```
import pandas as pd
import numpy as np
import re
import seaborn as sns
import matplotlib.pyplot as plt
from matplotlib import style
style.use('ggplot')
from textblob import TextBlob
from nltk.tokenize import word_tokenize
from nltk.stem import PorterStemmer
from nltk.corpus import stopwords
stop_words = set(stopwords.words('english'))
from wordcloud import WordCloud
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix, ConfusionMatrixDisplay
```

```
df = pd.read_csv('vaccination_tweets.csv')
```

```
df.head()
```

	id	user_name	user_location	user_description	user_created	user_followers	user_friends	user_favourites	user_v
0	1340539111971516416	Rachel Roh	La Crescenta-Montrose, CA	Aggregator of Asian American news; scanning di...	2009-04-08 17:52:46	405	1692	3247	
1	1338158543359250433	Albert Fong	San Francisco, CA	Marketing dude, tech geek, heavy metal & '80s ...	2009-09-21 15:27:30	834	666	178	
2	1337858199140118533	eli ʟᴛᴇᴜ ✌	Your Bed	heil, hydra 🖐 ☺	2020-06-25 23:30:28	10	88	155	
3	1337855739918835717	Charles Adler	Vancouver, BC - Canada	Hosting "CharlesAdlerTonight" Global News Radi...	2008-09-10 11:28:53	49165	3933	21853	
4	1337854064604966912	Citizen News Channel	NaN	Citizen News Channel bringing you an alternati...	2020-04-23 17:58:42	152	580	1473	

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 11020 entries, 0 to 11019
Data columns (total 16 columns):
 #   Column            Non-Null Count  Dtype 
---  ------            --------------  ----- 
 0   id                11020 non-null  int64 
 1   user_name         11020 non-null  object
 2   user_location     8750 non-null   object
 3   user_description  10341 non-null  object
 4   user_created      11020 non-null  object
 5   user_followers    11020 non-null  int64 
 6   user_friends      11020 non-null  int64 
 7   user_favourites   11020 non-null  int64 
 8   user_verified     11020 non-null  bool  
 9   date              11020 non-null  object
 10  text              11020 non-null  object
 11  hashtags          8438 non-null   object
 12  source            11019 non-null  object
 13  retweets          11020 non-null  int64 
 14  favorites         11020 non-null  int64 
 15  is_retweet        11020 non-null  bool  
dtypes: bool(2), int64(6), object(8)
memory usage: 1.2+ MB
```

```
df.isnull().sum()
```

```
id                    0
user_name             0
user_location      2270
user_description    679
user_created          0
user_followers        0
user_friends          0
user_favourites       0
user_verified         0
date                  0
text                  0
hashtags           2582
source                1
retweets              0
favorites             0
is_retweet            0
dtype: int64
```

```
df.columns
```

```
Index(['id', 'user_name', 'user_location', 'user_description', 'user_created',
       'user_followers', 'user_friends', 'user_favourites', 'user_verified',
       'date', 'text', 'hashtags', 'source', 'retweets', 'favorites',
       'is_retweet'],
      dtype='object')
```

```
text_df = df.drop(['id', 'user_name', 'user_location', 'user_description', 'user_created',
       'user_followers', 'user_friends', 'user_favourites', 'user_verified',
       'date', 'hashtags', 'source', 'retweets', 'favorites',
       'is_retweet'], axis=1)
text_df.head()
```

	text
0	Same folks said daikon paste could treat a cyt...
1	While the world has been on the wrong side of ...
2	#coronavirus #SputnikV #AstraZeneca #PfizerBio...
3	Facts are immutable, Senator, even when you're...
4	Explain to me again why we need a vaccine @Bor...

```
print(text_df['text'].iloc[0],"\n")
print(text_df['text'].iloc[1],"\n")
print(text_df['text'].iloc[2],"\n")
print(text_df['text'].iloc[3],"\n")
print(text_df['text'].iloc[4],"\n")
```

```
Same folks said daikon paste could treat a cytokine storm #PfizerBioNTech https://t.co/xeHhIMg1kF

While the world has been on the wrong side of history this year, hopefully, the biggest vaccination effort we've ev… https://t.co/dlCHr2

#coronavirus #SputnikV #AstraZeneca #PfizerBioNTech #Moderna #Covid_19 Russian vaccine is created to last 2-4 years… https://t.co/ieYlCk

Facts are immutable, Senator, even when you're not ethically sturdy enough to acknowledge them. (1) You were born i… https://t.co/jqgV18

Explain to me again why we need a vaccine @BorisJohnson @MattHancock #whereareallthesickpeople #PfizerBioNTech… https://t.co/KxbSRoBEHq
```

```
text_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 11020 entries, 0 to 11019
Data columns (total 1 columns):
 #   Column  Non-Null Count  Dtype 
---  ------  --------------  ----- 
 0   text    11020 non-null  object
dtypes: object(1)
memory usage: 86.2+ KB
```

```
def data_processing(text):
    text = text.lower()
    text = re.sub(r"https\S+|www\S+https\S+", '',text, flags=re.MULTILINE)
    text = re.sub(r'\@w+|\#','',text)
    text = re.sub(r'[^\w\s]','',text)
    text_tokens = word_tokenize(text)
    filtered_text = [w for w in text_tokens if not w in stop_words]
    return " ".join(filtered_text)


text_df.text = text_df['text'].apply(data_processing)


text_df = text_df.drop_duplicates('text')


stemmer = PorterStemmer()
def stemming(data):
    text = [stemmer.stem(word) for word in data]
    return data


text_df['text'] = text_df['text'].apply(lambda x: stemming(x))


text_df.head()
```

	text
0	folks said daikon paste could treat cytokine s...
1	world wrong side history year hopefully bigges...
2	coronavirus sputnikv astrazeneca pfizerbiontec...
3	facts immutable senator even youre ethically s...
4	explain need vaccine borisjohnson matthancock ...

```
print(text_df['text'].iloc[0],"\n")
print(text_df['text'].iloc[1],"\n")
print(text_df['text'].iloc[2],"\n")
print(text_df['text'].iloc[3],"\n")
print(text_df['text'].iloc[4],"\n")
```

```
folks said daikon paste could treat cytokine storm pfizerbiontech

world wrong side history year hopefully biggest vaccination effort weve ev

coronavirus sputnikv astrazeneca pfizerbiontech moderna covid_19 russian vaccine created last 24 years

facts immutable senator even youre ethically sturdy enough acknowledge 1 born

explain need vaccine borisjohnson matthancock whereareallthesickpeople pfizerbiontech
```

```
text_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 10543 entries, 0 to 11019
Data columns (total 1 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   text    10543 non-null  object
dtypes: object(1)
memory usage: 164.7+ KB
```

```
def polarity(text):
    return TextBlob(text).sentiment.polarity


text_df['polarity'] = text_df['text'].apply(polarity)


text_df.head(10)
```

	text	polarity
0	folks said daikon paste could treat cytokine s...	0.000
1	world wrong side history year hopefully bigges...	-0.500
2	coronavirus sputnikv astrazeneca pfizerbiontec...	0.000
3	facts immutable senator even youre ethically s...	0.100
4	explain need vaccine borisjohnson matthancock ...	0.000
5	anyone useful adviceguidance whether covid vac...	0.400
6	bit sad claim fame success vaccination patriot...	-0.100
7	many bright days 2020 best 1 bidenharris winni...	0.675
8	covid vaccine getting covidvaccine covid19 pfi...	0.000
9	covidvaccine states start getting covid19vacci...	0.000

```
def sentiment(label):
    if label <0:
        return "Negative"
    elif label ==0:
        return "Neutral"
    elif label>0:
        return "Positive"
```

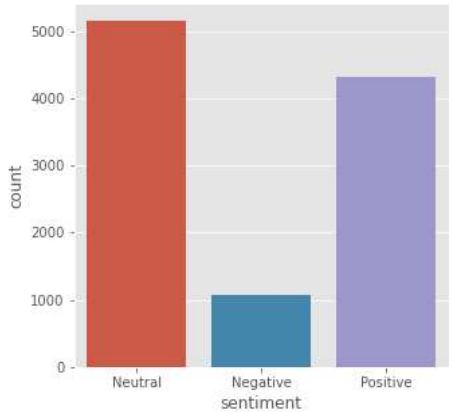
```
text_df['sentiment'] = text_df['polarity'].apply(sentiment)
```

```
text_df.head()
```

	text	polarity	sentiment
0	folks said daikon paste could treat cytokine s...	0.0	Neutral
1	world wrong side history year hopefully bigges...	-0.5	Negative
2	coronavirus sputnikv astrazeneca pfizerbiontec...	0.0	Neutral
3	facts immutable senator even youre ethically s...	0.1	Positive
4	explain need vaccine borisjohnson matthancock ...	0.0	Neutral

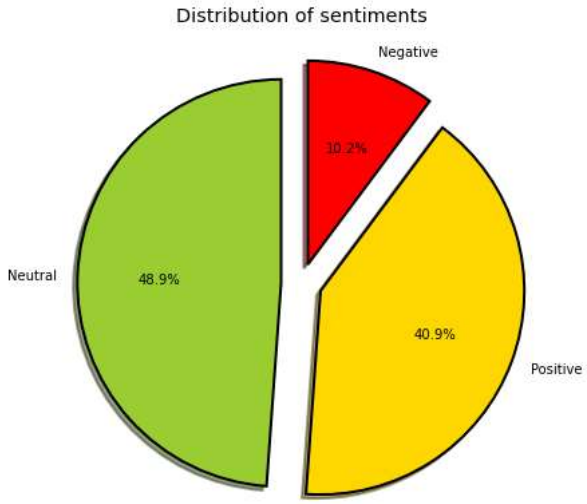
```
fig = plt.figure(figsize=(5,5))
sns.countplot(x='sentiment', data = text_df)
```

```
<AxesSubplot:xlabel='sentiment', ylabel='count'>
```




```
fig = plt.figure(figsize=(7,7))
colors = ("yellowgreen", "gold", "red")
wp = {'linewidth':2, 'edgecolor':"black"}
tags = text_df['sentiment'].value_counts()
explode = (0.1,0.1,0.1)
tags.plot(kind='pie', autopct='%1.1f%%', shadow=True, colors = colors,
          startangle=90, wedgeprops = wp, explode = explode, label='')
plt.title('Distribution of sentiments')
```

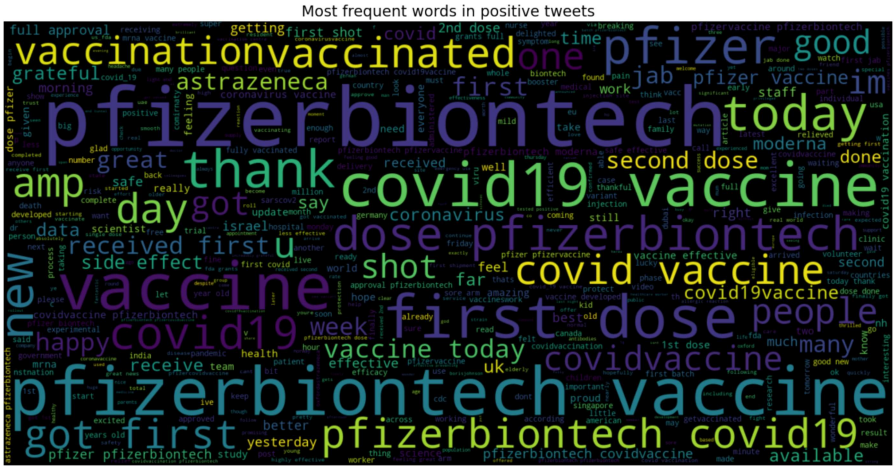
```
Text(0.5, 1.0, 'Distribution of sentiments')
```




```
pos_tweets = text_df[text_df.sentiment == 'Positive']
pos_tweets = pos_tweets.sort_values(['polarity'], ascending= False)
pos_tweets.head()
```

	text	polarity	sentiment
9317	best way get merrygoround pfizer pfizerbiontec...	1.0	Positive
2340	applying emotion pfizerbiontech based best evi...	1.0	Positive
6295	pfizer jab morning efficient wellorganised tha...	1.0	Positive
5041	get art printed awesome products support redbu...	1.0	Positive
1055	already vaccinated getting vaccine soon plan t...	1.0	Positive

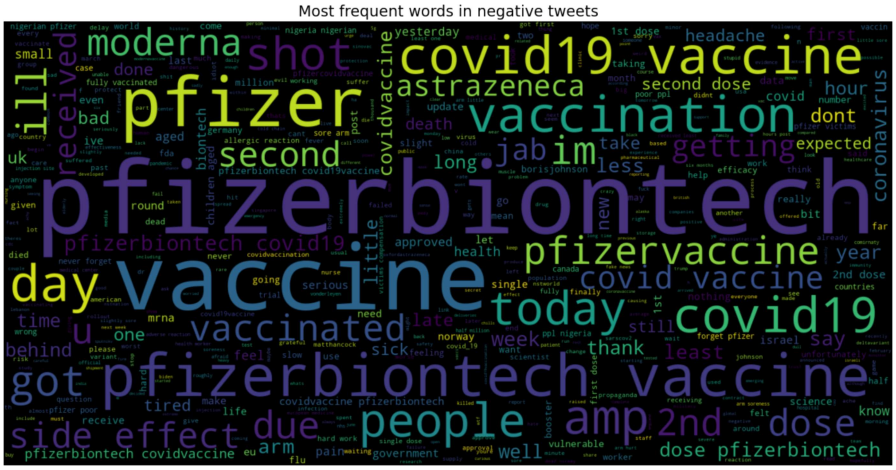
```
text = ' '.join([word for word in pos_tweets['text']])
plt.figure(figsize=(20,15), facecolor='None')
wordcloud = WordCloud(max_words=500, width=1600, height=800).generate(text)
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.title('Most frequent words in positive tweets', fontsize=19)
plt.show()
```




```
neg_tweets = text_df[text_df.sentiment == 'Negative']
neg_tweets = neg_tweets.sort_values(['polarity'], ascending= False)
neg_tweets.head()
```

	text	polarity	sentiment
2912	work skilled nursing facility got first vaccin...	-0.003333	Negative
7256	200321 752308 vaccinations new daily record da...	-0.003409	Negative
2073	ukgovernment cant even vaccinate properly ethi...	-0.004762	Negative
7715	got first dose less waiting time airport vacci...	-0.005556	Negative
7157	nas_k27 second dose due end next month well fa...	-0.006250	Negative

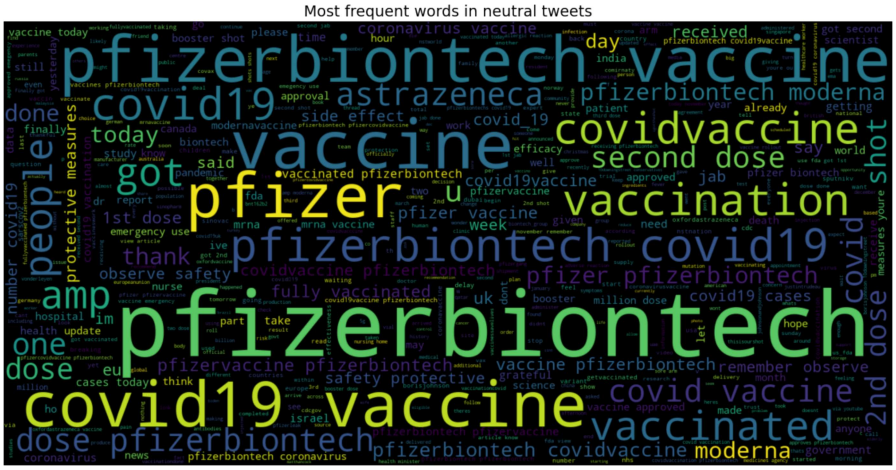
```
text = ' '.join([word for word in neg_tweets['text']])
plt.figure(figsize=(20,15), facecolor='None')
wordcloud = WordCloud(max_words=500, width=1600, height=800).generate(text)
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.title('Most frequent words in negative tweets', fontsize=19)
plt.show()
```




```
neutral_tweets = text_df[text_df.sentiment == 'Neutral']
neutral_tweets = neutral_tweets.sort_values(['polarity'], ascending= False)
neutral_tweets.head()
```

	text	polarity	sentiment
0	folks said daikon paste could treat cytokine s...	0.0	Neutral
7347	anyone else feel like framing vaccine card pfi...	0.0	Neutral
7458	looking forward getting second pfizer shot any...	0.0	Neutral
7454	never thought id running diff vaccine modernav...	0.0	Neutral
7453	john___m dont get choose one person know asked...	0.0	Neutral

```
text = ' '.join([word for word in neutral_tweets['text']])
plt.figure(figsize=(20,15), facecolor='None')
wordcloud = WordCloud(max_words=500, width=1600, height=800).generate(text)
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.title('Most frequent words in neutral tweets', fontsize=19)
plt.show()
```




```
vect = CountVectorizer(ngram_range=(1,2)).fit(text_df['text'])


feature_names = vect.get_feature_names()
print("Number of features: {}\n".format(len(feature_names)))
print("First 20 features:\n {}".format(feature_names[:20]))
```

```
Number of features: 78583

First 20 features:
 ['000', '000 doses', '000 initial', '000 people', '000 vaccines', '0000001', '0000001 covid19', '0011', '0011 abt', '004', '004 covid',
```

```
X = text_df['text']
Y = text_df['sentiment']
X = vect.transform(X)


x_train, x_test, y_train, y_test = train_test_split(X, Y, test_size=0.2, random_state=42)


print("Size of x_train:", (x_train.shape))
print("Size of y_train:", (y_train.shape))
print("Size of x_test:", (x_test.shape))
print("Size of y_test:", (y_test.shape))
```

```
Size of x_train: (8434, 78583)
Size of y_train: (8434,)
Size of x_test: (2109, 78583)
Size of y_test: (2109,)
```

```
import warnings
warnings.filterwarnings('ignore')


logreg = LogisticRegression()
logreg.fit(x_train, y_train)
logreg_pred = logreg.predict(x_test)
logreg_acc = accuracy_score(logreg_pred, y_test)
print("Test accuracy: {:.2f}%".format(logreg_acc*100))
```

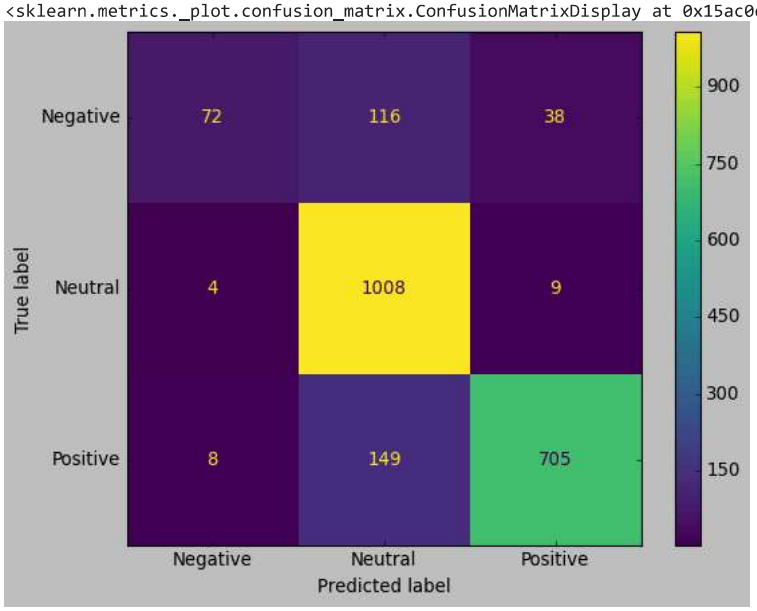
```
Test accuracy: 84.64%
```

```
print(confusion_matrix(y_test, logreg_pred))
print("\n")
print(classification_report(y_test, logreg_pred))
```

```
[[  72  116   38]
 [   4 1008    9]
 [   8  149  705]]


              precision    recall  f1-score   support

    Negative       0.86      0.32      0.46       226
     Neutral       0.79      0.99      0.88      1021
    Positive       0.94      0.82      0.87       862

    accuracy                           0.85      2109
   macro avg       0.86      0.71      0.74      2109
weighted avg       0.86      0.85      0.83      2109
```

```
style.use('classic')
cm = confusion_matrix(y_test, logreg_pred, labels=logreg.classes_)
disp = ConfusionMatrixDisplay(confusion_matrix = cm, display_labels=logreg.classes_)
disp.plot()
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x15ac0e79190>
```




```
from sklearn.model_selection import GridSearchCV
```

```
param_grid={'C':[0.001, 0.01, 0.1, 1, 10]}
grid = GridSearchCV(LogisticRegression(), param_grid)
grid.fit(x_train, y_train)
```

```
GridSearchCV(estimator=LogisticRegression(),
             param_grid={'C': [0.001, 0.01, 0.1, 1, 10]})
```

```
print("Best parameters:", grid.best_params_)
```

```
Best parameters: {'C': 10}
```

```
y_pred = grid.predict(x_test)
```

```
logreg_acc = accuracy_score(y_pred, y_test)
print("Test accuracy: {:.2f}%".format(logreg_acc*100))
```

```
Test accuracy: 85.92%
```

```
print(confusion_matrix(y_test, y_pred))
print("\n")
print(classification_report(y_test, y_pred))
```

```
[[  84  104   38]
 [   4 1008    9]
 [  10  132  720]]


                precision    recall  f1-score   support

      Negative       0.86      0.37      0.52       226
       Neutral       0.81      0.99      0.89      1021
      Positive       0.94      0.84      0.88       862

      accuracy                           0.86      2109
     macro avg       0.87      0.73      0.76      2109
  weighted avg       0.87      0.86      0.85      2109
```

```
from sklearn.svm import LinearSVC


SVCmodel = LinearSVC()
SVCmodel.fit(x_train, y_train)
```

```
LinearSVC()
```

```
svc_pred = SVCmodel.predict(x_test)
svc_acc = accuracy_score(svc_pred, y_test)
print("test accuracy: {:.2f}%".format(svc_acc*100))
```

```
test accuracy: 87.34%
```

```
print(confusion_matrix(y_test, svc_pred))
print("\n")
print(classification_report(y_test, svc_pred))
```

```
[[ 101   91   34]
 [   6 1007    8]
 [  14  114  734]]


                precision    recall  f1-score   support

      Negative       0.83      0.45      0.58       226
       Neutral       0.83      0.99      0.90      1021
      Positive       0.95      0.85      0.90       862

      accuracy                           0.87      2109
     macro avg       0.87      0.76      0.79      2109
  weighted avg       0.88      0.87      0.87      2109
```

```
grid = {
    'C':[0.01, 0.1, 1, 10],
    'kernel':["linear","poly","rbf","sigmoid"],
    'degree':[1,3,5,7],
    'gamma':[0.01,1]
}
grid = GridSearchCV(SVCmodel, param_grid)
grid.fit(x_train, y_train)
```

```
GridSearchCV(estimator=LinearSVC(), param_grid={'C': [0.001, 0.01, 0.1, 1, 10]})
```

```
print("Best parameter:", grid.best_params_)
```