In [76]:
```
import pandas as pd
import numpy as np
import tensorflow as tf
from tensorflow import keras
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, confusion_matrix
import math
import warnings
warnings.filterwarnings("ignore")
```

Exploration

In [77]:
```
df  = pd.read_csv("E://Churn_modelling.csv")
df.head()
```

Out[77]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsA
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	
4	5	15737888	Mitchell	850	Spain	Female	43	2	125510.82	1	1	

In [78]:
```
df.isnull().sum()
```

Out[78]:
```
RowNumber          0
CustomerId         0
Surname            0
CreditScore        0
Geography          0
Gender             0
Age                0
Tenure             0
Balance            0
NumOfProducts      0
HasCrCard          0
IsActiveMember     0
EstimatedSalary    0
Exited             0
dtype: int64
```

In [79]:
```
df.shape
```

Out[79]:
```
(10000, 14)
```

In [80]:
```
df  = df.drop(['RowNumber', 'CustomerId', 'Surname'], axis = 1)
```

In [81]:
```
df.columns
```

Out[81]:
```
Index(['CreditScore', 'Geography', 'Gender', 'Age', 'Tenure', 'Balance',
       'NumOfProducts', 'HasCrCard', 'IsActiveMember', 'EstimatedSalary',
       'Exited'],
      dtype='object')
```

In [82]:
```
df.head()
```

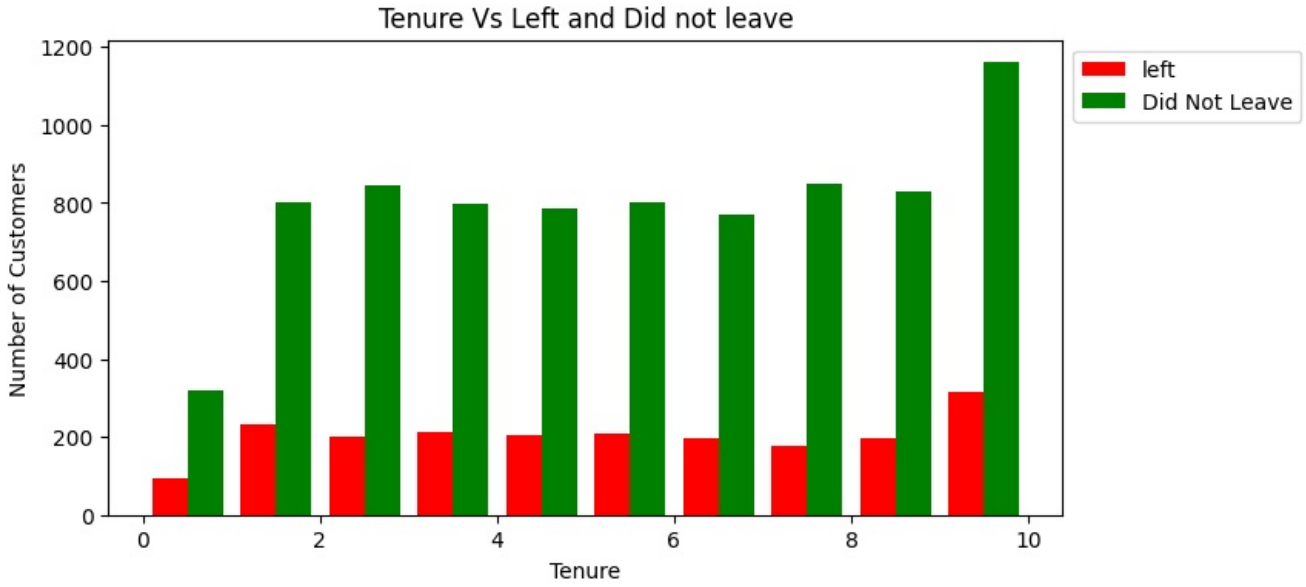
Out[82]:

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exite
0	619	France	Female	42	2	0.00	1	1	1	101348.88	
1	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	
2	502	France	Female	42	8	159660.80	3	1	0	113931.57	
3	699	France	Female	39	1	0.00	2	0	0	93826.63	
4	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	

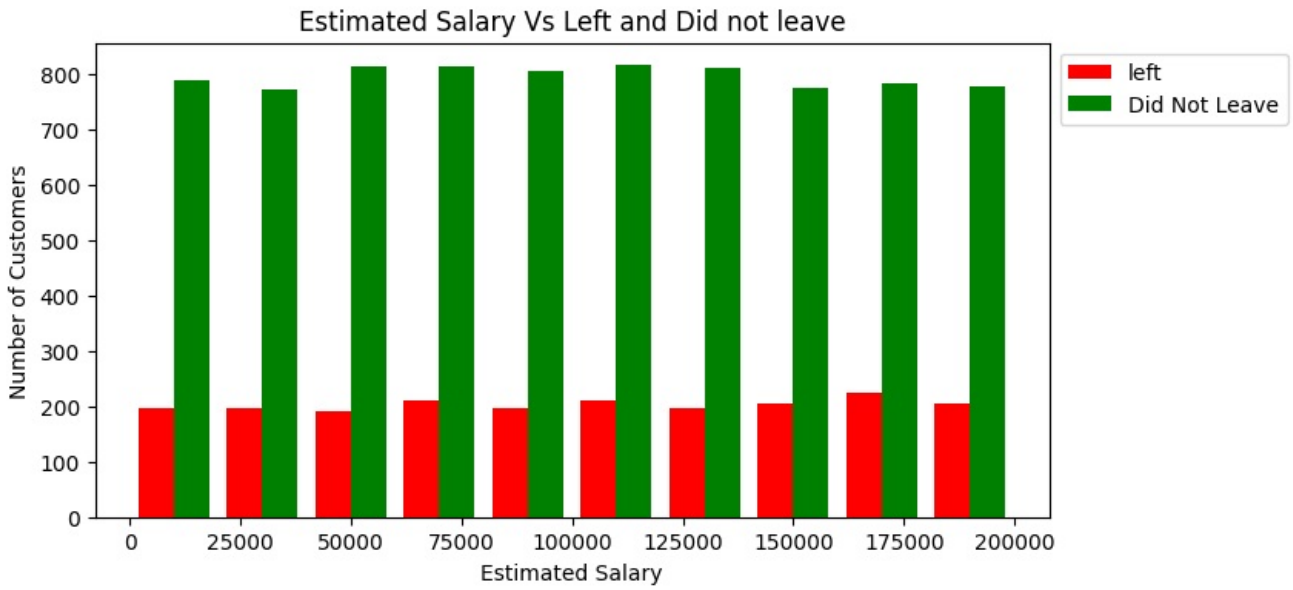
In [83]:
```
left  = df[df["Exited"] == 1].Tenure
not_left  = df[df["Exited"] == 0].Tenure
```

Visualization

In [84]:
```
plt.figure(figsize = (8,4))
plt.hist([left,not_left], color = ["red", "green"], label = ["left", "Did Not Leave"])
plt.legend(loc='upper left', bbox_to_anchor=(1, 1))
plt.xlabel("Tenure")
plt.ylabel("Number of Customers")
plt.title("Tenure Vs Left and Did not leave");
```



In [85]:
```
left  = df[df["Exited"] == 1].EstimatedSalary
not_left  = df[df["Exited"] == 0].EstimatedSalary
plt.figure(figsize = (8,4))
plt.hist([left,not_left], color = ["red", "green"], label = ["left", "Did Not Leave"])
plt.legend(loc='upper left', bbox_to_anchor=(1, 1))
plt.xlabel("Estimated Salary")
plt.ylabel("Number of Customers")
plt.title("Estimated Salary Vs Left and Did not leave");
```



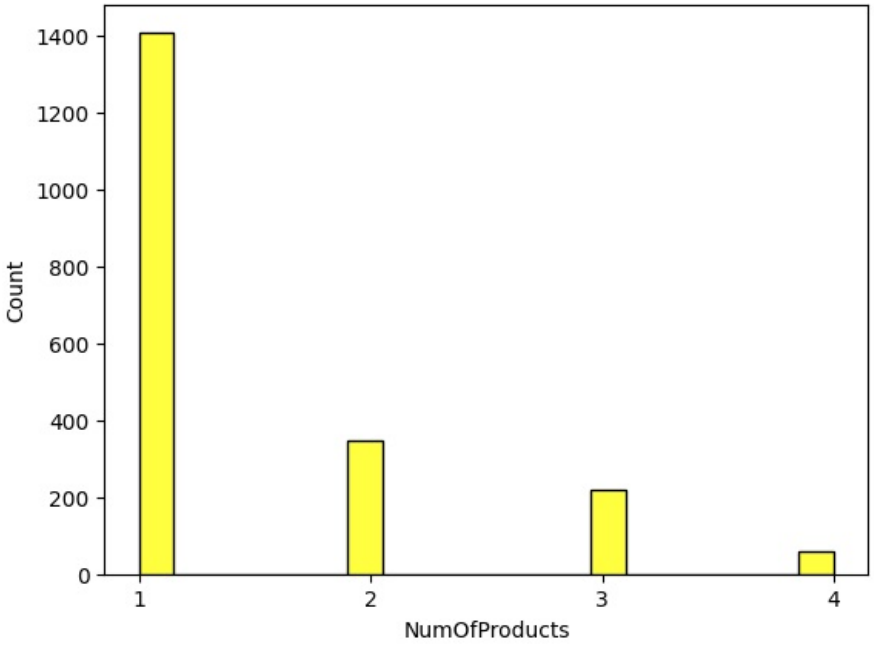
In [86]:
```
df.head()
```

Out[86]:

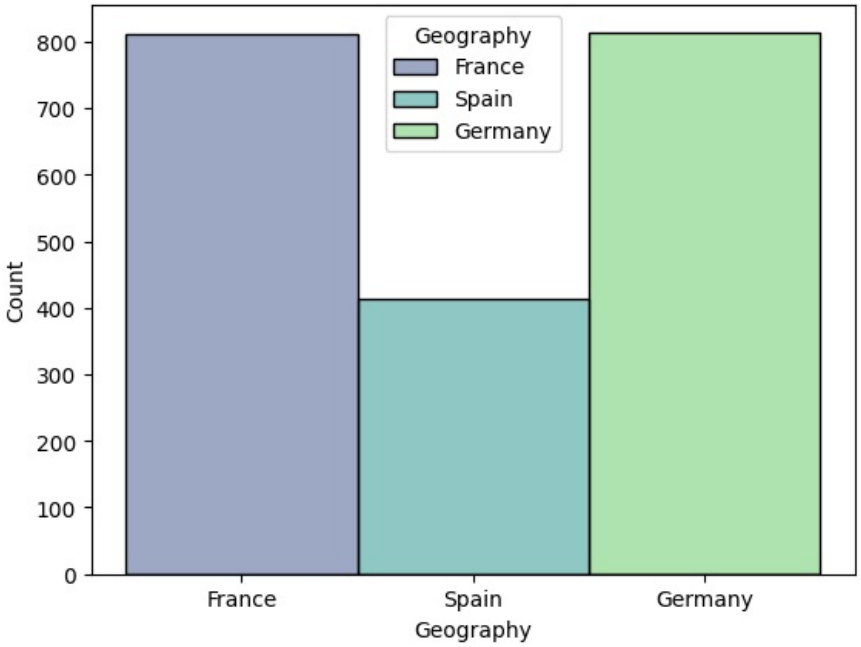
	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exite
0	619	France	Female	42	2	0.00	1	1	1	101348.88	
1	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	
2	502	France	Female	42	8	159660.80	3	1	0	113931.57	
3	699	France	Female	39	1	0.00	2	0	0	93826.63	
4	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	

In [87]:
```
left  = df[df["Exited"] == 1]
sns.histplot(data = left, x = "NumOfProducts", color = "Yellow")
```

```
plt.xticks(np.arange(1,5,1));
```



In [88]:
```
left  = df[df["Exited"] == 1]
sns.histplot(data = left, x= "Geography", palette = "viridis", hue ="Geography" );
```



In [89]:
```
df.NumOfProducts.unique()
```

Out[89]:
```
array([1, 3, 2, 4], dtype=int64)
```

Data Preparation

In [90]:
```
df.head()
```

Out[90]:

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exite
0	619	France	Female	42	2	0.00	1	1	1	101348.88	
1	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	
2	502	France	Female	42	8	159660.80	3	1	0	113931.57	
3	699	France	Female	39	1	0.00	2	0	0	93826.63	
4	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	

In [91]:
```
def categories(data):
    for column in data.columns:
        if data[column].dtypes == "object":
```

```
            print(f"{column}: {data[column].unique()}")

categories(df)
```

```
Geography: ['France' 'Spain' 'Germany']
Gender: ['Female' 'Male']
```

In [92]:
```
def non_categories(data):
    for column in data.columns:
        if data[column].dtypes != "object":
            if not np.all(np.isin(data[column].values, [0,1])):
               print(f"{column}")
non_categories(df)
```

```
CreditScore
Age
Tenure
Balance
NumOfProducts
EstimatedSalary
```

In [93]:
```
df["Gender"] = df["Gender"].replace({"Male":0, "Female":1})
```

In [94]:
```
modified_df = pd.get_dummies(data =df, columns =["Geography"]).astype("int")
```

In [95]:
```
modified_df.head()
```

Out[95]:

	CreditScore	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited	Geography_
0	619	1	42	2	0	1	1	1	101348	1	
1	608	1	41	1	83807	1	0	1	112542	0	
2	502	1	42	8	159660	3	1	0	113931	1	
3	699	1	39	1	0	2	0	0	93826	0	
4	850	1	43	2	125510	1	1	1	79084	0	

In [96]:
```
scaling_cols = ["CreditScore","Age", "Tenure", "Balance", "NumOfProducts", "EstimatedSalary"]
scaler = MinMaxScaler()
modified_df[scaling_cols] = scaler.fit_transform(modified_df[scaling_cols])
```

In [97]:
```
modified_df.head()
```

Out[97]:

	CreditScore	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited	Geogra
0	0.538	1	0.324324	0.2	0.000000	0.000000	1	1	0.506733	1	
1	0.516	1	0.310811	0.1	0.334028	0.000000	0	1	0.562708	0	
2	0.304	1	0.324324	0.8	0.636354	0.666667	1	0	0.569654	1	
3	0.698	1	0.283784	0.1	0.000000	0.333333	0	0	0.469120	0	
4	1.000	1	0.337838	0.2	0.500243	0.000000	1	1	0.395403	0	

In [98]:
```
x = modified_df.drop("Exited", axis = 1)
y = modified_df["Exited"]
```

In [99]:
```
x_train,x_test, y_train, y_test = train_test_split(x,y,test_size = 0.2, random_state = 5)
```

In [100…
```
model  = keras.Sequential([
    keras.Input(shape = (12,)),
    keras.layers.Dense(9, activation = "relu"),
    keras.layers.Dense(6, activation = "relu"),
    keras.layers.Dense(3, activation = "relu"),
    keras.layers.Dense(1, activation = "sigmoid")
])
```

In [101…
```
model.compile(optimizer = "adam", loss = "binary_crossentropy", metrics = ["accuracy"])
model.fit(x_train,y_train, epochs =100)
```

```
Epoch 1/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 4s 5ms/step - accuracy: 0.8037 - loss: 0.5863
Epoch 2/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7967 - loss: 0.4824
Epoch 3/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 6s 23ms/step - accuracy: 0.7927 - loss: 0.4755
Epoch 4/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.7911 - loss: 0.4680
Epoch 5/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 8ms/step - accuracy: 0.8110 - loss: 0.4424
```

```
Epoch 6/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.8099 - loss: 0.4447
Epoch 7/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 7ms/step - accuracy: 0.8073 - loss: 0.4462
Epoch 8/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8190 - loss: 0.4295
Epoch 9/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8139 - loss: 0.4266
Epoch 10/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8233 - loss: 0.4180
Epoch 11/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 8ms/step - accuracy: 0.8286 - loss: 0.4042
Epoch 12/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8296 - loss: 0.3988
Epoch 13/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8319 - loss: 0.3957
Epoch 14/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8408 - loss: 0.3756
Epoch 15/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8375 - loss: 0.3856
Epoch 16/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8492 - loss: 0.3578
Epoch 17/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8477 - loss: 0.3689
Epoch 18/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8416 - loss: 0.3699
Epoch 19/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 7ms/step - accuracy: 0.8627 - loss: 0.3423
Epoch 20/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8501 - loss: 0.3596
Epoch 21/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8518 - loss: 0.3493
Epoch 22/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8540 - loss: 0.3499
Epoch 23/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8536 - loss: 0.3505
Epoch 24/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8572 - loss: 0.3415
Epoch 25/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8570 - loss: 0.3460
Epoch 26/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 9ms/step - accuracy: 0.8563 - loss: 0.3459
Epoch 27/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.8542 - loss: 0.3520
Epoch 28/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8546 - loss: 0.3498
Epoch 29/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 8ms/step - accuracy: 0.8482 - loss: 0.3515
Epoch 30/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8585 - loss: 0.3388
Epoch 31/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8600 - loss: 0.3375
Epoch 32/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 9ms/step - accuracy: 0.8612 - loss: 0.3431
Epoch 33/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 8ms/step - accuracy: 0.8599 - loss: 0.3414
Epoch 34/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8513 - loss: 0.3619
Epoch 35/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8606 - loss: 0.3408
Epoch 36/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8597 - loss: 0.3353
Epoch 37/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8569 - loss: 0.3430
Epoch 38/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8547 - loss: 0.3456
Epoch 39/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8533 - loss: 0.3551
Epoch 40/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8591 - loss: 0.3468
Epoch 41/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8543 - loss: 0.3472
Epoch 42/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8600 - loss: 0.3401
Epoch 43/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8632 - loss: 0.3409
Epoch 44/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8582 - loss: 0.3462
Epoch 45/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8570 - loss: 0.3491
Epoch 46/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 9ms/step - accuracy: 0.8598 - loss: 0.3420
Epoch 47/100
```

```
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8542 - loss: 0.3487
Epoch 48/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 9ms/step - accuracy: 0.8665 - loss: 0.3340
Epoch 49/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8592 - loss: 0.3383
Epoch 50/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8596 - loss: 0.3379
Epoch 51/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8611 - loss: 0.3382
Epoch 52/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8556 - loss: 0.3425
Epoch 53/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8566 - loss: 0.3404
Epoch 54/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8644 - loss: 0.3425
Epoch 55/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8557 - loss: 0.3506
Epoch 56/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 9ms/step - accuracy: 0.8622 - loss: 0.3343
Epoch 57/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8686 - loss: 0.3337
Epoch 58/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8644 - loss: 0.3316
Epoch 59/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 8ms/step - accuracy: 0.8614 - loss: 0.3372
Epoch 60/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8645 - loss: 0.3337
Epoch 61/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8626 - loss: 0.3368
Epoch 62/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 8ms/step - accuracy: 0.8540 - loss: 0.3494
Epoch 63/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8652 - loss: 0.3332
Epoch 64/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8582 - loss: 0.3403
Epoch 65/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8659 - loss: 0.3354
Epoch 66/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8580 - loss: 0.3446
Epoch 67/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8537 - loss: 0.3421
Epoch 68/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8560 - loss: 0.3486
Epoch 69/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8682 - loss: 0.3272
Epoch 70/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 12ms/step - accuracy: 0.8613 - loss: 0.3329
Epoch 71/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8643 - loss: 0.3277
Epoch 72/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8568 - loss: 0.3436
Epoch 73/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8580 - loss: 0.3425
Epoch 74/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8605 - loss: 0.3349
Epoch 75/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.8591 - loss: 0.3392
Epoch 76/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 7ms/step - accuracy: 0.8593 - loss: 0.3412
Epoch 77/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8649 - loss: 0.3298
Epoch 78/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8632 - loss: 0.3358
Epoch 79/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8547 - loss: 0.3472
Epoch 80/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8703 - loss: 0.3279
Epoch 81/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 5ms/step - accuracy: 0.8634 - loss: 0.3363
Epoch 82/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8648 - loss: 0.3386
Epoch 83/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 10ms/step - accuracy: 0.8570 - loss: 0.3374
Epoch 84/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8630 - loss: 0.3415
Epoch 85/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8679 - loss: 0.3210
Epoch 86/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.8604 - loss: 0.3334
Epoch 87/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8625 - loss: 0.3382
Epoch 88/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 10ms/step - accuracy: 0.8583 - loss: 0.3416
```

```
Epoch 89/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 10ms/step - accuracy: 0.8623 - loss: 0.3246
Epoch 90/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.8642 - loss: 0.3346
Epoch 91/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.8663 - loss: 0.3331
Epoch 92/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 6ms/step - accuracy: 0.8664 - loss: 0.3255
Epoch 93/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 7ms/step - accuracy: 0.8581 - loss: 0.3375
Epoch 94/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 5ms/step - accuracy: 0.8628 - loss: 0.3349
Epoch 95/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 4s 11ms/step - accuracy: 0.8631 - loss: 0.3336
Epoch 96/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 6ms/step - accuracy: 0.8609 - loss: 0.3378
Epoch 97/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.8630 - loss: 0.3298
Epoch 98/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 6ms/step - accuracy: 0.8547 - loss: 0.3497
Epoch 99/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 4s 10ms/step - accuracy: 0.8616 - loss: 0.3341
Epoch 100/100
250/250 ━━━━━━━━━━━━━━━━━━━━ 2s 6ms/step - accuracy: 0.8614 - loss: 0.3378
```

Out[101…

```
<keras.src.callbacks.history.History at 0x20ebe354b30>
```

In [102…

```
y_predicted = model.predict(x_test)
y_predicted
predictions= []
```

```
63/63 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step
```

In [103…

```
for prediction in y_predicted:
    if prediction > 0.5:
        predictions.append(1)
    else:
        predictions.append(0)
```

In [104…

```
predictions[:5]
```

Out[104…

```
[0, 0, 0, 0, 0]
```

In [105…

```
y_test[:5]
```

Out[105…

```
7054    0
442     0
3954    0
2288    0
3196    0
Name: Exited, dtype: int32
```

In [106…

```
model.evaluate(x_test, y_test)
```

```
63/63 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8434 - loss: 0.3605
```

Out[106…

```
[0.357290655374527, 0.8475000262260437]
```

In [107…

```
print(classification_report( y_test, predictions))
```

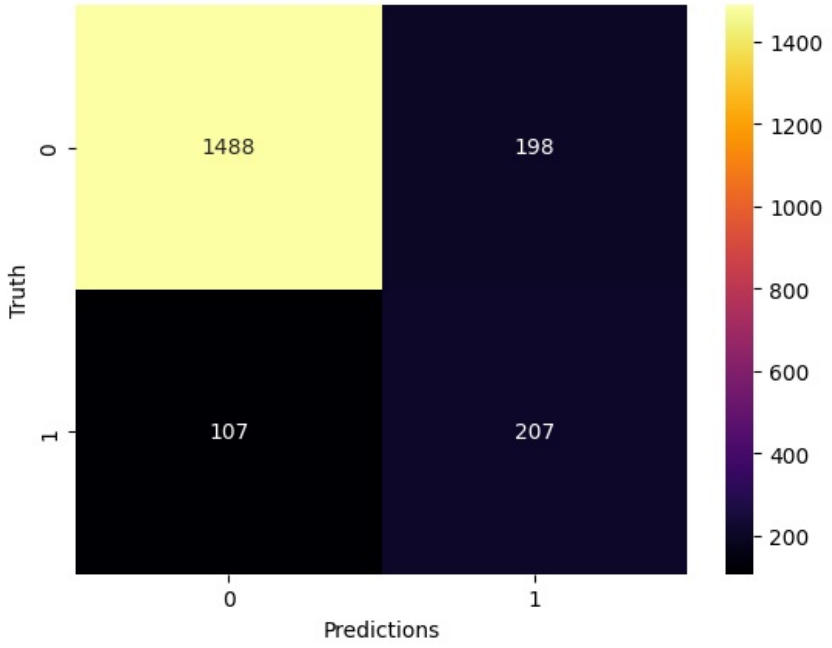
```
              precision    recall  f1-score   support

           0       0.88      0.93      0.91      1595
           1       0.66      0.51      0.58       405

    accuracy                           0.85      2000
   macro avg       0.77      0.72      0.74      2000
weighted avg       0.84      0.85      0.84      2000
```

In [108…

```
cm  = tf.math.confusion_matrix(predictions,y_test)
```

In [109…

```
sns.heatmap(cm, annot = True, cmap = "inferno", fmt =  'd')
plt.xlabel("Predictions")
plt.ylabel("Truth");
```



Under Sampling

In [110…
```
x_train.shape, y_train.shape
```

Out[110…
```
((8000, 12), (8000,))
```

In [ ]:
```
```

In [111…
```
x_test.shape
```

Out[111…
```
(2000, 12)
```

In [112…
```
merged_train = pd.concat([x_train, y_train], axis = 1)
merged_train.Exited.value_counts()
```

Out[112…
```
Exited
0    6368
1    1632
Name: count, dtype: int64
```

In [113…
```
train_0s = merged_train[merged_train["Exited"] == 0]
train_1s = merged_train[merged_train["Exited"] == 1]
train_0s.shape, train_1s.shape
```

Out[113…
```
((6368, 13), (1632, 13))
```

In [114…
```
train_us_0s = train_0s.sample(train_1s.shape[0])
train_us_0s.shape
```

Out[114…
```
(1632, 13)
```

In [115…
```
final_train  = pd.concat([train_us_0s, train_1s], axis = 0)
final_train.shape, final_train["Exited"].value_counts()
```

Out[115…
```
((3264, 13),
 Exited
 0    1632
 1    1632
 Name: count, dtype: int64)
```

In [159…
```
def classification_r(x_train_us,y_train_us, x_test, y_test):
    model  = keras.Sequential([
    keras.Input(shape = (12,)),
    keras.layers.Dense(9, activation = "relu"),
    keras.layers.Dense(6, activation = "relu"),
    keras.layers.Dense(3, activation = "relu"),
    keras.layers.Dense(1, activation = "sigmoid")])
    model.compile(optimizer = "adam", loss = "binary_crossentropy", metrics = ["accuracy"])
    model.fit(x_train_us,y_train_us, epochs =100)
    y_pred = model.predict(x_test)
    predictions_new= []
    for prediction in y_pred:
       if prediction > 0.5:
```

```
            predictions_new.append(1)
        else:
            predictions_new.append(0)
    print("Classification Report: \n",classification_report( y_test, predictions_new))
    return predictions_new
```

In [117…
```
x_train_us = final_train.drop("Exited", axis=1)
y_train_us = final_train["Exited"]
classification_r(x_train_us,y_train_us, x_test, y_test)
```

```
Epoch 1/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.5246 - loss: 0.6874
Epoch 2/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - accuracy: 0.5794 - loss: 0.6741
Epoch 3/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6191 - loss: 0.6662
Epoch 4/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.6343 - loss: 0.6586
Epoch 5/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6482 - loss: 0.6488
Epoch 6/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6702 - loss: 0.6406
Epoch 7/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6529 - loss: 0.6399
Epoch 8/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6484 - loss: 0.6394
Epoch 9/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.6606 - loss: 0.6297
Epoch 10/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6588 - loss: 0.6259
Epoch 11/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6837 - loss: 0.6143
Epoch 12/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6810 - loss: 0.6003
Epoch 13/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6942 - loss: 0.5957
Epoch 14/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7053 - loss: 0.5689
Epoch 15/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7288 - loss: 0.5506
Epoch 16/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7467 - loss: 0.5401
Epoch 17/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7540 - loss: 0.5278
Epoch 18/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7547 - loss: 0.5285
Epoch 19/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7667 - loss: 0.5051
Epoch 20/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - accuracy: 0.7475 - loss: 0.5138
Epoch 21/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7562 - loss: 0.5061
Epoch 22/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7634 - loss: 0.4953
Epoch 23/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7663 - loss: 0.4990
Epoch 24/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7620 - loss: 0.4999
Epoch 25/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7713 - loss: 0.4849
Epoch 26/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7722 - loss: 0.4890
Epoch 27/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7852 - loss: 0.4712
Epoch 28/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7579 - loss: 0.4950
Epoch 29/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7687 - loss: 0.4940
Epoch 30/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7638 - loss: 0.4884
Epoch 31/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7679 - loss: 0.4852
Epoch 32/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 2s 11ms/step - accuracy: 0.7780 - loss: 0.4789
Epoch 33/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7747 - loss: 0.4606
Epoch 34/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7706 - loss: 0.4776
Epoch 35/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7555 - loss: 0.4997
Epoch 36/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7732 - loss: 0.4779
```

```
Epoch 37/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7569 - loss: 0.4955
Epoch 38/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7727 - loss: 0.4755
Epoch 39/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7715 - loss: 0.4768
Epoch 40/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7744 - loss: 0.4795
Epoch 41/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7689 - loss: 0.4791
Epoch 42/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - accuracy: 0.7793 - loss: 0.4769
Epoch 43/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7672 - loss: 0.4882
Epoch 44/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7839 - loss: 0.4723
Epoch 45/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7727 - loss: 0.4778
Epoch 46/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 2s 11ms/step - accuracy: 0.7562 - loss: 0.4952
Epoch 47/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7678 - loss: 0.4836
Epoch 48/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7707 - loss: 0.4780
Epoch 49/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7680 - loss: 0.4742
Epoch 50/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7693 - loss: 0.4729
Epoch 51/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7621 - loss: 0.4926
Epoch 52/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7795 - loss: 0.4698
Epoch 53/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7606 - loss: 0.4784
Epoch 54/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7613 - loss: 0.4804
Epoch 55/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7645 - loss: 0.4805
Epoch 56/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7686 - loss: 0.4751
Epoch 57/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - accuracy: 0.7723 - loss: 0.4753
Epoch 58/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7769 - loss: 0.4693
Epoch 59/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7690 - loss: 0.4675
Epoch 60/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7613 - loss: 0.4891
Epoch 61/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7787 - loss: 0.4614
Epoch 62/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7610 - loss: 0.4718
Epoch 63/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7662 - loss: 0.4730
Epoch 64/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7627 - loss: 0.4716
Epoch 65/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7654 - loss: 0.4761
Epoch 66/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7731 - loss: 0.4782
Epoch 67/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7617 - loss: 0.4829
Epoch 68/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7806 - loss: 0.4646
Epoch 69/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7744 - loss: 0.4660
Epoch 70/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7694 - loss: 0.4779
Epoch 71/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7744 - loss: 0.4690
Epoch 72/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7798 - loss: 0.4751
Epoch 73/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7674 - loss: 0.4800
Epoch 74/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - accuracy: 0.7640 - loss: 0.4814
Epoch 75/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7746 - loss: 0.4557
Epoch 76/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7658 - loss: 0.4754
Epoch 77/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7592 - loss: 0.4869
Epoch 78/100
```

```
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7674 - loss: 0.4716
Epoch 79/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7731 - loss: 0.4702
Epoch 80/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7678 - loss: 0.4769
Epoch 81/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7681 - loss: 0.4732
Epoch 82/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7547 - loss: 0.4794
Epoch 83/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7890 - loss: 0.4605
Epoch 84/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7746 - loss: 0.4628
Epoch 85/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7887 - loss: 0.4444
Epoch 86/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7797 - loss: 0.4562
Epoch 87/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7807 - loss: 0.4620
Epoch 88/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7741 - loss: 0.4686
Epoch 89/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7703 - loss: 0.4669
Epoch 90/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7713 - loss: 0.4757
Epoch 91/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7849 - loss: 0.4517
Epoch 92/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7904 - loss: 0.4368
Epoch 93/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7768 - loss: 0.4666
Epoch 94/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7732 - loss: 0.4649
Epoch 95/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7787 - loss: 0.4559
Epoch 96/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7832 - loss: 0.4487
Epoch 97/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7827 - loss: 0.4545
Epoch 98/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7748 - loss: 0.4536
Epoch 99/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7828 - loss: 0.4542
Epoch 100/100
102/102 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - accuracy: 0.7818 - loss: 0.4393
63/63 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step
Classification Report:
              precision    recall  f1-score   support

           0       0.91      0.81      0.86      1595
           1       0.48      0.68      0.56       405

    accuracy                           0.78      2000
   macro avg       0.69      0.75      0.71      2000
weighted avg       0.82      0.78      0.80      2000
```

Over Sampling

In [118…
```
x_train_us.shape,y_train_us.shape
```

Out[118…
```
((3264, 12), (3264,))
```

In [119…
```
train_0s.shape, train_1s.shape
```

Out[119…
```
((6368, 13), (1632, 13))
```

In [120…
```
train_os_1s = train_1s.sample(6368,replace =True)
train_os_1s.shape
```

Out[120…
```
(6368, 13)
```

In [121…
```
final_os = pd.concat([train_0s,train_os_1s], axis = 0)
final_os.shape, final_os["Exited"].value_counts()
```

Out[121…
```
((12736, 13),
 Exited
 0    6368
 1    6368
 Name: count, dtype: int64)
```

In [122…
```
x_train_os = final_os.drop("Exited", axis =1)
y_train_os = final_os["Exited"]
```

In [123…
```
x_train_os.shape, y_train_os.value_counts()
```

Out[123…
```
((12736, 12),
 Exited
 0    6368
 1    6368
 Name: count, dtype: int64)
```

In [124…
```
classification_r(x_train_os,y_train_os, x_test, y_test)
```

```
Epoch 1/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 3ms/step - accuracy: 0.5014 - loss: 0.7118
Epoch 2/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6426 - loss: 0.6569
Epoch 3/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 6ms/step - accuracy: 0.6828 - loss: 0.6288
Epoch 4/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.6823 - loss: 0.6101
Epoch 5/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 6ms/step - accuracy: 0.7175 - loss: 0.5777
Epoch 6/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7321 - loss: 0.5556
Epoch 7/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7516 - loss: 0.5352
Epoch 8/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.7498 - loss: 0.5267
Epoch 9/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.7579 - loss: 0.5151
Epoch 10/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.7617 - loss: 0.5086
Epoch 11/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7673 - loss: 0.4998
Epoch 12/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7639 - loss: 0.4965
Epoch 13/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.7676 - loss: 0.4947
Epoch 14/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7663 - loss: 0.4897
Epoch 15/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.7657 - loss: 0.4907
Epoch 16/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.7665 - loss: 0.4919
Epoch 17/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 3ms/step - accuracy: 0.7705 - loss: 0.4838
Epoch 18/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7719 - loss: 0.4789
Epoch 19/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7609 - loss: 0.4886
Epoch 20/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7670 - loss: 0.4838
Epoch 21/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7673 - loss: 0.4851
Epoch 22/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 8ms/step - accuracy: 0.7708 - loss: 0.4796
Epoch 23/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 6ms/step - accuracy: 0.7689 - loss: 0.4761
Epoch 24/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.7668 - loss: 0.4814
Epoch 25/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 3ms/step - accuracy: 0.7702 - loss: 0.4737
Epoch 26/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7763 - loss: 0.4679
Epoch 27/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7675 - loss: 0.4713
Epoch 28/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7691 - loss: 0.4724
Epoch 29/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 5ms/step - accuracy: 0.7698 - loss: 0.4705
Epoch 30/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.7702 - loss: 0.4711
Epoch 31/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7719 - loss: 0.4676
Epoch 32/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 5ms/step - accuracy: 0.7704 - loss: 0.4667
Epoch 33/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7737 - loss: 0.4686
Epoch 34/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.7763 - loss: 0.4603
Epoch 35/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.7750 - loss: 0.4626
```

```
Epoch 36/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 6ms/step - accuracy: 0.7702 - loss: 0.4629
Epoch 37/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 3ms/step - accuracy: 0.7725 - loss: 0.4659
Epoch 38/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.7826 - loss: 0.4555
Epoch 39/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 3ms/step - accuracy: 0.7746 - loss: 0.4599
Epoch 40/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7776 - loss: 0.4572
Epoch 41/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 3ms/step - accuracy: 0.7650 - loss: 0.4734
Epoch 42/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7687 - loss: 0.4617
Epoch 43/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 5ms/step - accuracy: 0.7771 - loss: 0.4641
Epoch 44/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7807 - loss: 0.4568
Epoch 45/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 2ms/step - accuracy: 0.7701 - loss: 0.4636
Epoch 46/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7698 - loss: 0.4682
Epoch 47/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7784 - loss: 0.4602
Epoch 48/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7765 - loss: 0.4594
Epoch 49/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7797 - loss: 0.4545
Epoch 50/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7817 - loss: 0.4538
Epoch 51/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7776 - loss: 0.4593
Epoch 52/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7817 - loss: 0.4571
Epoch 53/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7789 - loss: 0.4613
Epoch 54/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.7798 - loss: 0.4541
Epoch 55/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7751 - loss: 0.4556
Epoch 56/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7726 - loss: 0.4607
Epoch 57/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 3ms/step - accuracy: 0.7762 - loss: 0.4625
Epoch 58/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.7772 - loss: 0.4541
Epoch 59/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.7729 - loss: 0.4636
Epoch 60/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7722 - loss: 0.4585
Epoch 61/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 3ms/step - accuracy: 0.7776 - loss: 0.4543
Epoch 62/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 3ms/step - accuracy: 0.7824 - loss: 0.4520
Epoch 63/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.7749 - loss: 0.4613
Epoch 64/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.7759 - loss: 0.4628
Epoch 65/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7761 - loss: 0.4567
Epoch 66/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7699 - loss: 0.4661
Epoch 67/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.7785 - loss: 0.4564
Epoch 68/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 8ms/step - accuracy: 0.7716 - loss: 0.4632
Epoch 69/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 7ms/step - accuracy: 0.7785 - loss: 0.4545
Epoch 70/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 8ms/step - accuracy: 0.7732 - loss: 0.4617
Epoch 71/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 7ms/step - accuracy: 0.7712 - loss: 0.4593
Epoch 72/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 5ms/step - accuracy: 0.7817 - loss: 0.4515
Epoch 73/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 5ms/step - accuracy: 0.7735 - loss: 0.4574
Epoch 74/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 5ms/step - accuracy: 0.7735 - loss: 0.4640
Epoch 75/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 8ms/step - accuracy: 0.7767 - loss: 0.4529
Epoch 76/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 8ms/step - accuracy: 0.7756 - loss: 0.4555
Epoch 77/100
```

```
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7753 - loss: 0.4555
Epoch 78/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 5ms/step - accuracy: 0.7782 - loss: 0.4527
Epoch 79/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 12ms/step - accuracy: 0.7790 - loss: 0.4548
Epoch 80/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 8s 17ms/step - accuracy: 0.7741 - loss: 0.4629
Epoch 81/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 10s 14ms/step - accuracy: 0.7772 - loss: 0.4486
Epoch 82/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 15ms/step - accuracy: 0.7807 - loss: 0.4549
Epoch 83/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 9ms/step - accuracy: 0.7779 - loss: 0.4511
Epoch 84/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.7790 - loss: 0.4583
Epoch 85/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 10ms/step - accuracy: 0.7756 - loss: 0.4636
Epoch 86/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 8ms/step - accuracy: 0.7792 - loss: 0.4618
Epoch 87/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7805 - loss: 0.4515
Epoch 88/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 9ms/step - accuracy: 0.7796 - loss: 0.4503
Epoch 89/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7779 - loss: 0.4567
Epoch 90/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 10ms/step - accuracy: 0.7771 - loss: 0.4545
Epoch 91/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 8ms/step - accuracy: 0.7789 - loss: 0.4545
Epoch 92/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 8ms/step - accuracy: 0.7768 - loss: 0.4535
Epoch 93/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 8ms/step - accuracy: 0.7790 - loss: 0.4521
Epoch 94/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 8ms/step - accuracy: 0.7718 - loss: 0.4609
Epoch 95/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7773 - loss: 0.4517
Epoch 96/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 11ms/step - accuracy: 0.7753 - loss: 0.4580
Epoch 97/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 8ms/step - accuracy: 0.7732 - loss: 0.4590
Epoch 98/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7757 - loss: 0.4568
Epoch 99/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 8ms/step - accuracy: 0.7746 - loss: 0.4597
Epoch 100/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 8ms/step - accuracy: 0.7773 - loss: 0.4522
63/63 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step
Classification Report:
              precision    recall  f1-score   support

           0       0.93      0.79      0.85      1595
           1       0.48      0.76      0.59       405

    accuracy                           0.78      2000
   macro avg       0.70      0.77      0.72      2000
weighted avg       0.84      0.78      0.80      2000
```

SMOTE

In [125…
```
from imblearn.over_sampling import SMOTE
```

In [126…
```
smote = SMOTE(sampling_strategy="minority")
```

In [127…
```
x_sm, y_sm = smote.fit_resample(x_train, y_train)
```

In [128…
```
x_sm.shape
```

Out[128… (12736, 12)

In [129…
```
y_sm.value_counts()
```

Out[129…
```
Exited
0    6368
1    6368
Name: count, dtype: int64
```

In [130…
```
classification_r(x_sm,y_sm, x_test, y_test)
```

```
Epoch 1/100
```

```
398/398 ━━━━━━━━━━━━━━━━━━━━ 11s 11ms/step - accuracy: 0.5487 - loss: 0.6868
Epoch 2/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 8ms/step - accuracy: 0.6681 - loss: 0.6365
Epoch 3/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 6ms/step - accuracy: 0.7023 - loss: 0.5962
Epoch 4/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7214 - loss: 0.5765
Epoch 5/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7197 - loss: 0.5674
Epoch 6/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7205 - loss: 0.5665
Epoch 7/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 7ms/step - accuracy: 0.7180 - loss: 0.5594
Epoch 8/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.7280 - loss: 0.5490
Epoch 9/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7235 - loss: 0.5466
Epoch 10/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7374 - loss: 0.5327
Epoch 11/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.7493 - loss: 0.5154
Epoch 12/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7628 - loss: 0.5057
Epoch 13/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7597 - loss: 0.4977
Epoch 14/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7574 - loss: 0.4946
Epoch 15/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 7ms/step - accuracy: 0.7738 - loss: 0.4767
Epoch 16/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 5ms/step - accuracy: 0.7763 - loss: 0.4721
Epoch 17/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.7752 - loss: 0.4726
Epoch 18/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 6ms/step - accuracy: 0.7750 - loss: 0.4707
Epoch 19/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 9ms/step - accuracy: 0.7792 - loss: 0.4632
Epoch 20/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 6ms/step - accuracy: 0.7762 - loss: 0.4627
Epoch 21/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 6ms/step - accuracy: 0.7801 - loss: 0.4614
Epoch 22/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 12ms/step - accuracy: 0.7795 - loss: 0.4557
Epoch 23/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 6ms/step - accuracy: 0.7796 - loss: 0.4593
Epoch 24/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 2s 6ms/step - accuracy: 0.7840 - loss: 0.4528
Epoch 25/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 7ms/step - accuracy: 0.7724 - loss: 0.4616
Epoch 26/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 7ms/step - accuracy: 0.7696 - loss: 0.4642
Epoch 27/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 7ms/step - accuracy: 0.7839 - loss: 0.4451
Epoch 28/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 11ms/step - accuracy: 0.7840 - loss: 0.4472
Epoch 29/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 7ms/step - accuracy: 0.7865 - loss: 0.4454
Epoch 30/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 10ms/step - accuracy: 0.7833 - loss: 0.4540
Epoch 31/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 11ms/step - accuracy: 0.7777 - loss: 0.4512
Epoch 32/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 8ms/step - accuracy: 0.7827 - loss: 0.4532
Epoch 33/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 7ms/step - accuracy: 0.7783 - loss: 0.4509
Epoch 34/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7810 - loss: 0.4529
Epoch 35/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 3s 8ms/step - accuracy: 0.7858 - loss: 0.4433
Epoch 36/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 10ms/step - accuracy: 0.7831 - loss: 0.4464
Epoch 37/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 11ms/step - accuracy: 0.7837 - loss: 0.4445
Epoch 38/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 8ms/step - accuracy: 0.7839 - loss: 0.4449
Epoch 39/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7848 - loss: 0.4453
Epoch 40/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 8ms/step - accuracy: 0.7773 - loss: 0.4529
Epoch 41/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7833 - loss: 0.4439
Epoch 42/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 9s 16ms/step - accuracy: 0.7855 - loss: 0.4432
```

```
Epoch 43/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 8s 9ms/step - accuracy: 0.7884 - loss: 0.4363
Epoch 44/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7851 - loss: 0.4430
Epoch 45/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7930 - loss: 0.4354
Epoch 46/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7858 - loss: 0.4397
Epoch 47/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 8s 15ms/step - accuracy: 0.7805 - loss: 0.4487
Epoch 48/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 9s 9ms/step - accuracy: 0.7908 - loss: 0.4357
Epoch 49/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.7893 - loss: 0.4344
Epoch 50/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 9ms/step - accuracy: 0.7895 - loss: 0.4361
Epoch 51/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 11ms/step - accuracy: 0.7934 - loss: 0.4345
Epoch 52/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 12ms/step - accuracy: 0.7915 - loss: 0.4371
Epoch 53/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 12ms/step - accuracy: 0.7907 - loss: 0.4354
Epoch 54/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 11ms/step - accuracy: 0.7912 - loss: 0.4390
Epoch 55/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 11ms/step - accuracy: 0.7876 - loss: 0.4386
Epoch 56/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 11ms/step - accuracy: 0.7914 - loss: 0.4350
Epoch 57/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 10ms/step - accuracy: 0.7820 - loss: 0.4488
Epoch 58/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.7916 - loss: 0.4326
Epoch 59/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 10ms/step - accuracy: 0.7832 - loss: 0.4434
Epoch 60/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 10ms/step - accuracy: 0.7894 - loss: 0.4388
Epoch 61/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 14ms/step - accuracy: 0.7878 - loss: 0.4354
Epoch 62/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 11ms/step - accuracy: 0.7892 - loss: 0.4371
Epoch 63/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 11ms/step - accuracy: 0.7895 - loss: 0.4373
Epoch 64/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 14ms/step - accuracy: 0.7965 - loss: 0.4294
Epoch 65/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 13ms/step - accuracy: 0.8005 - loss: 0.4315
Epoch 66/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 12ms/step - accuracy: 0.7935 - loss: 0.4286
Epoch 67/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 10ms/step - accuracy: 0.7944 - loss: 0.4292
Epoch 68/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 11ms/step - accuracy: 0.7969 - loss: 0.4270
Epoch 69/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 14ms/step - accuracy: 0.7924 - loss: 0.4342
Epoch 70/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 16ms/step - accuracy: 0.7911 - loss: 0.4363
Epoch 71/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 9s 11ms/step - accuracy: 0.7891 - loss: 0.4341
Epoch 72/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 14ms/step - accuracy: 0.7947 - loss: 0.4388
Epoch 73/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 11ms/step - accuracy: 0.7948 - loss: 0.4338
Epoch 74/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 12ms/step - accuracy: 0.7875 - loss: 0.4357
Epoch 75/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 12ms/step - accuracy: 0.8002 - loss: 0.4249
Epoch 76/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 9ms/step - accuracy: 0.7915 - loss: 0.4310
Epoch 77/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 14ms/step - accuracy: 0.7949 - loss: 0.4381
Epoch 78/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 9ms/step - accuracy: 0.7944 - loss: 0.4336
Epoch 79/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7915 - loss: 0.4272
Epoch 80/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 8s 14ms/step - accuracy: 0.7921 - loss: 0.4337
Epoch 81/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 9ms/step - accuracy: 0.7937 - loss: 0.4340
Epoch 82/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.7952 - loss: 0.4301
Epoch 83/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 8s 15ms/step - accuracy: 0.7910 - loss: 0.4321
Epoch 84/100
```

```
398/398 ━━━━━━━━━━━━━━━━━━━━ 4s 9ms/step - accuracy: 0.8009 - loss: 0.4253
Epoch 85/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 11ms/step - accuracy: 0.7997 - loss: 0.4271
Epoch 86/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.7981 - loss: 0.4254
Epoch 87/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 10ms/step - accuracy: 0.7977 - loss: 0.4348
Epoch 88/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.7965 - loss: 0.4247
Epoch 89/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 8ms/step - accuracy: 0.7992 - loss: 0.4287
Epoch 90/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.7938 - loss: 0.4279
Epoch 91/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.8018 - loss: 0.4235
Epoch 92/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 9ms/step - accuracy: 0.8042 - loss: 0.4191
Epoch 93/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 11ms/step - accuracy: 0.7983 - loss: 0.4224
Epoch 94/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.8044 - loss: 0.4166
Epoch 95/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 8ms/step - accuracy: 0.8005 - loss: 0.4232
Epoch 96/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 6s 15ms/step - accuracy: 0.8056 - loss: 0.4141
Epoch 97/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 10ms/step - accuracy: 0.8029 - loss: 0.4167
Epoch 98/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 5s 8ms/step - accuracy: 0.8048 - loss: 0.4141
Epoch 99/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 9ms/step - accuracy: 0.7970 - loss: 0.4194
Epoch 100/100
398/398 ━━━━━━━━━━━━━━━━━━━━ 7s 13ms/step - accuracy: 0.8002 - loss: 0.4202
63/63 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step
Classification Report:
              precision    recall  f1-score   support

           0       0.92      0.81      0.86      1595
           1       0.50      0.73      0.59       405

    accuracy                           0.80      2000
   macro avg       0.71      0.77      0.73      2000
weighted avg       0.84      0.80      0.81      2000
```

Ensemble

In [187…
```
x_train, x_test, y_train, y_test  = train_test_split(x, y, test_size = 0.2, stratify = y, random_state = 15)
y_train.value_counts()
```

Out[187…
```
Exited
0    6370
1    1630
Name: count, dtype: int64
```

In [188…
```
6370/1630
```

Out[188…
```
3.9079754601226995
```

In [189…
```
merged_train = pd.concat([x_train, y_train], axis  = 1)
train_0s = merged_train[merged_train["Exited"] == 0]
train_1s = merged_train[merged_train["Exited"] == 1]
train_0s.shape, train_1s.shape
```

Out[189…
```
((6370, 13), (1630, 13))
```

In [ ]:
```
```

In [190…
```
def ensemble(df_majority, df_minority, start , end):
    final_df  = pd.concat([df_majority[start:end], df_minority], axis = 0)
    x_train = final_df.drop("Exited", axis =1)
    y_train = final_df.Exited
    return x_train, y_train
```

In [191…
```
x_train_1, y_train_1  = ensemble(train_0s, train_1s, 0 , 2666)
```

In [192…
```
x_train.shape, y_test.shape
```

Out[192…
```
((8000, 12), (2000,))
```

In [193…
```
pred_1 = classification_r(x_train_1,y_train_1, x_test, y_test)
```

```
Epoch 1/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 4s 4ms/step - accuracy: 0.4220 - loss: 0.8000
Epoch 2/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.6436 - loss: 0.6480
Epoch 3/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6552 - loss: 0.6321
Epoch 4/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.6703 - loss: 0.6119
Epoch 5/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6727 - loss: 0.6104
Epoch 6/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.6808 - loss: 0.5932
Epoch 7/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.6846 - loss: 0.5878
Epoch 8/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.6950 - loss: 0.5834
Epoch 9/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.6975 - loss: 0.5786
Epoch 10/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7123 - loss: 0.5660
Epoch 11/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7214 - loss: 0.5502
Epoch 12/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7201 - loss: 0.5543
Epoch 13/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7067 - loss: 0.5661
Epoch 14/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7177 - loss: 0.5514
Epoch 15/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7201 - loss: 0.5478
Epoch 16/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7224 - loss: 0.5525
Epoch 17/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7224 - loss: 0.5480
Epoch 18/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7105 - loss: 0.5580
Epoch 19/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7181 - loss: 0.5553
Epoch 20/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7193 - loss: 0.5548
Epoch 21/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7190 - loss: 0.5521
Epoch 22/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7223 - loss: 0.5380
Epoch 23/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7391 - loss: 0.5298
Epoch 24/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7234 - loss: 0.5427
Epoch 25/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 9ms/step - accuracy: 0.7344 - loss: 0.5474
Epoch 26/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7275 - loss: 0.5434
Epoch 27/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7127 - loss: 0.5586
Epoch 28/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7332 - loss: 0.5383
Epoch 29/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7275 - loss: 0.5405
Epoch 30/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7427 - loss: 0.5258
Epoch 31/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7386 - loss: 0.5258
Epoch 32/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7333 - loss: 0.5402
Epoch 33/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7271 - loss: 0.5379
Epoch 34/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7389 - loss: 0.5362
Epoch 35/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7347 - loss: 0.5298
Epoch 36/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7355 - loss: 0.5309
Epoch 37/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7427 - loss: 0.5188
Epoch 38/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7393 - loss: 0.5315
Epoch 39/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7485 - loss: 0.5213
Epoch 40/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 12ms/step - accuracy: 0.7388 - loss: 0.5315
Epoch 41/100
```

```
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7510 - loss: 0.5217
Epoch 42/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7447 - loss: 0.5146
Epoch 43/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7420 - loss: 0.5205
Epoch 44/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7492 - loss: 0.5187
Epoch 45/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7480 - loss: 0.5268
Epoch 46/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7559 - loss: 0.5116
Epoch 47/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7447 - loss: 0.5091
Epoch 48/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7666 - loss: 0.4980
Epoch 49/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7556 - loss: 0.5109
Epoch 50/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7646 - loss: 0.4954
Epoch 51/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7610 - loss: 0.5071
Epoch 52/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7666 - loss: 0.5009
Epoch 53/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7701 - loss: 0.4877
Epoch 54/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7677 - loss: 0.4870
Epoch 55/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 8ms/step - accuracy: 0.7661 - loss: 0.4902
Epoch 56/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7733 - loss: 0.4827
Epoch 57/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7732 - loss: 0.4817
Epoch 58/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7786 - loss: 0.4778
Epoch 59/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 7ms/step - accuracy: 0.7736 - loss: 0.4753
Epoch 60/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7631 - loss: 0.4948
Epoch 61/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7778 - loss: 0.4787
Epoch 62/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7669 - loss: 0.4896
Epoch 63/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7807 - loss: 0.4700
Epoch 64/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7752 - loss: 0.4702
Epoch 65/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7798 - loss: 0.4756
Epoch 66/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 7ms/step - accuracy: 0.7889 - loss: 0.4639
Epoch 67/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7860 - loss: 0.4597
Epoch 68/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7756 - loss: 0.4720
Epoch 69/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7775 - loss: 0.4739
Epoch 70/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 9ms/step - accuracy: 0.7904 - loss: 0.4498
Epoch 71/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7790 - loss: 0.4674
Epoch 72/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7875 - loss: 0.4650
Epoch 73/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7892 - loss: 0.4647
Epoch 74/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7887 - loss: 0.4602
Epoch 75/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7909 - loss: 0.4565
Epoch 76/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7795 - loss: 0.4653
Epoch 77/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7853 - loss: 0.4554
Epoch 78/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7763 - loss: 0.4715
Epoch 79/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7762 - loss: 0.4674
Epoch 80/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7884 - loss: 0.4646
Epoch 81/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7921 - loss: 0.4487
Epoch 82/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7841 - loss: 0.4679
```

```
Epoch 83/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7865 - loss: 0.4595
Epoch 84/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 17ms/step - accuracy: 0.7752 - loss: 0.4708
Epoch 85/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7856 - loss: 0.4583
Epoch 86/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7894 - loss: 0.4584
Epoch 87/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7896 - loss: 0.4520
Epoch 88/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7865 - loss: 0.4516
Epoch 89/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7866 - loss: 0.4389
Epoch 90/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7902 - loss: 0.4549
Epoch 91/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7888 - loss: 0.4535
Epoch 92/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7930 - loss: 0.4437
Epoch 93/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7799 - loss: 0.4721
Epoch 94/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7933 - loss: 0.4465
Epoch 95/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7941 - loss: 0.4476
Epoch 96/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 7ms/step - accuracy: 0.7970 - loss: 0.4394
Epoch 97/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 9ms/step - accuracy: 0.7963 - loss: 0.4446
Epoch 98/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.7853 - loss: 0.4624
Epoch 99/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7959 - loss: 0.4429
Epoch 100/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7883 - loss: 0.4581
63/63 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step
Classification Report:
              precision    recall  f1-score   support

           0       0.90      0.90      0.90      1593
           1       0.61      0.62      0.61       407

    accuracy                           0.84      2000
   macro avg       0.75      0.76      0.76      2000
weighted avg       0.84      0.84      0.84      2000
```

In [194…
```
x_train_2, y_train_2  = ensemble(train_0s, train_1s, 2666 , 2666*2)
x_train_3, y_trian_3  =ensemble(train_0s, train_1s, 2666*2 , 8001)
```

In [195…
```
pred_2 = classification_r(x_train_2, y_train_2, x_test, y_test)
```

```
Epoch 1/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 4s 3ms/step - accuracy: 0.6268 - loss: 0.6759
Epoch 2/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.6197 - loss: 0.6489
Epoch 3/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6242 - loss: 0.6284
Epoch 4/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.6290 - loss: 0.6068
Epoch 5/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.6932 - loss: 0.5960
Epoch 6/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.6853 - loss: 0.6011
Epoch 7/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.6980 - loss: 0.5863
Epoch 8/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7108 - loss: 0.5806
Epoch 9/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7152 - loss: 0.5801
Epoch 10/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7254 - loss: 0.5662
Epoch 11/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7237 - loss: 0.5564
Epoch 12/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7253 - loss: 0.5544
Epoch 13/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7365 - loss: 0.5540
Epoch 14/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.7396 - loss: 0.5466
Epoch 15/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7277 - loss: 0.5547
Epoch 16/100
```

```
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7366 - loss: 0.5514
Epoch 17/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7467 - loss: 0.5370
Epoch 18/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7316 - loss: 0.5483
Epoch 19/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7564 - loss: 0.5322
Epoch 20/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7368 - loss: 0.5463
Epoch 21/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7295 - loss: 0.5423
Epoch 22/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7409 - loss: 0.5408
Epoch 23/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7368 - loss: 0.5501
Epoch 24/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7407 - loss: 0.5419
Epoch 25/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7490 - loss: 0.5311
Epoch 26/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7509 - loss: 0.5252
Epoch 27/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7454 - loss: 0.5399
Epoch 28/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7401 - loss: 0.5355
Epoch 29/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7426 - loss: 0.5387
Epoch 30/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7478 - loss: 0.5389
Epoch 31/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7388 - loss: 0.5368
Epoch 32/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7478 - loss: 0.5301
Epoch 33/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7511 - loss: 0.5249
Epoch 34/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7641 - loss: 0.5197
Epoch 35/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 11ms/step - accuracy: 0.7636 - loss: 0.5012
Epoch 36/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 4ms/step - accuracy: 0.7569 - loss: 0.5092
Epoch 37/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7628 - loss: 0.5106
Epoch 38/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7502 - loss: 0.5117
Epoch 39/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7665 - loss: 0.4987
Epoch 40/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7643 - loss: 0.5007
Epoch 41/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7591 - loss: 0.4973
Epoch 42/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7671 - loss: 0.4924
Epoch 43/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7744 - loss: 0.4837
Epoch 44/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7712 - loss: 0.4861
Epoch 45/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7874 - loss: 0.4711
Epoch 46/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7767 - loss: 0.4785
Epoch 47/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7868 - loss: 0.4681
Epoch 48/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7865 - loss: 0.4651
Epoch 49/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7703 - loss: 0.4875
Epoch 50/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 14ms/step - accuracy: 0.7943 - loss: 0.4661
Epoch 51/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 5ms/step - accuracy: 0.7845 - loss: 0.4675
Epoch 52/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7972 - loss: 0.4548
Epoch 53/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7930 - loss: 0.4585
Epoch 54/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7942 - loss: 0.4606
Epoch 55/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7895 - loss: 0.4645
Epoch 56/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7869 - loss: 0.4627
Epoch 57/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7908 - loss: 0.4488
```

```
Epoch 58/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8009 - loss: 0.4498
Epoch 59/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7964 - loss: 0.4518
Epoch 60/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7935 - loss: 0.4522
Epoch 61/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7923 - loss: 0.4643
Epoch 62/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7951 - loss: 0.4582
Epoch 63/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.8050 - loss: 0.4411
Epoch 64/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.7946 - loss: 0.4543
Epoch 65/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7964 - loss: 0.4535
Epoch 66/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 2s 8ms/step - accuracy: 0.7972 - loss: 0.4429
Epoch 67/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8008 - loss: 0.4463
Epoch 68/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8011 - loss: 0.4456
Epoch 69/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7865 - loss: 0.4650
Epoch 70/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7897 - loss: 0.4511
Epoch 71/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8013 - loss: 0.4405
Epoch 72/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7894 - loss: 0.4487
Epoch 73/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7962 - loss: 0.4481
Epoch 74/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7827 - loss: 0.4610
Epoch 75/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7904 - loss: 0.4581
Epoch 76/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.8117 - loss: 0.4260
Epoch 77/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7888 - loss: 0.4564
Epoch 78/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7963 - loss: 0.4412
Epoch 79/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7944 - loss: 0.4524
Epoch 80/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8029 - loss: 0.4440
Epoch 81/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7908 - loss: 0.4486
Epoch 82/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7932 - loss: 0.4554
Epoch 83/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7904 - loss: 0.4539
Epoch 84/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8086 - loss: 0.4376
Epoch 85/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8014 - loss: 0.4393
Epoch 86/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7922 - loss: 0.4514
Epoch 87/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7937 - loss: 0.4553
Epoch 88/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.8001 - loss: 0.4381
Epoch 89/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7964 - loss: 0.4382
Epoch 90/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.8026 - loss: 0.4274
Epoch 91/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.8075 - loss: 0.4299
Epoch 92/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7917 - loss: 0.4532
Epoch 93/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.7915 - loss: 0.4545
Epoch 94/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7903 - loss: 0.4512
Epoch 95/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7927 - loss: 0.4574
Epoch 96/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7933 - loss: 0.4489
Epoch 97/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.7970 - loss: 0.4456
Epoch 98/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8035 - loss: 0.4409
Epoch 99/100
```

```
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 4ms/step - accuracy: 0.8041 - loss: 0.4309
Epoch 100/100
135/135 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7963 - loss: 0.4355
63/63 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step
Classification Report:
              precision    recall  f1-score   support

           0       0.91      0.87      0.89      1593
           1       0.57      0.66      0.61       407

    accuracy                           0.83      2000
   macro avg       0.74      0.77      0.75      2000
weighted avg       0.84      0.83      0.83      2000
```

In [196…

```
pred_3 = classification_r(x_train_3, y_trian_3, x_test, y_test)
```

```
Epoch 1/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 4s 5ms/step - accuracy: 0.5997 - loss: 0.6719
Epoch 2/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.6351 - loss: 0.6421
Epoch 3/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.6592 - loss: 0.6298
Epoch 4/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.6685 - loss: 0.6116
Epoch 5/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.6888 - loss: 0.5970
Epoch 6/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.6993 - loss: 0.5837
Epoch 7/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.6751 - loss: 0.5977
Epoch 8/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.6861 - loss: 0.5889
Epoch 9/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 21ms/step - accuracy: 0.7027 - loss: 0.5728
Epoch 10/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7076 - loss: 0.5689
Epoch 11/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.6968 - loss: 0.5825
Epoch 12/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.7055 - loss: 0.5652
Epoch 13/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7091 - loss: 0.5589
Epoch 14/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.7005 - loss: 0.5613
Epoch 15/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 6ms/step - accuracy: 0.7273 - loss: 0.5511
Epoch 16/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7105 - loss: 0.5608
Epoch 17/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7284 - loss: 0.5369
Epoch 18/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7163 - loss: 0.5454
Epoch 19/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7184 - loss: 0.5507
Epoch 20/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7398 - loss: 0.5264
Epoch 21/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7400 - loss: 0.5320
Epoch 22/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - accuracy: 0.7420 - loss: 0.5341
Epoch 23/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7393 - loss: 0.5207
Epoch 24/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7419 - loss: 0.5204
Epoch 25/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7319 - loss: 0.5344
Epoch 26/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7616 - loss: 0.5096
Epoch 27/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7631 - loss: 0.5109
Epoch 28/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7550 - loss: 0.5128
Epoch 29/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7619 - loss: 0.4912
Epoch 30/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7548 - loss: 0.5084
Epoch 31/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7605 - loss: 0.5078
Epoch 32/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7614 - loss: 0.4952
Epoch 33/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7583 - loss: 0.5009
Epoch 34/100
```

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84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7592 - loss: 0.4957
Epoch 35/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7737 - loss: 0.4812
Epoch 36/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7687 - loss: 0.4796
Epoch 37/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7647 - loss: 0.4880
Epoch 38/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7696 - loss: 0.4840
Epoch 39/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7684 - loss: 0.4762
Epoch 40/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - accuracy: 0.7708 - loss: 0.4758
Epoch 41/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7590 - loss: 0.4843
Epoch 42/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7763 - loss: 0.4738
Epoch 43/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 16ms/step - accuracy: 0.7607 - loss: 0.4889
Epoch 44/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 11ms/step - accuracy: 0.7564 - loss: 0.4857
Epoch 45/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 11ms/step - accuracy: 0.7515 - loss: 0.5040
Epoch 46/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7603 - loss: 0.4890
Epoch 47/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7703 - loss: 0.4777
Epoch 48/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7502 - loss: 0.4958
Epoch 49/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7825 - loss: 0.4651
Epoch 50/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - accuracy: 0.7597 - loss: 0.4956
Epoch 51/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 11ms/step - accuracy: 0.7653 - loss: 0.4789
Epoch 52/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 11ms/step - accuracy: 0.7549 - loss: 0.4832
Epoch 53/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7701 - loss: 0.4766
Epoch 54/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 22ms/step - accuracy: 0.7549 - loss: 0.4935
Epoch 55/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 10ms/step - accuracy: 0.7628 - loss: 0.4760
Epoch 56/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - accuracy: 0.7691 - loss: 0.4800
Epoch 57/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7697 - loss: 0.4764
Epoch 58/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7636 - loss: 0.4744
Epoch 59/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7680 - loss: 0.4879
Epoch 60/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7758 - loss: 0.4693
Epoch 61/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7678 - loss: 0.4747
Epoch 62/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 8ms/step - accuracy: 0.7706 - loss: 0.4812
Epoch 63/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 16ms/step - accuracy: 0.7612 - loss: 0.4805
Epoch 64/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 10ms/step - accuracy: 0.7669 - loss: 0.4697
Epoch 65/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7593 - loss: 0.4793
Epoch 66/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7587 - loss: 0.4928
Epoch 67/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7536 - loss: 0.4861
Epoch 68/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7738 - loss: 0.4727
Epoch 69/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 14ms/step - accuracy: 0.7680 - loss: 0.4679
Epoch 70/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7650 - loss: 0.4788
Epoch 71/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7749 - loss: 0.4738
Epoch 72/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7460 - loss: 0.4955
Epoch 73/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 13ms/step - accuracy: 0.7739 - loss: 0.4781
Epoch 74/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7657 - loss: 0.4814
Epoch 75/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 9ms/step - accuracy: 0.7767 - loss: 0.4669
```

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Epoch 76/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7641 - loss: 0.4727
Epoch 77/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7635 - loss: 0.4843
Epoch 78/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7600 - loss: 0.4870
Epoch 79/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7769 - loss: 0.4606
Epoch 80/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7727 - loss: 0.4642
Epoch 81/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7753 - loss: 0.4602
Epoch 82/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7733 - loss: 0.4663
Epoch 83/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 19ms/step - accuracy: 0.7634 - loss: 0.4868
Epoch 84/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 14ms/step - accuracy: 0.7607 - loss: 0.4775
Epoch 85/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.7715 - loss: 0.4844
Epoch 86/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7693 - loss: 0.4739
Epoch 87/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7832 - loss: 0.4453
Epoch 88/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 10ms/step - accuracy: 0.7644 - loss: 0.4712
Epoch 89/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7770 - loss: 0.4740
Epoch 90/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 3s 18ms/step - accuracy: 0.7714 - loss: 0.4701
Epoch 91/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 13ms/step - accuracy: 0.7665 - loss: 0.4824
Epoch 92/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 10ms/step - accuracy: 0.7719 - loss: 0.4576
Epoch 93/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7605 - loss: 0.4754
Epoch 94/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7714 - loss: 0.4747
Epoch 95/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - accuracy: 0.7664 - loss: 0.4685
Epoch 96/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7704 - loss: 0.4621
Epoch 97/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7788 - loss: 0.4692
Epoch 98/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - accuracy: 0.7660 - loss: 0.4623
Epoch 99/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 10ms/step - accuracy: 0.7633 - loss: 0.4708
Epoch 100/100
84/84 ━━━━━━━━━━━━━━━━━━━━ 2s 12ms/step - accuracy: 0.7742 - loss: 0.4673
63/63 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step
Classification Report:
              precision    recall  f1-score   support

           0       0.95      0.68      0.79      1593
           1       0.41      0.86      0.55       407

    accuracy                           0.72      2000
   macro avg       0.68      0.77      0.67      2000
weighted avg       0.84      0.72      0.74      2000
```

In [206…
```
final_pred= pred_1.copy()
def ones():
    for i in range(len(pred_1)):
        ones  = pred_1[i] + pred_2[i] + pred_3[i]
        if ones > 1:
            final_pred[i] = 1
        else:
            final_pred[i] = 0
    return final_pred
final_pred = ones()
```

In [207…
```
print(classification_report(y_test, final_pred))
```

```
              precision    recall  f1-score   support

           0       0.92      0.86      0.89      1593
           1       0.55      0.70      0.62       407

    accuracy                           0.82      2000
   macro avg       0.73      0.78      0.75      2000
weighted avg       0.84      0.82      0.83      2000
```