In [1]:
```python
import numpy as np
import pandas as pd
import warnings
import os
os.chdir("C:\\Users\\kumar\\OneDrive\\Desktop\\Machine Learning")
def warn(*args, **kwargs):
    pass
warnings.warn = warn
```

In [2]:
```python
df = pd.read_csv("spam.csv", encoding='ISO-8859-1')
df.head()
```

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 |

In [3]:
```python
len(df)
```

Out[3]:
```
5572
```

In [4]:
```python
df.isnull().sum()
```

Out[4]:
```
v1               0
v2               0
Unnamed: 2    5522
Unnamed: 3    5560
Unnamed: 4    5566
dtype: int64
```

In [5]:
```python
df = df[['v1', 'v2']]
df.head()
```

Out[5]:

| | 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 [6]:
```python
blanks = []
for i, v1, v2 in df.itertuples():
    if type(v2) == str and v2.isspace():
        blanks.append(i)
if len(blanks) > 0:
    print(f'There are len(blanks) empty space strings in the dataset')
    df.drop(blanks, inplace=True)
```

In [7]:
```python
df.nunique()
```

```
Out[7]: v1       2
        v2    5169
        dtype: int64
```

```
In [8]: df['v1'].value_counts()
```

```
Out[8]: ham     4825
        spam     747
        Name: v1, dtype: int64
```

```
In [9]: from scipy import stats

        df['v2_length'] = df['v2'].apply(len)

        hams = df[df['v1'] == 'ham']['v2_length']
        spams = df[df['v1'] == 'spam']['v2_length']

        t_stat, p_value = stats.ttest_ind(hams, spams)

        alpha = 0.05

        if p_value < alpha:
            print('The difference in sms lengths are significance')
        else:
            print('The difference in sms lengths are not significance')

        print(f'T-Stat: {t_stat}')
        print(f'P-Value: {p_value}')
```

```
The difference in sms lengths are significance
T-Stat: -31.350650338992136
P-Value: 7.702078585492358e-199
```

```
In [10]: X = df['v2']
         y = df['v1']
         display(X, y)
```

```
0       Go until jurong point, crazy.. Available only ...
1                           Ok lar... Joking wif u oni...
2       Free entry in 2 a wkly comp to win FA Cup fina...
3       U dun say so early hor... U c already then say...
4       Nah I don't think he goes to usf, he lives aro...
                              ...                        
5567    This is the 2nd time we have tried 2 contact u...
5568                Will Ì_ b going to esplanade fr home?
5569    Pity, * was in mood for that. So...any other s...
5570    The guy did some bitching but I acted like i'd...
5571                           Rofl. Its true to its name
Name: v2, Length: 5572, dtype: object
0        ham
1        ham
2       spam
3        ham
4        ham
        ... 
5567    spam
5568     ham
5569     ham
5570     ham
5571     ham
Name: v1, Length: 5572, dtype: object
```

```
In [11]: from sklearn.preprocessing import LabelEncoder

         le = LabelEncoder()
```

```python
y = le.fit_transform(y)

display(y)
```

```
array([0, 0, 1, ..., 0, 0, 0])
```

In [12]:
```python
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_sta
```

In [13]:
```python
from sklearn.pipeline import Pipeline
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.svm import LinearSVC
```

In [14]:
```python
from sklearn.model_selection import GridSearchCV

pipeline = Pipeline([('tfidf', TfidfVectorizer()), ('classifier', LinearSVC())])

grid_params_svm = {
    'tfidf__ngram_range': [(1,1), (1,2)],
    'tfidf__stop_words': [None, 'english'],
    'classifier__C': [0.01, 0.1, 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 10.0],
}

model_svm = GridSearchCV(pipeline, grid_params_svm, cv=5, scoring='accuracy')

model_svm.fit(X_train, y_train)
```

Out[14]:
```
GridSearchCV(cv=5,
             estimator=Pipeline(steps=[('tfidf', TfidfVectorizer()),
                                       ('classifier', LinearSVC())]),
             param_grid={'classifier__C': [0.01, 0.1, 0.5, 1.0, 1.5, 2.0, 2.5,
                                           5.0, 10.0],
                         'tfidf__ngram_range': [(1, 1), (1, 2)],
                         'tfidf__stop_words': [None, 'english']},
             scoring='accuracy')
```

In [15]:
```python
from sklearn.naive_bayes import MultinomialNB

pipeline = Pipeline([('tfidf', TfidfVectorizer()), ('classifier', MultinomialNB())

grid_params_nb = {
    'tfidf__ngram_range': [(1,1), (1,2)],
    'tfidf__stop_words': [None, 'english'],
    'classifier__alpha': [0.01, 0.1, 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 10.0]
}

model_nb = GridSearchCV(pipeline, grid_params_nb, cv=5, scoring='accuracy')

model_nb.fit(X_train, y_train)
```

Out[15]:
```
GridSearchCV(cv=5,
             estimator=Pipeline(steps=[('tfidf', TfidfVectorizer()),
                                       ('classifier', MultinomialNB())]),
             param_grid={'classifier__alpha': [0.01, 0.1, 0.5, 1.0, 1.5, 2.0,
                                               2.5, 5.0, 10.0],
                         'tfidf__ngram_range': [(1, 1), (1, 2)],
                         'tfidf__stop_words': [None, 'english']},
             scoring='accuracy')
```

In [16]:
```python
def show_metrics(y_true, y_pred, grid_search=None):
    from sklearn.metrics import (classification_report,
                                 confusion_matrix,
                                 ConfusionMatrixDisplay)
    print('-' * 20)
    print(classification_report(y_true, y_pred))
    print(confusion_matrix(y_true, y_pred))

    if grid_search:
        print('-' * 20)
        print(grid_search.best_params_)
```

In [17]:

```
best_svm = model_svm.best_estimator_
y_pred_svm = best_svm.predict(X_test)

show_metrics(y_test, y_pred_svm, model_svm)
```

```
--------------------
              precision    recall  f1-score   support

           0       0.99      1.00      0.99      1464
           1       0.97      0.93      0.95       208

    accuracy                           0.99      1672
   macro avg       0.98      0.96      0.97      1672
weighted avg       0.99      0.99      0.99      1672

[[1458    6]
 [  14  194]]
--------------------
{'classifier__C': 10.0, 'tfidf__ngram_range': (1, 2), 'tfidf__stop_words': None}
```

In [18]:

```
best_nb = model_nb.best_estimator_
y_pred_nb = best_nb.predict(X_test)

show_metrics(y_test, y_pred_nb, model_nb)
```

```
--------------------
              precision    recall  f1-score   support

           0       0.99      0.99      0.99      1464
           1       0.96      0.92      0.94       208

    accuracy                           0.99      1672
   macro avg       0.97      0.96      0.97      1672
weighted avg       0.99      0.99      0.99      1672

[[1456    8]
 [  16  192]]
--------------------
{'classifier__alpha': 0.01, 'tfidf__ngram_range': (1, 2), 'tfidf__stop_words': Non
e}
```

In [19]:

```
def save_model(model, prefix=''):
    import joblib
    from datetime import datetime

    # Get the current date and time as a string to define the file name
    current_datetime = datetime.now().strftime("%Y-%m-%d_%H-%M-%S")
    filename = f"{prefix}model_{current_datetime}.joblib"

    joblib.dump(model, filename)

    print(f"Model saved to {filename}")
```

In [20]:

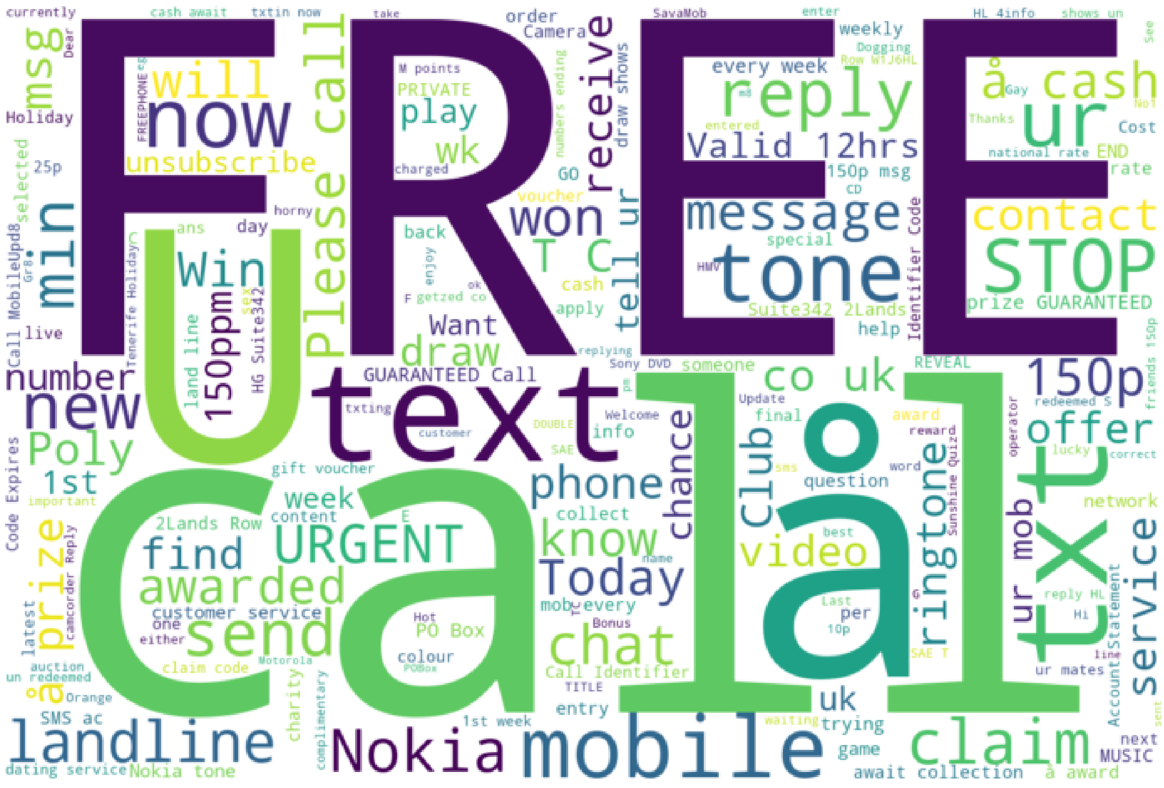
```
save_model(model_svm, prefix='svm_')
save_model(model_nb, prefix='nb_')
```

```
Model saved to svm_model_2023-09-27_19-36-01.joblib
Model saved to nb_model_2023-09-27_19-36-01.joblib
```

In [21]:

```python
import matplotlib.pyplot as plt
from wordcloud import WordCloud
df_results = pd.DataFrame({'message': X_test, 'label': y_pred_svm})
spam_messages = df_results[df_results['label'] == 1]['message']
spam_text = " ".join(spam_messages)
wordcloud = WordCloud(width=1200, height=800, background_color='white').generate(sp
plt.figure(figsize=(10, 6))
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.title("Word Cloud for Spam Messages")
plt.show()
```

Word Cloud for Spam Messages



In [ ]: