In [4]:
```
import pandas as pd
```

1) Read the datset

In [5]:
```
df=pd.read_csv("Churn_Modelling.csv")
# 0 means not exit and 1 means exit
```

In [6]:
```
df.head(4)
```

Out [6]:

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

In [7]:
```
df.shape
```

Out [7]:
```
(10000, 14)
```

2) Distinguish the feature and target set and divide the data set into training and test sets.

In [8]:
```
df.columns
```

Out [8]:
```
Index(['RowNumber', 'CustomerId', 'Surname', 'CreditScore', 'Geography',
       'Gender', 'Age', 'Tenure', 'Balance', 'NumOfProducts', 'HasCrCard',
       'IsActiveMember', 'EstimatedSalary', 'Exited'],
      dtype='object')
```

In [9]:
```
X=df[['CreditScore', 'Age', 'Tenure', 'Balance', 'NumOfProducts', 'HasCrCard','IsActiveMember', 'Est
Y=df['Exited']
```

In [10]:
```
Y.value_counts()
```

Out [10]:
```
Exited
0    7963
1    2037
Name: count, dtype: int64
```

3) Normalize the train and test data.

In [17]:
```
from sklearn.preprocessing import StandardScaler
scaler=StandardScaler()
X_scaled=scaler.fit_transform(X)
```

In [18]:
```
X_scaled
```

Out [18]:
```
array([[-0.32622142,  0.29351742, -1.04175968, ...,  0.64609167,
         0.97024255,  0.02188649],
       [-0.44003595,  0.19816383, -1.38753759, ..., -1.54776799,
         0.97024255,  0.21653375],
       [-1.53679418,  0.29351742,  1.03290776, ...,  0.64609167,
        -1.03067011,  0.2406869 ],
       ...,
       [ 0.60498839, -0.27860412,  0.68712986, ..., -1.54776799,
         0.97024255, -1.00864308],
       [ 1.25683526,  0.29351742, -0.69598177, ...,  0.64609167,
        -1.03067011, -0.12523071],
       [ 1.46377078, -1.04143285, -0.35020386, ...,  0.64609167,
        -1.03067011, -1.07636976]])
```

4) Initialize and build the model. Identify the points of improvement and implement the same.

In [19]:
```
from sklearn.model_selection import train_test_split
X_train,X_test,Y_train,Y_test=train_test_split(X_scaled,Y,test_size=0.25,random_state=0)
```

In [20]:
```
from sklearn.neural_network import MLPClassifier
nn_model=MLPClassifier(hidden_layer_sizes=(80,80,80),random_state=0,max_iter=100,activation='relu')
```

In [21]:

```
# MLPClassifier stands for Multilayer Perceptron Classifier. It is a type of neural network that cons
# The tuple (80, 80, 80) indicates that the neural network will have three hidden layers, each conta
# max_iter sets the maximum number of iterations (epochs) the optimizer will perform during training
# activation specifies the activation function to use for the hidden layers.'relu': Rectified Linear
```

In [22]:

```
nn_model.fit(X_train,Y_train)
```

```
C:\Users\Ashvini Mahajan\Anaconda\Lib\site-packages\sklearn\neural_network\_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and the optimization hasn't converged yet.
  warnings.warn(
```

Out [22]:

```
MLPClassifier
MLPClassifier(hidden_layer_sizes=(80, 80, 80), max_iter=100, random_state=0)
```

In [23]:

```
y_pred=nn_model.predict(X_test)
y_pred
```

Out [23]:

```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [24]:

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

In [25]:

```
Y_test.value_counts()
```

Out [25]:

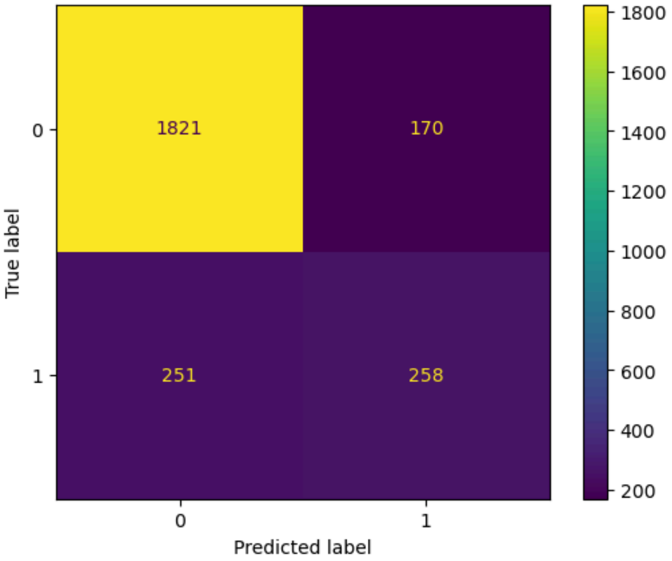
```
Exited
0    1991
1     509
Name: count, dtype: int64
```

In [26]:

```
ConfusionMatrixDisplay.from_predictions(Y_test,y_pred)
```

Out [26]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x1f9f58d7550>
```



In [27]:

```
accuracy_score(Y_test,y_pred)
```

Out [27]:

```
0.8316
```

In [28]:

```
print(classification_report(Y_test,y_pred))
```

```
              precision    recall  f1-score   support

           0       0.88      0.91      0.90      1991
           1       0.60      0.51      0.55       509

    accuracy                           0.83      2500
   macro avg       0.74      0.71      0.72      2500
weighted avg       0.82      0.83      0.83      2500
```

In [29]:

```
# the recall value for 0 (not exit) is 0.81 whereas recall value for 1 (exit) is 0.24, so there is hu
# the gap should be as less as possible.
# this happens because of imbalance dataset, we can see that entries for 0 are very more compared to
# So, we need to balance the dataset
```

In [30]:
```
Y.value_counts()
```

Out [30]:
```
Exited
0    7963
1    2037
Name: count, dtype: int64
```

In [31]:
```
# here we need to increase entries of 1
```

In [3]:
```
pip install imbalanced-learn
```

```
Requirement already satisfied: imbalanced-learn in c:\users\ashvini mahajan\anaconda\lib\site-packages (0.11.0)
Requirement already satisfied: numpy>=1.17.3 in c:\users\ashvini mahajan\anaconda\lib\site-packages (from imbalanced-learn) (1.26.4)
Requirement already satisfied: scipy>=1.5.0 in c:\users\ashvini mahajan\anaconda\lib\site-packages (from imbalanced-learn) (1.11.4)
Requirement already satisfied: scikit-learn>=1.0.2 in c:\users\ashvini mahajan\anaconda\lib\site-packages (from imbalanced-learn) (1.2.2
Requirement already satisfied: joblib>=1.1.1 in c:\users\ashvini mahajan\anaconda\lib\site-packages (from imbalanced-learn) (1.1.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\ashvini mahajan\anaconda\lib\site-packages (from imbalanced-learn) (2.2.0
Note: you may need to restart the kernel to use updated packages.
```

In [14]:
```
from imblearn.over_sampling import RandomOverSampler
ros=RandomOverSampler(random_state=0)
X_new,Y_new=ros.fit_resample(X,Y)
```

In [15]:
```
Y_new.value_counts()
```

Out [15]:
```
Exited
1    7963
0    7963
Name: count, dtype: int64
```

In [16]:
```
# now dataset is balanced
# now again make the model
```

In [32]:
```
from sklearn.preprocessing import StandardScaler
scaler=StandardScaler()
X_scaled=scaler.fit_transform(X_new)
```

In [33]:
```
Xn_train,Xn_test,Yn_train,Yn_test =train_test_split(X_scaled,Y_new,random_state=0,test_size=0.25)
```

In [34]:
```
from sklearn.neural_network import MLPClassifier
nn_model=MLPClassifier(hidden_layer_sizes=(80,80,80),random_state=0,max_iter=100,activation='relu')
nn_model.fit(Xn_train,Yn_train)
```

```
C:\Users\Ashvini Mahajan\Anaconda\Lib\site-packages\sklearn\neural_network\_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (100) reached and the optimization hasn't converged yet.
  warnings.warn(
```

Out [34]:
```
▾                    MLPClassifier
MLPClassifier(hidden_layer_sizes=(80, 80, 80), max_iter=100, random_state=0)
```

In [35]:
```
y_pred=nn_model.predict(Xn_test)
y_pred
```

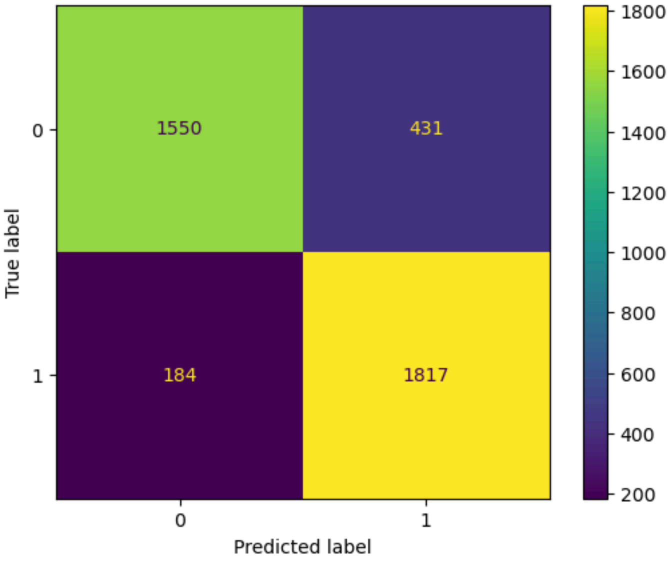
Out [35]:
```
array([1, 1, 1, ..., 1, 1, 0], dtype=int64)
```

In [37]:
```
Yn_test.value_counts()
```

Out [37]:
```
Exited
1    2001
0    1981
Name: count, dtype: int64
```

In [38]:
```
ConfusionMatrixDisplay.from_predictions(Yn_test,y_pred)
```

Out [38]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x1f9f73d3d50>
```



```
In [40]: accuracy_score(Yn_test,y_pred)
```

```
Out [40]: 0.8455549974886991
```

```
In [42]: print(classification_report(Yn_test,y_pred))
```

```
              precision    recall  f1-score   support

           0       0.89      0.78      0.83      1981
           1       0.81      0.91      0.86      2001

    accuracy                           0.85      3982
   macro avg       0.85      0.85      0.84      3982
weighted avg       0.85      0.85      0.84      3982
```

```
In [ ]:
```