In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from collections import Counter
import plotly.express as px

from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier, GradientBoostingClassifier
from sklearn.naive_bayes import MultinomialNB, BernoulliNB
from sklearn.pipeline import Pipeline
from sklearn.metrics import confusion_matrix, classification_report, accuracy_score, precision_score, recall_score
```

In [2]:
```
df = pd.read_csv('spam.csv', encoding = 'LATIN-1')
df
```

Out[2]:

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
0	ham	Go until jurong point, crazy.. Available only ...	NaN	NaN	NaN
1	ham	Ok lar... Joking wif u oni...	NaN	NaN	NaN
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	NaN	NaN	NaN
3	ham	U dun say so early hor... U c already then say...	NaN	NaN	NaN
4	ham	Nah I don't think he goes to usf, he lives aro...	NaN	NaN	NaN
...	...	...	...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...	NaN	NaN	NaN
5568	ham	Will Ì_ b going to esplanade fr home?	NaN	NaN	NaN
5569	ham	Pity, * was in mood for that. So...any other s...	NaN	NaN	NaN
5570	ham	The guy did some bitching but I acted like i'd...	NaN	NaN	NaN
5571	ham	Rofl. Its true to its name	NaN	NaN	NaN

5572 rows × 5 columns

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5572 entries, 0 to 5571
Data columns (total 5 columns):
 #   Column      Non-Null Count  Dtype 
---  ------      --------------  ----- 
 0   v1          5572 non-null   object
 1   v2          5572 non-null   object
 2   Unnamed: 2  50 non-null     object
 3   Unnamed: 3  12 non-null     object
 4   Unnamed: 4  6 non-null      object
dtypes: object(5)
memory usage: 217.8+ KB
```

In [4]:
```
df.drop(columns=['Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'], inplace=True)
df.head()
```

Out[4]:

	v1	v2
0	ham	Go until jurong point, crazy.. Available only ...
1	ham	Ok lar... Joking wif u oni...
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...
3	ham	U dun say so early hor... U c already then say...
4	ham	Nah I don't think he goes to usf, he lives aro...

In [5]:
```
df.rename(columns={'v1': 'label', 'v2': 'text'}, inplace=True)
df.head()
```

Out[5]:

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

In [6]:
```
label_map = {'ham': 0, 'spam': 1}
df['label'] = df['label'].map(lambda x: label_map[x])
df.head()
```

Out[6]:

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

In [7]:
```
df.isnull().sum()
```

Out[7]:
```
label    0
text     0
dtype: int64
```

In [8]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5572 entries, 0 to 5571
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype 
---  ------  --------------  ----- 
 0   label   5572 non-null   int64 
 1   text    5572 non-null   object
dtypes: int64(1), object(1)
memory usage: 87.2+ KB
```

In [9]:
```
df.shape
```

Out[9]:
```
(5572, 2)
```

In [10]:
```
df.label.value_counts()
```

Out[10]:
```
label
0    4825
1     747
Name: count, dtype: int64
```

In [11]:
```
df.text.nunique()
```

Out[11]:
```
5169
```

In [12]:
```
df.duplicated().sum()
```

Out[12]:
```
403
```

In [13]:
```
print(df[df.duplicated(keep=False)])
```

```
     label                                               text
2        1  Free entry in 2 a wkly comp to win FA Cup fina...
7        0  As per your request 'Melle Melle (Oru Minnamin...
8        1  WINNER!! As a valued network customer you have...
9        1  Had your mobile 11 months or more? U R entitle...
11       1  SIX chances to win CASH! From 100 to 20,000 po...
...    ...                                                ...
5524     1  You are awarded a SiPix Digital Camera! call 0...
5535     0  I know you are thinkin malaria. But relax, chi...
5539     0                        Just sleeping..and surfing
5553     0                       Hahaha..use your brain dear
5558     0                            Sorry, I'll call later

[684 rows x 2 columns]
```

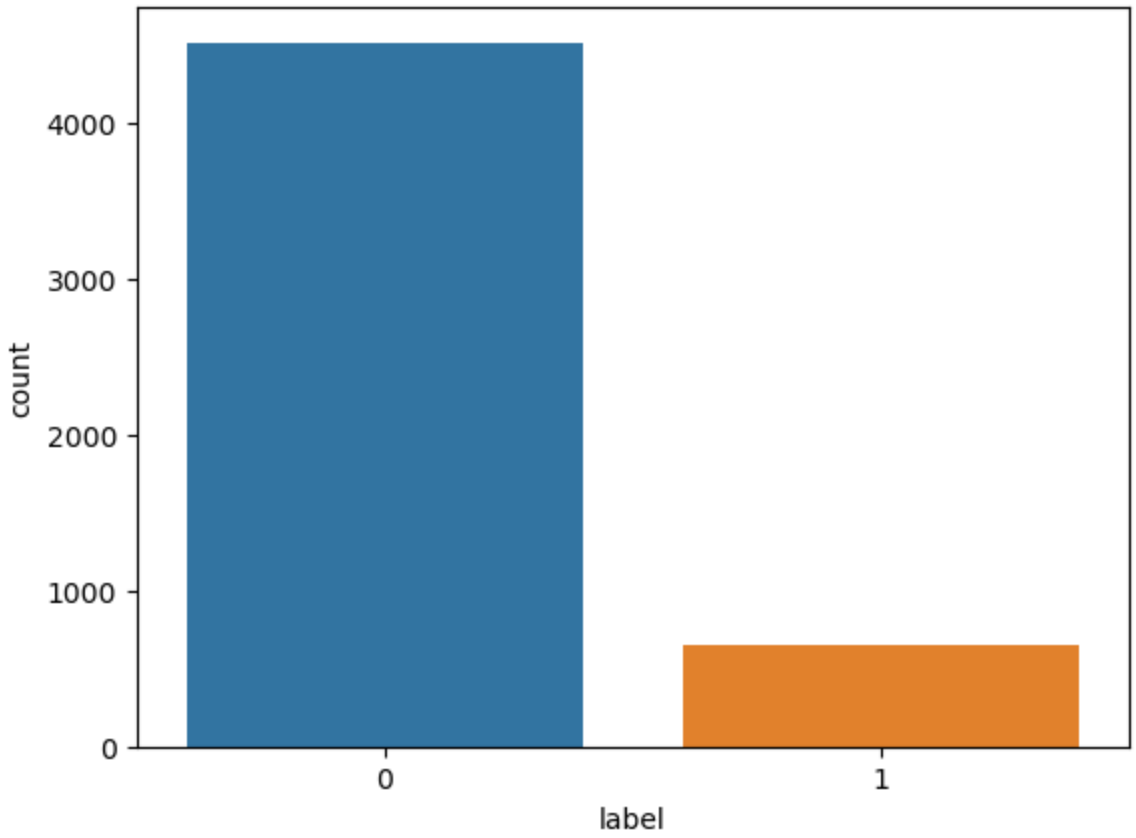
In [14]:
```
df = df.drop_duplicates(keep='first')
df.duplicated().sum()
```

Out[14]:
```
0
```

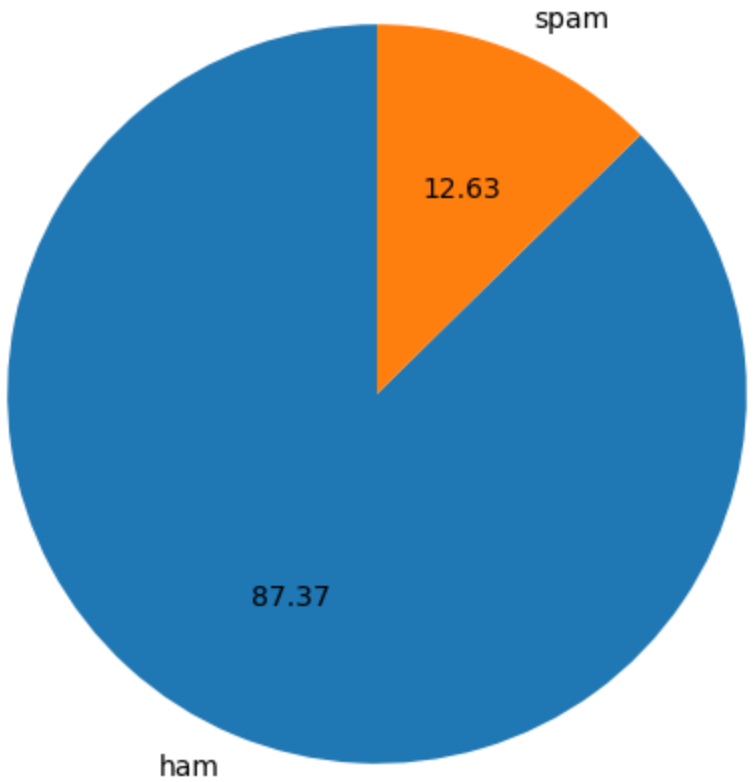
In [15]:
```
df.shape
```

Out[15]:
```
(5169, 2)
```

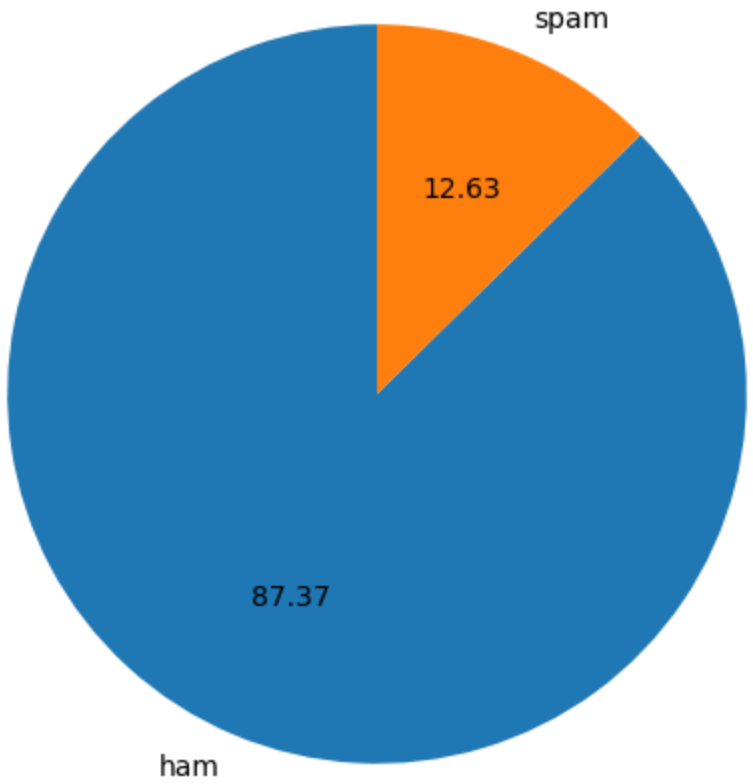
In [16]:
```
sns.countplot(x='label', data=df)
plt.show()
```



In [17]:
```
plt.figure(figsize=(10, 6))
plt.pie(df['label'].value_counts(), labels=['ham', 'spam'], autopct="%1.2f", startangle=90)
plt.show()
```



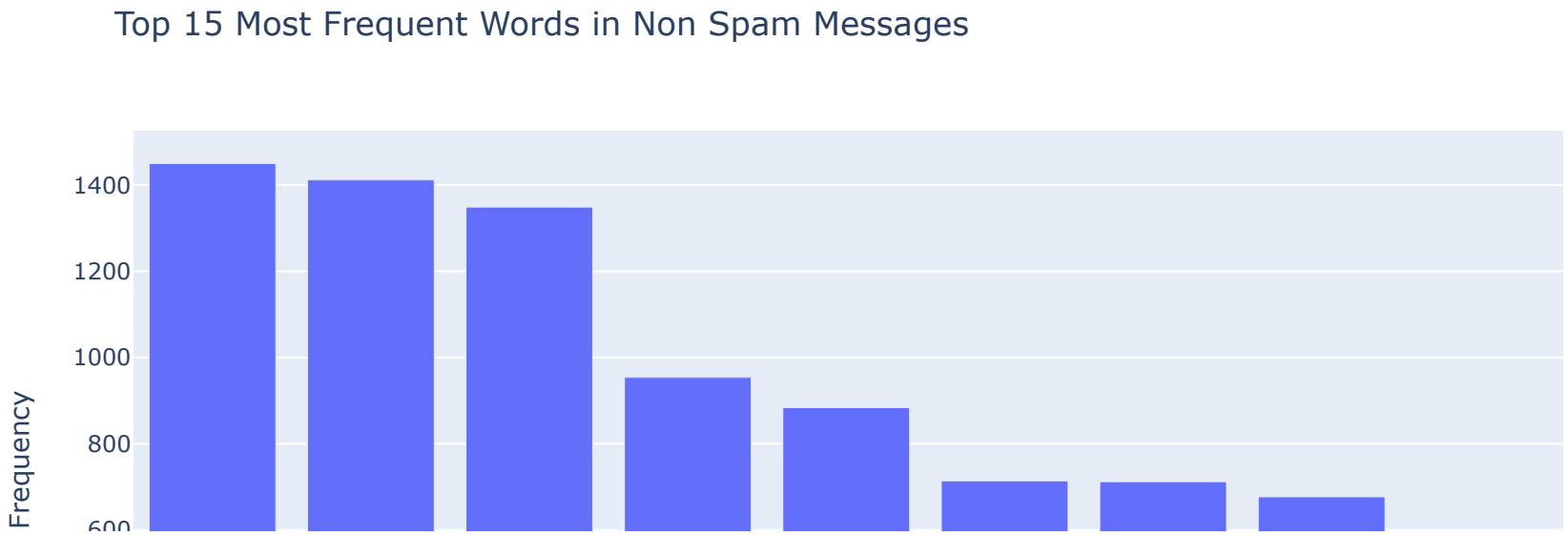
In [18]:
```
plt.figure(figsize=(10, 6))
plt.pie(df['label'].value_counts(), labels=['ham', 'spam'], autopct="%1.2f", startangle=90)
plt.show()
```



In [19]:
```
ham_words = ' '.join(df.query('label == 0')['text']).split()

word_counts = Counter(ham_words)
word_counts_df = pd.DataFrame(word_counts.most_common(15), columns=['Word', 'Frequency'])

# Plot
px.bar(word_counts_df, x='Word', y='Frequency', title='Top 15 Most Frequent Words in Non Spam Messages')
```

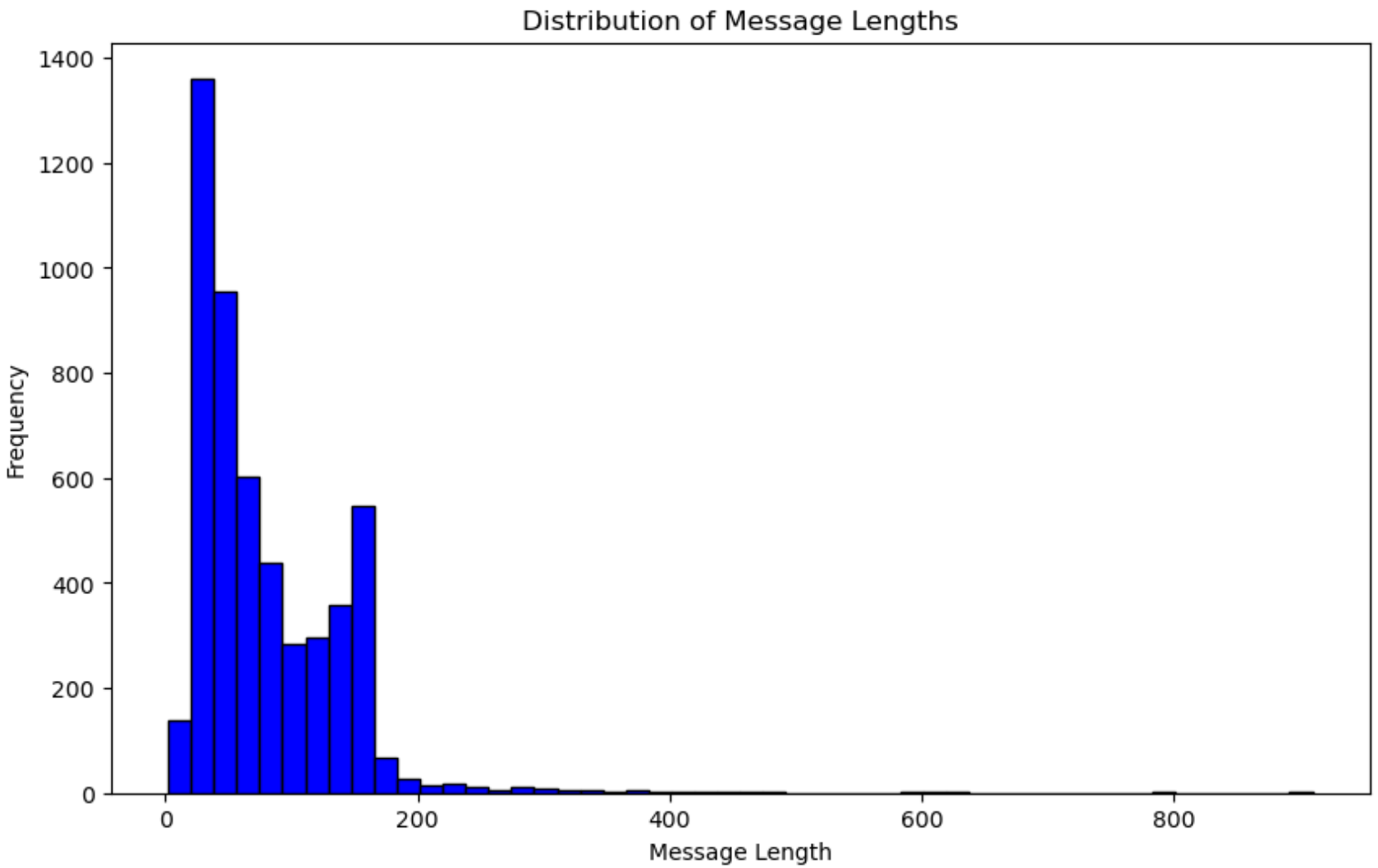


In [20]:
```
import warnings
warnings.filterwarnings('ignore')

# Calculate the length of each message
df['message_length'] = df['text'].apply(len)

# Plot the distribution of message lengths
plt.figure(figsize=(10, 6))
plt.hist(df['message_length'], bins=50, color='blue', edgecolor='black')
plt.title('Distribution of Message Lengths')
```

```
plt.xlabel('Message Length')
plt.ylabel('Frequency')
plt.show()
```



In [21]:
```
X = df['text']
y = df['label']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

In [22]:
```
X.shape
```

Out[22]: (5169,)

In [23]:
```
from sklearn.feature_extraction.text import TfidfVectorizer
tfidf = TfidfVectorizer()
X_train = tfidf.fit_transform(X_train)
X_test = tfidf.transform(X_test)
```

In [ ]:
```
from sklearn.model_selection import cross_val_score

models = [
    ('LogisticRegression', LogisticRegression()),
    ('SVC', SVC()),
    ('DecisionTreeClassifier', DecisionTreeClassifier()),
    ('RandomForestClassifier', RandomForestClassifier()),
    ('AdaBoostClassifier', AdaBoostClassifier()),
    ('GradientBoostingClassifier', GradientBoostingClassifier()),
    ('MultinomialNB', MultinomialNB()),
    ('BernoulliNB', BernoulliNB())
]

best_model = None
best_accuracy = 0
# Iterate over the models and evaluate their performance
for name, model in models:
    # Create a pipeline for each model
    pipeline = Pipeline([
        ('model', model)
    ])

    # Perform cross-validation

    scores = cross_val_score(pipeline, X_train, y_train, cv=5)

    # Calculate mean accuracy
    mean_accuracy = scores.mean()

    # Fit the pipeline on the training data
    pipeline.fit(X_train, y_train)
```

```
    # Make predictions on the test data
    y_pred = pipeline.predict(X_test)

    # Calculate accuracy score
    accuracy = accuracy_score(y_test, y_pred)

    # Print the performance metrics
    print("Model:", name)
    print("Cross-validation Accuracy:", mean_accuracy)
    print("Test Accuracy:", accuracy)
    print()

    # Check if the current model has the best accuracy
    if accuracy > best_accuracy:
        best_accuracy = accuracy
        best_model = pipeline


import pickle
pickle.dump(best_model, open('email_spam_classifier.pkl', 'wb'))
print("------------------------------------------------------------")
print(f"Best model: {name} with accuracy score: {best_accuracy}")
```

```
Model: LogisticRegression
Cross-validation Accuracy: 0.9496977025392986
Test Accuracy: 0.9680851063829787

Model: SVC
Cross-validation Accuracy: 0.969528415961306
Test Accuracy: 0.9845261121856866

Model: DecisionTreeClassifier
Cross-validation Accuracy: 0.9613059250302298
Test Accuracy: 0.9555125725338491

Model: RandomForestClassifier
Cross-validation Accuracy: 0.9726723095525998
Test Accuracy: 0.9796905222437138

Model: AdaBoostClassifier
Cross-validation Accuracy: 0.9668681983071343
Test Accuracy: 0.9729206963249516
```

In [ ]:
```
model = pickle.load(open('email_spam_classifier.pkl', 'rb'))
```

In [ ]:
```
def inference(message):
    message = tfidf.transform(message)[0]
    pred = best_model.predict(message)
    if pred == 0:
        print('This is a ham message')
    else:
        print('This is a spam message')
```

In [30]:
```
new_data = ["Don't forget about the team lunch tomorrow at 1 PM. See you there!"]
inference(new_data)

new_data = ["Congratulations! You have won 1,000,000. Claim your prize now!"]
inference(new_data)
```

```
This is a ham message
This is a spam message
```