```
import pandas as pd
import seaborn as sns
```

Read The DataSet

```
df = pd.read_csv('Churn_Modelling.csv')

df.shape

(10000, 14)

df.columns

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

df

      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
```

```
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

```
df.head()
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41

2          3    15619304      Onio          502    France  Female   42

3          4    15701354      Boni          699    France  Female   39

4          5    15737888  Mitchell          850     Spain  Female   43


   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
```

```
2       113931.57       1
3        93826.63       0
4        79084.10       0
```

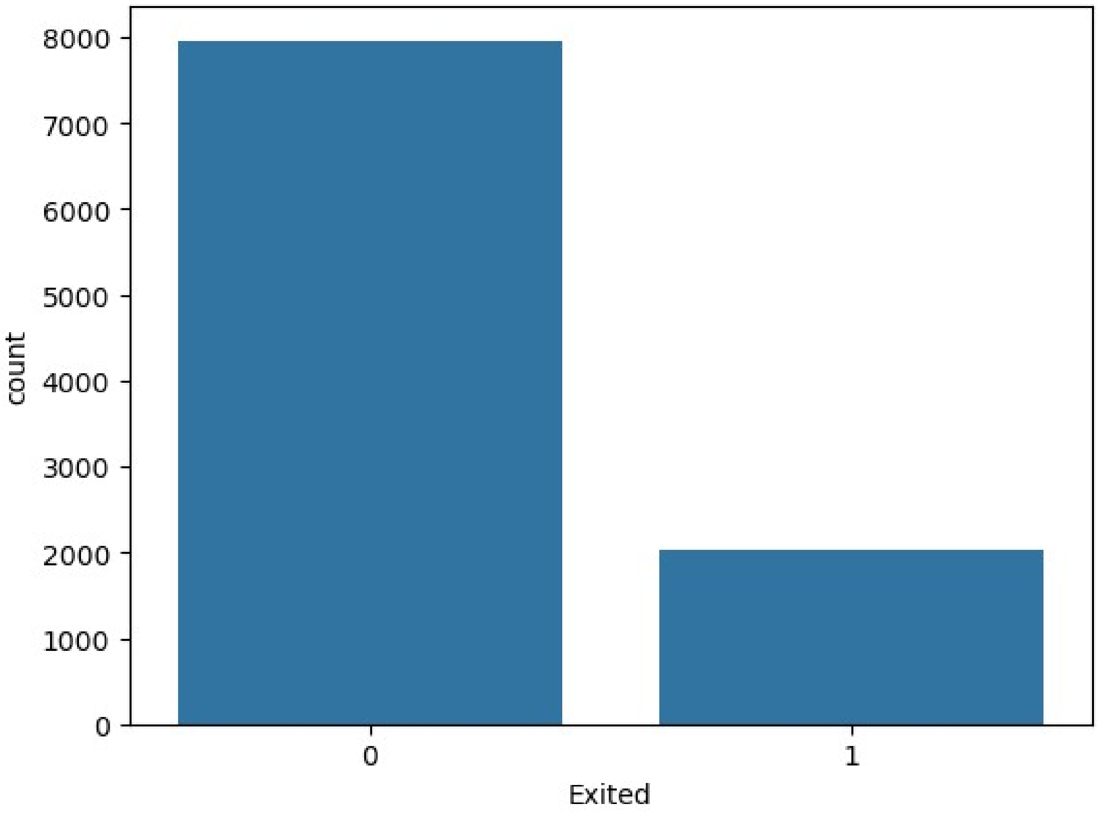
Distinguish The Feature And Target Set

```
# input data/ Features Set
x = df[['CreditScore', 'Age', 'Tenure', 'Balance', 'NumOfProducts',
      'HasCrCard', 'IsActiveMember', 'EstimatedSalary']]

# output data/ Target Set
y = df['Exited']

x
```

```
      CreditScore  Age  Tenure    Balance  NumOfProducts  HasCrCard  \
0             619   42       2       0.00              1          1
1             608   41       1   83807.86              1          0
2             502   42       8  159660.80              3          1
3             699   39       1       0.00              2          0
4             850   43       2  125510.82              1          1
...           ...  ...     ...        ...            ...        ...
9995          771   39       5       0.00              2          1
9996          516   35      10   57369.61              1          1
9997          709   36       7       0.00              1          0
9998          772   42       3   75075.31              2          1
9999          792   28       4  130142.79              1          1

      IsActiveMember  EstimatedSalary
0                  1        101348.88
1                  1        112542.58
2                  0        113931.57
3                  0         93826.63
4                  1         79084.10
...              ...              ...
9995               0         96270.64
9996               1        101699.77
9997               1         42085.58
9998               0         92888.52
9999               0         38190.78

[10000 rows x 8 columns]
```

```
sns.countplot(x=y)
```

```
<Axes: xlabel='Exited', ylabel='count'>
```



```
y.value_counts()

Exited
0    7963
1    2037
Name: count, dtype: int64
```

Normalize The Train And Test Data

```
# Normalize The Train And Test Data
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

x_scaled = scaler.fit_transform(x)

x_scaled

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]])
```

Cross Validation - Train Test Data

```
# Cross Validation - Train Test Data
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(x_scaled, y,
random_state=0, test_size=0.25)

x.shape

(10000, 8)

x_test.shape

(2500, 8)

x_train.shape

(7500, 8)
```

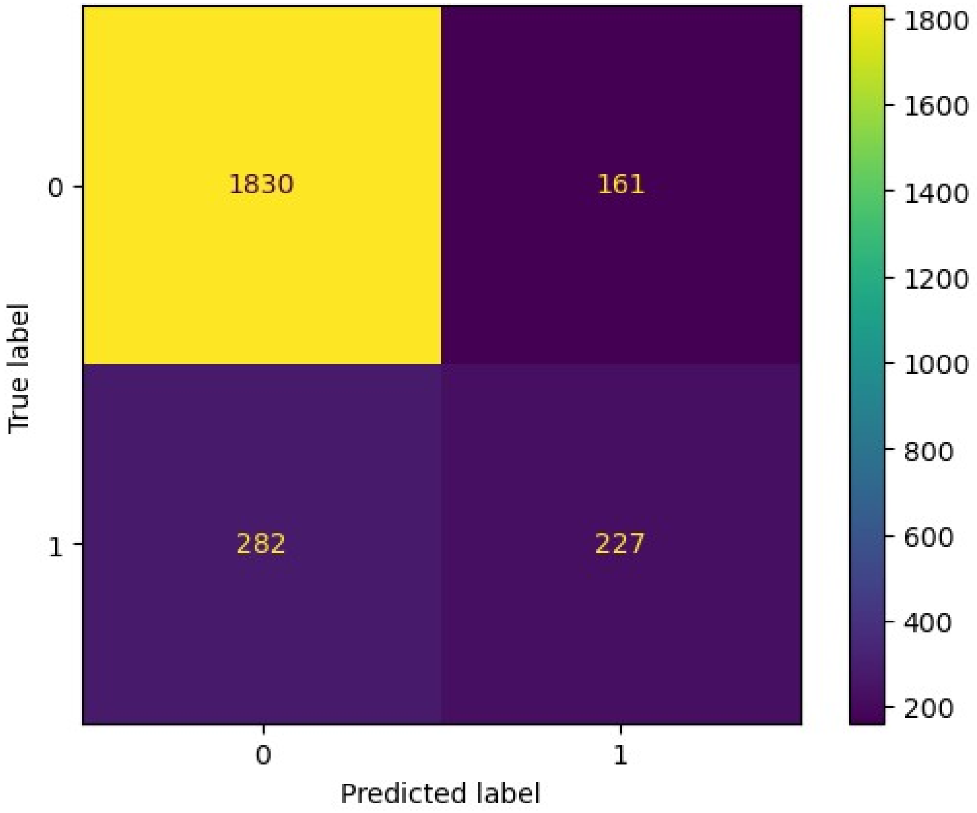
Initialize and build the model

```
# Initialize and build the model
from sklearn.neural_network import MLPClassifier

ann = MLPClassifier(hidden_layer_sizes=(100,100,100), random_state=0,
max_iter=100, activation='relu')

ann.fit(x_train, y_train)

C:\Users\Shubham\anaconda3\Lib\site-packages\sklearn\neural_network\
_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic
Optimizer: Maximum iterations (100) reached and the optimization
hasn't converged yet.
  warnings.warn(

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

```
y_pred = ann.predict(x_test)

y_pred

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

from sklearn.metrics import ConfusionMatrixDisplay,
classification_report, accuracy_score

y_test.value_counts()

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

Print Accuracy Score And Confusion Matrics

```
ConfusionMatrixDisplay.from_predictions(y_test, y_pred)

<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at
0x1e15a2fc6e0>
```



```
accuracy_score(y_test, y_pred)

0.8228
```

imbalenced Classifier is this

```
print(classification_report(y_test, y_pred))

              precision    recall  f1-score   support

           0       0.87      0.92      0.89      1991
           1       0.59      0.45      0.51       509

    accuracy                           0.82      2500
   macro avg       0.73      0.68      0.70      2500
weighted avg       0.81      0.82      0.81      2500
```

to balace the dataset

```
!pip install imbalanced-learn

Requirement already satisfied: imbalanced-learn in c:\users\shubham\
anaconda3\lib\site-packages (0.12.3)
Requirement already satisfied: numpy>=1.17.3 in c:\users\shubham\
anaconda3\lib\site-packages (from imbalanced-learn) (1.26.4)
Requirement already satisfied: scipy>=1.5.0 in c:\users\shubham\
anaconda3\lib\site-packages (from imbalanced-learn) (1.13.1)
Requirement already satisfied: scikit-learn>=1.0.2 in c:\users\
shubham\anaconda3\lib\site-packages (from imbalanced-learn) (1.4.2)
Requirement already satisfied: joblib>=1.1.1 in c:\users\shubham\
anaconda3\lib\site-packages (from imbalanced-learn) (1.4.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\
shubham\anaconda3\lib\site-packages (from imbalanced-learn) (2.2.0)

from imblearn.over_sampling import RandomOverSampler

ros = RandomOverSampler(random_state = 0)

x_res, y_res = ros.fit_resample(x,y)

y_res.value_counts()

Exited
1    7963
0    7963
Name: count, dtype: int64
```

This above data is balanced using Over Sampler techniques

```
# Normalize
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

x_scaled = scaler.fit_transform(x_res)

x_scaled
```

```
array([[-0.29877723,  0.08418894, -1.01840607, ...,  0.6512495 ,
         1.08223556,  0.00817382],
       [-0.4103938 , -0.01032629, -1.36135608, ..., -1.53550983,
         1.08223556,  0.20261687],
       [-1.48597169,  0.08418894,  1.03929402, ...,  0.6512495 ,
        -0.92401325,  0.22674468],
       ...,
       [-0.84671313,  1.02934128,  0.01044398, ...,  0.6512495 ,
        -0.92401325,  1.28878188],
       [-0.96847667,  0.65128034, -0.67545605, ..., -1.53550983,
         1.08223556, -1.21851316],
       [-1.5874413 ,  0.74579558,  1.03929402, ...,  0.6512495 ,
         1.08223556,  1.42417217]])
```

```
# Cross Validation - Train Test Data
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(x_scaled, y_res,
random_state=0, test_size=0.25)

x_res.shape
```

```
(15926, 8)
```

```
x_test.shape
```

```
(3982, 8)
```

```
x_train.shape
```

```
(11944, 8)
```

```
# Initialize and build the model
from sklearn.neural_network import MLPClassifier

ann = MLPClassifier(hidden_layer_sizes=(100,100,100), random_state=0,
max_iter=100, activation='relu')

ann.fit(x_train, y_train)
```

```
C:\Users\Shubham\anaconda3\Lib\site-packages\sklearn\neural_network\
_multilayer_perceptron.py:691: ConvergenceWarning: Stochastic
Optimizer: Maximum iterations (100) reached and the optimization
hasn't converged yet.
  warnings.warn(
```

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

```
y_pred = ann.predict(x_test)
```

```
y_pred
```

```
array([1, 1, 1, ..., 1, 1, 1], dtype=int64)
```

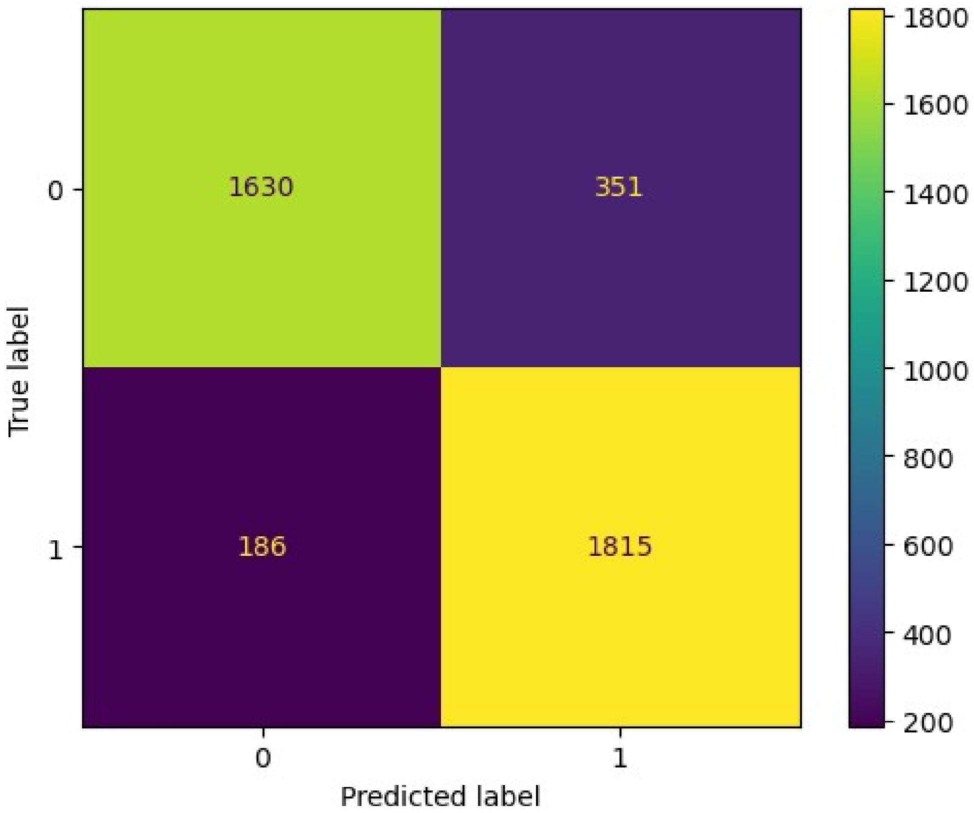
```
from sklearn.metrics import ConfusionMatrixDisplay,
classification_report, accuracy_score
```

```
y_test.value_counts()
```

```
Exited
1    2001
0    1981
Name: count, dtype: int64
```

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

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at
0x1e15a48b260>
```



```
accuracy_score(y_test, y_pred)

0.865143144148669
```

balenced Classifier is this

```
print(classification_report(y_test, y_pred))

              precision    recall  f1-score   support

           0       0.90      0.82      0.86      1981
           1       0.84      0.91      0.87      2001

    accuracy                           0.87      3982
   macro avg       0.87      0.86      0.86      3982
weighted avg       0.87      0.87      0.86      3982
```