```
Start coding or generate with AI.
```

```
# Import Libraries
# Importing Numpy & Pandas for data processing & data wrangling
import numpy as np
import pandas as pd

# Importing  tools for visualization
import matplotlib.pyplot as plt
import seaborn as sns

# Import evaluation metric libraries
from sklearn.metrics import confusion_matrix, accuracy_score, precision_score, recall_score, f1_score, roc_auc_score, roc_curve

# Word Cloud library
from wordcloud import WordCloud, STOPWORDS

# Library used for data preprocessing
from sklearn.feature_extraction.text import CountVectorizer

# Import model selection libraries
from sklearn.model_selection import train_test_split

# Library used for ML Model implementation
from sklearn.naive_bayes import MultinomialNB

# Importing the Pipeline class from scikit-learn
from sklearn.pipeline import Pipeline

# Library used for ignore warnings
import warnings
warnings.filterwarnings('ignore')
%matplotlib inline
```

```
# Load Dataset from github repository
df = pd.read_csv("https://raw.githubusercontent.com/Apaulgithub/oibsip_taskno4/main/spam.csv", encoding='ISO-8859-1')
```

```
# Dataset Columns
df.columns
```

```
Index(['v1', 'v2', 'Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'], dtype='object')
```

```
# Dataset Describe (all columns included)
df.describe(include= 'all').round(2)
```

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
count	5572	5572	50	12	6
unique	2	5169	43	10	5
top	ham	Sorry, I'll call later	bt not his girlfrnd... G o o d n i g h t . . .@"	MK17 92H. 450Ppw 16"	GNT:-)"
freq	4825	30	3	2	2

```
# Check Unique Values for each variable using a for loop.
for i in df.columns.tolist():
  print("No. of unique values in",i,"is",df[i].nunique())
```

```
No. of unique values in v1 is 2
No. of unique values in v2 is 5169
No. of unique values in Unnamed: 2 is 43
No. of unique values in Unnamed: 3 is 10
No. of unique values in Unnamed: 4 is 5
```

```
# Change the v1 & v2 columns as Category and Message
df.rename(columns={"v1": "Category", "v2": "Message"}, inplace=True)
```

```
# Removing the all unnamed columns (its include much number of missing values)
df.drop(columns={'Unnamed: 2','Unnamed: 3','Unnamed: 4'}, inplace=True)
```

```
# Create a binary 'Spam' column: 1 for 'spam' and 0 for 'ham', based on the 'Category' column.
df['Spam'] = df['Category'].apply(lambda x: 1 if x == 'spam' else 0)
```

```
# Updated new dataset
df.head()
```

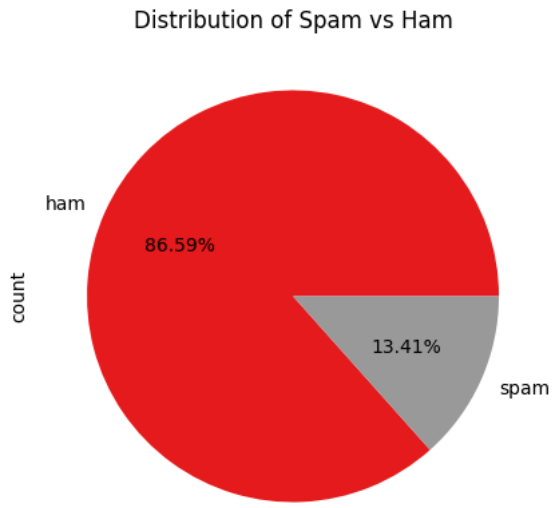
	Category	Message	Spam
0	ham	Go until jurong point, crazy.. Available only ...	0
1	ham	Ok lar... Joking wif u oni...	0
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	1
3	ham	U dun say so early hor... U c already then say...	0
4	ham	Nah I don't think he goes to usf, he lives aro...	0

Next steps: Generate code with df | New interactive sheet

```
# Chart - 1 Pie Chart Visualization Code For Distribution of Spam vs Ham Messages
spread = df['Category'].value_counts()
plt.rcParams['figure.figsize'] = (5,5)

# Set Labels
spread.plot(kind = 'pie', autopct='%1.2f%%', cmap='Set1')
plt.title(f'Distribution of Spam vs Ham')

# Display the Chart
plt.show()
```




```
# Splitting Spam Messages
df_spam = df[df['Category']=='spam'].copy()
```

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```
# Chart - 2 WordCloud Plot Visualization Code For Most Used Words in Spam Messages
# Create a String to Store All The Words
comment_words = ''

# Remove The Stopwords
stopwords = set(STOPWORDS)

# Iterate Through The Column
for val in df_spam.Message:

    # Typecaste Each Val to String
    val = str(val)

    # Split The Value
    tokens = val.split()

    # Converts Each Token into lowercase
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()

    comment_words += " ".join(tokens)+" "

# Set Parameters
wordcloud = WordCloud(width = 1000, height = 500,
                background_color ='white',
                stopwords = stopwords,
```

```
                min_font_size = 10,
                max_words = 1000,
                colormap = 'gist_heat_r').generate(comment_words)

# Set Labels
plt.figure(figsize = (6,6), facecolor = None)
plt.title('Most Used Words In Spam Messages', fontsize = 15, pad=20)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

# Display Chart
plt.show()
```


```
# Splitting the data to train and test
X_train,X_test,y_train,y_test=train_test_split(df.Message,df.Spam,test_size=0.25)
```

```
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```
def evaluate_model(model, X_train, X_test, y_train, y_test):
    '''The function will take model, x train, x test, y train, y test
    and then it will fit the model, then make predictions on the trained model,
    it will then print roc-auc score of train and test, then plot the roc, auc curve,
    print confusion matrix for train and test, then print classification report for train and test,
    then plot the feature importances if the model has feature importances,
    and finally it will return the following scores as a list:
    recall_train, recall_test, acc_train, acc_test, roc_auc_train, roc_auc_test, F1_train, F1_test
    '''

    # fit the model on the training data
    model.fit(X_train, y_train)

    # make predictions on the test data
    y_pred_train = model.predict(X_train)
    y_pred_test = model.predict(X_test)
    pred_prob_train = model.predict_proba(X_train)[:,1]
    pred_prob_test = model.predict_proba(X_test)[:,1]

    # calculate ROC AUC score
    roc_auc_train = roc_auc_score(y_train, y_pred_train)
    roc_auc_test = roc_auc_score(y_test, y_pred_test)
    print("\nTrain ROC AUC:", roc_auc_train)
    print("Test ROC AUC:", roc_auc_test)

    # plot the ROC curve
    fpr_train, tpr_train, thresholds_train = roc_curve(y_train, pred_prob_train)
    fpr_test, tpr_test, thresholds_test = roc_curve(y_test, pred_prob_test)
    plt.plot([0,1],[0,1],'k--')
    plt.plot(fpr_train, tpr_train, label="Train ROC AUC: {:.2f}".format(roc_auc_train))
    plt.plot(fpr_test, tpr_test, label="Test ROC AUC: {:.2f}".format(roc_auc_test))
    plt.legend()
    plt.title("ROC Curve")
    plt.xlabel("False Positive Rate")
    plt.ylabel("True Positive Rate")
    plt.show()

    # calculate confusion matrix
    cm_train = confusion_matrix(y_train, y_pred_train)
    cm_test = confusion_matrix(y_test, y_pred_test)
```

```
    fig, ax = plt.subplots(1, 2, figsize=(11,4))

    print("\nConfusion Matrix:")
    sns.heatmap(cm_train, annot=True, xticklabels=['Negative', 'Positive'], yticklabels=['Negative', 'Positive'], cmap="Orang
    ax[0].set_xlabel("Predicted Label")
    ax[0].set_ylabel("True Label")
    ax[0].set_title("Train Confusion Matrix")

    sns.heatmap(cm_test, annot=True, xticklabels=['Negative', 'Positive'], yticklabels=['Negative', 'Positive'], cmap="Orange
    ax[1].set_xlabel("Predicted Label")
    ax[1].set_ylabel("True Label")
    ax[1].set_title("Test Confusion Matrix")

    plt.tight_layout()
    plt.show()


    # calculate classification report
    cr_train = classification_report(y_train, y_pred_train, output_dict=True)
    cr_test = classification_report(y_test, y_pred_test, output_dict=True)
    print("\nTrain Classification Report:")
    crt = pd.DataFrame(cr_train).T
    print(crt.to_markdown())
    # sns.heatmap(pd.DataFrame(cr_train).T.iloc[:, :-1], annot=True, cmap="Blues")
    print("\nTest Classification Report:")
    crt2 = pd.DataFrame(cr_test).T
    print(crt2.to_markdown())
    # sns.heatmap(pd.DataFrame(cr_test).T.iloc[:, :-1], annot=True, cmap="Blues")


    precision_train = cr_train['weighted avg']['precision']
    precision_test = cr_test['weighted avg']['precision']

    recall_train = cr_train['weighted avg']['recall']
    recall_test = cr_test['weighted avg']['recall']

    acc_train = accuracy_score(y_true = y_train, y_pred = y_pred_train)
    acc_test = accuracy_score(y_true = y_test, y_pred = y_pred_test)

    F1_train = cr_train['weighted avg']['f1-score']
    F1_test = cr_test['weighted avg']['f1-score']

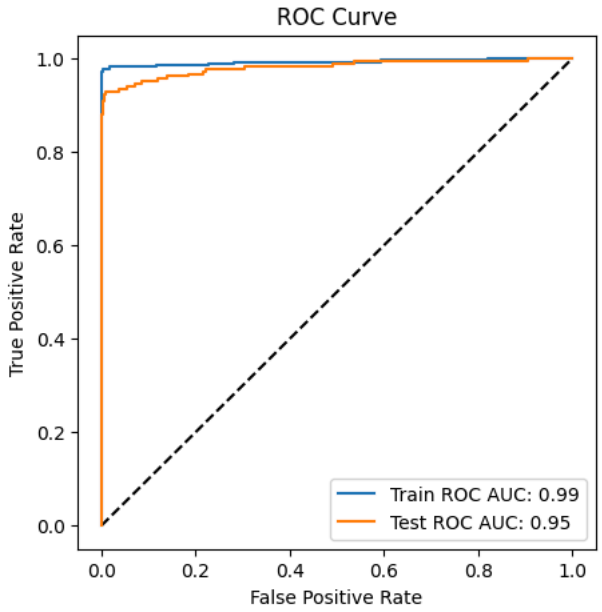
    model_score = [precision_train, precision_test, recall_train, recall_test, acc_train, acc_test, roc_auc_train, roc_auc_te
    return model_score
```

```
# ML Model - 1 Implementation
# Create a machine learning pipeline using scikit-learn, combining text vectorization (CountVectorizer)
# and a Multinomial Naive Bayes classifier for email spam detection.
clf = Pipeline([
    ('vectorizer', CountVectorizer()),  # Step 1: Text data transformation
    ('nb', MultinomialNB())  # Step 2: Classification using Naive Bayes
])

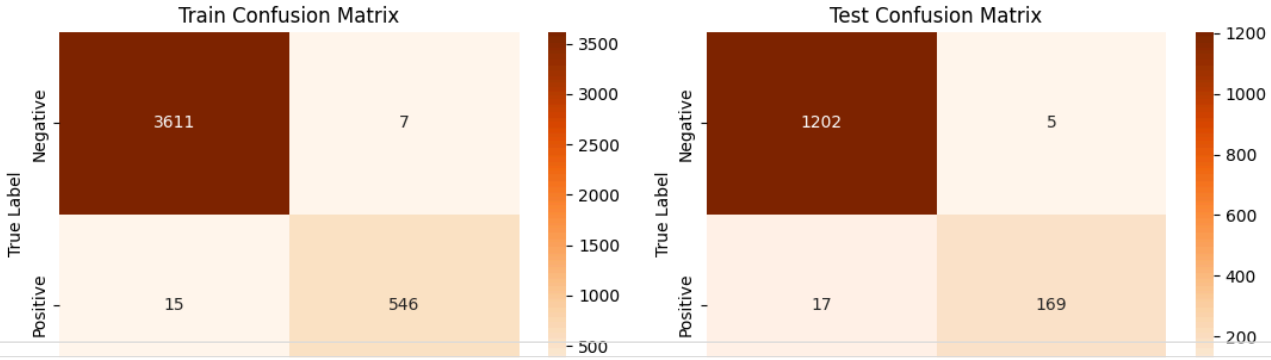
# Model is trained (fit) and predicted in the evaluate model
```

```
# Visualizing evaluation Metric Score chart
MultinomialNB_score = evaluate_model(clf, X_train, X_test, y_train, y_test)
```

```
Train ROC AUC: 0.9856636307470371
Test ROC AUC: 0.9522298242331918
```




```
Confusion Matrix:
```




```
# Defining a function for the Email Spam Detection System
def detect_spam(email_text):
    # Load the trained classifier (clf) here
    # Replace the comment with your code to load the classifier model

    # Make a prediction using the loaded classifier
    prediction = clf.predict([email_text])

    if prediction == 0:
        return "This is a Ham Email!"
    else:
        return "This is a Spam Email!"
```

```
Test Classification Report:
```

```
sample_email = 'Bonus point'
result = detect_spam(sample_email)
print(result)
```

```
This is a Spam Email!
```

```
| accuracy     |    0.984207 | 0.984207 |   0.984207 |    0.984207 |
| macro avg    |    0.978659 | 0.95223  |   0.96491  | 1393        |
| weighted avg |    0.984079 | 0.984207 |   0.983983 | 1393        |
```