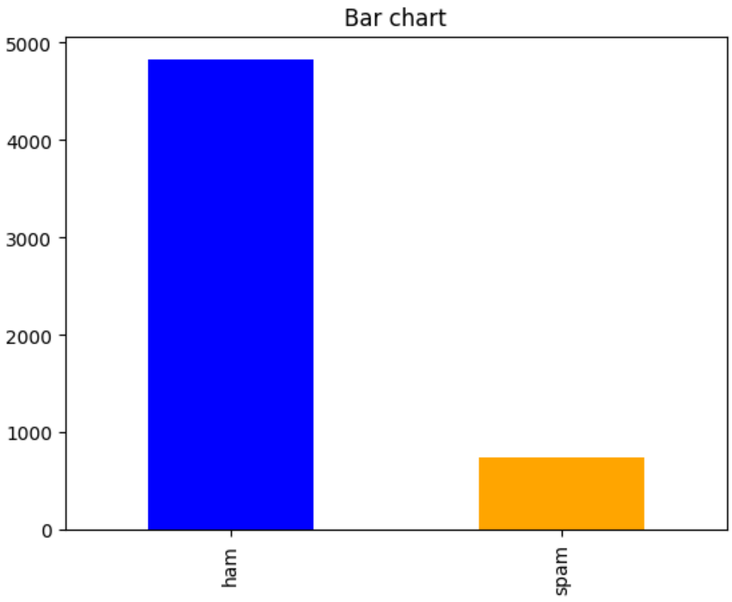
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from collections import Counter
from sklearn import feature_extraction, model_selection, naive_bayes, metrics, svm
from IPython.display import Image
import warnings
warnings.filterwarnings("ignore")
%matplotlib inline
```

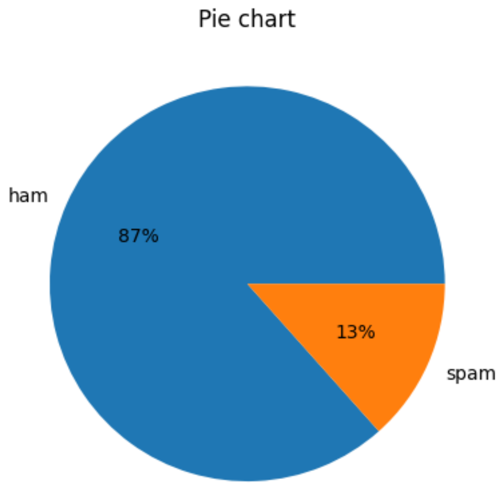
```
data = pd.read_csv('/content/archive.zip', encoding='latin-1')
data.head(n=10)
```

	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
5	spam	FreeMsg Hey there darling it's been 3 week's n...	NaN	NaN	NaN
6	ham	Even my brother is not like to speak with me. ...	NaN	NaN	NaN
		As per your request 'Melle Melle (Oru			

```
count_Class=pd.value_counts(data["v1"], sort= True)
count_Class.plot(kind= 'bar', color= ["blue", "orange"])
plt.title('Bar chart')
plt.show()
```

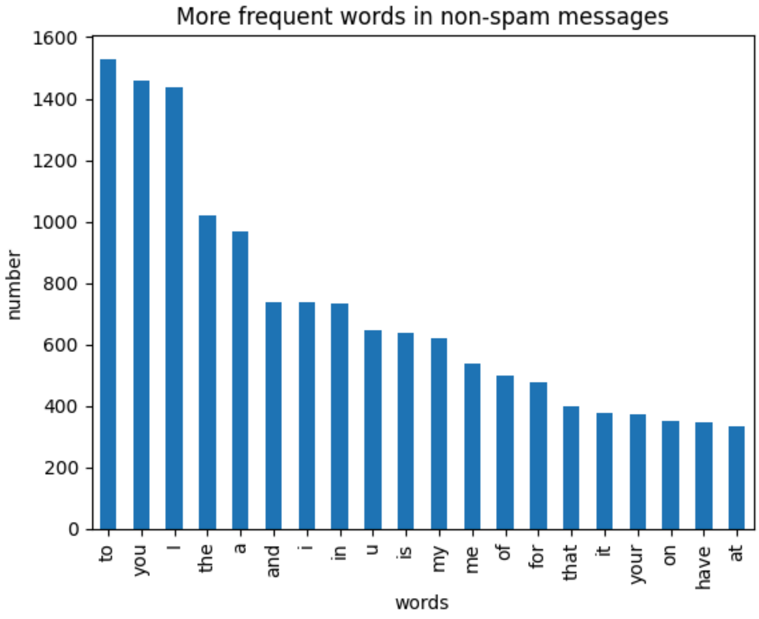


```
count_Class.plot(kind = 'pie',  autopct='%1.0f%%')
plt.title('Pie chart')
plt.ylabel('')
plt.show()
```

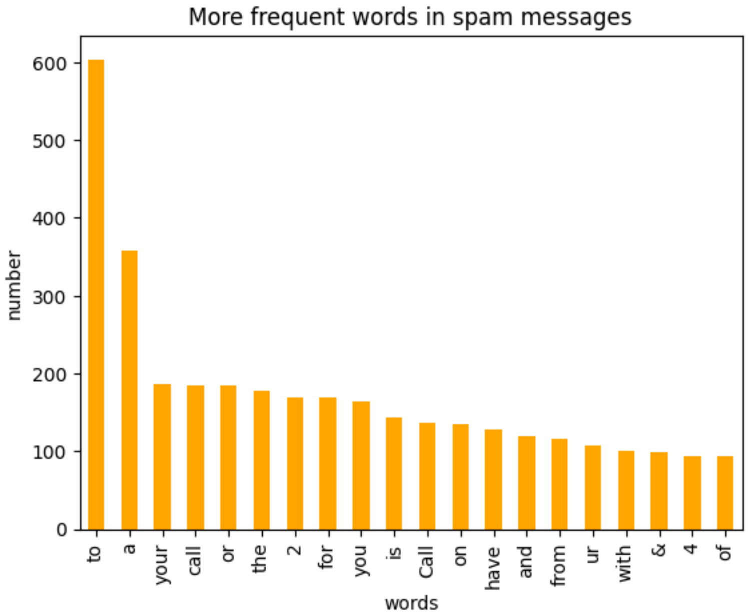


```
count1 = Counter(" ".join(data[data['v1']=='ham']["v2"]).split()).most_common(20)
df1 = pd.DataFrame.from_dict(count1)
df1 = df1.rename(columns={0: "words in non-spam", 1 : "count"})
count2 = Counter(" ".join(data[data['v1']=='spam']["v2"]).split()).most_common(20)
df2 = pd.DataFrame.from_dict(count2)
df2 = df2.rename(columns={0: "words in spam", 1 : "count_"})
```

```
df1.plot.bar(legend = False)
y_pos = np.arange(len(df1["words in non-spam"]))
plt.xticks(y_pos, df1["words in non-spam"])
plt.title('More frequent words in non-spam messages')
plt.xlabel('words')
plt.ylabel('number')
plt.show()
```



```
df2.plot.bar(legend = False, color = 'orange')
y_pos = np.arange(len(df2["words in spam"]))
plt.xticks(y_pos, df2["words in spam"])
plt.title('More frequent words in spam messages')
plt.xlabel('words')
plt.ylabel('number')
plt.show()
```



```
f = feature_extraction.text.CountVectorizer(stop_words = 'english')
X = f.fit_transform(data["v2"])
np.shape(X)
```

```
(5572, 8404)
```

```
data["v1"]=data["v1"].map({'spam':1,'ham':0})
X_train, X_test, y_train, y_test = model_selection.train_test_split(X, data['v1'], test_size=0.33, random_state=42)
print([np.shape(X_train), np.shape(X_test)])
```

```
[(3733, 8404), (1839, 8404)]
```

```
list_alpha = np.arange(1/100000, 20, 0.11)
score_train = np.zeros(len(list_alpha))
score_test = np.zeros(len(list_alpha))
recall_test = np.zeros(len(list_alpha))
precision_test= np.zeros(len(list_alpha))
count = 0
for alpha in list_alpha:
    bayes = naive_bayes.MultinomialNB(alpha=alpha)
    bayes.fit(X_train, y_train)
    score_train[count] = bayes.score(X_train, y_train)
    score_test[count]= bayes.score(X_test, y_test)
    recall_test[count] = metrics.recall_score(y_test, bayes.predict(X_test))
    precision_test[count] = metrics.precision_score(y_test, bayes.predict(X_test))
    count = count + 1
```

```
matrix = np.matrix(np.c_[list_alpha, score_train, score_test, recall_test, precision_test])
models = pd.DataFrame(data = matrix, columns =
             ['alpha', 'Train Accuracy', 'Test Accuracy', 'Test Recall', 'Test Precision'])
models.head(n=10)
```

	alpha	Train Accuracy	Test Accuracy	Test Recall	Test Precision
0	0.00001	0.998661	0.974443	0.920635	0.895753
1	0.11001	0.997857	0.976074	0.936508	0.893939
2	0.22001	0.997857	0.977162	0.936508	0.900763
3	0.33001	0.997589	0.977162	0.936508	0.900763
4	0.44001	0.997053	0.977162	0.936508	0.900763
5	0.55001	0.996250	0.976618	0.936508	0.897338
6	0.66001	0.996518	0.976074	0.932540	0.896947
7	0.77001	0.996518	0.976074	0.924603	0.903101
8	0.88001	0.996250	0.976074	0.924603	0.903101
9	0.99001	0.995982	0.976074	0.920635	0.906250

```
best_index = models['Test Precision'].idxmax()
models.iloc[best_index, :]
```

```
alpha             15.730010
Train Accuracy     0.979641
Test Accuracy      0.969549
Test Recall        0.777778
Test Precision     1.000000
Name: 143, dtype: float64
```

```
models[models['Test Precision']==1].head(n=5)
```

	alpha	Train Accuracy	Test Accuracy	Test Recall	Test Precision
143	15.73001	0.979641	0.969549	0.777778	1.0
144	15.84001	0.979641	0.969549	0.777778	1.0
145	15.95001	0.979641	0.969549	0.777778	1.0
146	16.06001	0.979373	0.969549	0.777778	1.0
147	16.17001	0.979373	0.969549	0.777778	1.0

```
best_index = models[models['Test Precision']==1]['Test Accuracy'].idxmax()
bayes = naive_bayes.MultinomialNB(alpha=list_alpha[best_index])
bayes.fit(X_train, y_train)
models.iloc[best_index, :]
```

```
alpha             15.730010
Train Accuracy     0.979641
Test Accuracy      0.969549
Test Recall        0.777778
Test Precision     1.000000
Name: 143, dtype: float64
```

```
m_confusion_test = metrics.confusion_matrix(y_test, bayes.predict(X_test))
pd.DataFrame(data = m_confusion_test, columns = ['Predicted 0', 'Predicted 1'],
            index = ['Actual 0', 'Actual 1'])
```

	Predicted 0	Predicted 1
Actual 0	1587	0
Actual 1	56	196

```
list_C = np.arange(500, 2000, 100) #100000
score_train = np.zeros(len(list_C))
score_test = np.zeros(len(list_C))
recall_test = np.zeros(len(list_C))
precision_test= np.zeros(len(list_C))
count = 0
for C in list_C:
    svc = svm.SVC(C=C)
    svc.fit(X_train, y_train)
    score_train[count] = svc.score(X_train, y_train)
    score_test[count]= svc.score(X_test, y_test)
    recall_test[count] = metrics.recall_score(y_test, svc.predict(X_test))
    precision_test[count] = metrics.precision_score(y_test, svc.predict(X_test))
    count = count + 1
```

```
matrix = np.matrix(np.c_[list_C, score_train, score_test, recall_test, precision_test])
models = pd.DataFrame(data = matrix, columns =
             ['C', 'Train Accuracy', 'Test Accuracy', 'Test Recall', 'Test Precision'])
models.head(n=10)
```

	C	Train Accuracy	Test Accuracy	Test Recall	Test Precision
0	500.0	1.0	0.979337	0.853175	0.99537
1	600.0	1.0	0.979337	0.853175	0.99537
2	700.0	1.0	0.979337	0.853175	0.99537
3	800.0	1.0	0.979337	0.853175	0.99537
4	900.0	1.0	0.979337	0.853175	0.99537
5	1000.0	1.0	0.979337	0.853175	0.99537
6	1100.0	1.0	0.979337	0.853175	0.99537
7	1200.0	1.0	0.979337	0.853175	0.99537
8	1300.0	1.0	0.979337	0.853175	0.99537
9	1400.0	1.0	0.979337	0.853175	0.99537

```
best_index = models['Test Precision'].idxmax()
models.iloc[best_index, :]
```

```
C                 500.000000
Train Accuracy      1.000000
Test Accuracy       0.979337
Test Recall         0.853175
Test Precision      0.995370
Name: 0, dtype: float64
```