Spam Message Classification

1) Data Preprocessing

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

```
df = pd.read_csv('spam.tsv', sep='\t')
```

```
df.head()
```

	label	message	length	punct
0	ham	Go until jurong point, crazy.. Available only ...	111	9
1	ham	Ok lar... Joking wif u oni...	29	6
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	155	6
3	ham	U dun say so early hor... U c already then say...	49	6
4	ham	Nah I don't think he goes to usf, he lives aro...	61	2

```
df.isna()
```

	label	message	length	punct
0	False	False	False	False
1	False	False	False	False
2	False	False	False	False
3	False	False	False	False
4	False	False	False	False
...	...	...	...	...
5567	False	False	False	False
5568	False	False	False	False
5569	False	False	False	False
5570	False	False	False	False
5571	False	False	False	False

5572 rows × 4 columns

```
df.isna().sum()
```

```
label      0
message    0
length     0
punct      0
dtype: int64
```

```
df.tail()
```

	label	message	length	punct
5567	spam	This is the 2nd time we have tried 2 contact u...	160	8
5568	ham	Will ü b going to esplanade fr home?	36	1
5569	ham	Pity, * was in mood for that. So...any other s...	57	7
5570	ham	The guy did some bitching but I acted like i'd...	125	1
5571	ham	Rofl. Its true to its name	26	1

```
df.describe()
```

	length	punct
count	5572.000000	5572.000000
mean	80.489950	4.177495
std	59.942907	4.623919
min	2.000000	0.000000
25%	36.000000	2.000000
50%	62.000000	3.000000
75%	122.000000	6.000000
max	910.000000	133.000000

```
df['label'].value_counts()/ (len(df))
```

```
ham     0.865937
spam    0.134063
Name: label, dtype: float64
```

```
df['label'].value_counts()      #Here the imbalnced data set
```

```
ham     4825
spam     747
Name: label, dtype: int64
```

```
ham = df[df['label'] == 'ham']      #Try to make it balnced
spam = df[df['label'] == 'spam']
```

```
ham.shape, spam.shape
```

```
((4825, 4), (747, 4))
```

```
spam.shape[0]
```

```
747
```

```
ham = ham.sample(spam.shape[0])
```

```
ham.shape, spam.shape
```

```
((747, 4), (747, 4))
```

```
data = ham.append(spam, ignore_index=True)
```

```
<ipython-input-16-ea3b8d22737f>:1: FutureWarning: The frame.append method is deprecated and will be rem
  data = ham.append(spam, ignore_index=True)
```

```
data.shape
```

```
(1494, 4)
```

```
data['label'].value_counts()
```

```
ham     747
spam    747
Name: label, dtype: int64
```

```
data.head()
```

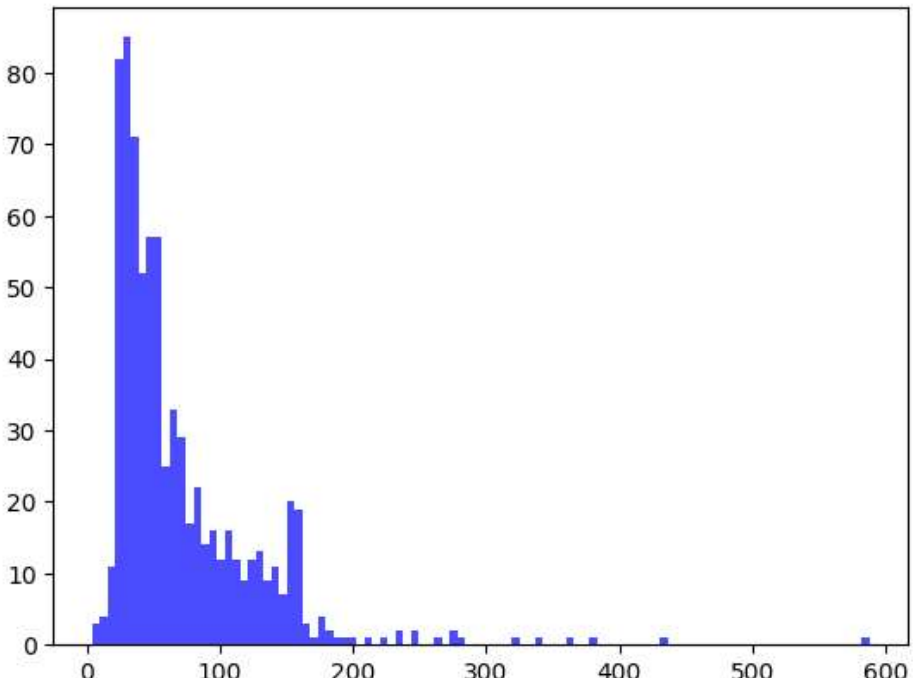
	label	message	length	punct
0	ham	(That said can you text him one more time?)	43	3
1	ham	Arms fine, how's Cardiff and uni?	34	3
2	ham	Ü v ma fan...	13	3
3	ham	hows my favourite person today? r u workin har...	101	4
4	ham	Can you let me know details of fri when u find...	104	3

```
from google.colab import drive
drive.mount('/content/drive')
```

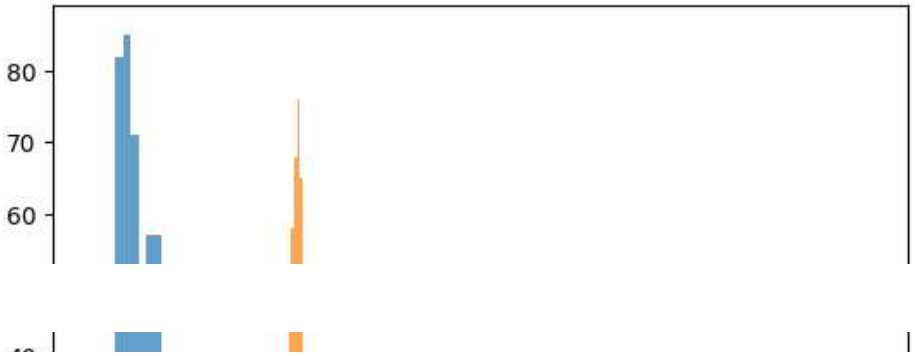
```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/dri
```

```
plt.hist(data[data['label'] == 'ham']['length'], bins = 100, alpha = 0.7,color='blue')
```

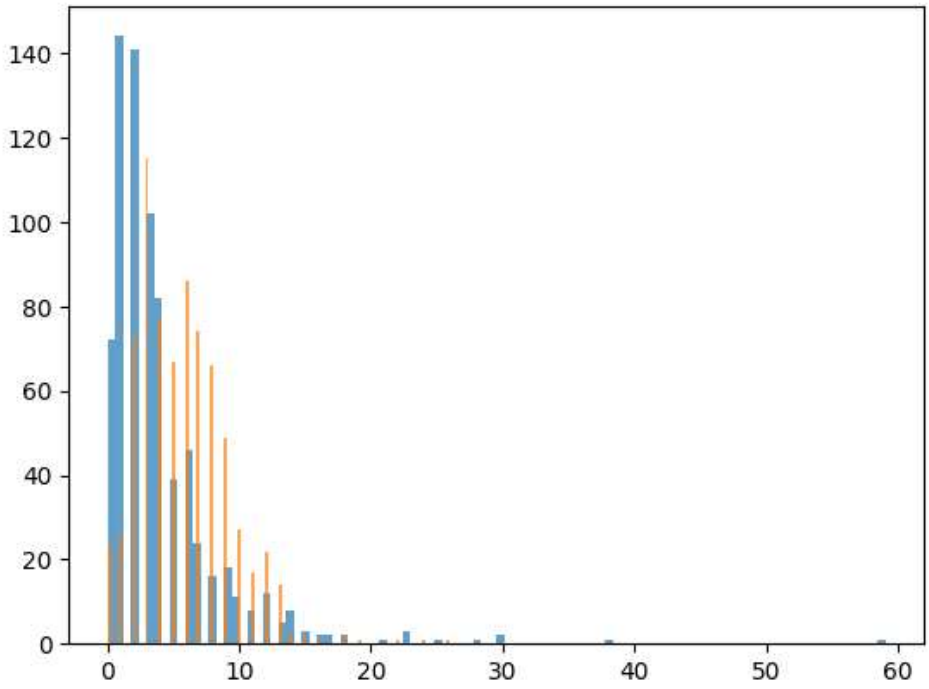
```
(array([ 3.,  4., 11., 82., 85., 71., 52., 57., 57., 25., 33., 29., 17.,
        22., 14., 16., 12., 16., 12.,  9., 12., 13.,  9., 11.,  7., 20.,
        19.,  3.,  1.,  4.,  2.,  1.,  1.,  1.,  0.,  1.,  0.,  1.,  0.,
         2.,  0.,  2.,  0.,  0.,  1.,  0.,  2.,  1.,  0.,  0.,  0.,  0.,
         0.,  0.,  1.,  0.,  0.,  1.,  0.,  0.,  0.,  1.,  0.,  0.,  1.,
         0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  1.,  0.,  0.,  0.,  0.,
         0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,
         0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  1.]),
 array([  4.  ,   9.84,  15.68,  21.52,  27.36,  33.2 ,  39.04,  44.88,
         50.72,  56.56,  62.4 ,  68.24,  74.08,  79.92,  85.76,  91.6 ,
         97.44, 103.28, 109.12, 114.96, 120.8 , 126.64, 132.48, 138.32,
        144.16, 150.  , 155.84, 161.68, 167.52, 173.36, 179.2 , 185.04,
        190.88, 196.72, 202.56, 208.4 , 214.24, 220.08, 225.92, 231.76,
        237.6 , 243.44, 249.28, 255.12, 260.96, 266.8 , 272.64, 278.48,
        284.32, 290.16, 296.  , 301.84, 307.68, 313.52, 319.36, 325.2 ,
        331.04, 336.88, 342.72, 348.56, 354.4 , 360.24, 366.08, 371.92,
        377.76, 383.6 , 389.44, 395.28, 401.12, 406.96, 412.8 , 418.64,
        424.48, 430.32, 436.16, 442.  , 447.84, 453.68, 459.52, 465.36,
        471.2 , 477.04, 482.88, 488.72, 494.56, 500.4 , 506.24, 512.08,
        517.92, 523.76, 529.6 , 535.44, 541.28, 547.12, 552.96, 558.8 ,
        564.64, 570.48, 576.32, 582.16, 588.  ]),
 <BarContainer object of 100 artists>)
```



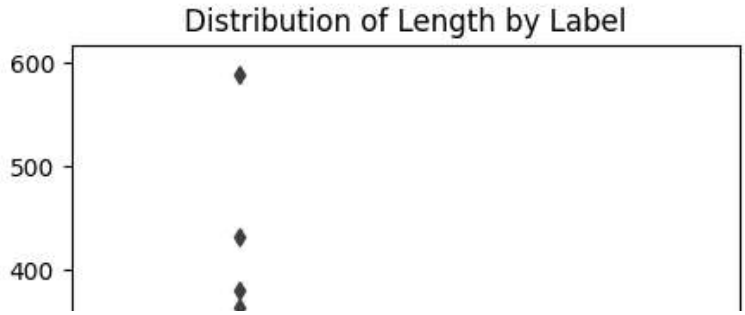

```
plt.hist(data[data['label'] == 'ham']['length'], bins = 100, alpha = 0.7)
plt.hist(data[data['label'] == 'spam']['length'], bins = 100, alpha = 0.7)
plt.show()
```



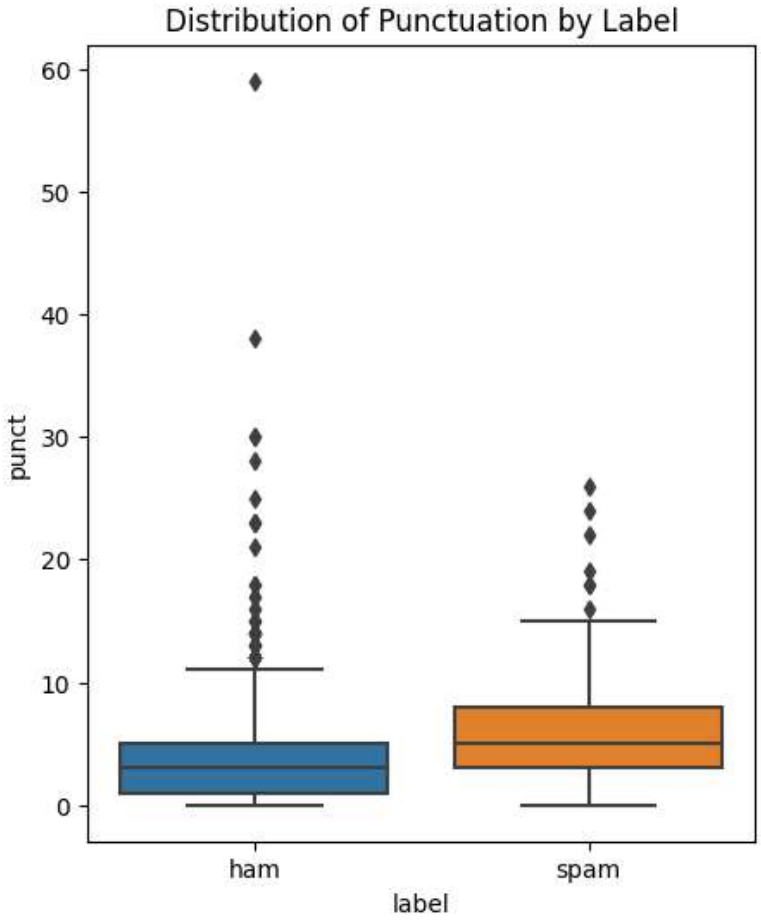

```
plt.hist(data[data['label'] == 'ham']['punct'], bins = 100, alpha = 0.7)
plt.hist(data[data['label'] == 'spam']['punct'], bins = 100, alpha = 0.7)
plt.show()
```



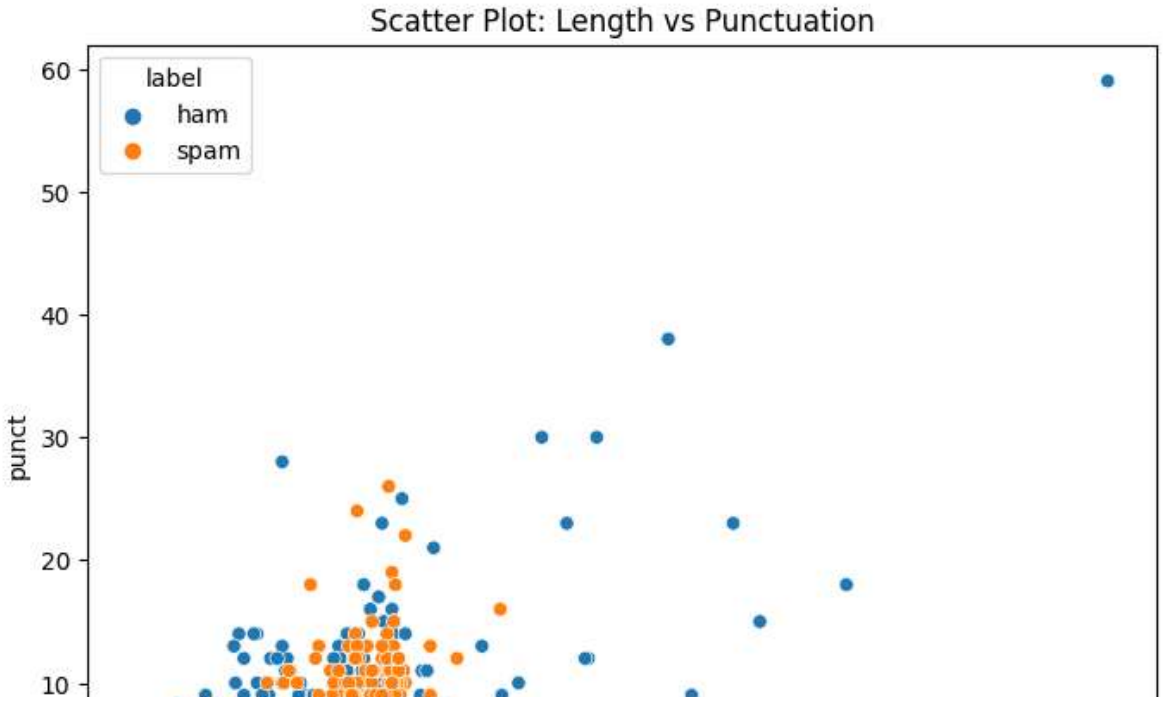

```
plt.figure(figsize=(5, 5))
sns.boxplot(x='label', y='length', data=data)
plt.title('Distribution of Length by Label')
plt.show()
```



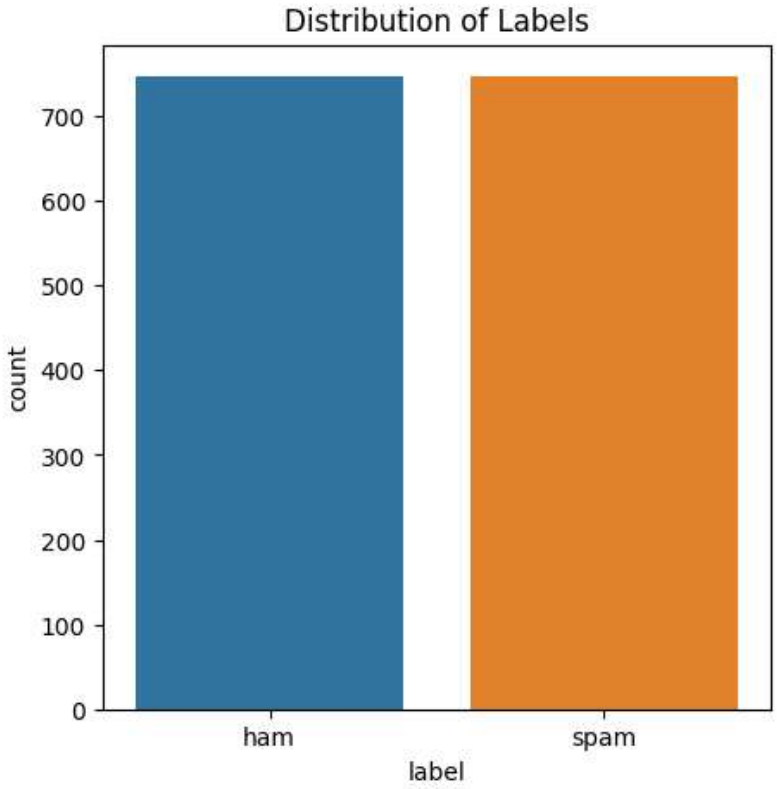

```
plt.figure(figsize=(5, 6))
sns.boxplot(x='label', y='punct', data=data)
plt.title('Distribution of Punctuation by Label')
plt.show()
```




```
# Scatter plot for 'length' vs 'punctuation'
plt.figure(figsize=(8, 6))
sns.scatterplot(x='length', y='punct', hue='label', data=data)
plt.title('Scatter Plot: Length vs Punctuation')
plt.show()
```




```
# Bar chart for 'label'
plt.figure(figsize=(5, 5))
sns.countplot(x='label', data=data)
plt.title('Distribution of Labels')
plt.show()
```

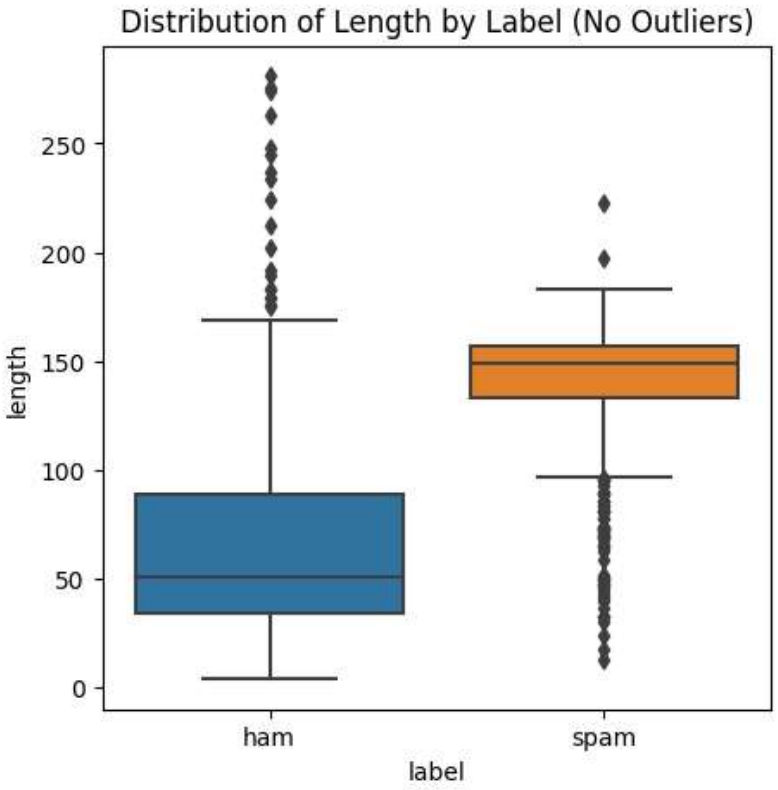



```
from wordcloud import WordCloud
```

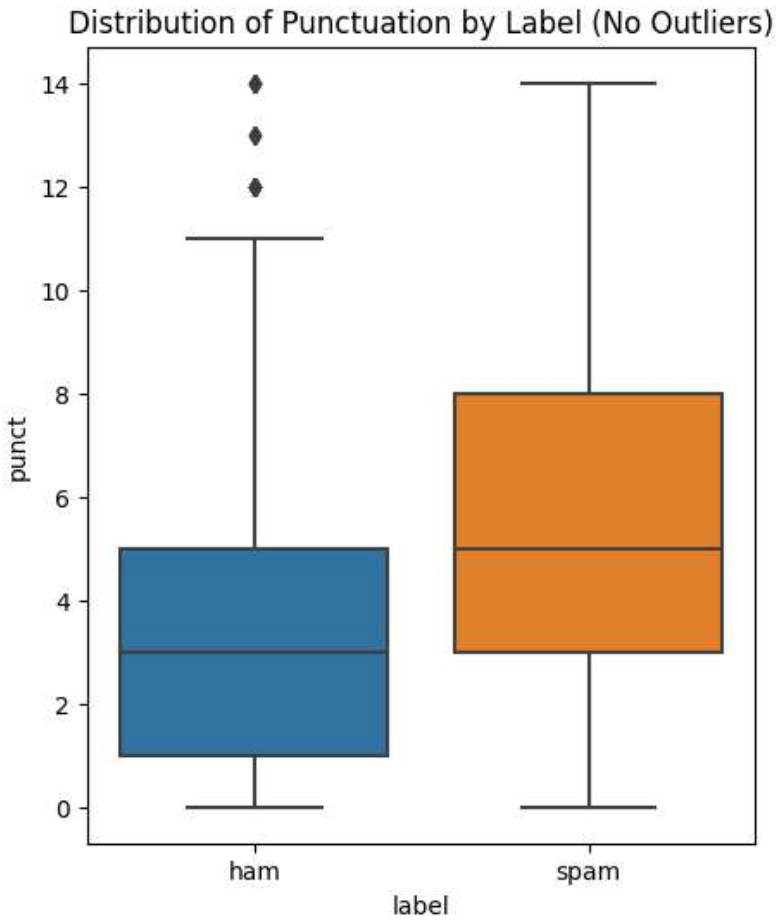
```
# Word Cloud for 'spam' messages
spam_wordcloud = WordCloud(width=600, height=300, background_color='white').generate(' '.join(data[data['la
plt.figure(figsize=(10, 6))
plt.imshow(spam_wordcloud, interpolation='bilinear')
plt.title('Word Cloud for Spam Messages')
plt.axis('off')
plt.show()
```


```
# Word Cloud for 'ham' messages
ham_wordcloud = WordCloud(width=600, height=300, background_color='white').generate(' '.join(data[data['lab
plt.figure(figsize=(10, 6))
plt.imshow(ham_wordcloud, interpolation='bilinear')
plt.title('Word Cloud for Ham Messages')
plt.axis('off')
plt.show()
```

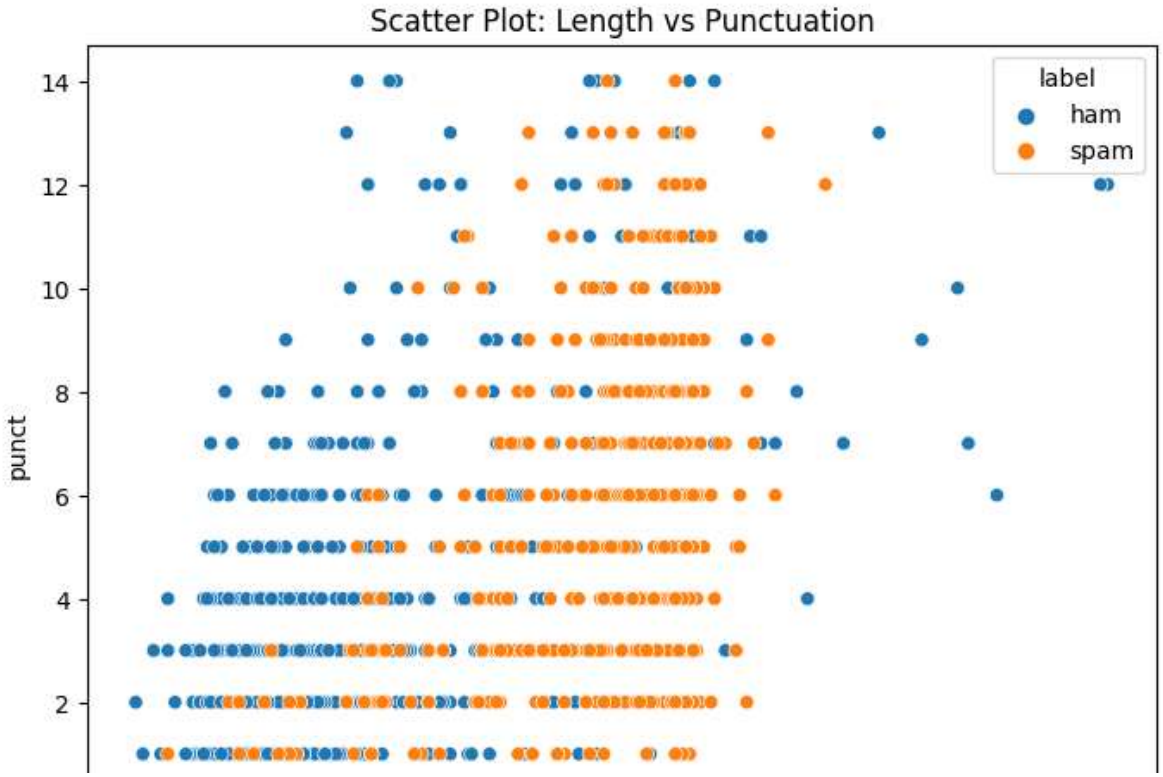

```
# Calculate the first and third quartiles (Q1 and Q3) and the interquartile range (IQR)
Q1 = data['length'].quantile(0.25)
Q3 = data['length'].quantile(0.75)
IQR = Q3 - Q1

# Define the lower and upper bounds to filter out outliers
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

# Filter out rows where 'length' is outside the bounds
data = data[(data['length'] >= lower_bound) & (data['length'] <= upper_bound)]

# Create a boxplot for the data without outliers
plt.figure(figsize=(5, 5))
sns.boxplot(x='label', y='length', data=data)
plt.title('Distribution of Length by Label (No Outliers)')
plt.show()
```



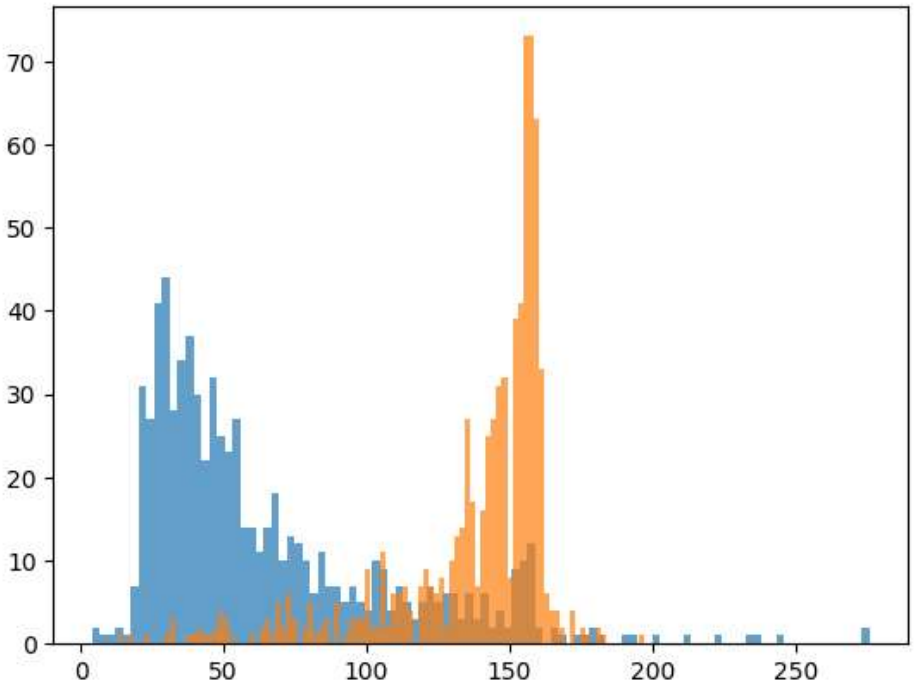
```
# Calculate the first and third quartiles (Q1 and Q3) and the interquartile range (IQR)
Q1 = data['punct'].quantile(0.25)
Q3 = data['punct'].quantile(0.75)
IQR = Q3 - Q1

# Define the lower and upper bounds to filter out outliers
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

# Filter out rows where 'punct' is outside the bounds
data = data[(data['punct'] >= lower_bound) & (data['punct'] <= upper_bound)]

# Create a boxplot for the data without outliers
plt.figure(figsize=(5, 6))
sns.boxplot(x='label', y='punct', data=data)
plt.title('Distribution of Punctuation by Label (No Outliers)')
plt.show()
```



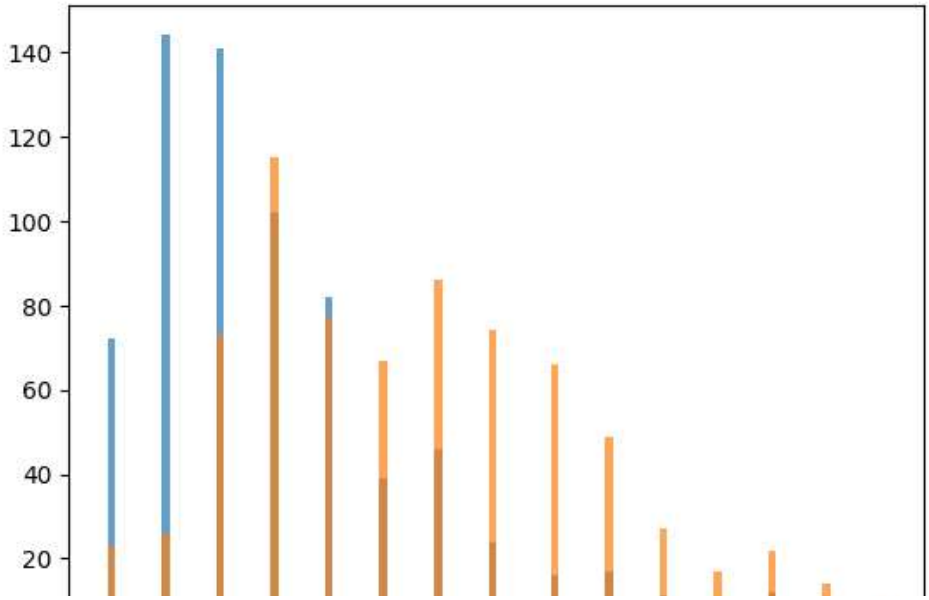

```
# Scatter plot for 'length' vs 'punctuation'
plt.figure(figsize=(8, 6))
sns.scatterplot(x='length', y='punct', hue='label', data=data)
plt.title('Scatter Plot: Length vs Punctuation')
plt.show()
```



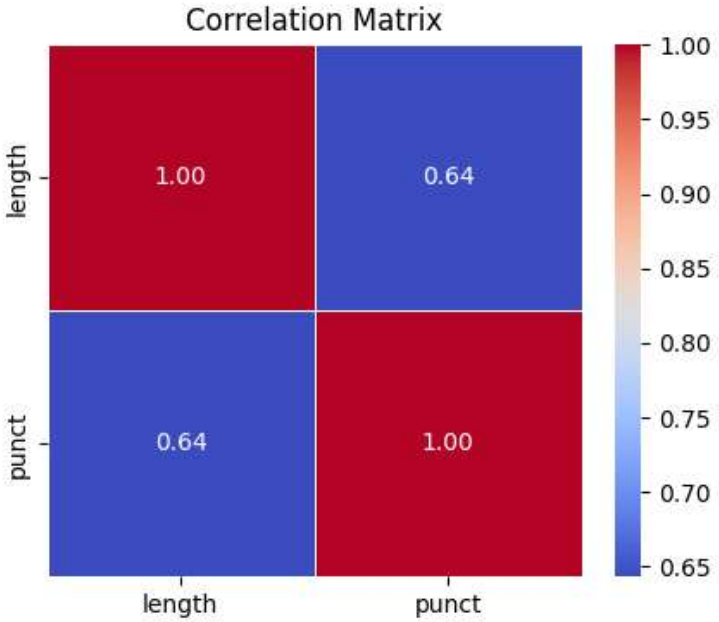

```
plt.hist(data[data['label'] == 'ham']['length'], bins = 100, alpha = 0.7)
plt.hist(data[data['label'] == 'spam']['length'], bins = 100, alpha = 0.7)
plt.show()
```




```
plt.hist(data[data['label'] == 'ham']['punct'], bins = 100, alpha = 0.7)
plt.hist(data[data['label'] == 'spam']['punct'], bins = 100, alpha = 0.7)
plt.show()
```




```
# Select numeric columns for correlation analysis
numeric_columns = ['length', 'punct']

# Create a subset DataFrame with numeric columns
numeric_df = df[numeric_columns]

# Calculate the correlation matrix
correlation_matrix = numeric_df.corr()

# Plot the heatmap for visualizing the correlation matrix
plt.figure(figsize=(5,4))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f", linewidths=.5)
plt.title('Correlation Matrix')
plt.show()
```




```
data
```

	label	message	length	punct
0	ham	(That said can you text him one more time?)	43	3
1	ham	Arms fine, how's Cardiff and uni?	34	3
2	ham	Ü v ma fan...	13	3
3	ham	hows my favourite person today? r u workin har...	101	4
4	ham	Can you let me know details of fri when u find...	104	3
...	...	...	...	...
1489	spam	Want explicit SEX in 30 secs? Ring 02073162414...	90	3
1490	spam	ASKED 3MOBILE IF 0870 CHATLINES INCLU IN FREE ...	158	5
1491	spam	Had your contract mobile 11 Mnths? Latest Moto...	160	8
1492	spam	REMINDER FROM O2: To get 2.50 pounds free call...	147	3
1493	spam	This is the 2nd time we have tried 2 contact u...	160	8

```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test =  train_test_split(data['message'], data['label'], test_size = 0.3, rando

1494 * 0.3

     448.2

X_train.shape

     (1025,)

X_test.shape

     (440,)
```

2) Building the Model (Random Forest)

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.ensemble import RandomForestClassifier

from sklearn.pipeline import Pipeline

#The TF-IDF (Term Frequency-Inverse Document Frequency) vectorizer is commonly used in natural language pro

#we use TfidfVectorizer to convert a collection of text documents into numerical features that can be used

# It allows you to assemble a series of data processing steps, including feature extraction, transformation
```

```
classifier = Pipeline([("tfidf", TfidfVectorizer()) , ("classifier", RandomForestClassifier(n_estimators=10
```

```
classifier.fit(X_train, y_train)
```

```
Pipeline(steps=[('tfidf', TfidfVectorizer()),
                ('classifier', RandomForestClassifier())])
```

Pipeline
TfidfVectorizer
TfidfVectorizer()
RandomForestClassifier
RandomForestClassifier()

3) Predicting the results (Random Forest)

```
y_pred = classifier.predict(X_test)
```

```
y_test, y_pred
```

```
(1016    spam
 451      ham
 766     spam
 674      ham
 32       ham
         ...
 1155    spam
 731      ham
 10       ham
 1055    spam
 711      ham
 Name: label, Length: 440, dtype: object,
 array(['spam', 'ham', 'spam', 'ham', 'ham', 'ham', 'ham', 'spam', 'spam',
        'ham', 'ham', 'ham', 'spam', 'spam', 'spam', 'ham', 'ham', 'spam',
        'ham', 'spam', 'spam', 'ham', 'ham', 'ham', 'ham', 'spam', 'spam',
        'spam', 'ham', 'ham', 'ham', 'ham', 'spam', 'spam', 'ham', 'ham',
        'spam', 'ham', 'ham', 'ham', 'ham', 'ham', 'spam', 'spam', 'ham',
        'spam', 'ham', 'spam', 'ham', 'ham', 'ham', 'ham', 'spam', 'ham',
        'spam', 'ham', 'ham', 'spam', 'ham', 'spam', 'spam', 'spam', 'ham',
        'ham', 'ham', 'spam', 'spam', 'ham', 'ham', 'ham', 'spam', 'ham',
        'ham', 'spam', 'ham', 'ham', 'ham', 'spam', 'spam', 'spam', 'spam',
        'spam', 'ham', 'ham', 'ham', 'spam', 'spam', 'spam', 'spam', 'ham',
        'ham', 'ham', 'spam', 'ham', 'ham', 'spam', 'ham', 'ham', 'ham',
        'spam', 'ham', 'ham', 'ham', 'ham', 'ham', 'spam', 'ham', 'ham',
        'spam', 'spam', 'ham', 'ham', 'ham', 'spam', 'spam', 'spam',
        'spam', 'ham', 'ham', 'ham', 'ham', 'spam', 'ham', 'ham', 'ham',
        'spam', 'ham', 'spam', 'ham', 'ham', 'ham', 'ham', 'ham', 'ham',
        'ham', 'spam', 'spam', 'spam', 'ham', 'ham', 'spam', 'spam',
        'spam', 'spam', 'ham', 'ham', 'ham', 'ham', 'ham', 'spam', 'spam',
        'spam', 'spam', 'spam', 'ham', 'ham', 'spam', 'ham', 'ham', 'spam',
        'ham', 'spam', 'spam', 'spam', 'ham', 'ham', 'spam', 'ham', 'spam',
        'spam', 'ham', 'spam', 'ham', 'spam', 'ham', 'ham', 'spam', 'ham',
        'spam', 'ham', 'ham', 'ham', 'ham', 'ham', 'spam', 'ham', 'spam',
        'spam', 'spam', 'ham', 'ham', 'spam', 'ham', 'spam', 'spam', 'ham',
        'spam', 'ham', 'spam', 'ham', 'ham', 'ham', 'ham', 'ham', 'ham',
        'ham', 'spam', 'ham', 'ham', 'spam', 'spam', 'spam', 'spam',
        'spam', 'spam', 'spam', 'spam', 'ham', 'spam', 'ham', 'ham',
```

```
       'spam', 'ham', 'ham', 'ham', 'spam', 'spam', 'ham', 'ham', 'ham',
       'ham', 'spam', 'ham', 'ham', 'ham', 'ham', 'spam', 'ham', 'spam',
       'ham', 'ham', 'ham', 'ham', 'spam', 'spam', 'spam', 'ham', 'ham',
       'ham', 'spam', 'ham', 'ham', 'spam', 'ham', 'spam', 'ham', 'ham',
       'spam', 'spam', 'spam', 'ham', 'ham', 'ham', 'ham', 'ham', 'ham',
       'ham', 'ham', 'ham', 'spam', 'spam', 'ham', 'ham', 'ham', 'spam',
       'spam', 'spam', 'spam', 'spam', 'ham', 'ham', 'spam', 'spam',
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       'ham', 'ham', 'spam', 'ham', 'spam', 'ham', 'ham', 'spam', 'ham',
       'spam', 'ham', 'ham', 'ham', 'ham', 'ham', 'ham', 'spam', 'ham',
       'ham', 'ham', 'ham', 'ham', 'ham', 'ham', 'ham', 'ham', 'ham',
       'ham', 'spam', 'spam', 'spam', 'ham', 'spam', 'spam', 'spam',
       'spam', 'ham', 'spam', 'spam', 'ham', 'ham', 'ham', 'spam', 'ham',
       'ham', 'ham', 'ham', 'spam', 'spam', 'ham', 'spam', 'ham', 'ham',
       'spam', 'spam', 'spam', 'ham', 'spam', 'spam', 'ham', 'ham',
       'spam', 'spam', 'ham', 'spam', 'ham', 'spam', 'ham', 'ham', 'ham',
       'ham', 'spam', 'spam', 'ham', 'ham', 'ham', 'spam', 'spam', 'ham',
       'spam', 'ham', 'spam', 'spam', 'spam', 'spam', 'spam', 'ham',
       'spam', 'ham', 'spam', 'spam', 'spam', 'spam', 'spam', 'ham',
       'ham', 'spam', 'ham', 'spam', 'spam', 'ham', 'ham', 'ham', 'spam',
       'spam', 'ham', 'spam', 'ham', 'spam', 'spam', 'ham', 'spam',
```

```
from sklearn.metrics import classification_report, accuracy_score, confusion_matrix
```

```
accuracy_score(y_test, y_pred)
```

```
0.95
```

```
0.9465478841870824 * 449 #Out of 449 we got 425 correct smaples right.
```

```
425.0
```

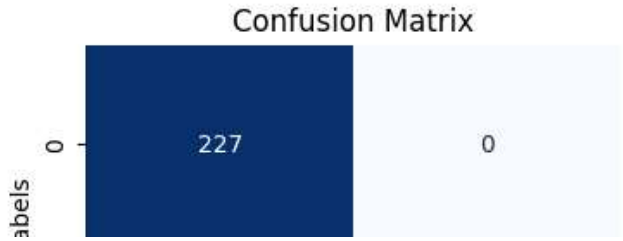
```
confusion_matrix(y_test, y_pred)
```

```
array([[227,   0],
       [ 22, 191]])
```

```
from sklearn.metrics import confusion_matrix
```

```
cm = confusion_matrix(y_test, y_pred)

# Display confusion matrix as a heatmap
plt.figure(figsize=(4, 3))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues", cbar=False)
plt.xlabel("Predicted Labels")
plt.ylabel("True Labels")
plt.title("Confusion Matrix")
plt.show()
```




```
print(classification_report(y_test, y_pred))
```

```
                  precision    recall  f1-score   support

             ham       0.91      1.00      0.95       227
            spam       1.00      0.90      0.95       213

        accuracy                           0.95       440
       macro avg       0.96      0.95      0.95       440
    weighted avg       0.95      0.95      0.95       440
```

4) Building the Model (SVM)

```
from sklearn.svm import SVC
```

```
svm = Pipeline([("tfidf", TfidfVectorizer()) , ("SVM", SVC(C = 100, gamma='auto'))])
```

```
svm.fit(X_train, y_train)
```

```
Pipeline(steps=[('tfidf', TfidfVectorizer()),
                ('SVM', SVC(C=100, gamma='auto'))])
```

5) Predicting the results (SVM)

```
y_pred = svm.predict(X_test)
```

```
accuracy_score(y_test, y_pred)
```

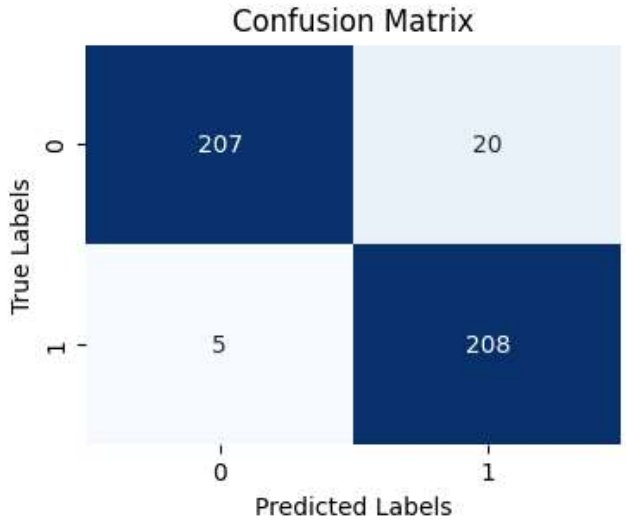
```
0.9431818181818182
```

```
confusion_matrix(y_test, y_pred)
```

```
array([[207,  20],
       [  5, 208]])
```

```
cm = confusion_matrix(y_test, y_pred)

# Display confusion matrix as a heatmap
plt.figure(figsize=(4, 3))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues", cbar=False)
plt.xlabel("Predicted Labels")
plt.ylabel("True Labels")
plt.title("Confusion Matrix")
plt.show()
```




```
print(classification_report(y_test, y_pred))
```

```
                  precision    recall  f1-score   support

             ham       0.98      0.91      0.94       227
            spam       0.91      0.98      0.94       213

        accuracy                           0.94       440
       macro avg       0.94      0.94      0.94       440
    weighted avg       0.95      0.94      0.94       440
```

Building the Model (GridSerach CV)

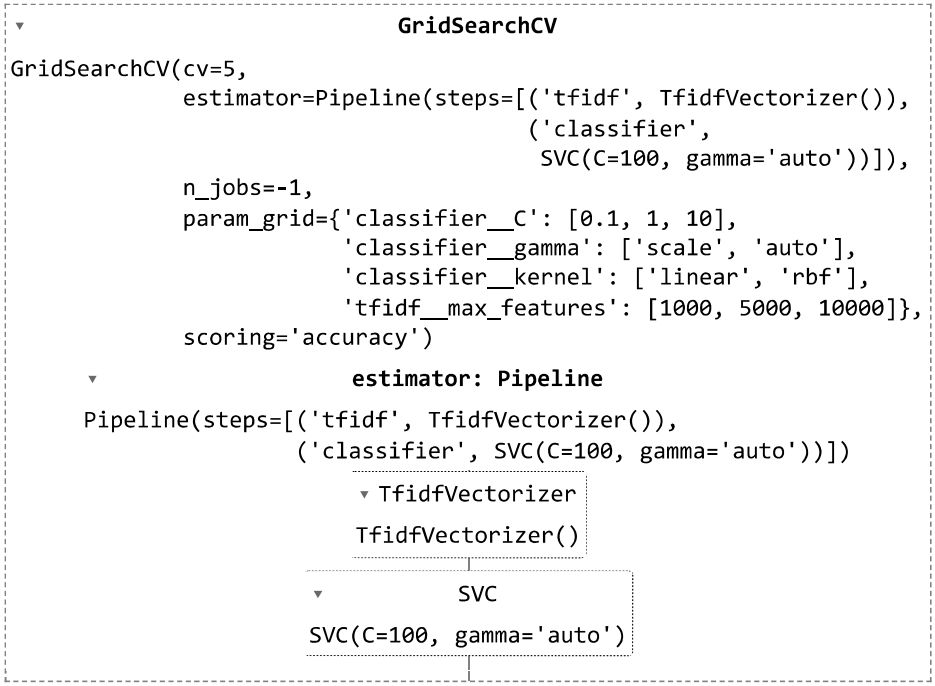
```
# Define the hyperparameter grid to search
param_grid = {
    'tfidf__max_features': [1000, 5000, 10000],  # Example TF-IDF hyperparameter
    'classifier__C': [0.1, 1, 10],
    'classifier__kernel': ['linear', 'rbf'],
    'classifier__gamma': ['scale', 'auto']
}
```

```
from sklearn.model_selection import GridSearchCV


# Create GridSearchCV object
grid_search = GridSearchCV(svm, param_grid, cv=5, scoring='accuracy', n_jobs=-1)



grid_search.fit(X_train, y_train)
```




```
# Get the best parameters and best estimator
best_params = grid_search.best_params_
best_model = grid_search.best_estimator_


# Print the best parameters
print("Best Parameters:")
print(best_params)
```

```
Best Parameters:
{'classifier__C': 1, 'classifier__gamma': 'scale', 'classifier__kernel': 'rbf', 'tfidf__max_features':
```

```
# Evaluate the best model on the test set
y_pred = best_model.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
print(f"Test Set Accuracy: {accuracy:.2f}")
```

```
Test Set Accuracy: 0.96
```

```
accuracy_score(y_test, y_pred)
```

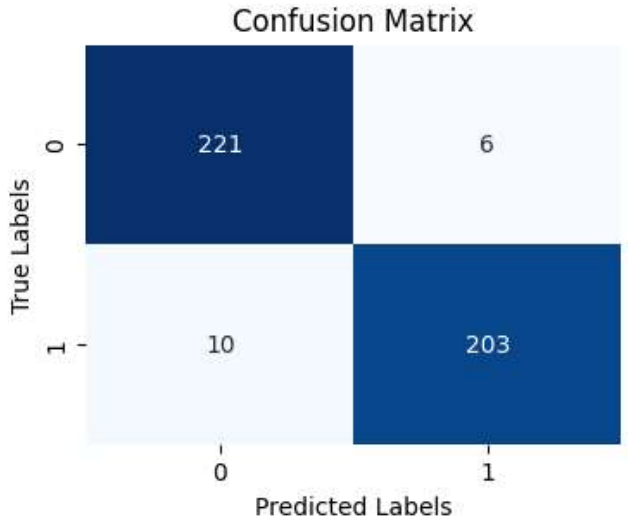
```
0.9636363636363636
```

```
confusion_matrix(y_test, y_pred)
```

```
array([[221,   6],
       [ 10, 203]])
```

```
cm = confusion_matrix(y_test, y_pred)

# Display confusion matrix as a heatmap
plt.figure(figsize=(4, 3))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues", cbar=False)
plt.xlabel("Predicted Labels")
plt.ylabel("True Labels")
plt.title("Confusion Matrix")
plt.show()
```




```
print(classification_report(y_test, y_pred))
```

```
                  precision    recall  f1-score   support

             ham       0.96      0.97      0.97       227
            spam       0.97      0.95      0.96       213

        accuracy                           0.96       440
       macro avg       0.96      0.96      0.96       440
    weighted avg       0.96      0.96      0.96       440
```

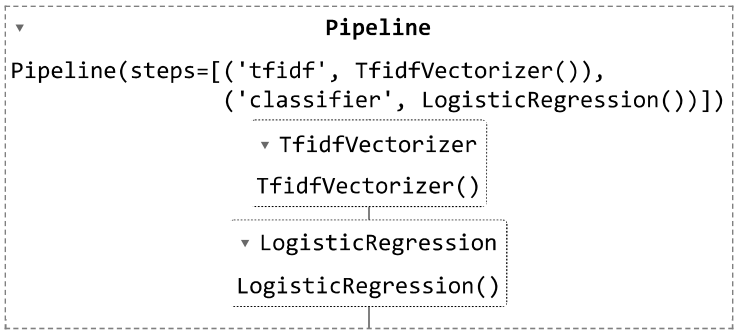
Building the Model (Logistic Regression)

```
from sklearn.linear_model import LogisticRegression
```

```
# Define the hyperparameter grid to search
param_grid = {
    'tfidf__max_features': [1000, 5000, 10000],  # Example TF-IDF hyperparameter
    'classifier__C': [0.1, 1, 10],
    'classifier__max_iter': [100, 200, 300]
}
```

```
logreg_pipeline = Pipeline([
    ('tfidf', TfidfVectorizer()),  # TF-IDF vectorization for text features
    ('classifier', LogisticRegression())  # Logistic Regression classifier
])


logreg_pipeline.fit(X_train, y_train)
```




```
# Make predictions on the test set
y_pred = logreg_pipeline.predict(X_test)


# Evaluate the model
accuracy = accuracy_score(y_test, y_pred)
print(f"Test Set Accuracy: {accuracy:.2f}")
```

```
Test Set Accuracy: 0.95
```

```
confusion_matrix(y_test, y_pred)
```

```
array([[215,  12],
       [  9, 204]])
```

```
cm = confusion_matrix(y_test, y_pred)

# Display confusion matrix as a heatmap
plt.figure(figsize=(4, 3))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues", cbar=False)
plt.xlabel("Predicted Labels")
plt.ylabel("True Labels")
plt.title("Confusion Matrix")
plt.show()
```


```
print(classification_report(y_test, y_pred))
```

```
                  precision    recall  f1-score   support

             ham       0.96      0.95      0.95       227
            spam       0.94      0.96      0.95       213

        accuracy                           0.95       440
       macro avg       0.95      0.95      0.95       440
    weighted avg       0.95      0.95      0.95       440
```

Testing all classifiers

```
test1 = ['Hello, You are learning natural Language Processing']
test2 = ['Hope you are doing good and learning new things !']
test3 = ['Congratulations, You won a lottery ticket worth $1 Million ! To claim call on 446677']
```

```
print(classifier.predict(test1))
print(classifier.predict(test2))
print(classifier.predict(test3))
```

```
['ham']
['ham']
['spam']
```

```
print(svm.predict(test1))
print(svm.predict(test2))
print(svm.predict(test3))
```

```
['ham']
['ham']
['spam']
```

```
print(grid_search.predict(test1))
print(grid_search.predict(test2))
print(grid_search.predict(test3))
```

```
['ham']
['ham']
['spam']
```