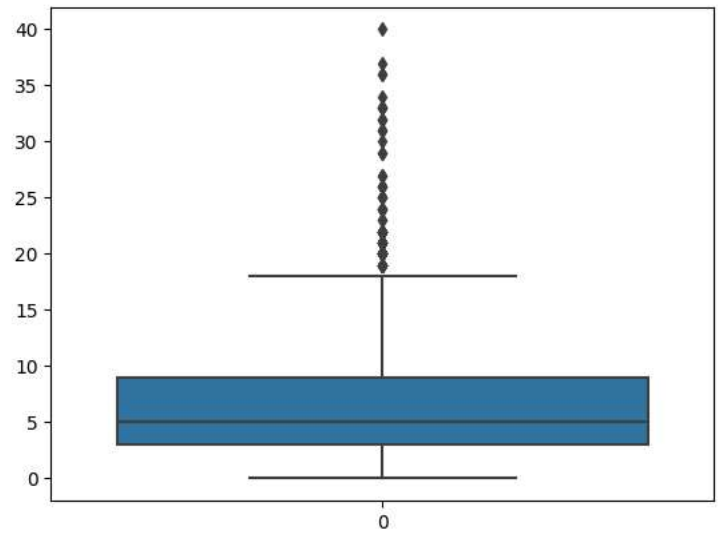

```
sns.boxplot(df['EmployeeNumber'])
```

```
<Axes: >
```



```
sns.boxplot(df['YearsAtCompany'])
```

```
<Axes: >
```




```
q1=df.YearsAtCompany.quantile(0.25)
q3=df.YearsAtCompany.quantile(0.75)
```

```
q1,q3
```

```
(3.0, 9.0)
```

```
IQR=q3-q1
```

```
upper_limit = q3+1.5*IQR
```

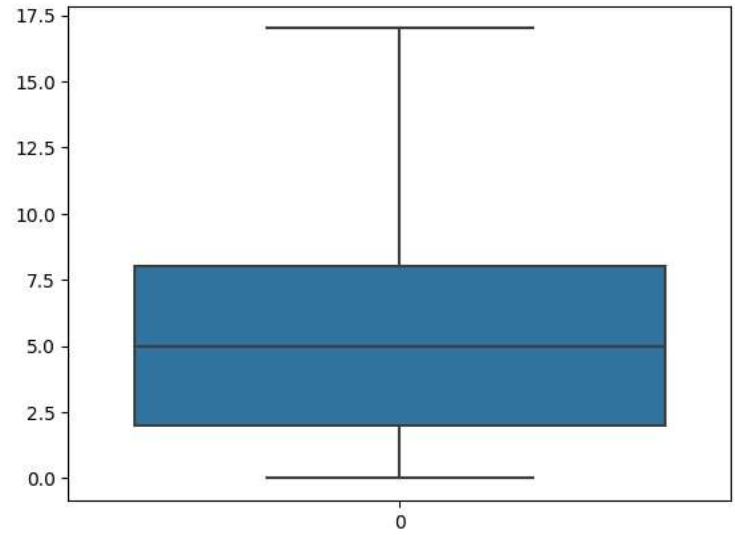
```
upper_limit
```

```
18.0
```

```
df=df[df['YearsAtCompany']<upper_limit]
```

```
sns.boxplot(df['YearsAtCompany'])
```

```
<Axes: >
```




```
df.head()
```

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

5 rows × 28 columns

```
x=df.drop(['Attrition'],axis=1)
```

```
y=df.Attrition
```

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

```
le=LabelEncoder()
```

```
columns=['BusinessTravel','Department','EducationField','Gender','JobRole','MaritalStatus','OverTime']
x[columns]=x[columns].apply(le.fit_transform)
```

```
x.head()
```

	Age	BusinessTravel	DailyRate	Department	Education	EducationField	EmployeeCount	EmployeeNumber	Gender	HourlyRate	...	Percent
0	41	2	1102	2	2	1	1	1	0	94	...	
1	49	1	279	1	1	1	1	2	1	61	...	
2	37	2	1373	1	2	4	1	4	1	92	...	
3	33	1	1392	1	4	1	1	5	0	56	...	
4	27	2	591	1	1	3	1	7	1	40	...	

5 rows × 27 columns

```
from sklearn.preprocessing import MinMaxScaler
ms=MinMaxScaler()
```

```
x_scaled=pd.DataFrame(ms.fit_transform(x),columns=x.columns)
```

```
x_scaled.head()
```

	Age	BusinessTravel	DailyRate	Department	Education	EducationField	EmployeeCount	EmployeeNumber	Gender	HourlyRate	...	Per
0	0.547619	1.0	0.716332	1.0	0.25	0.2	0.0	0.000000	0.0	0.914286	...	
1	0.738095	0.5	0.126791	0.5	0.00	0.2	0.0	0.000484	1.0	0.442857	...	
2	0.452381	1.0	0.910458	0.5	0.25	0.8	0.0	0.001451	1.0	0.885714	...	
3	0.357143	0.5	0.924069	0.5	0.75	0.2	0.0	0.001935	0.0	0.371429	...	
4	0.214286	1.0	0.350287	0.5	0.00	0.6	0.0	0.002903	1.0	0.142857	...	

5 rows × 27 columns

```
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)
```

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

```
((1082, 27), (271, 27), (1082,), (271,))
```

Model building

Logistic Regression

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

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

```
LogisticRegression()
```

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

```
pred
```

```
array(['No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'Yes',
       'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No'],
      dtype=object)
```

```
y_test
```

```
459      No
1076     No
1377     No
91       No
1103     No
        ...
525     Yes
1159     No
1179     No
1435     No
531      No
Name: Attrition, Length: 271, dtype: object
```

```
model.predict(ms.transform([[41,2,1102,2,2,1,1,1,0,94,2,4,3,1,3,1,1,11,3,80,8,0,1,6,4,0,5]]))
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not have valid feature names, but MinMaxScaler was fitt
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not have valid feature names, but LogisticRegression wa
  warnings.warn(
array(['Yes'], dtype=object)
```

```
from sklearn.metrics import accuracy_score,classification_report,roc_auc_score,roc_curve
```

```
print(accuracy_score(y_test,pred))
```

```
0.8560885608856088
```

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

```
                  precision    recall  f1-score   support

              No       0.87      0.97      0.92       228
             Yes       0.62      0.23      0.34        43

        accuracy                           0.86       271
       macro avg       0.75      0.60      0.63       271
    weighted avg       0.83      0.86      0.83       271
```

Decision Tree Classifier

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

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

```
DecisionTreeClassifier()
```

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

```
y_pred
```

```
array(['No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'Yes',
       'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'Yes',
       'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'Yes',
       'Yes', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'Yes',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'Yes', 'No',
       'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'Yes',
       'Yes', 'Yes', 'No', 'No', 'No', 'No', 'Yes', 'Yes', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'Yes', 'Yes', 'No', 'Yes', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'Yes', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'Yes',
       'Yes', 'Yes', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'Yes', 'No', 'Yes', 'No', 'No', 'Yes', 'No', 'Yes',
       'No', 'No', 'Yes', 'No', 'Yes', 'No', 'Yes', 'No', 'No', 'Yes',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'Yes', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No',
       'No', 'No', 'No', 'Yes', 'No', 'No', 'No'], dtype=object)
```

```
y_test
```

```
459      No
1076     No
1377     No
91       No
1103     No
        ...
525     Yes
1159     No
1179     No
1435     No
531      No
Name: Attrition, Length: 271, dtype: object
```

```
from sklearn.metrics import accuracy_score,classification_report
```

```
print(accuracy_score(y_test,y_pred))
```

```
0.7601476014760148
```

```
print(classification_report(y_test,y_pred))
```

```
              precision    recall  f1-score   support

          No       0.87      0.84      0.85       228
         Yes       0.29      0.35      0.32        43

    accuracy                           0.76       271
   macro avg       0.58      0.59      0.59       271
weighted avg       0.78      0.76      0.77       271
```

Huper parameter tuning

```
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']

}
```

```
grid_search=GridSearchCV(estimator=dtc,param_grid=parameter,cv=5,scoring="accuracy")
```

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

```
/usr/local/lib/python3.10/dist-packages/sklearn/tree/_classes.py:269: FutureWarning: `max_features='auto'` has been deprecated in 1.1 an
  warnings.warn(
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```

```
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/usr/local/lib/python3.10/dist-packages/sklearn/tree/_classes.py:269: FutureWarning: `max_features='auto'` has been deprecated in 1.1 an
```

```
grid_search.best_params_
```

```
{'criterion': 'gini',
 'max_depth': 4,
 'max_features': 'sqrt',
 'splitter': 'random'}
```

```
dtc_cv=DecisionTreeClassifier(criterion= 'gini',
 max_depth=4,
 max_features='sqrt',
 splitter='random')
dtc_cv.fit(x_train,y_train)
```

```
DecisionTreeClassifier
DecisionTreeClassifier(max_depth=4, max_features='sqrt', splitter='random')
```

```
y1_pred=dtc_cv.predict(x_test)
```

```
print(accuracy_score(y_test,y1_pred))
```

```
0.8302583025830258
```

```
print(classification_report(y_test,y1_pred))
```

```
              precision    recall  f1-score   support

          No       0.85      0.97      0.91       228
         Yes       0.36      0.09      0.15        43

    accuracy                           0.83       271
   macro avg       0.61      0.53      0.53       271
weighted avg       0.77      0.83      0.79       271
```

Random Forest Classifier

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

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

▾ RandomForestClassifier

RandomForestClassifier()

```
y2_pred=rfc.predict(x_test)
```

```
y2_pred
```

```
array(['No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'Yes', 'Yes', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'Yes', 'Yes', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No',
       'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No'],
      dtype=object)
```

```
y_test
```

```
459      No
1076     No
1377     No
91       No
1103     No
        ...
525     Yes
1159     No
1179     No
1435     No
531      No
Name: Attrition, Length: 271, dtype: object
```

```
print(accuracy_score(y_test,y2_pred))
```

```
0.8560885608856088
```

```
print(classification_report(y_test,y2_pred))
```

```
                  precision    recall  f1-score   support

              No       0.87      0.98      0.92       228
             Yes       0.64      0.21      0.32        43

        accuracy                           0.86       271
       macro avg       0.76      0.59      0.62       271
    weighted avg       0.83      0.86      0.82       271
```

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

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

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

```
/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_validation.py:378: 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 "/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_validation.py", line 686, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/ensemble/_forest.py", line 340, in fit
    self._validate_params()
  File "/usr/local/lib/python3.10/dist-packages/sklearn/base.py", line 600, in _validate_params
    validate_parameter_constraints(
  File "/usr/local/lib/python3.10/dist-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 must be an int in the rang

  warnings.warn(some_fits_failed_message, FitFailedWarning)
/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_search.py:952: UserWarning: One or more of the test scores are non-fini
 0.84470778 0.84378186 0.84563371 0.84380734 0.84471628 0.85488447
 0.84562521 0.85027183        nan 0.83734285 0.84288141 0.84194699
 0.84285593 0.84472477 0.84470778 0.8456507  0.8483945  0.84195549
 0.84657662 0.84841148 0.84193    0.8456507         nan 0.83825178
 0.83733435 0.8456422  0.83824329 0.8419385  0.84472477 0.8391947
 0.84563371 0.84380734 0.84471628 0.84746857 0.85210669 0.84751104
        nan 0.83825178 0.84286442 0.8456422  0.84656813 0.84933741
 0.84655963 0.84751104 0.84565919 0.84657662 0.84563371 0.85210669
 0.84655963 0.85211519        nan 0.83826028 0.83826028 0.8456422
 0.84102107 0.84840299 0.84750255 0.8456507  0.84469079 0.85025484
 0.84749405 0.84655114 0.8520982  0.84751954]
  warnings.warn(
```

▸ GridSearchCV
▸ estimator: RandomForestClassifier

```
y3_pred=rfc_cv.predict(x_test)


print(accuracy_score(y_test,y3_pred))
```

```
0.8376383763837638
```

```
print(classification_report(y_test,y3_pred))
```

```
                   precision    recall  f1-score   support

               No       0.87      0.95      0.91       228
              Yes       0.48      0.23      0.31        43

         accuracy                           0.84       271
        macro avg       0.67      0.59      0.61       271
     weighted avg       0.81      0.84      0.81       271
```

```
rfc_cv.best_params_
```

```
{'max_depth': 10, 'max_features': 11}
```