

```
In [10]: import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import confusion_matrix, accuracy_score, precision_score

df = pd.read_csv("/home/csl-4/Documents/7348/ASSIGNMENT6/spam_ham_dataset.csv")
df.head()
```

	Unnamed: 0	label	text	label_num
0	605	ham	Subject: enron methanol ; meter # : 988291\r\n...	0
1	2349	ham	Subject: hpl nom for january 9 , 2001\r\n(see...	0
2	3624	ham	Subject: neon retreat\r\nho ho ho , we ' re ar...	0
3	4685	spam	Subject: photoshop , windows , office . cheap ...	1
4	2030	ham	Subject: re : indian springs\r\nthis deal is t...	0

```
In [11]: X = df['text']          # Email text
y = df['label_num'] # 0 = ham, 1 = spam
```

```
In [12]: vectorizer = CountVectorizer(stop_words='english')
X_vectorized = vectorizer.fit_transform(X)
```

```
In [13]: X_train, X_test, y_train, y_test = train_test_split(
    X_vectorized, y, test_size=0.3, random_state=42
)
```

```
In [14]: model = MultinomialNB()
model.fit(X_train, y_train)
```

Out[14]:

▼ MultinomialNB ⓘ ⓘ

MultinomialNB()

```
In [15]: y_pred = model.predict(X_test)
```

```
In [16]: cm = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", cm)
```

Confusion Matrix:
[[1101 20]
 [16 415]]

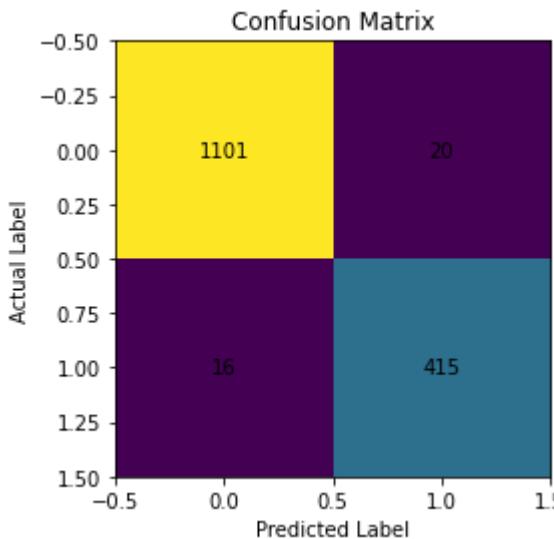
```
In [18]: from sklearn.metrics import confusion_matrix
import matplotlib.pyplot as plt

# Generate confusion matrix
cm = confusion_matrix(y_test, y_pred)
```

```
# Plot
plt.figure()
plt.imshow(cm)
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("Actual Label")

# Show values inside boxes
for i in range(cm.shape[0]):
    for j in range(cm.shape[1]):
        plt.text(j, i, cm[i, j], ha="center", va="center")

plt.show()
```



In [19]: `TN, FP, FN, TP = cm.ravel()`

```
print("TP:", TP)
print("FP:", FP)
print("TN:", TN)
print("FN:", FN)

accuracy = accuracy_score(y_test, y_pred)
error_rate = 1 - accuracy
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)

print("Accuracy:", accuracy)
print("Error Rate:", error_rate)
print("Precision:", precision)
print("Recall:", recall)
```

```
TP: 415
FP: 20
TN: 1101
FN: 16
Accuracy: 0.9768041237113402
Error Rate: 0.023195876288659822
Precision: 0.9540229885057471
Recall: 0.962877030162413
```

In []: