```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

df = pd.read_csv('emails.csv')

df.shape

(5172, 3002)

df

       Email No.  the  to  ect  and  for  of    a  you  hou  ...
connevey  \
0        Email 1    0   0    1    0    0   0    2    0    0  ...
0
1        Email 2    8  13   24    6    6   2  102    1   27  ...
0
2        Email 3    0   0    1    0    0   0    8    0    0  ...
0
3        Email 4    0   5   22    0    5   1   51    2   10  ...
0
4        Email 5    7   6   17    1    5   2   57    0    9  ...
0
...          ...  ...  ..  ...  ...  ...  ..  ...  ...  ...  ...
...
5167  Email 5168    2   2    2    3    0   0   32    0    0  ...
0
5168  Email 5169   35  27   11    2    6   5  151    4    3  ...
0
5169  Email 5170    0   0    1    1    0   0   11    0    0  ...
0
5170  Email 5171    2   7    1    0    2   1   28    2    0  ...
0
5171  Email 5172   22  24    5    1    6   5  148    8    2  ...
0

      jay  valued  lay  infrastructure  military  allowing  ff  dry  \
0       0       0    0               0         0         0   0    0
1       0       0    0               0         0         0   1    0
2       0       0    0               0         0         0   0    0
3       0       0    0               0         0         0   0    0
4       0       0    0               0         0         0   1    0
...   ...     ...  ...             ...       ...       ...  ..  ...
5167    0       0    0               0         0         0   0    0
5168    0       0    0               0         0         0   1    0
5169    0       0    0               0         0         0   0    0
5170    0       0    0               0         0         0   1    0
5171    0       0    0               0         0         0   0    0
```

```
      Prediction
0              0
1              0
2              0
3              0
4              0
...          ...
5167           0
5168           0
5169           1
5170           1
5171           0

[5172 rows x 3002 columns]
```

```
df.head()
```

```
  Email No.  the  to  ect  and  for  of    a  you  hou  ...  connevey
jay  \
0   Email 1    0   0    1    0    0   0    2    0    0  ...         0
0
1   Email 2    8  13   24    6    6   2  102    1   27  ...         0
0
2   Email 3    0   0    1    0    0   0    8    0    0  ...         0
0
3   Email 4    0   5   22    0    5   1   51    2   10  ...         0
0
4   Email 5    7   6   17    1    5   2   57    0    9  ...         0
0

   valued  lay  infrastructure  military  allowing  ff  dry
Prediction
0       0    0               0         0         0   0    0
0
1       0    0               0         0         0   1    0
0
2       0    0               0         0         0   0    0
0
3       0    0               0         0         0   0    0
0
4       0    0               0         0         0   1    0
0

[5 rows x 3002 columns]
```

```
# input data
x = df.drop(['Email No.', 'Prediction'], axis = 1)

# output data
y = df['Prediction']
```

```
x.shape
```

```
(5172, 3000)
```

```
x.dtypes
```

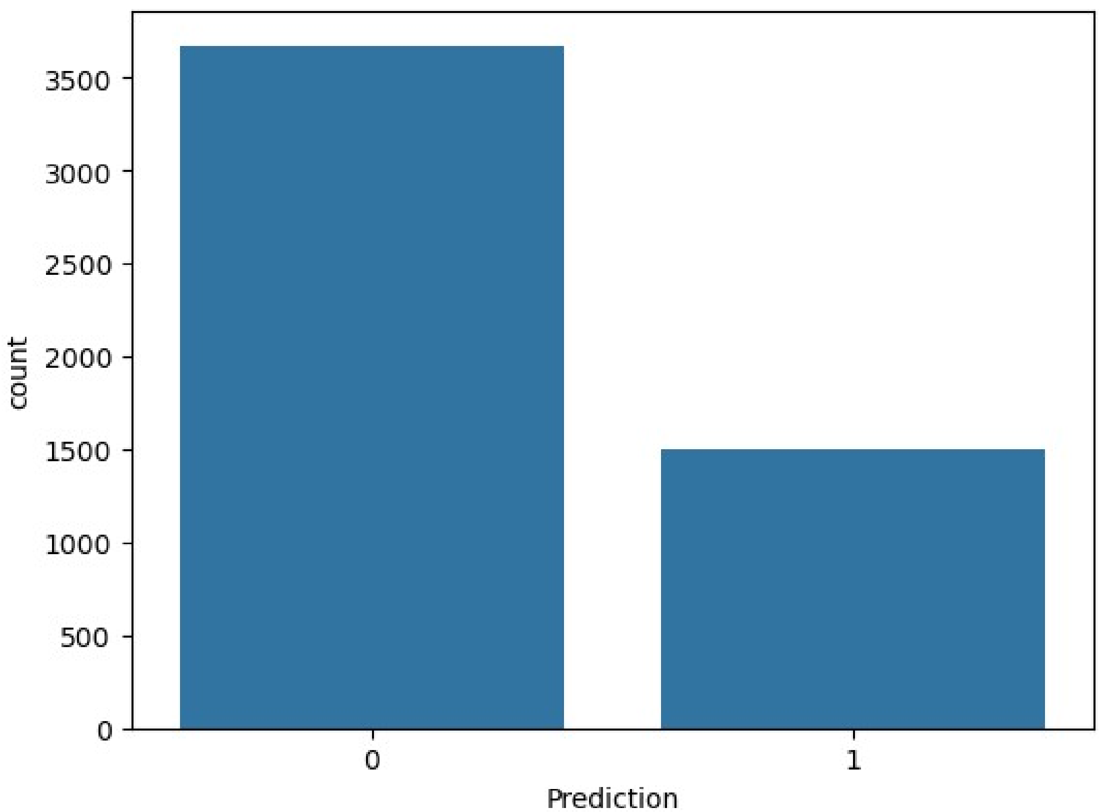
```
the                  int64
to                   int64
ect                  int64
and                  int64
for                  int64
                      ...
infrastructure       int64
military             int64
allowing             int64
ff                   int64
dry                  int64
Length: 3000, dtype: object
```

```
set(x.dtypes)
```

```
{dtype('int64')}
```

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

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



```
y.value_counts()
```

```
Prediction
0    3672
1    1500
Name: count, dtype: int64
```

```
# Feature Scaling
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()
x_scaled = scaler.fit_transform(x)
```

```
x_scaled
```

```
array([[0.        , 0.        , 0.        , ..., 0.        , 0.
,
        0.        ],
       [0.03809524, 0.09848485, 0.06705539, ..., 0.        ,
0.00877193,
        0.        ],
       [0.        , 0.        , 0.        , ..., 0.        , 0.
,
        0.        ],
       ...,
       [0.        , 0.        , 0.        , ..., 0.        , 0.
,
        0.        ],
       [0.00952381, 0.0530303 , 0.        , ..., 0.        ,
0.00877193,
        0.        ],
       [0.1047619 , 0.18181818, 0.01166181, ..., 0.        , 0.
,
        0.        ]])
```

```
# Cross Validation -75% training and 25% testing
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_scaled.shape
```

```
(5172, 3000)
```

```
x_train.shape
```

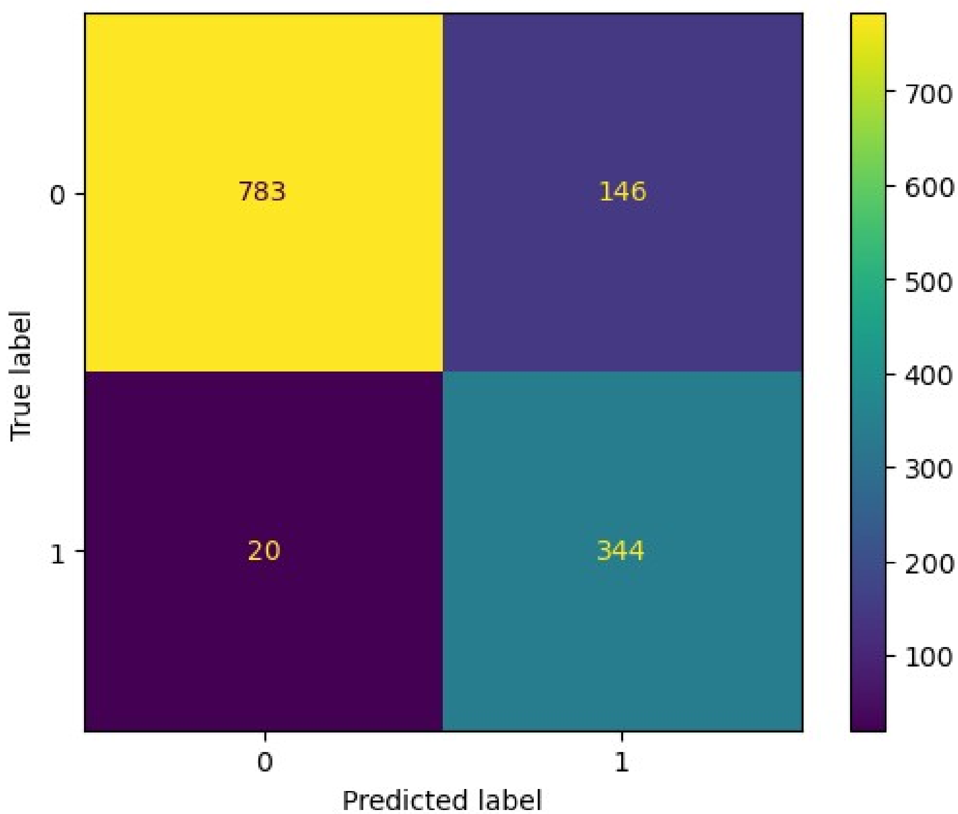
```
(3879, 3000)
```

```
x_test.shape
```

```
(1293, 3000)
```

KNN - K Nearest Neighbors

```
# Accuracy = (TP + TN)/ Total

# Error Rate = 1 - Accuracy
# Error Rate = (FP+FN)/Total

# Precision = TP / Predicted Yes

# Recall = TP / Actual Yes

# F1 Score = 2 * (Precision * Recall)/(Precision + recall)

# import the class
from sklearn.neighbors import KNeighborsClassifier

# Create the object
knn = KNeighborsClassifier(n_neighbors = 5)

# Train the algorithm
knn.fit(x_train, y_train)

KNeighborsClassifier()

# Predict on test data
y_pred = knn.predict(x_test)

y_pred

array([1, 0, 0, ..., 1, 0, 1], dtype=int64)

# Import the evalution metrics
from sklearn.metrics import ConfusionMatrixDisplay, accuracy_score,
classification_report

ConfusionMatrixDisplay.from_predictions(y_test, y_pred)

<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at
0x2c2a4418f20>
```




```
y_test.value_counts()

Prediction
0    929
1    364
Name: count, dtype: int64

accuracy_score(y_test, y_pred)

0.871616395978345

print(classification_report(y_test, y_pred))

              precision    recall  f1-score   support

           0       0.98      0.84      0.90       929
           1       0.70      0.95      0.81       364

    accuracy                           0.87      1293
   macro avg       0.84      0.89      0.85      1293
weighted avg       0.90      0.87      0.88      1293


error = []
for k in range(1,41):
    knn = KNeighborsClassifier(n_neighbors = k)
```

```
    knn.fit(x_train, y_train)
    pred = knn.predict(x_test)
    error.append(np.mean(pred != y_test))

error
```

```
[0.10827532869296211,
 0.10982211910286156,
 0.12296983758700696,
 0.11523588553750967,
 0.12838360402165508,
 0.1214230471771075,
 0.15158546017014696,
 0.14849187935034802,
 0.17246713070378963,
 0.16705336426914152,
 0.1871616395978345,
 0.18329466357308585,
 0.21500386697602475,
 0.21345707656612528,
 0.22815158546017014,
 0.2266047950502707,
 0.23588553750966745,
 0.23356535189481825,
 0.2459396751740139,
 0.24361948955916474,
 0.2559938128383604,
 0.2552204176334107,
 0.2699149265274555,
 0.2691415313225058,
 0.2822892498066512,
 0.28306264501160094,
 0.2954369682907966,
 0.2923433874709977,
 0.3039443155452436,
 0.300077339520495,
 0.30549110595514306,
 0.30549110595514306,
 0.31245166279969067,
 0.31245166279969067,
 0.3194122196442382,
 0.317092034029389,
 0.32637277648878577,
 0.32559938128383603,
 0.33410672853828305,
 0.3325599381283836]
```

```
knn = KNeighborsClassifier(n_neighbors = 1)

knn.fit(x_train, y_train)
```

```
KNeighborsClassifier(n_neighbors=1)

y_pred = knn.predict(x_test)

accuracy_score(y_test, y_pred)

0.8917246713070379

print(classification_report(y_test, y_pred))

              precision    recall  f1-score   support

           0       0.95      0.90      0.92       929
           1       0.77      0.88      0.82       364

    accuracy                           0.89      1293
   macro avg       0.86      0.89      0.87      1293
weighted avg       0.90      0.89      0.89      1293
```

SVM - Support Vector Machine

```
from sklearn.svm import SVC

svm = SVC(kernel = 'linear')

svm.fit(x_train, y_train)

SVC(kernel='linear')

y_pred = svm.predict(x_test)

accuracy_score(y_test, y_pred)

0.9767981438515081

svm = SVC(kernel = 'rbf')

svm.fit(x_train, y_train)

SVC()

y_pred = svm.predict(x_test)

accuracy_score(y_test, y_pred)

0.9450889404485692

svm = SVC(kernel = 'poly')

svm.fit(x_train, y_train)
```

```
SVC(kernel='poly')

y_pred = svm.predict(x_test)

accuracy_score(y_test, y_pred)

0.7548337200309359

svm = SVC(kernel='sigmoid')

svm.fit(x_train, y_train)

SVC(kernel='sigmoid')

y_pred = svm.predict(x_test)

accuracy_score(y_test, y_pred)

0.839907192575406

# Linear: 0.9767981438515081
# RBF: 0.9450889404485692
# Polynomial: 0.7548337200309359
# Sigmoid: 0.839907192575406
```