Given a bank customer, build a neural network-based classifier that can determine whether they will leave or not in the next 6 months. Dataset Description: The case study is from an open-source dataset from Kaggle. The dataset contains 10,000 sample points with 14 distinct features such as CustomerId, CreditScore, Geography, Gender, Age, Tenure, Balance, etc. Link to the Kaggle project: https://www.kaggle.com/barelydedicated/bank-customer-churn-modeling Perform following steps:

1. Read the dataset.
2. Distinguish the feature and target set and divide the data set into training and test sets.
3. Normalize the train and test data.
4. Initialize and build the model. Identify the points of improvement and implement the same.
5. Print the accuracy score and confusion matrix (5 points)

In [64]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
import warnings
warnings.filterwarnings('ignore')
from sklearn.model_selection import train_test_split

from sklearn import metrics
df=pd.read_csv("C:\\Users\\Owner\\Desktop\\Machine Learning BE\\Practical\\Practica
df.head()
```

Out[64]:

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

In [65]:
```
df.shape
```

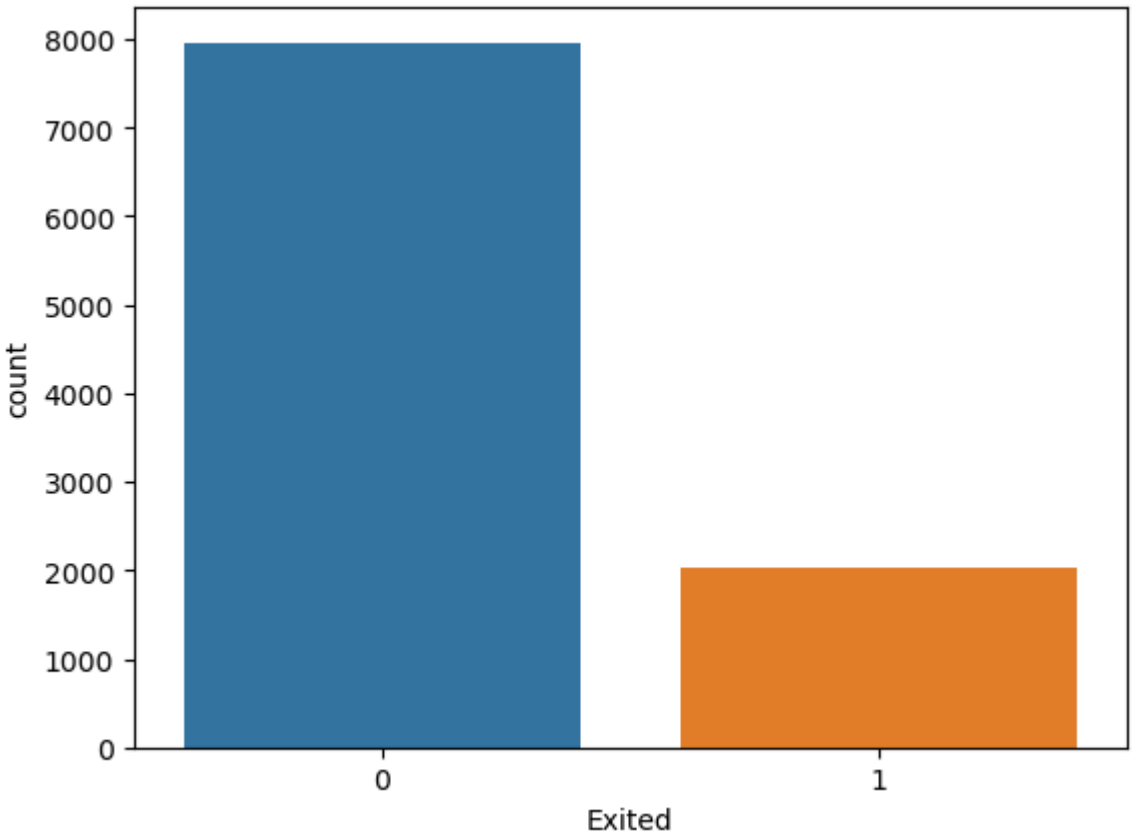
Out[65]:
```
(10000, 14)
```

In [66]:
```
df.columns
```

Out[66]:
```
Index(['RowNumber', 'CustomerId', 'Surname', 'CreditScore', 'Geography',
       'Gender', 'Age', 'Tenure', 'Balance', 'NumOfProducts', 'HasCrCard',
       'IsActiveMember', 'EstimatedSalary', 'Exited'],
      dtype='object')
```

In [67]:
```
# input data
x=df[['CreditScore','Age', 'Tenure', 'Balance', 'NumOfProducts', 'HasCrCard','IsAct
# output data
y=df[ 'Exited']
```

In [68]:
```
sns.countplot(x=y);
```



In [69]:
```
y.value_counts()
```

Out[69]:
```
0    7963
1    2037
Name: Exited, dtype: int64
```

In [70]:
```
# Normalise
from sklearn.preprocessing import StandardScaler
```

In [71]:
```
Scaler =StandardScaler()
```

In [72]:
```
x_scaled=Scaler.fit_transform(x)
```

In [73]:
```
x_scaled
```

Out[73]:
```
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]])
```

In [75]:
```
from sklearn.model_selection import train_test_split
```

In [76]:
```
x_train,x_test,y_train,y_test =train_test_split(x_scaled,y,random_state=0,test_size
```

In [77]:
```
x.shape
```

Out[77]:
```
(10000, 8)
```

In [78]:
```
x_train.shape
```

Out[78]:
```
(7500, 8)
```

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

Out[79]:
```
(2500, 8)
```

In [80]:
```
from sklearn.neural_network import MLPClassifier
```

In [81]:
```
ann= MLPClassifier(hidden_layer_sizes=(100,100,100),random_state = 0, max_iter=100,
```

In [82]:
```
ann.fit(x_train,y_train)
```

Out[82]:

MLPClassifier

```
MLPClassifier(hidden_layer_sizes=(100, 100, 100), max_iter=100, random_st
ate=0)
```

In [83]:
```
y_pred = ann.predict(x_test)
```

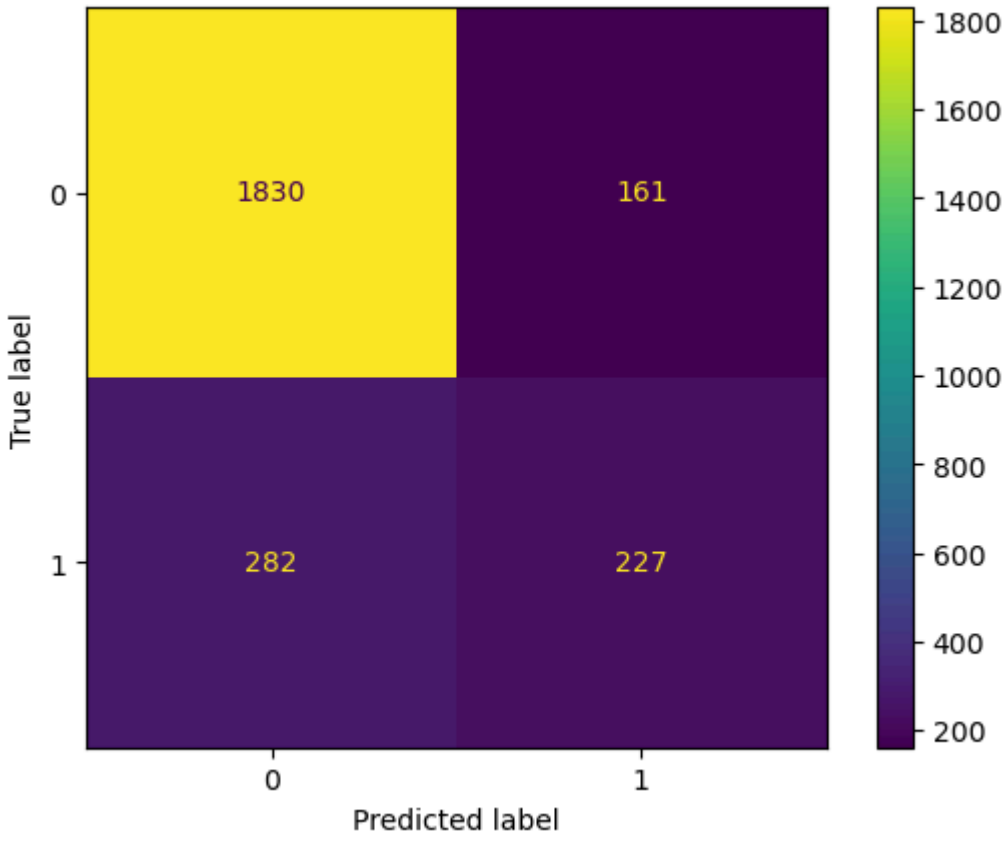
In [84]:
```
from sklearn.metrics import ConfusionMatrixDisplay,classification_report,accuracy_s
```

In [85]:
```
y_test.value_counts()
```

Out[85]:
```
0    1991
1     509
Name: Exited, dtype: int64
```

In [86]:
```
ConfusionMatrixDisplay.from_predictions(y_test,y_pred)
```

Out[86]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x139fa9f38b0>
```



In [87]:
```
accuracy_score(y_test,y_pred)
```

Out[87]:
```
0.8228
```

In [88]:
```
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
```

In [89]:
```
!pip install imbalanced-learn
```

```
Requirement already satisfied: imbalanced-learn in c:\users\owner\anaconda3\lib\si
te-packages (0.10.1)
Requirement already satisfied: joblib>=1.1.1 in c:\users\owner\anaconda3\lib\site-
packages (from imbalanced-learn) (1.1.1)
Requirement already satisfied: scipy>=1.3.2 in c:\users\owner\anaconda3\lib\site-p
ackages (from imbalanced-learn) (1.10.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\owner\anaconda3\li
b\site-packages (from imbalanced-learn) (2.2.0)
Requirement already satisfied: numpy>=1.17.3 in c:\users\owner\anaconda3\lib\site-
packages (from imbalanced-learn) (1.23.5)
Requirement already satisfied: scikit-learn>=1.0.2 in c:\users\owner\anaconda3\lib
\site-packages (from imbalanced-learn) (1.2.1)
```

In [90]:
```
from imblearn.over_sampling import RandomOverSampler
```

In [91]:
```
ros = RandomOverSampler (random_state =0)
```

In [92]:
```
x_res,y_res = ros.fit_resample(x,y)
```

In [93]:
```
y_res.value_counts()
```

Out[93]:
```
1    7963
0    7963
Name: Exited, dtype: int64
```

In [94]:
```
# Normalise
from sklearn.preprocessing import StandardScaler
```

In [95]:
```
Scaler =StandardScaler()
```

In [96]:
```
x_scaled=Scaler.fit_transform(x_res)
```

In [97]:
```
x_scaled
```

Out[97]:
```
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]])
```

In [98]:
```
from sklearn.model_selection import train_test_split
```

In [99]:
```
x_train,x_test,y_train,y_test =train_test_split(x_scaled,y_res,random_state=0,test_
```

In [100…
```
x_res.shape
```

Out[100]:
```
(15926, 8)
```

In [101…
```
from sklearn.neural_network import MLPClassifier
```

In [102…
```
ann= MLPClassifier(hidden_layer_sizes=(100,100,100),random_state = 0, max_iter=100,
```

In [103…
```
ann.fit(x_train,y_train)
```

Out[103]:
```
MLPClassifier(hidden_layer_sizes=(100, 100, 100), max_iter=100, random_st
ate=0)
```

In [104…
```
y_pred = ann.predict(x_test)
```

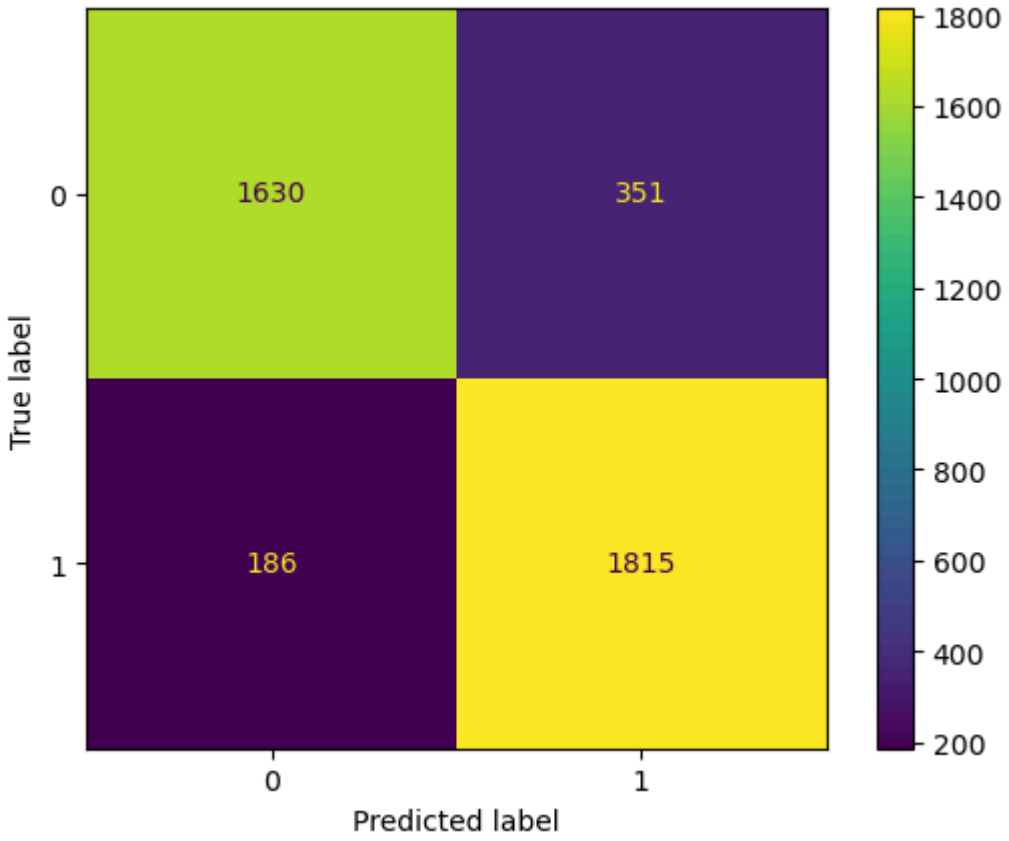
In [105…
```
from sklearn.metrics import ConfusionMatrixDisplay,classification_report,accuracy_s
```

In [106…
```
y_test.value_counts()
```

Out[106]:
```
1    2001
0    1981
Name: Exited, dtype: int64
```

In [107…
```
ConfusionMatrixDisplay.from_predictions(y_test,y_pred)
```

Out[107]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x139fa836860>
```



In [108…
```
accuracy_score(y_test,y_pred)
```

Out[108]:
```
0.865143144148669
```

In [109…
```
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
```

In [ ]: