

```
In [22]: import pandas as pd
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.neural_network import MLPClassifier
from sklearn.metrics import ConfusionMatrixDisplay, accuracy_score
from sklearn.metrics import classification_report
from imblearn.over_sampling import RandomOverSampler
```

```
In [2]: df=pd.read_csv("Bank-Turnover-Dataset.csv")
df
```

Out[2]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	
0	1	15634602	Hargrave	619	France	Female	42	2	
1	2	15647311	Hill	608	Spain	Female	41	1	
2	3	15619304	Onio	502	France	Female	42	8	15
3	4	15701354	Boni	699	France	Female	39	1	
4	5	15737888	Mitchell	850	Spain	Female	43	2	15
...
9995	9996	15606229	Obijaku	771	France	Male	39	5	
9996	9997	15569892	Johnstone	516	France	Male	35	10	15
9997	9998	15584532	Liu	709	France	Female	36	7	
9998	9999	15682355	Sabbatini	772	Germany	Male	42	3	15
9999	10000	15628319	Walker	792	France	Female	28	4	15

10000 rows × 14 columns



```
In [3]: df.head()
```

Out[3]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance
0	1	15634602	Hargrave	619	France	Female	42	2	
1	2	15647311	Hill	608	Spain	Female	41	1	8380
2	3	15619304	Onio	502	France	Female	42	8	15966
3	4	15701354	Boni	699	France	Female	39	1	
4	5	15737888	Mitchell	850	Spain	Female	43	2	12551



```
In [4]: df.shape
```

Out[4]: (10000, 14)

```
In [5]: x=df[['CreditScore', 'Age', 'Tenure', 'Balance', 'NumOfProducts', 'HasCrCard', 'I  
y=df['Exited']
```

```
In [23]: ros=RandomOverSampler(random_state=0)
```

```
In [26]: x_res,y_res=ros.fit_resample(x,y)
```

```
In [28]: scaler=StandardScaler()
```

```
In [29]: x_scaled=scaler.fit_transform(x_res)
```

```
In [30]: x_train,x_test,y_train,y_test=train_test_split(x,y,random_state=0,test_size
```

```
In [31]: ann=MLPClassifier(hidden_layer_sizes=(100,100,100),random_state=0,max_iter=
```

```
In [32]: ann.fit(x_train,y_train)
```

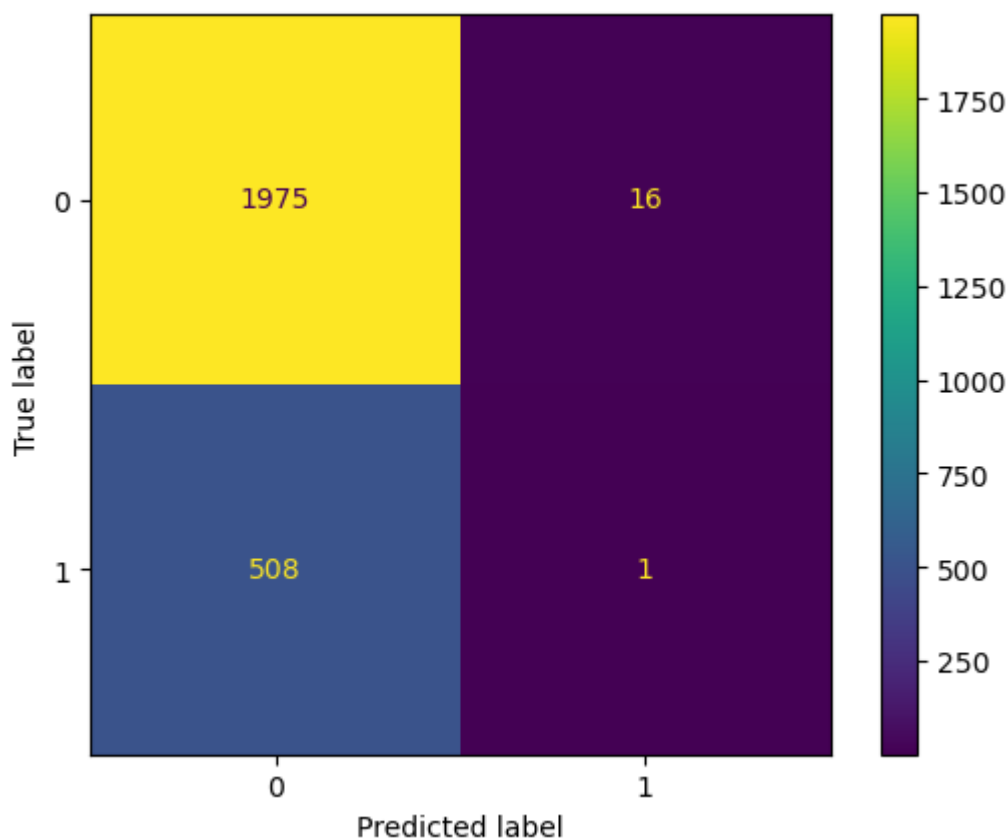
```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\neural_network\_multila  
yer_perceptron.py:692: ConvergenceWarning: Stochastic Optimizer: Maximum i  
terations (100) reached and the optimization hasn't converged yet.  
warnings.warn(
```

```
Out[32]: MLPClassifier(hidden_layer_sizes=(100, 100, 100), max_iter=100, random_sta  
te=0)
```

```
In [33]: y_pred=ann.predict(x_test)
```

In [34]: `ConfusionMatrixDisplay.from_predictions(y_test, y_pred)`

Out[34]: `<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2cd19deafd0>`



In [35]: `accuracy_score(y_test, y_pred)`

Out[35]: 0.7904

In [36]: `print(classification_report(y_test, y_pred))`

	precision	recall	f1-score	support
0	0.80	0.99	0.88	1991
1	0.06	0.00	0.00	509
accuracy			0.79	2500
macro avg	0.43	0.50	0.44	2500
weighted avg	0.65	0.79	0.70	2500

```
In [15]: pip install imbalanced-learn
```

```
Defaulting to user installation because normal site-packages is not writeable
```

```
Requirement already satisfied: imbalanced-learn in c:\users\hp\appdata\roaming\python\python39\site-packages (0.11.0)
```

```
Requirement already satisfied: numpy>=1.17.3 in c:\programdata\anaconda3\lib\site-packages (from imbalanced-learn) (1.21.5)
```

```
Requirement already satisfied: scipy>=1.5.0 in c:\programdata\anaconda3\lib\site-packages (from imbalanced-learn) (1.9.1)
```

```
Requirement already satisfied: scikit-learn>=1.0.2 in c:\programdata\anaconda3\lib\site-packages (from imbalanced-learn) (1.0.2)
```

```
Requirement already satisfied: joblib>=1.1.1 in c:\users\hp\appdata\roaming\python\python39\site-packages (from imbalanced-learn) (1.3.2)
```

```
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\programdata\anaconda3\lib\site-packages (from imbalanced-learn) (2.2.0)
```

```
Note: you may need to restart the kernel to use updated packages.
```