Problem Statement: Predicting Diabetes in Pima Indian Women

Description:

The Pima Indians Diabetes dataset is a collection of medical data from Pima Indian women in Arizona, USA. This dataset is widely used for the development and evaluation of predictive models to identify individuals at high risk of developing diabetes. The goal of this project is to build a predictive model that can accurately classify individuals as either diabetic or non-diabetic based on a set of medical and demographic features.

Dataset Details:

The dataset contains the following features:

1.Pregnancies: Number of times pregnant.

2. Glucose: Plasma glucose concentration a 2 hours in an oral glucose tolerance test.

3. BloodPressure: Diastolic blood pressure (mm Hg).

4. SkinThickness: Triceps skin fold thickness (mm).

5. Insulin: 2-Hour serum insulin (mu U/ml).

6. BMI: Body mass index (weight in kg / (height in m)^2).

7. DiabetesPedigreeFunction: A function that scores the likelihood of diabetes based on family history.

8. Age: Age in years.

9. Class The binary target variable indicating the presence (1) or absence (0) of diabetes.

Apply Logistic Regression Model.

In [132…

```
#Pima-Indians-Diabetes Prediction
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)
```

Loading the Data set

In [133…
```
df=pd.read_csv("pima-indians-diabetes .csv")
```

In [134…
```
df.head()
```

Out[134]:

	Preg	Plas	Pres	skin	test	mass	pedi	age	class
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1

EDA Operations

In [135…
```
df.set_axis(['Pregnancies','Glucose','BloodPressure','SkinThickness','Insulin','BMI
```

In [136…
```
df.head()
```

Out[136]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	A
0	6	148	72	35	0	33.6	0.627	
1	1	85	66	29	0	26.6	0.351	
2	8	183	64	0	0	23.3	0.672	
3	1	89	66	23	94	28.1	0.167	
4	0	137	40	35	168	43.1	2.288	

Analysing the data

In [137…
```
df.describe()
```

Out[137]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPe
count	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	
mean	3.845052	120.894531	69.105469	20.536458	79.799479	31.992578	
std	3.369578	31.972618	19.355807	15.952218	115.244002	7.884160	
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	1.000000	99.000000	62.000000	0.000000	0.000000	27.300000	
50%	3.000000	117.000000	72.000000	23.000000	30.500000	32.000000	
75%	6.000000	140.250000	80.000000	32.000000	127.250000	36.600000	
max	17.000000	199.000000	122.000000	99.000000	846.000000	67.100000	

We have some '0's in data set which not be '0' like "Glucose" , "BloodPressure" , "SkinThickness" , "Insulin" and "BMI"

In [138…
```
df.Glucose=df.Glucose.replace(0,df.Glucose.mean())
df.BloodPressure=df.BloodPressure.replace(0,df.BloodPressure.mean())
df.SkinThickness=df.SkinThickness.replace(0,df.SkinThickness.mean())
df.Insulin=df.Insulin.replace(0,df.Insulin.mean())
df.BMI=df.BMI.replace(0,df.BMI.mean())
```

In [139…
```
df.describe()
```

Out[139]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPe
count	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	
mean	3.845052	121.681605	72.254807	26.606479	118.660163	32.450805	
std	3.369578	30.436016	12.115932	9.631241	93.080358	6.875374	
min	0.000000	44.000000	24.000000	7.000000	14.000000	18.200000	
25%	1.000000	99.750000	64.000000	20.536458	79.799479	27.500000	
50%	3.000000	117.000000	72.000000	23.000000	79.799479	32.000000	
75%	6.000000	140.250000	80.000000	32.000000	127.250000	36.600000	
max	17.000000	199.000000	122.000000	99.000000	846.000000	67.100000	

In [140…
```
df.columns.values
```

Out[140]:
```
array(['Pregnancies', 'Glucose', 'BloodPressure', 'SkinThickness',
       'Insulin', 'BMI', 'DiabetesPedigreeFunction', 'Age', 'Class'],
      dtype=object)
```

In [141…
```
df.Class.value_counts()
```

Out[141]:
```
0    500
1    268
Name: Class, dtype: int64
```

Class The binary target variable indicating the presence (1) or absence (0) of diabetes.

Also Data is not balanced

In [142…
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
 #   Column                    Non-Null Count  Dtype  
---  ------                    --------------  -----  
 0   Pregnancies               768 non-null    int64  
 1   Glucose                   768 non-null    float64
 2   BloodPressure             768 non-null    float64
 3   SkinThickness             768 non-null    float64
 4   Insulin                   768 non-null    float64
 5   BMI                       768 non-null    float64
 6   DiabetesPedigreeFunction  768 non-null    float64
 7   Age                       768 non-null    int64  
 8   Class                     768 non-null    int64  
dtypes: float64(6), int64(3)
memory usage: 54.1 KB
```

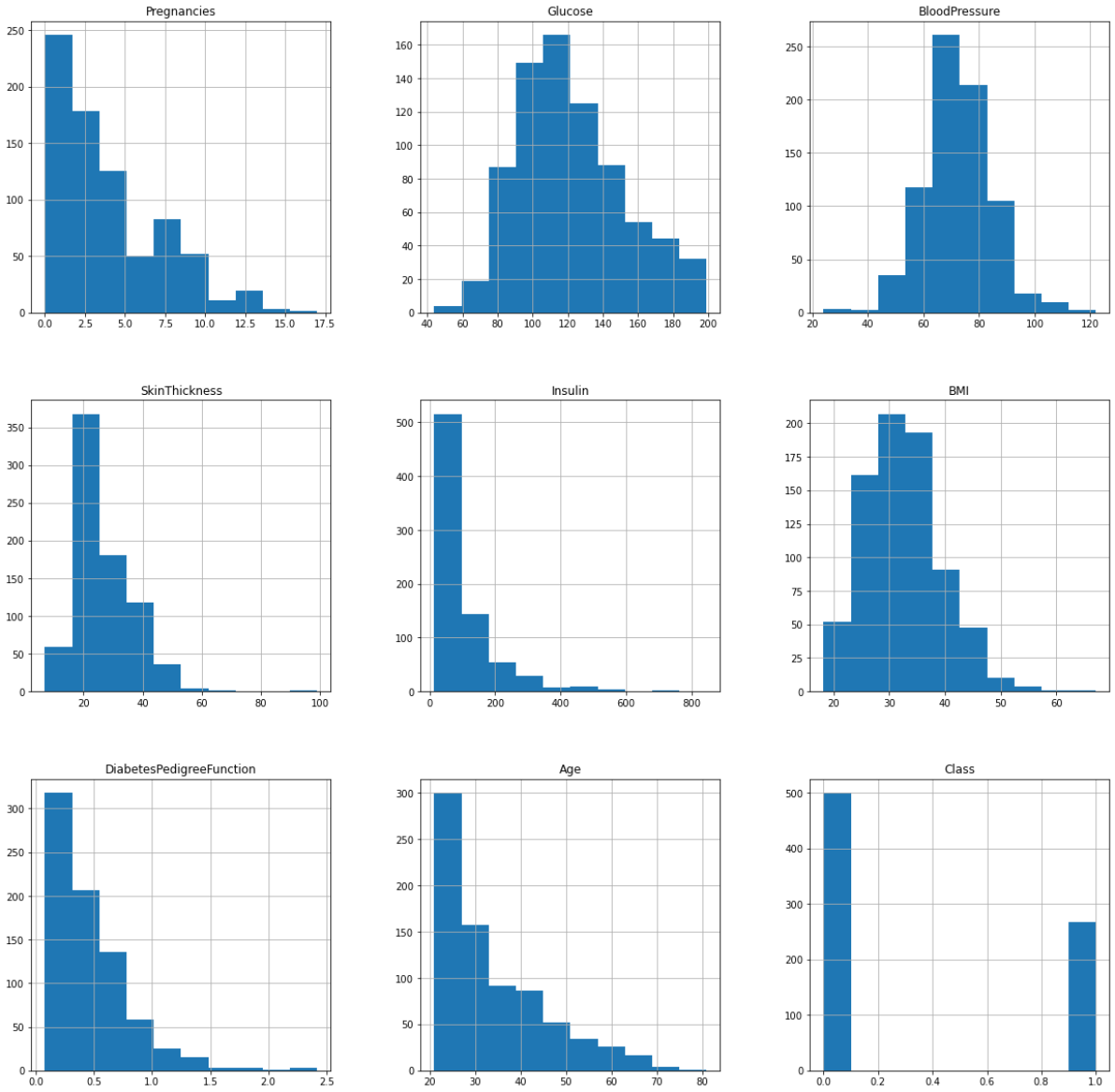
All variables are numbers

In [143…
```
df.isnull().sum()
```

Out[143]:
```
Pregnancies                 0
Glucose                     0
BloodPressure               0
SkinThickness               0
Insulin                     0
BMI                         0
DiabetesPedigreeFunction    0
Age                         0
Class                       0
dtype: int64
```

No Missing values in data set

In [144…
```
df.hist(figsize=(20,20))
plt.show()
```

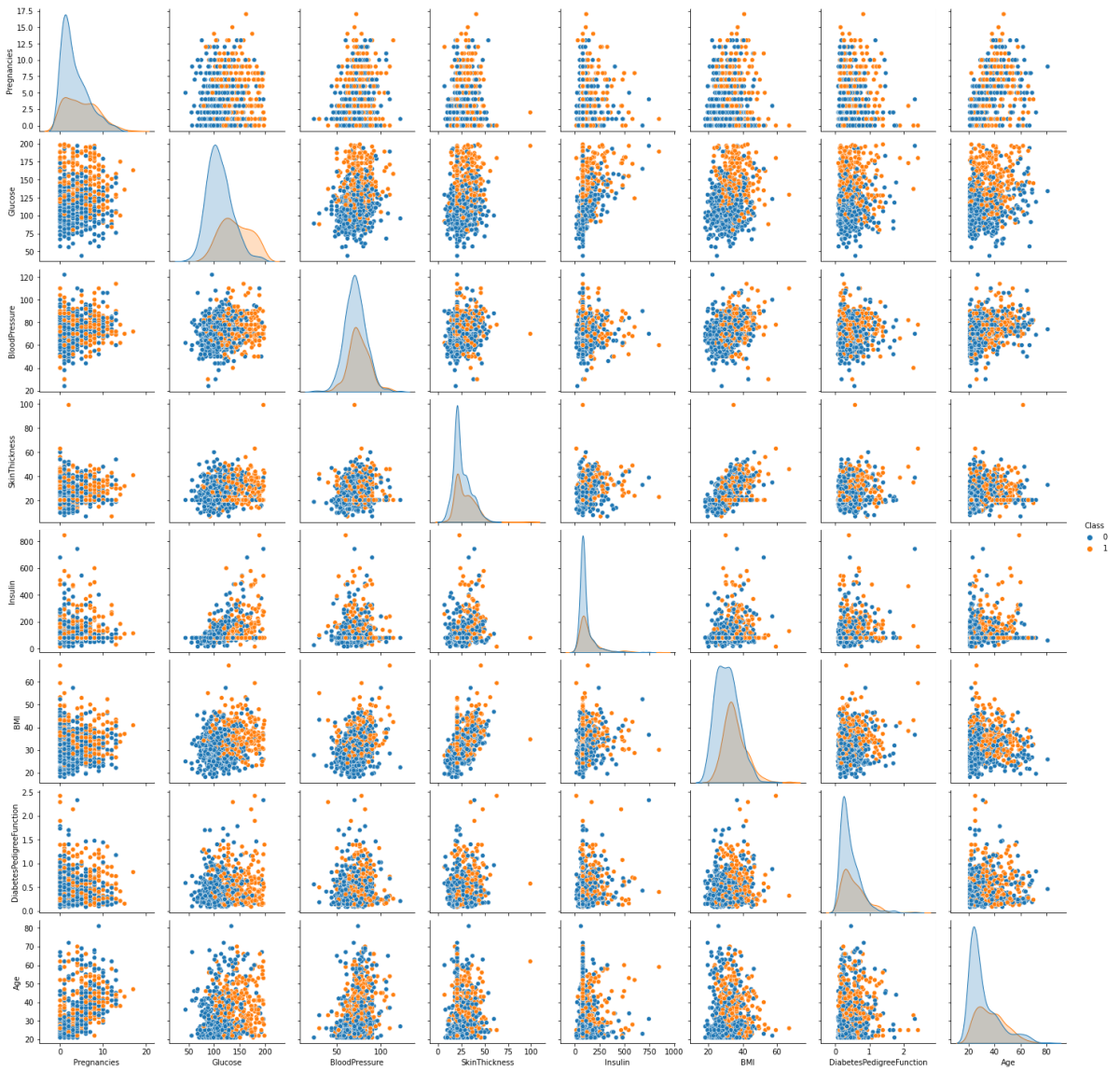


In [145…
```
df.skew()
```

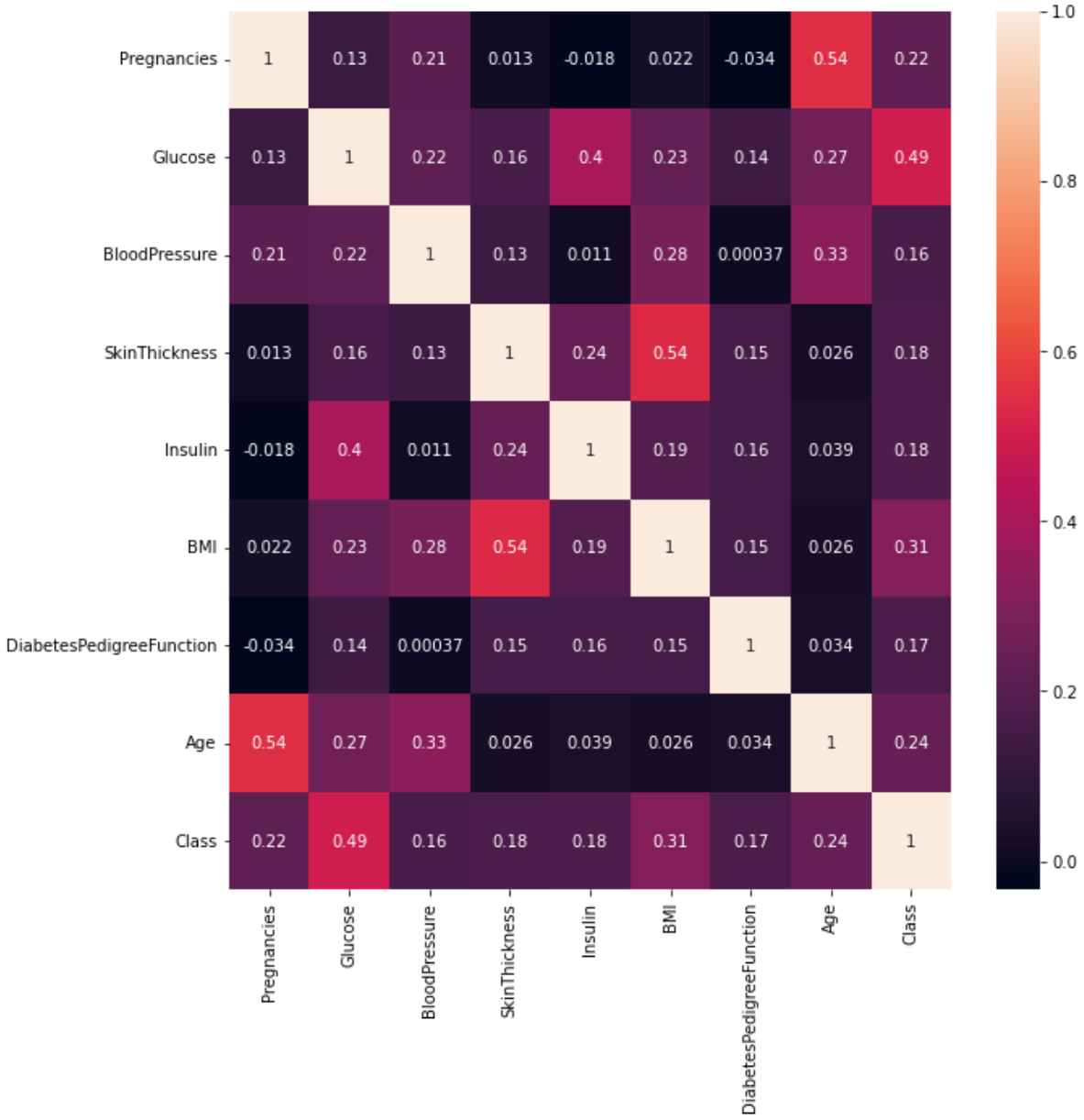
Out[145]:
```
Pregnancies                 0.901674
Glucose                     0.533225
BloodPressure               0.173050
SkinThickness               1.226670
Insulin                     3.291825
BMI                         0.601103
DiabetesPedigreeFunction    1.919911
Age                         1.129597
Class                       0.635017
dtype: float64
```

'DiabetesPedigreeFunction' variable is more skewed

In [146…
```
sns.pairplot(hue='Class', data=df)
plt.show()
```



In [147…
```
plt.figure(figsize=(10,10))
sns.heatmap(df.corr(),annot=True)
plt.show()
```



Logistic Regression (Used for Classification only)

In [148…
```
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
```

In [149…
```
X=df.iloc[:,0:8]
y=df.iloc[:,-1].values
```

In [150…
```
y
```

Out[150]:
```
array([1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 0,
       1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1,
       0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0,
       1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0,
       1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1,
       1, 1, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 1,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
       1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1,
       0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1,
       1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 1,
       1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0,
       1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0,
       1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0,
       0, 1, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0,
       1, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 0, 1, 0,
       0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
       0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0,
       0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 1, 0,
       0, 1, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 1, 0, 1,
       0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
       1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 1, 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, 1, 0, 0, 0,
       1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0,
       1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
       0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0,
       0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0,
       0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0,
       1, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1,
       0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1,
       0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 1, 0,
       0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0,
       0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0,
       1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0],
      dtype=int64)
```

In [151…
```
X_train, X_test,y_train, y_test = train_test_split(X, y,test_size=0.20,random_state
```

In [152…
```
# LogisticRegression
clf = LogisticRegression(random_state=0)
clf.fit(X_train, y_train)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

Out[152]:
```
LogisticRegression(random_state=0)
```

In [153…
```
# Prediction for train data set
y_pred = clf.predict(X_train)
```

In [154…
```
acc1 = accuracy_score(y_train, y_pred)
print("Logistic Regression model accuracy for train data (in %):", acc1*100)
```

```
Logistic Regression model accuracy for train data (in %): 76.54723127035831
```

In [155…
```
# Prediction for train data set
y_pred1 = clf.predict(X_test)
```

In [156…
```
acc = accuracy_score(y_test, y_pred1)
print("Logistic Regression model accuracy for test data (in %):", acc*100)
```

```
Logistic Regression model accuracy for test data (in %): 80.51948051948052
```

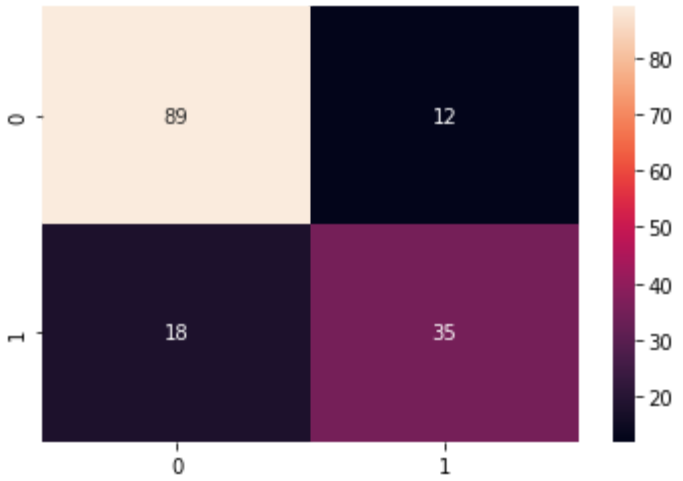
Confusion Matrix

In [157…
```
from sklearn.metrics import confusion_matrix,accuracy_score,classification_report
cm = confusion_matrix(y_test, y_pred1)
```

In [158…
```
cm
```

Out[158]:
```
array([[89, 12],
       [18, 35]], dtype=int64)
```

In [159…
```
sns.heatmap(cm,annot=True)
plt.show()
```



In [160…
```
log_train1=round(clf.score(X_train,y_train)*100,2)
log_accuracy1=round(accuracy_score(y_pred1,y_test)*100,2)
```

In [161…
```
print("Training Accuracy :",log_train1,"%")
print("Test Accuracy :",log_accuracy1,"%")
print("\033[1m-----------------------------------------\033[0m")
print("Classification Report Test data :",classification_report(y_test,y_pred1))
print("\033[1m-----------------------------------------\033[0m")
```

```
Training Accuracy : 76.55 %
Test Accuracy : 80.52 %
-----------------------------------------
Classification Report Test data :              precision    recall  f1-score   su
pport

           0       0.83      0.88      0.86       101
           1       0.74      0.66      0.70        53

    accuracy                           0.81       154
   macro avg       0.79      0.77      0.78       154
weighted avg       0.80      0.81      0.80       154

-----------------------------------------
```

Naive Bayes Algorithoms

In [162…
```
# Feature Scaling
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
x_train = sc.fit_transform(X_train)
x_test = sc.transform(X_test)
```

In [163…
```
# Fitting Naive Bayes to the Training set
from sklearn.naive_bayes import GaussianNB
classifier = GaussianNB()
classifier.fit(X_train, y_train)
```

Out[163]:
```
GaussianNB()
```

In [164…
```
# Predicting the Test set results
y_pred2 = classifier.predict(x_test)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\base.py:450: UserWarning: X doe
s not have valid feature names, but GaussianNB was fitted with feature names
  warnings.warn(
```

In [165…
```
acc1 = accuracy_score(y_test, y_pred2)
print("Logistic Regression model accuracy for train data (in %):", acc1*100)
```

```
Logistic Regression model accuracy for train data (in %): 65.5844155844156
```

In [166…
```
# Prediction for train data set
y_pred3 = clf.predict(x_train)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\base.py:450: UserWarning: X doe
s not have valid feature names, but LogisticRegression was fitted with feature nam
es
  warnings.warn(
```

In [167…
```
acc = accuracy_score(y_train, y_pred3)
print("Logistic Regression model accuracy for test data (in %):", acc*100)
```

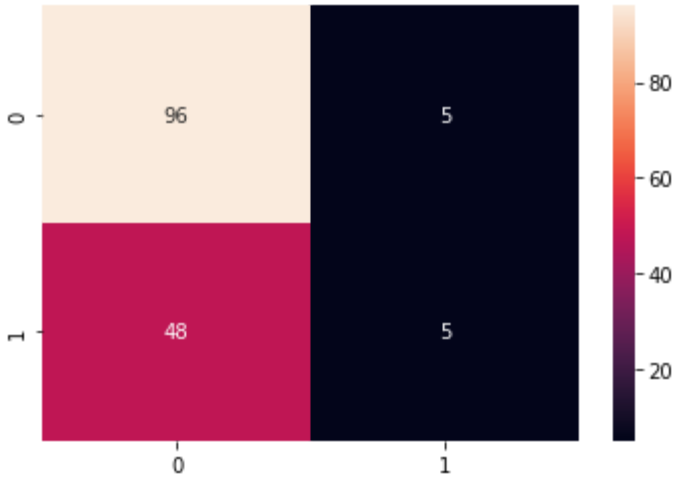
```
Logistic Regression model accuracy for test data (in %): 64.82084690553745
```

In [168…
```
# Making the Confusion Matrix
from sklearn.metrics import confusion_matrix
cm1 = confusion_matrix(y_test, y_pred2)
```

In [169…
```
cm1
```

Out[169]:
```
array([[96,  5],
       [48,  5]], dtype=int64)
```

In [170…
```
sns.heatmap(cm1,annot=True)
plt.show()
```



In [171…
```
log_train2=round(clf.score(x_train,y_train)*100,2)
log_accuracy2=round(accuracy_score(y_pred2,y_test)*100,2)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\base.py:450: UserWarning: X doe
s not have valid feature names, but LogisticRegression was fitted with feature nam
es
  warnings.warn(
```

In [172…
```
print("Training Accuracy :",log_train2,"%")
print("Testing Accuracy :",log_accuracy2,"%")
print("\033[1m-----------------------------------------\033[0m")
print("Classification Report Testing data :",classification_report(y_test,y_pred2))
print("\033[1m-----------------------------------------\033[0m")
```

```
Training Accuracy : 64.82 %
Testing Accuracy : 65.58 %
-----------------------------------------
Classification Report Testing data :               precision    recall  f1-score
support

           0       0.67      0.95      0.78       101
           1       0.50      0.09      0.16        53

    accuracy                           0.66       154
   macro avg       0.58      0.52      0.47       154
weighted avg       0.61      0.66      0.57       154

-----------------------------------------
```

In [ ]: