Importing the Datasets

In [81]:

```python
import numpy as np
import pandas as pd

import matplotlib.pyplot as plt # Data Visualization
import seaborn as sns # For creating interactive plots
```

In [82]:

```python
# Libraries for Modellling & Feature Selection
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import confusion_matrix

from sklearn.ensemble import RandomForestClassifier
from sklearn.feature_selection import RFECV

from sklearn.model_selection import train_test_split

from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import cross_val_score

from sklearn.feature_selection import mutual_info_classif as MIC
```

In [83]:

```python
import warnings
warnings.filterwarnings('ignore')
```

Context

The dataset is the details of the customers in a company.

Content

The column are about it's estimated salary, age, sex, etc. Aiming to provide all details about an employee.

In [84]:

```
df = pd.read_csv("Churn_Modelling.csv")
df.head()
```

Out[84]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	A
0	1	15634602	Hargrave	619	France	Female	
1	2	15647311	Hill	608	Spain	Female	
2	3	15619304	Onio	502	France	Female	
3	4	15701354	Boni	699	France	Female	
4	5	15737888	Mitchell	850	Spain	Female	

Dropping RowNumber , CustomerID , Surname

In [85]:

```
df.drop(["RowNumber","CustomerId","Surname"],axis = 1,inplace = True)
```

In [86]:

```
df.nunique()
```

Out[86]:

```
CreditScore         460
Geography             3
Gender                2
Age                  70
Tenure               11
Balance            6382
NumOfProducts         4
HasCrCard             2
IsActiveMember        2
EstimatedSalary    9999
Exited                2
dtype: int64
```

In [87]:

```
df.describe().T
```

Out[87]:

	count	mean	std	min	25%
CreditScore	10000.0	650.528800	96.653299	350.00	584.00
Age	10000.0	38.921800	10.487806	18.00	32.00
Tenure	10000.0	5.012800	2.892174	0.00	3.00
Balance	10000.0	76485.889288	62397.405202	0.00	0.00
NumOfProducts	10000.0	1.530200	0.581654	1.00	1.00
HasCrCard	10000.0	0.705500	0.455840	0.00	0.00
IsActiveMember	10000.0	0.515100	0.499797	0.00	0.00
EstimatedSalary	10000.0	100090.239881	57510.492818	11.58	51002.11
Exited	10000.0	0.203700	0.402769	0.00	0.00

Missing Values

In [88]:

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

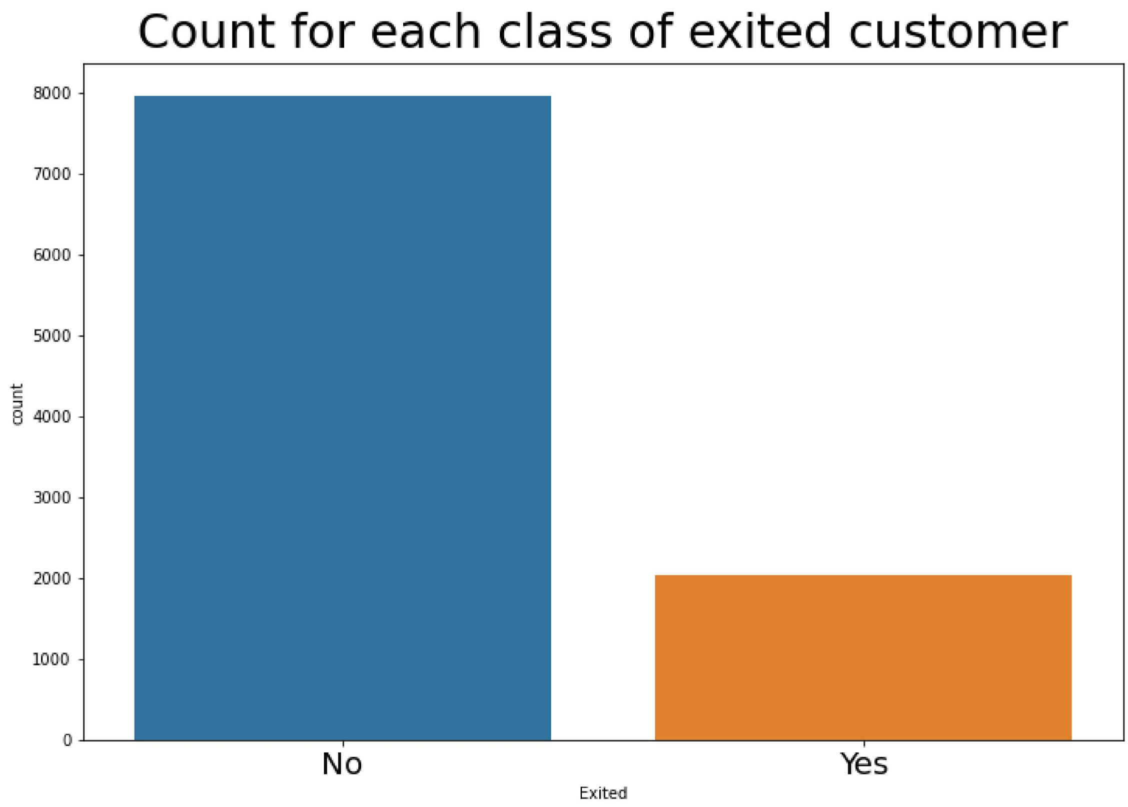
Out[88]:

```
CreditScore        0
Geography          0
Gender             0
Age                0
Tenure             0
Balance            0
NumOfProducts      0
HasCrCard          0
IsActiveMember     0
EstimatedSalary    0
Exited             0
dtype: int64
```

EDA

In [89]:

```
#Count for each class of exited customer
df.Exited.value_counts()
plt.figure(figsize=(12, 8))
exited_plot = sns.countplot(x=df.Exited)
exited_plot.set_title('Count for each class of exited customer',
                      fontsize=30,
                      pad=10)
exited_plot.set_xticklabels(['No', 'Yes'], fontsize=20)
plt.show()
```

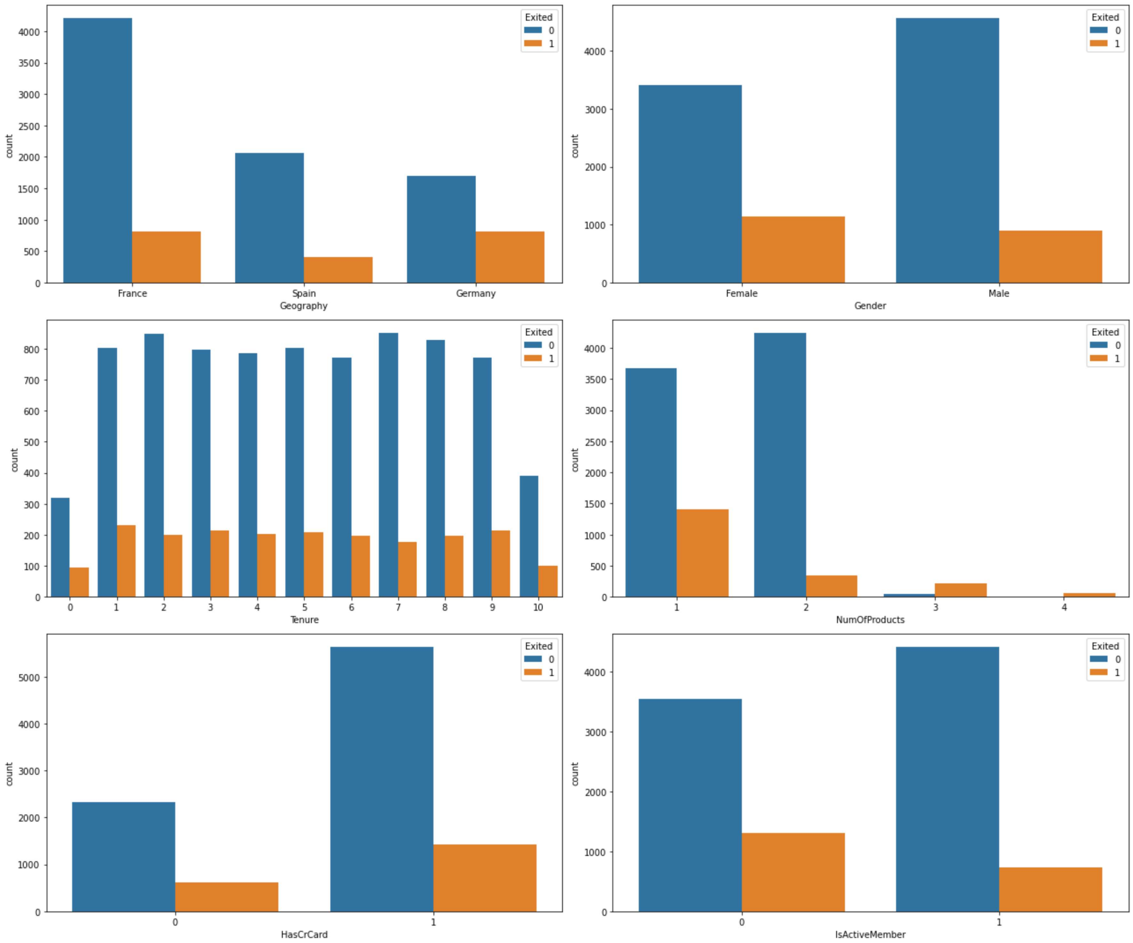


In [90]:

```
#COmparision Using Count Plot
fig, ax = plt.subplots(3, 2, figsize = (18, 15))

sns.countplot('Geography', hue = 'Exited', data = df, ax = ax[0][0])
sns.countplot('Gender', hue = 'Exited', data = df, ax = ax[0][1])
sns.countplot('Tenure', hue = 'Exited', data = df, ax = ax[1][0])
sns.countplot('NumOfProducts', hue = 'Exited', data = df, ax = ax[1][1
sns.countplot('HasCrCard', hue = 'Exited', data = df, ax = ax[2][0])
sns.countplot('IsActiveMember', hue = 'Exited', data = df, ax = ax[2][

plt.tight_layout()
plt.show()
```

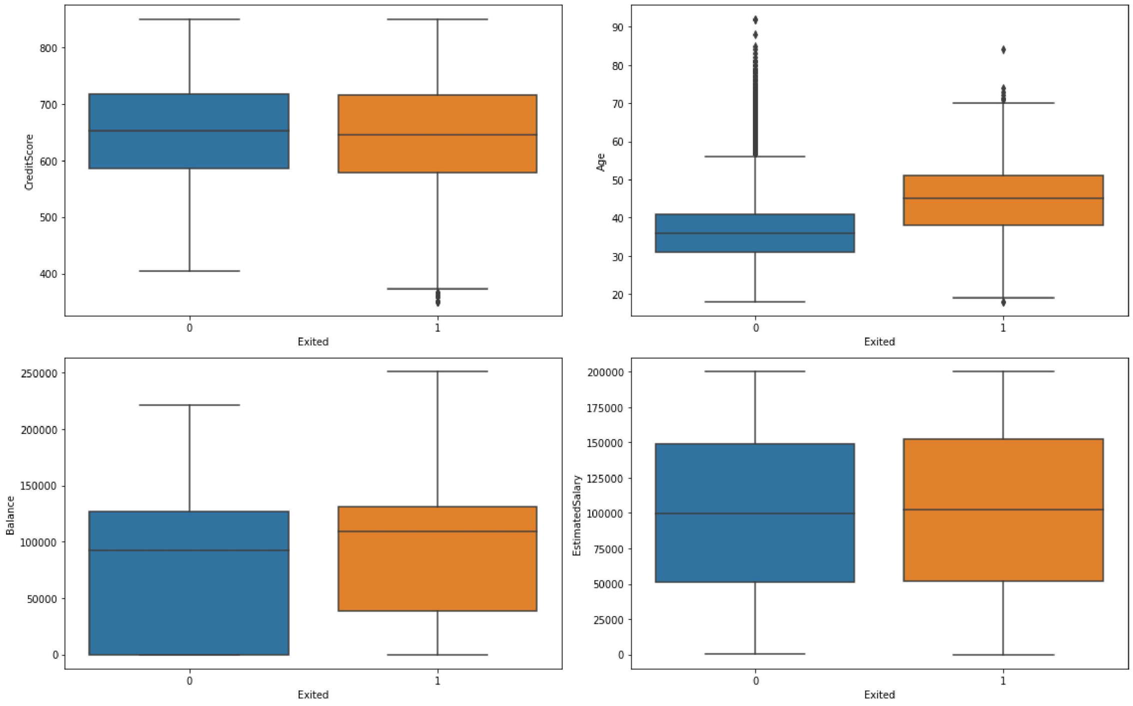


In [91]:

```
#Boxbolot based Variable COmparision
fig, ax = plt.subplots(2, 2, figsize = (16, 10))

sns.boxplot(x = 'Exited', y = 'CreditScore', data = df, ax = ax[0][0])
sns.boxplot(x = 'Exited', y = 'Age', data = df, ax = ax[0][1])
sns.boxplot(x = 'Exited', y = 'Balance', data = df, ax = ax[1][0])
sns.boxplot(x = 'Exited', y = 'EstimatedSalary', data = df, ax = ax[1]

plt.tight_layout()
plt.show()
```

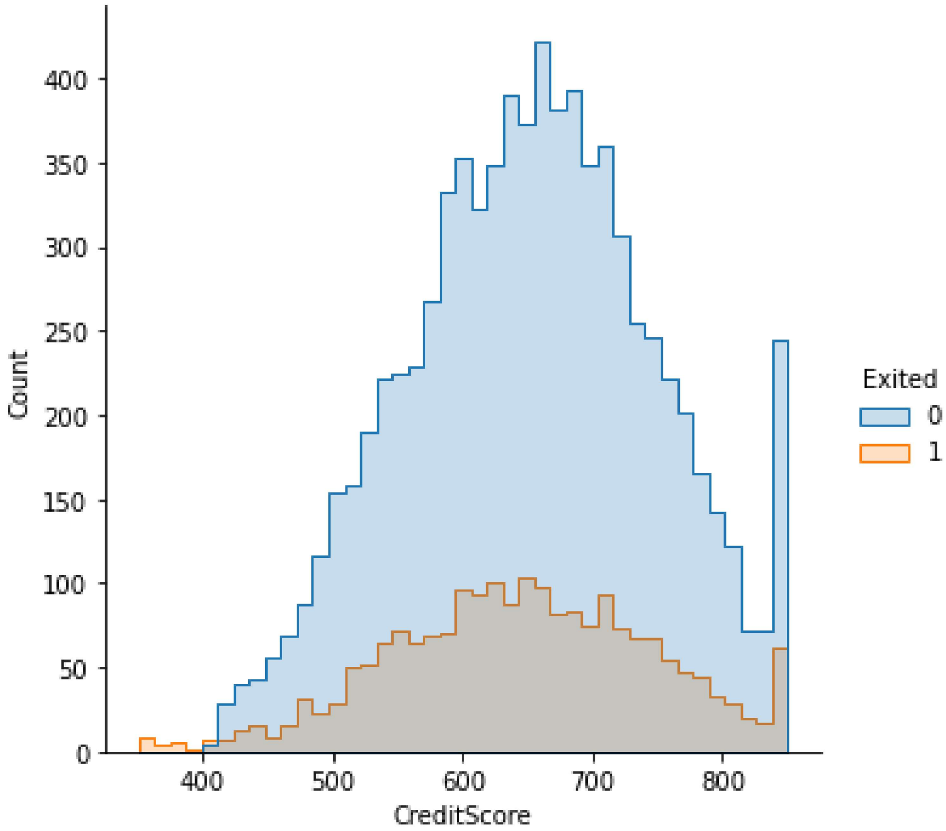


In [92]:

```
# COmparing the Distribution of the Data
sns.displot(df, x="CreditScore", hue="Exited", element="step")
```

Out[92]:

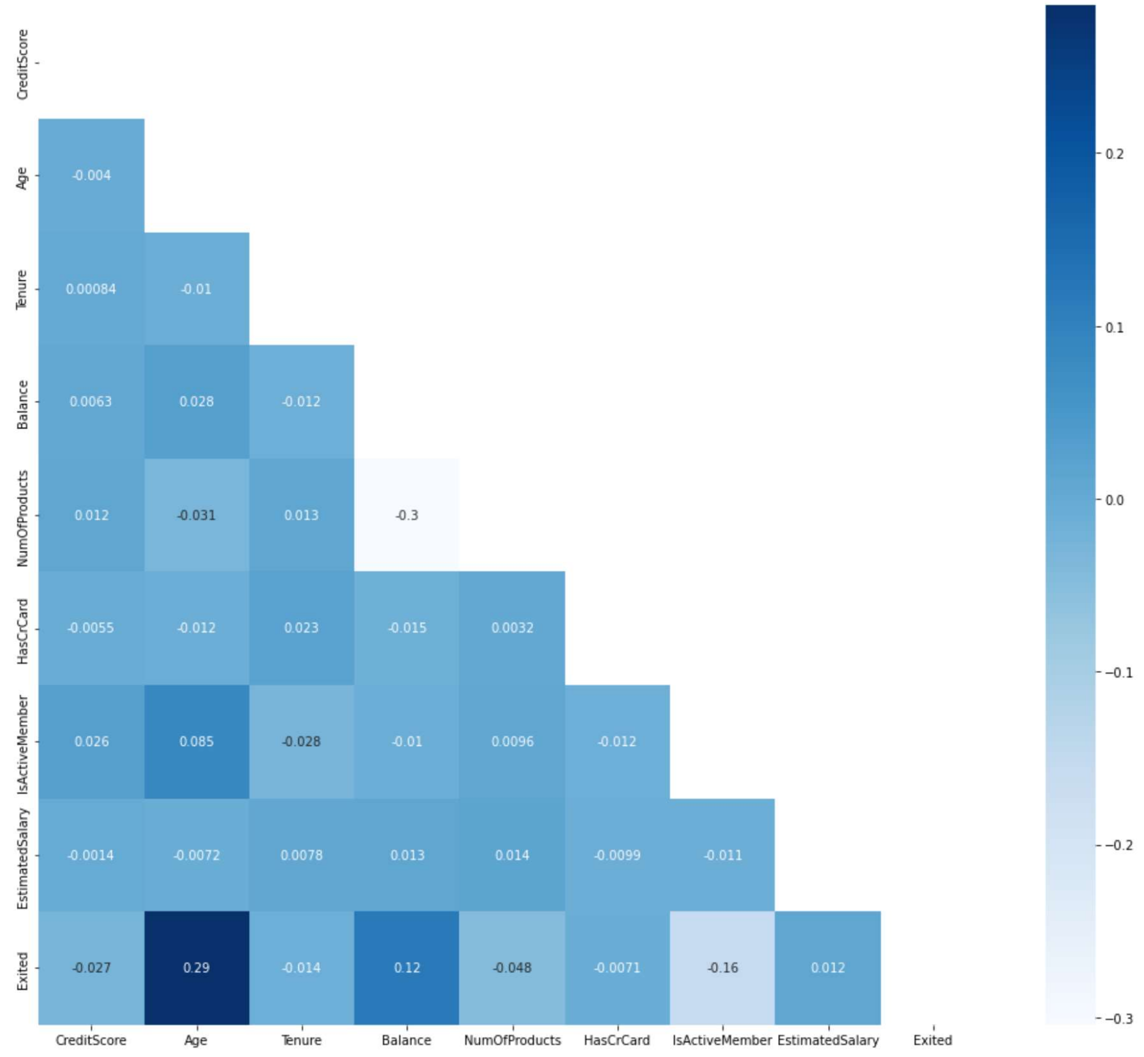
```
<seaborn.axisgrid.FacetGrid at 0x1dfc4cd7c70>
```



In [93]:

```
# Correlation Plot : TO test for multicollinearity     : Multicolllinea
plt.figure(figsize=(17, 15))

corr_mask = np.triu(df.corr())
h_map = sns.heatmap(df.corr(), mask=corr_mask, cmap='Blues',annot=True
plt.show()
```



Feature Selection Based on Target & Feature

- From the boxplot we can see that credit score for both exited and not exited are same. So this varibale may not be able to create good decision boundaries.
- MultiCollinearity doesnt exist as noe of the two independent variables have high correlation

In [94]:

```
df.drop(["CreditScore"],axis=1,inplace=True)
```

Seperating Independent and Dependent Feature

In [95]:

```
Y  = df["Exited"]
X = df.drop(["Exited"],axis=1)
```

In [96]:

```
## Encoding Categorical Columns
X['Geography'] = X['Geography'].map({'France' : 0, 'Germany' : 1, 'Spa
X['Gender'] = X['Gender'].map({'Male' : 0, 'Female' : 1})
```

In [97]:

```
X.shape
```

Out[97]:

```
(10000, 9)
```

Entropy Based Feature Selection

In [98]:

```
mi_score = MIC(X,Y)
mi_score
```

Out[98]:

```
array([0.01756461, 0.00473645, 0.07002521, 0.00473808, 0.008
41287,
       0.06494458, 0.        , 0.01061439, 0.00270893])
```

In [99]:

```
selected_index = list(np.where(mi_score >0.005)[0])
X1 = X.iloc[:,selected_index]
X1.head()
```

Out[99]:

	Geography	Age	Balance	NumOfProducts	IsActiveMember
0	0	42	0.00	1	1
1	2	41	83807.86	1	1
2	0	42	159660.80	3	0
3	0	39	0.00	2	0
4	2	43	125510.82	1	1

In [100]:

```
print("Removed Columns are : ", set(X.columns) - set(X1.columns))
```

```
Removed Columns are :  {'Tenure', 'Gender', 'HasCrCard', 'Es
timatedSalary'}
```

Model Based : Using Random Forest

In [101]:

```
rf = RandomForestClassifier(random_state=0)
rf.fit(X1,Y)
```

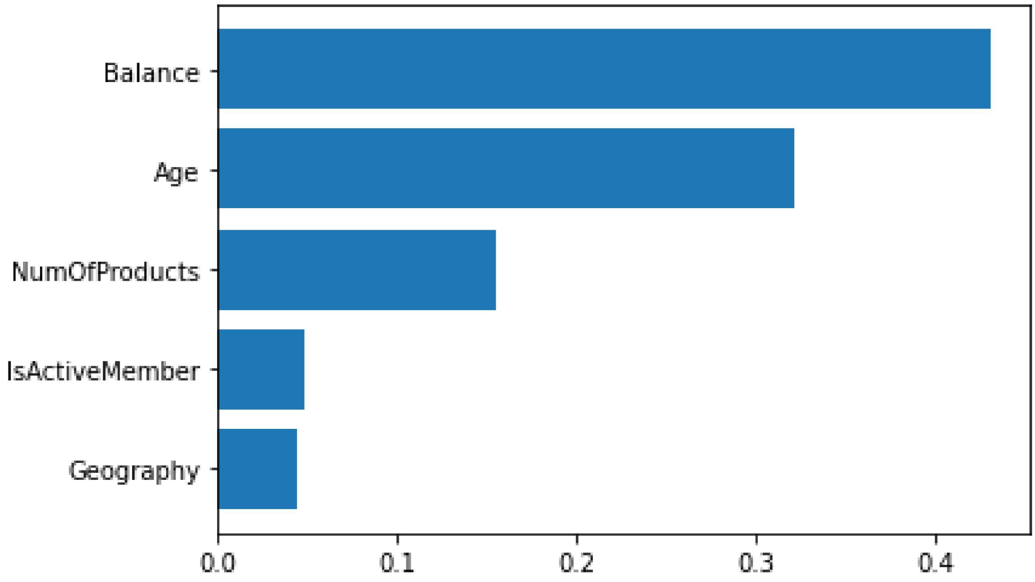
Out[101]:

```
RandomForestClassifier(random_state=0)
```

In [102]:

```
# Plotting the Feature Importance
features = X1.columns
f_i = list(zip(features,rf.feature_importances_))
f_i.sort(key = lambda x : x[1])
plt.barh([x[0] for x in f_i],[x[1] for x in f_i])

plt.show()
```



- Is ActiveMember & Geography has least feature Importance; so we can remove them

In [103]:

```
X1.drop(["IsActiveMember","Geography"],axis=1,inplace=True)
```

In [104]:

```
X1.head()
```

Out[104]:

	Age	Balance	NumOfProducts
0	42	0.00	1
1	41	83807.86	1
2	42	159660.80	3
3	39	0.00	2
4	43	125510.82	1

Data Standardization

In [105]:

```
sc = StandardScaler()
X1 = sc.fit_transform(X1)
```

Train Test Split

In [106]:

```
X_train, X_test, y_train, y_test = train_test_split(X1, Y, test_size =
```

In [107]:

```
X_train.shape
```

Out[107]:

```
(8000, 3)
```

Fitting Logistic Regression Model

In [108]:

```
#Intitalizing the Model
model_LR = LogisticRegression()

#Fitting the Model
model_LR.fit(X_train, y_train)
```

Out[108]:

```
LogisticRegression()
```

In [109]:

```
# Prediction
y_prob = model_LR.predict_proba(X_test)[:,1]
y_pred = np.where(y_prob > 0.5, 1, 0)
```

In [110]:

```
confusion_matrix = confusion_matrix(y_test,y_pred)

confusion_matrix
```

Out[110]:

```
array([[1551,   56],
       [ 368,   25]], dtype=int64)
```

In [111]:

```
from sklearn.metrics import accuracy_score

accuracy_score(y_test, y_pred)
```

Out[111]:

```
0.788
```

In [114]:

```
## ROC AUC Score & Curve
from sklearn.metrics import roc_curve, auc

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test

roc_auc = auc(false_positive_rate, true_positive_rate)
roc_auc
```

Out[114]:

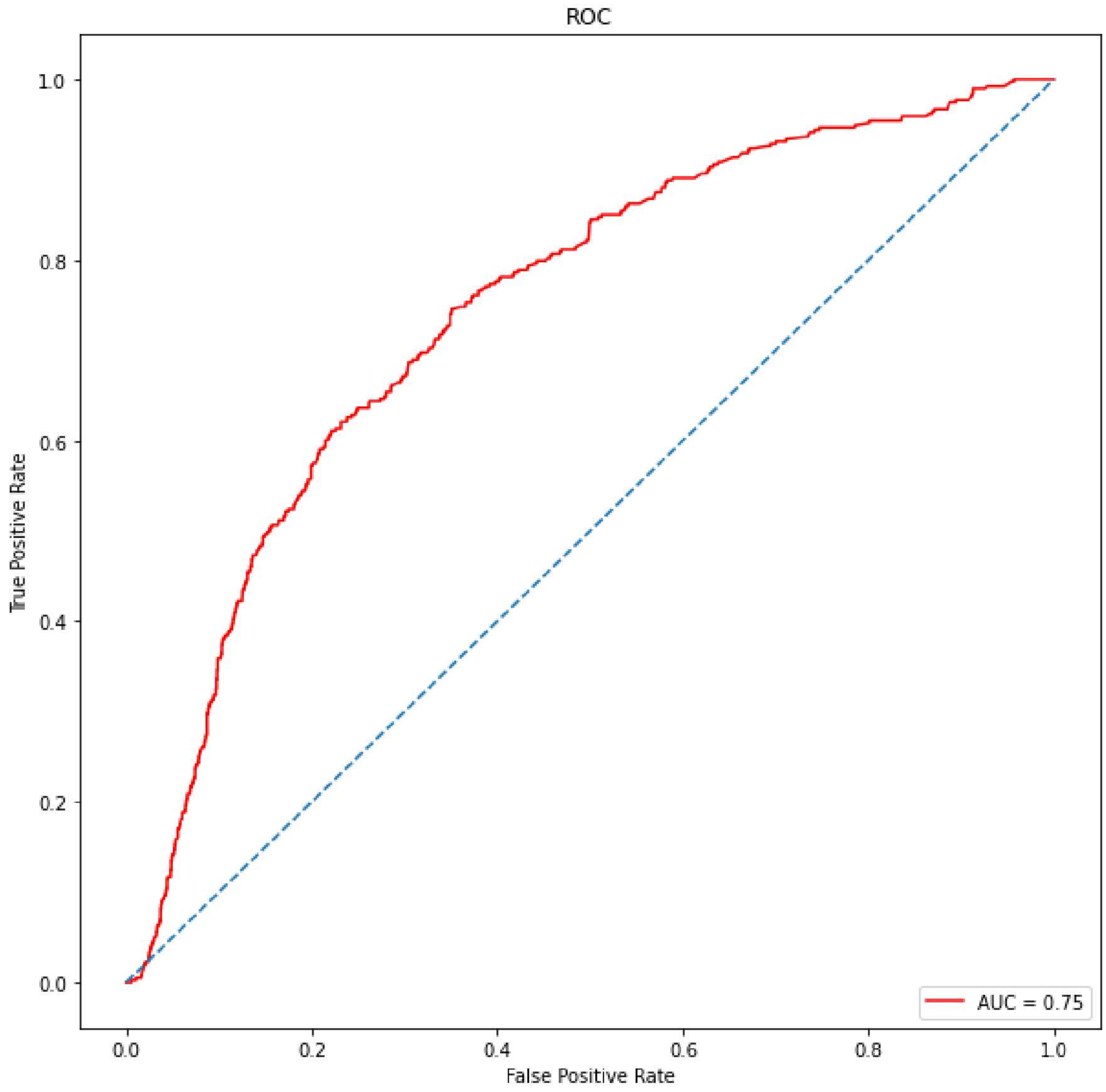
```
0.7451298469957296
```

In [115]:

```
plt.figure(figsize=(10,10))
plt.title('ROC')

plt.plot(false_positive_rate,true_positive_rate, color='red',label = '

plt.legend(loc = 'lower right')
plt.plot([0, 1], [0, 1],linestyle='--')
plt.axis('tight')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```



→ **Thank You** ←