```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, classification_report,
confusion_matrix,roc_auc_score,roc_curve
```

get data :

```
ad_data = pd.read_csv('C:\\Users\DELL\\OneDrive\\Bureau\\
selfeducations\\projects\\Logistic Regression advertising\\
advertising.csv')

# show the head of data 5 first rows
ad_data.head()

   Daily Time Spent on Site  Age  Area Income  Daily Internet Usage  \
0                     68.95   35     61833.90                256.09
1                     80.23   31     68441.85                193.77
2                     69.47   26     59785.94                236.50
3                     74.15   29     54806.18                245.89
4                     68.37   35     73889.99                225.58

                           Ad Topic Line            City  Male
Country  \
0     Cloned 5thgeneration orchestration     Wrightburgh     0
Tunisia
1     Monitored national standardization       West Jodi     1
Nauru
2       Organic bottom-line service-desk        Davidton     0  San
Marino
3  Triple-buffered reciprocal time-frame  West Terrifurt     1
Italy
4          Robust logistical utilization    South Manuel     0
Iceland

             Timestamp  Clicked on Ad
0  2016-03-27 00:53:11              0
1  2016-04-04 01:39:02              0
2  2016-03-13 20:35:42              0
3  2016-01-10 02:31:19              0
4  2016-06-03 03:36:18              0

# show the shape of data :
ad_data.shape

(1000, 10)
```

```
#show only columns names :
ad_data.columns
```

```
Index(['Daily Time Spent on Site', 'Age', 'Area Income',
       'Daily Internet Usage', 'Ad Topic Line', 'City', 'Male',
'Country',
       'Timestamp', 'Clicked on Ad'],
      dtype='object')
```

```
# show data columns and data type :
ad_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 10 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   Daily Time Spent on Site  1000 non-null   float64
 1   Age                       1000 non-null   int64
 2   Area Income               1000 non-null   float64
 3   Daily Internet Usage      1000 non-null   float64
 4   Ad Topic Line             1000 non-null   object
 5   City                      1000 non-null   object
 6   Male                      1000 non-null   int64
 7   Country                   1000 non-null   object
 8   Timestamp                 1000 non-null   object
 9   Clicked on Ad             1000 non-null   int64
dtypes: float64(3), int64(3), object(4)
memory usage: 78.2+ KB
```

```
# descriptive statistic :
ad_data.describe()
```

```
       Daily Time Spent on Site          Age   Area Income  \
count               1000.000000  1000.000000   1000.000000
mean                  65.000200    36.009000  55000.000080
std                   15.853615     8.785562  13414.634022
min                   32.600000    19.000000  13996.500000
25%                   51.360000    29.000000  47031.802500
50%                   68.215000    35.000000  57012.300000
75%                   78.547500    42.000000  65470.635000
max                   91.430000    61.000000  79484.800000

       Daily Internet Usage         Male  Clicked on Ad
count           1000.000000  1000.000000     1000.00000
mean             180.000100     0.481000        0.50000
std               43.902339     0.499889        0.50025
min              104.780000     0.000000        0.00000
25%              138.830000     0.000000        0.00000
50%              183.130000     0.000000        0.50000
```

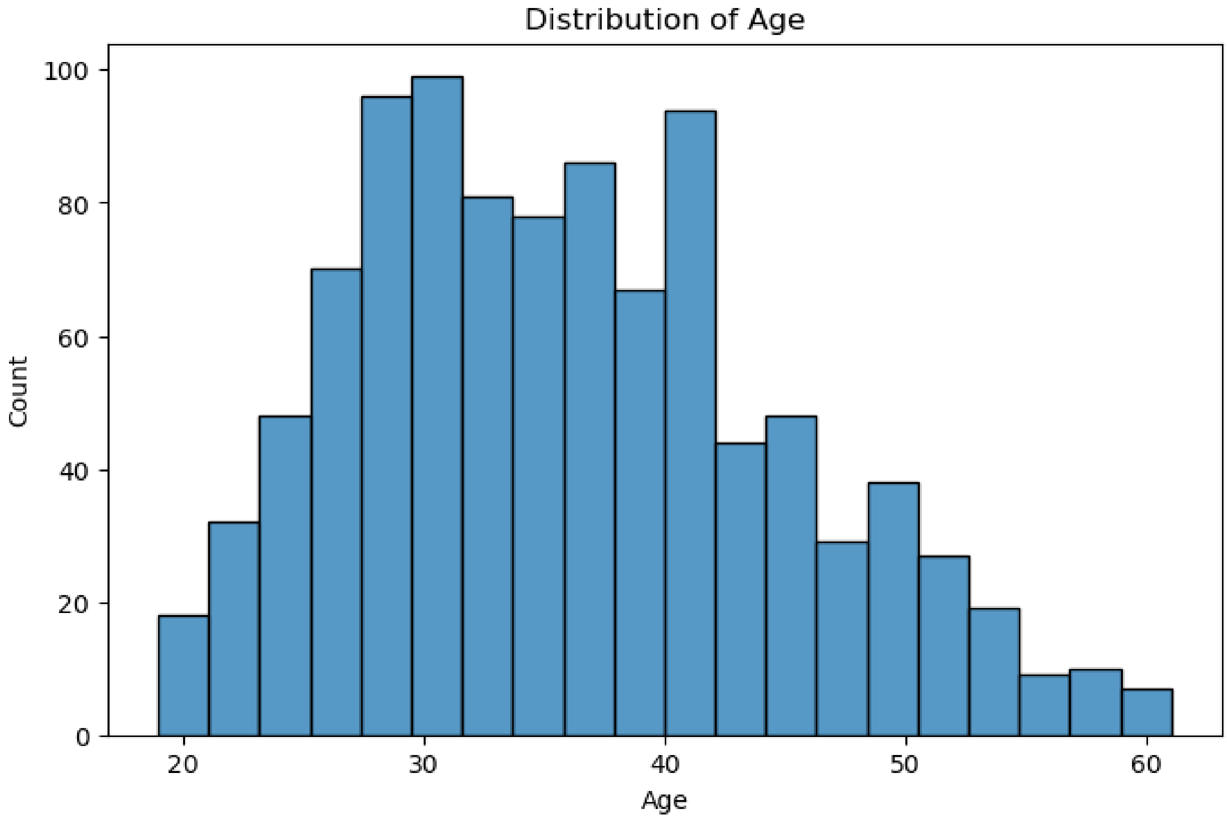
```
75%                218.792500      1.000000        1.00000
max                269.960000      1.000000        1.00000
```

Exploratory Data Analysis :

Univariate Analysis:

Distribution of age :

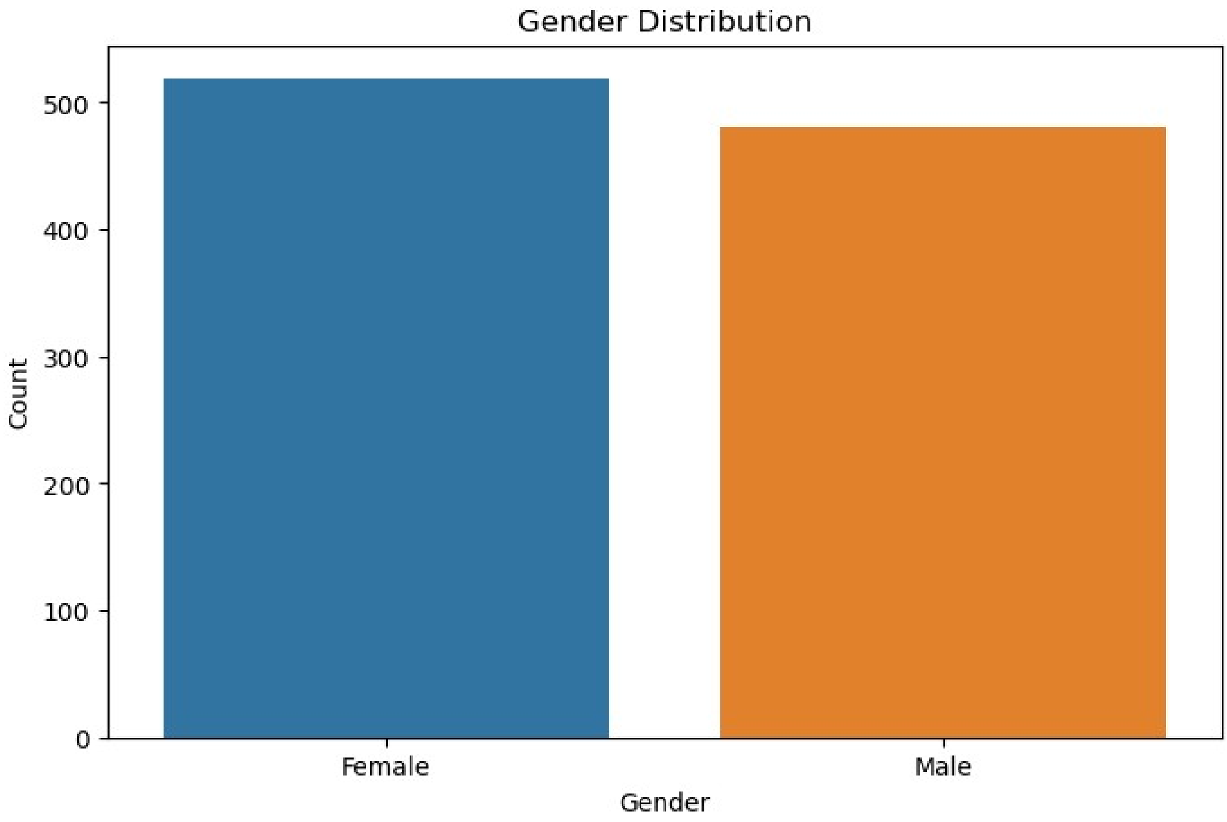
```
plt.figure(figsize=(8,5)) # set a fig size 8 by 5
sns.histplot(ad_data['Age'],bins= 20) # creat a histograme of 20 bins of Age
plt.title('Distribution of Age')
plt.xlabel('Age')
plt.ylabel('Count')
plt.show()
```



Distribution of Gender :

```
plt.figure(figsize=(8,5))
sns.countplot(x='Male',data = ad_data)  # Create a count plot with
```

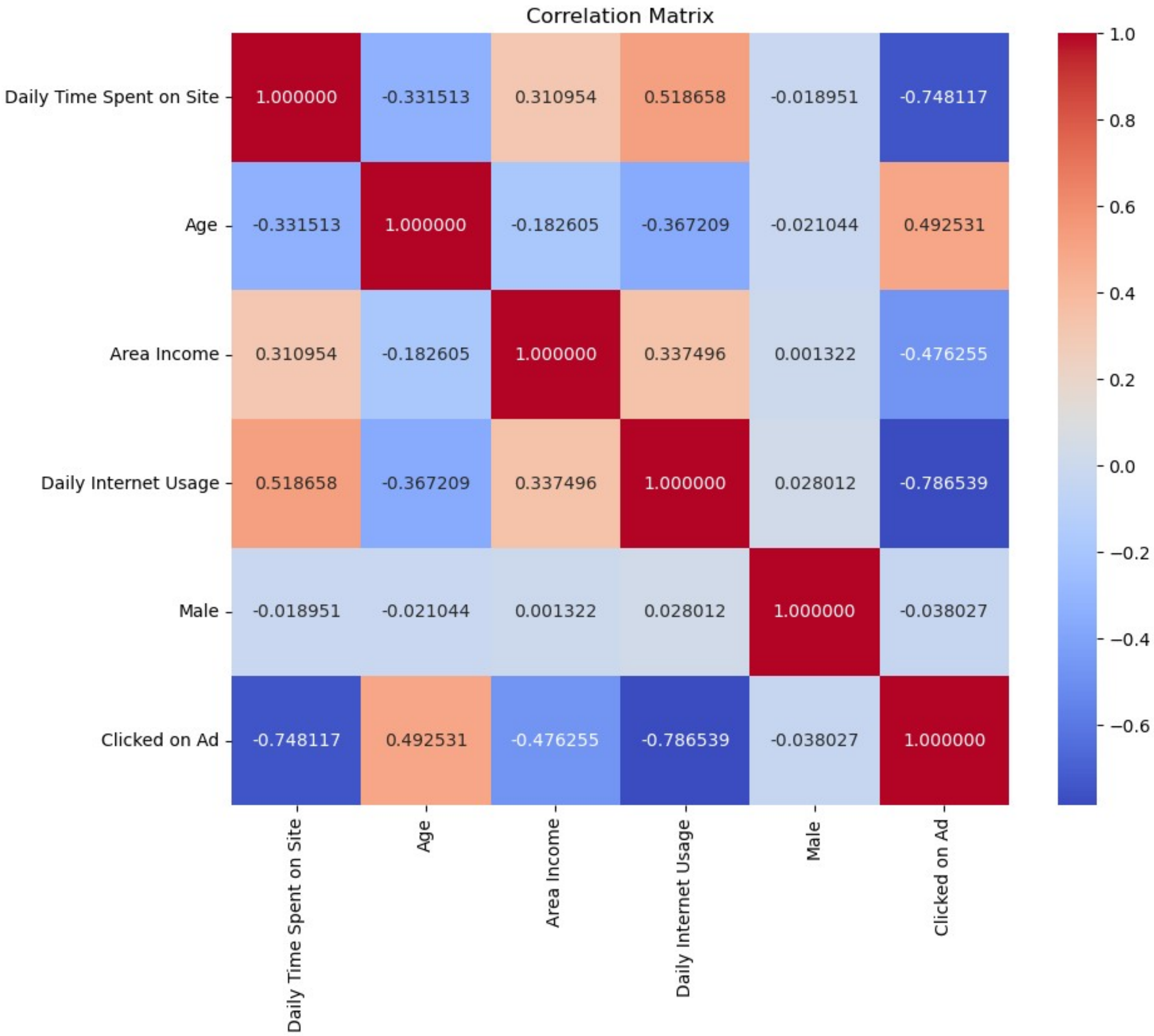
```
'Male' as the x-axis and 'ad_data' as the data source
plt.xlabel('Gender')
plt.ylabel('Count')
plt.title('Gender Distribution')
plt.xticks([0, 1], ['Female', 'Male'])  # Set custom tick labels for
the x-axis
plt.show()
```



Correlation :

```
correlation_matrix = ad_data.corr()
plt.figure(figsize = (10,8))
sns.heatmap(correlation_matrix,annot = True, cmap = 'coolwarm',fmt =
'2f'  )
plt.title('Correlation Matrix')
plt.show()
```

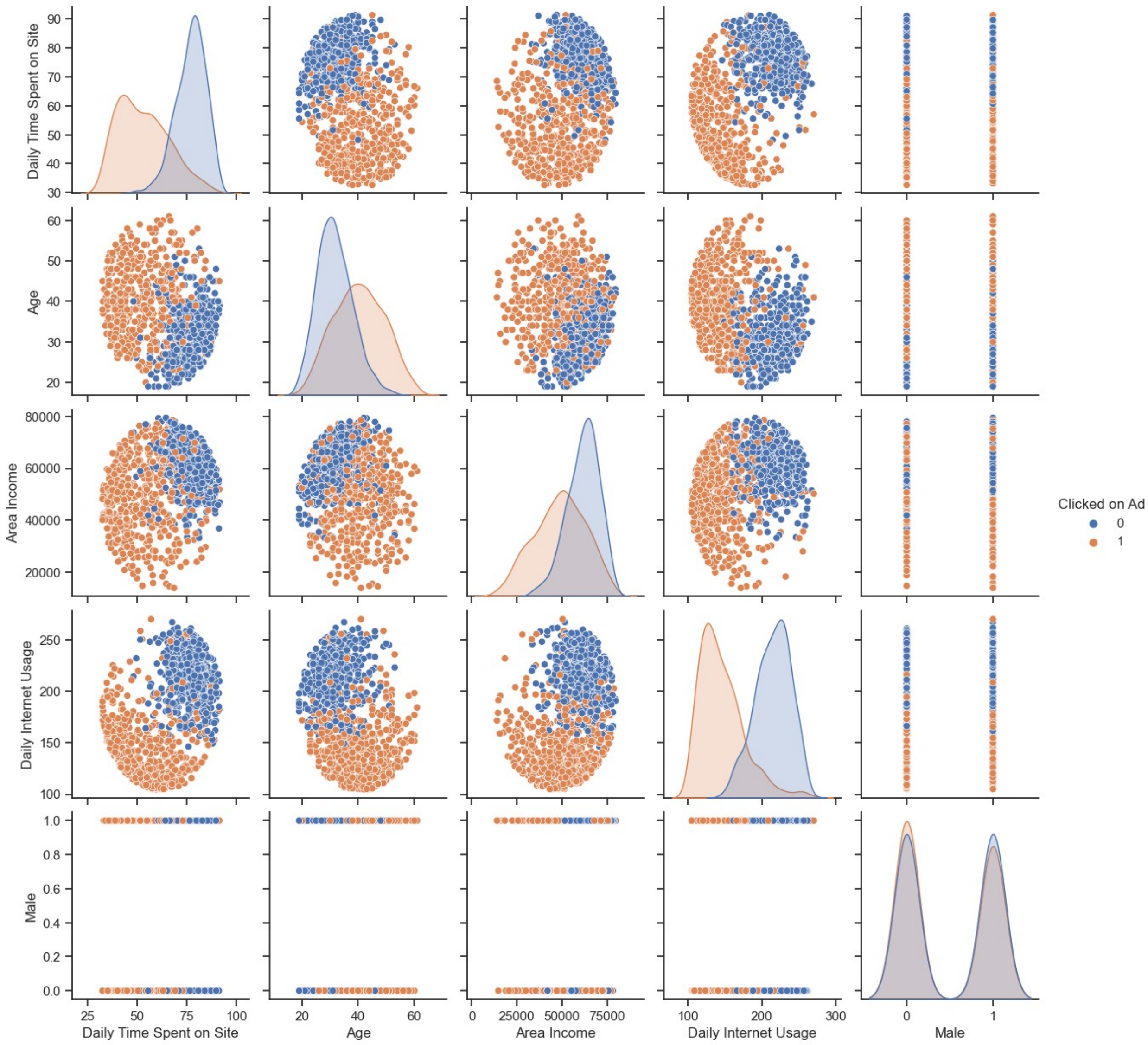
```
C:\Users\DELL\AppData\Local\Temp\ipykernel_7420\1951576788.py:1:
FutureWarning: The default value of numeric_only in DataFrame.corr is
deprecated. In a future version, it will default to False. Select only
valid columns or specify the value of numeric_only to silence this
warning.
  correlation_matrix = ad_data.corr()
```



Vizualization of relations betewwen colmuns:

```
sns.pairplot(ad_data,hue='Clicked on Ad')
```

```
<seaborn.axisgrid.PairGrid at 0x1e85c8a58a0>
```



Logistique Regression :

Data Preprocessing

```
# create the input varaibles for data
X = ad_data[['Daily Time Spent on Site','Age','Area Income','Daily
Internet Usage','Male']]
# create the target variable click on add as output :
Y = ad_data['Clicked on Ad']

# Split the data into train data 80% and test data 20% :
X_train,X_test,Y_train,Y_test=train_test_split(X,Y,test_size=0.2,rando
m_state=20)
```

Model Training

```
# intialize the Logistic Regression Model :
logReg_model = LogisticRegression()
# train the model :
logReg_model.fit(X_train,Y_train)
```

```
LogisticRegression()
```

Model Evaluation :

```
# make predection on the test set :
Y_pred = logReg_model.predict(X_test)
```

```
results_df = pd.DataFrame({'Y_pred': Y_pred, 'Y_test': Y_test})
results_df.head()
```

```
     Y_pred  Y_test
890       0       0
694       0       0
798       1       0
147       1       1
858       1       1
```

```
# calculate the acuarcy of the model :
accuracy = accuracy_score(Y_test,Y_pred)
print("The Accuracy  = ",accuracy)
print("The Accuracy  = ",accuracy*100,'%')
```

```
The Accuracy  =  0.91
The Accuracy  =  91.0 %
```

```
# generate a classification report :
Classification_rep =
classification_report(Y_test,Y_pred,target_names=['Classe 0 ','Classe
1'],output_dict=True)
#convert the classification reprt dictionary to DataFrame:
report_df = pd.DataFrame(Classification_rep).transpose()
print("Classification report : \n\n")
report_df.head()
```

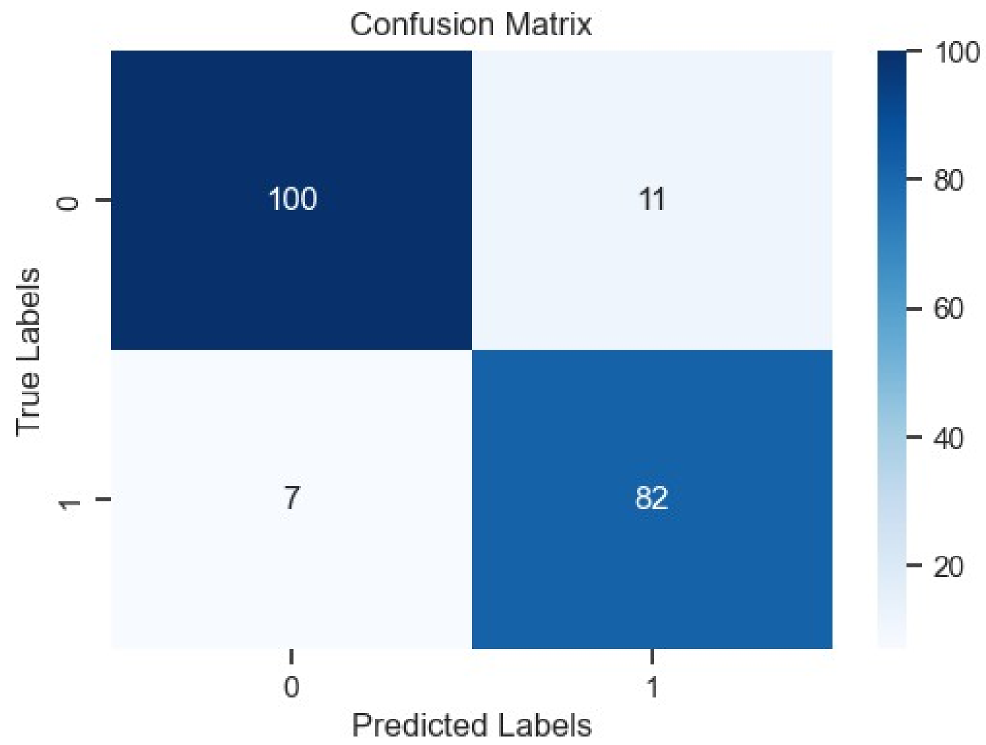
```
Classification report :



              precision    recall  f1-score  support
Classe 0       0.934579  0.900901  0.917431   111.00
Classe 1       0.881720  0.921348  0.901099    89.00
accuracy       0.910000  0.910000  0.910000     0.91
```

```
macro avg      0.908150  0.911125  0.909265   200.00
weighted avg   0.911057  0.910000  0.910163   200.00
```

```
# Generate a confusion matrix :
conf_matrix = confusion_matrix(Y_test,Y_pred)
# transforme it to DataFrame :
conf_matrix_df = pd.DataFrame(conf_matrix).transpose()
conf_matrix_df
```

```
     0   1
0  100   7
1   11  82
```

```
# Visualize the Confusion Matrix
plt.figure(figsize=(6, 4))
sns.heatmap(conf_matrix, annot=True, cmap='Blues', fmt='d')
plt.title('Confusion Matrix')
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.show()
```

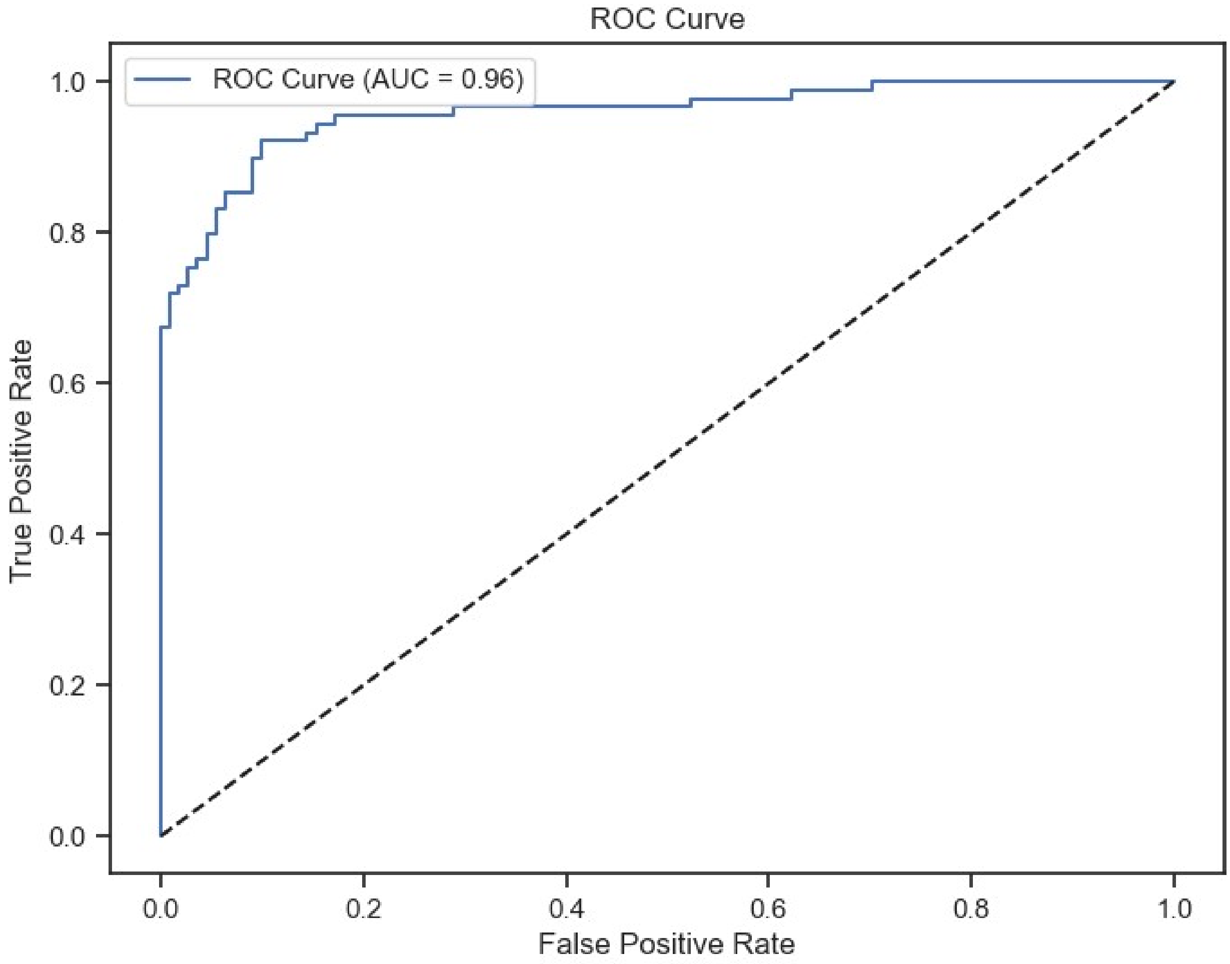


```
#calculate the roc AUC score :
roc_AUC_score =
roc_auc_score(Y_test,logReg_model.predict_proba(X_test)[:,-1])
print('ROC AUC Score : ', roc_AUC_score)
```

```
ROC AUC Score :  0.9580929243850592
```

ROC AUC score of 0.958 indicates a highly effective classifier with a strong ability to discriminate between the two classes in the binary classification problem. It's considered a very good result and suggests that the model is making accurate predictions for the target variable.

```
# Additional Visualization (ROC Curve) :
fpr, tpr, thresholds = roc_curve(Y_test,
logReg_model.predict_proba(X_test)[:, 1])
plt.figure(figsize=(8, 6))
plt.plot(fpr, tpr, label=f'ROC Curve (AUC = {roc_AUC_score:.2f})')
plt.plot([0, 1], [0, 1], 'k--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve')
plt.legend()
plt.show()
```


ROC Curve
ROC Curve (AUC = 0.96)
True Positive Rate
False Positive Rate